Reasons Governing the Adoption and Denial of TickITplus
A Survey

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ABSTRACT

Context. Software Process Improvement (SPI) initiatives like Capability Maturity Model (CMM), Capability Maturity Model Integration (CMMI), Bootstrap etc., have been developed on the primary agenda of continuous software process improvement. Similarly, about two decades ago, the United Kingdom Accreditation Services (UKAS) have laid down a set of guidelines based on the ISO quality standards for providing certification to organizations named TickIT. TickIT is now obsolete with its successor scheme TickITplus taking up its place with a lot of significant additions. All the companies which were certified based on TickIT guidelines (more than 1000 companies) were asked to move to TickITplus in order to keep their TickIT certification. However, until now it has been three years since the inception of TickITplus and only 70 companies have adopted TickITplus. This is way below relative to the number of TickIT certified organizations. The present thesis is done in order to find the factors why most of the companies have not adopted TickITplus and also why the 70 organizations have moved to TickITplus.

Objectives In this study, an attempt has been made to accomplish the following objectives: Identifying the changes that have been brought about in the new scheme. The factors that a software organization looks into while adopting or migrating to a new software quality certification scheme are identified. Validate these factors with the help of survey and interviews. Analyze the results of survey and interviews to provide the reasons why most of the organizations haven’t adopted TickITplus certification scheme.

Methods. This research is done by using a mixed method approach by incorporating both quantitative and qualitative research methods. An online survey is conducted with the help of an online questionnaire as part of the quantitative leg. Two survey questionnaires have been framed to gather responses. With respect to the qualitative research method interviews are conducted to get a wider understanding about the factors that led an organization to migrate or not to migrate to TickITplus. The gathered data is analyzed using statistical methods like bivariate and univariate analysis for the quantitative method and thematic coding has been applied for the qualitative method. Triangulation method is used to validate the data obtained by correlating the results from the survey and interviews with those extracted from the literature review.

Results. Results pertaining to the reasons why companies have moved to and also why other companies haven’t taken up TickITplus have been gathered from the survey and interviews. It was identified that high costs and low customer demand were the main reasons for the organizations not to choose TickITplus while among the organizations which have moved to TickITplus have also chosen the scheme based on customer requirement. However, few other reasons apart from these have also been identified which are presented in this document

Conclusions. Conclusions have been drawn citing the importance of costs incurred for implementing TickITplus as a reason for not selecting TickITplus as it was considered very expensive. Among other reasons customer requirement was also low which was identified as a factor for the relatively low number of TickITplus certified organizations. On the other hand, among the TickITplus certified firms, customer demand forms the prominent reason for moving to TickITplus and lack of appropriate people to take up the work was considered as an important hindrance while implementing TickITplus. Several other reasons and challenges have also been identified which are clearly detailed in the document.

Keywords: TickITplus, TickIT, Software Process Improvement.
# Table of Contents

ABSTRACT .......................................................................................................................... 3

LIST OF FIGURES.................................................................................................................. 6

LIST OF TABLES..................................................................................................................... 7

1 INTRODUCTION .................................................................................................................. 8
   1.1 INTRODUCTION ............................................................................................................. 8
   1.2 PROBLEM DESCRIPTION .............................................................................................. 9
   1.3 AIMS AND OBJECTIVES ............................................................................................. 10
   1.4 RESEARCH QUESTIONS .............................................................................................. 10
   1.5 EXPECTED OUTCOMES ............................................................................................. 11
   1.6 STRUCTURE OF THE THESIS .................................................................................. 11

2 RESEARCH APPROACH ..................................................................................................... 13
   2.1 MIXED METHOD APPROACH ..................................................................................... 13
      2.1.1 How and Why Mixed Method Approach? ............................................................. 13
   2.2 QUANTITATIVE RESEARCH METHOD: SURVEY .................................................. 14
      2.2.1 Why Online Survey? ............................................................................................ 14
      2.2.2 Survey Objectives ............................................................................................... 14
      2.2.3 Implementing the Survey .................................................................................. 15
   2.3 QUALITATIVE RESEARCH APPROACH .................................................................. 18
      2.3.1 Literature Review: ............................................................................................... 18
      2.3.2 Implementing the Interviews .............................................................................. 18

3 LITERATURE REVIEW ...................................................................................................... 20
   3.1 SOFTWARE PROCESS IMPROVEMENT AND STANDARDS .................................. 20
   3.2 FACTORS CONSIDERED WHILE SELECTING AN SPI .......................................... 22
   3.3 TICKIT - THE END OF A NEW BEGINNING........................................................... 24
      3.3.1 History and the origin of TickIT ........................................................................... 24
      3.3.2 The TickIT infrastructure .................................................................................. 24
      3.3.3 Scope of TickIT .................................................................................................. 25
      3.3.4 Certification and Auditing ................................................................................ 25
      3.3.5 Cost of certification ........................................................................................... 26
   3.4 TICKITPLUS AND HOW IT IS DIFFERENT FROM ITS PREDECESSOR TICKIT ...... 26
      3.4.1 Key Components of TickITplus .......................................................................... 28

4 RESULTS AND DATA ANALYSIS OF SURVEY QUESTIONNAIRES .................. 31
   4.1 RESULTS AND DATA ANALYSIS OF SURVEY QUESTIONNAIRE 1 [SQ 1] ........ 31
      4.1.1 Designing Survey Questionnaire 1 [SQ1] ............................................................ 31
   4.2 RESULTS AND DATA ANALYSIS OF SURVEY QUESTIONNAIRE 2 [SQ 2] ...... 39
      4.2.1 Designing the Survey Questionnaire [SQ 2] ....................................................... 39
      4.2.2 Results and Data Analysis of Survey Questionnaire 2 [SQ 2] ......................... 39

5 RESULTS AND DATA ANALYSIS OF INTERVIEWS ............................................ 48
   5.1 INTERVIEWS .............................................................................................................. 48
      5.1.1 Interview Questions and their motive ................................................................. 48
      5.1.2 Introduction to Interviewee 1 .............................................................................. 49
      5.1.3 Introduction to Interviewee 2 .............................................................................. 49
      5.1.4 Introduction to Interviewee 3 .............................................................................. 49
   5.2 RESULTS AND DATA ANALYSIS OF INTERVIEWS ........................................ 49
      5.2.1 Transcription, Organizing and Familiarizing with Data ................................... 50
      5.2.2 Coding and Themes ........................................................................................... 50
LIST OF FIGURES

Figure 1: Quality Definition ............................................................................................................. 8
Figure 2: Diagram showing the flow of events in conducting the survey ....................................... 17
Figure 3: Summary of Respondents ............................................................................................... 33
Figure 4: Summary of responses on cost for implementing TickITplus ........................................ 34
Figure 5: Responses for training costs ......................................................................................... 34
Figure 6: Responses for Return on Investment ............................................................................. 35
Figure 7: Results on customer demand ........................................................................................ 36
Figure 8: Responses for Documentation Provided ......................................................................... 37
Figure 9: Difficulty level of Documentation ................................................................................ 37
Figure 10: Summary of Responses based on Country ................................................................. 41
Figure 11: Summary of Responses Based on Size of Organization and Country ....................... 41
Figure 12: Cross Tabular Analysis between size and Cost Related Questions ............................. 42
Figure 13: Cross Tabular Analysis for Training costs .................................................................. 43
Figure 14: Customer Demand as a reason for opting TickITplus................................................ 44
Figure 15: Cross Tabular Analysis between size and impact of the scheme ................................. 45
Figure 16: Coding .......................................................................................................................... 51
LIST OF TABLES

Table 1: Difference between TickIT and TickITplus .......................................................... 28
Table 2: Respondents General Information ......................................................................... 32
Table 3: Cost Related Reasons .............................................................................................. 34
Table 4: Business Related Reasons Results ........................................................................ 36
Table 5: Documentation Related Reasons ............................................................................ 37
Table 6: Other General Reasons ........................................................................................... 38
Table 7: Basic Information of organizations ........................................................................ 40
Table 8: Results for Cost Related Questions ......................................................................... 42
Table 9: Cross Tabular Analysis for Cost Related Questions ............................................... 42
Table 10: Cross Tabular Analysis for Training costs ............................................................... 43
Table 11: Results for Business Related Questions ................................................................. 44
Table 12: Results for Quality Concerned Questions ............................................................... 45
Table 13: Results for Questions Related to Documentation ............................................... 46
Table 14: Code and Themes for Question 1 .......................................................................... 51
Table 15: Codes and Themes for Question 2 ....................................................................... 52
Table 16: Codes and themes based on cost factor ................................................................. 53
Table 17: Coding and themes for choice of selecting TickITplus ........................................ 55
Table 18: Codification for challenges faced .......................................................................... 55
Table 19: Mapping SQ1 to the Research Questions .............................................................. 58
Table 20: Mapping SQ2 questions to Research Questions ................................................... 59
Table 21: Mapping of Interview Questions to Research Questions .................................... 59
1 INTRODUCTION

1.1 Introduction

In the past three decades or so, Software industry has witnessed the rise of several Software Process Improvement (SPI) models with the main objective of developing quality software by continuously improving the software development process. Several certification schemes and quality standards like ISO 9001 quality standards, Capability Maturity Model (CMM), Capability Maturity Model Integration (CMMI) etc., were developed with the same agenda of continuous process improvement. The now obsolete TickIT is one such certification scheme developed by the British Computer Society (BCS) back in 1990. Several changes have been brought about to the initial version of TickIT and recently a new certification scheme called TickITplus has been released. With effect from November 30, 2014 the TickIT scheme has ended with TickITplus as its successor. Before going any further into the topic it is important to understand the concept of quality in the context of software engineering and also get introduced to the SPI models and their importance in the field of software quality management.

Over the years a quality product has been the elusive target of any software organization. This continuous increase of focus on quality has put enormous pressure on the software organizations in developing and improving the quality of the products being produced[1][2]. The dictionary meaning of quality is “the standard of something as measured against other things of a similar kind; the degree of excellence of something.” However, in the context of software engineering, quality was given several definitions by the researchers [3][1][2]. One of the researcher, Kiumi Akingbehin in his article stated that the definition of quality can be categorized into qualitative and quantitative definitions[1]. Qualitative definitions explain about quality in non-numeric terms whereas quantitative definitions provide an explanation in numeric terms either directly or indirectly. Here are some of the prominent definitions of quality in the figure below.[1][3][2][4][5]

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**Quantitative Definition**
(Defined in numeric terms)

- Measured as loss imported to society after delivery
- Performance/ Expectations
- Measurable properties of software

**Qualitative Definition**
(Defined in non numeric terms)

- Fitness of use
- Minimization of variation(fixes) between releases
- User satisfaction
- Conformance to requirements
- ...and many such definitions

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**Figure 1**: Quality Definition

Thus, it is evident that there is no fixed definition for quality in the field of software engineering. Several quality standards have come up over the years trying to give a standardized explanation to the definition of quality and in the definitions
provided by the standards it is clear that requirements and characteristic play a key role in the definition of quality[2]. This urge in providing better quality software has motivated the software firms to find means and ways on how they can improve the quality of the software being developed. Researchers and software organizations have realized that improving the development process would lead to a better quality software product[6]. Many software process improvement (SPI) models have been developed with the main aim of improving the quality of process. The SPI models aim at continuous improvement of software quality.

As stated by Pressman in [4], an SPI is defined as a model designed to enhance an organizations overall ability to produce a quality product by improving the quality of the software development process involved in developing the software. The main objective of SPI is to provide organizational stability and see to it that a concrete and firm control is gained on the software process which eventually produces a quality software[6][7]. This initiated the surge for developing quality standards and SPI models. In quench of quality software, software organizations and researchers have invested time and money in developing SPI models[3][8]. Over the past two decades several Software Process Improvement Models have been developed like ISO 9000, Capability Maturity Model (CMM), Capability Maturity Model Integration (CMMI) etc., aimed at continuous improvement of software development process[6].

1.2 Problem Description

In the early 1990s the United Kingdom software industries with the support of Swedish software industry, have developed a certification scheme called TickIT which was introduced to provide solutions to the problems within the classic software development areas with the main objective of improving software quality[9][10]. The TickIT scheme was introduced for encouraging good IT engineering, audit and certification practices. The scheme basically builds on the ISO 9001 quality standards. Along with the main objective of continuous process improvement, TickIT also promotes auditor competency by appropriately training experienced auditors[11]. ISO 9001 quality standards form a baseline from which processes can gain maximum advantage[12]. There has been much demand for this certification scheme in the United Kingdom and across the world. Around 1100 software companies across 44 nations have followed TickIT guidelines of which majority of the organizations belong to the United Kingdom[13]. Hence, TickIT was well known across many countries and several software firms followed the TickIT guidelines for continuous process improvement.

However, over the course of time, with the changing scenarios in the software industry, TickIT has brought about many changes to its initial guidelines proposed in its certification scheme. Further, several limitations have crept up and as a result, the researchers at British Standards Institution’s (BSI) Joint TickIT Industry Steering Committee (JTISC) have come up with a new certification auditing scheme addressing the limitations and have named it TickITplus. TickIT audits only resulted in a pass or fail whereas the organizations were demanding clearer and concrete indications of performance improvement. Many organizations have created integrated management systems and have requirements for combined assessments. With effect from November 30, 2014, the TickIT scheme has ended with TickITplus as its successor certification scheme. The limitations of TickIT and how the BSI and JTISC have tried to resolve these issues in its latest scheme shall be further discussed in the further chapters.

The TickIT organizations have given the companies that were registered to the TickIT scheme a transition period of about three years to transform to TickITplus. But, as per the sources present on the TickITplus website [10] only approximately 70 companies have adopted the new scheme. This is indeed a matter of concern for the
researchers at BSI’s Joint TickIT Industry Steering Committee (JTISC) to identify the reasons behind why so many organizations haven’t transformed in spite of including several changes and developing the old TickIT scheme. Thus, in this research we make an attempt to identify those reasons which made the organizations not to choose TickITplus. Along with this, the experiences of the companies from the certified TickITplus companies are also gathered and their reasons for moving to TickITplus and the challenges faced are also identified.

1.3 Aims and Objectives

Like mentioned in the previous section, 1100 software firms across 44 countries followed the TickIT guidelines whereas the new TickITplus scheme has been adopted by only 70 organization until now of which most of the organizations belong to the United Kingdom followed by Sweden. Few of the TickITplus certified companies are also from India, United States of America. Hence, this thesis is primarily aimed at identifying the reasons behind the adoption and denial of TickITplus. The research also aims at giving a brief account of the drawbacks of TickIT and how the new TickITplus guidelines plan to overcome those limitations.

These aims are attained by accomplishing the following objectives:

- Understanding the concepts of TickIT and TickITplus.
- Identifying the changes that have been brought about in the new scheme.
- Identifying the factors that a software organization looks into while adopting or migrating to a new software quality certification scheme.
- Validate these identified factors with respect to adoption and denial of TickITplus with the help of surveys and interviews.
- Analyze the results of survey and interviews to provide the reasons governing the reasons behind the selection and denial of the TickITplus scheme.

1.4 Research Questions

The thesis aims at providing answers for the following research questions.

RQ1: What impact does cost have for the organizations not to transfer or take up to TickITplus?

*Motivation:* Cost plays a major and dominant role during transition from an old or different quality standard to a new quality standard[14]. This research question is dedicated to evaluate the cost factor because cost is stated as an important factor in several research articles which are discussed in the literature review chapter of the present document. Speaking of cost, it also includes training costs, maintenance costs, and return on investment also. Considering all these factors, it is indeed crucial to consider cost as one of the most important factor that had an impact on lot of companies which haven’t adopted TickITplus.

RQ2: How do quality and business form a reason for the companies not to adopt TickITplus and also what other reasons stopped the companies from taking up TickITplus?

*Motivation:* The fact that the number of companies which haven’t adopted TickITplus is far more when compared to those which have; is indeed a matter of concern for the researchers to identify why the organizations haven’t taken up the updated scheme. Business and the confidence in the quality of the scheme are the common reasons that companies would look into before adopting a new quality standard[14], [15]. However, it could also be other reasons other than these which might have influenced the organizations for not migrating to TickITplus.
Answering this question will provide reasons which can be utilized in improvising the scheme.

**RQ3:** What are the main reasons that drove the organizations migrate to TickITplus and what were the challenges they have faced while implementing TickITplus?

**Motivation:** It would be interesting to investigate and identify the reasons as to why the 70 organizations which have opted TickITplus and investigate if there are any similarities to the reasons that are identified for not moving to TickITplus. Simultaneously, identifying the challenges the organizations have faced while implementing TickITplus would also serve to the body of knowledge by letting the other organizations of the potential risks involved. This would help the software firms in estimating the effort and risk involved while implementing TickITplus.

### 1.5 Expected Outcomes

The possible outcomes of this thesis are the following:
- A brief outlook of both TickIT and TickITplus certification schemes.
- A literature review of the factors a software organization looks into while adopting a quality certification scheme.
- An analysis of the TickITplus’s new policies and how it has attempted to solve the limitations of its older version.
- Survey and interviews to identify the reasons which made the software firms decide for or against adopting TickITplus.
- The challenges faced while transitioning and/or implementing TickITplus.
- Analysis of the results gathered
- Conclusions from the analysis and potential future work in the field.

### 1.6 Structure of the Thesis

This section gives the overview of the thesis report. The further chapters of the report are structured in the following way:

**Chapter 2:** Research Approach: This chapter describes about the research method adopted. It is divided into four sub sections where the first section gives an overview of the mixed method approach that has been adopted and the subsequent chapters explain how the survey and interviews were carried out to accomplish the thesis objectives. The final sub section charts the threats to validity for the research methods adopted.

**Chapter 3:** Background Study: This chapter gives a detailed account of the background study that has been done with respect to the thesis. The chapter is divided into 4 sub sections where it speaks software quality management, TickIT, TickITplus and the differences between TickIT and TickITplus.

**Chapter 4:** Results and Data Analysis of Survey Questionnaires: This section of the report is divided into survey results and the analysis of results. The results and analysis of both the surveys are presented in this section.

**Chapter 5:** Results and Data Analysis of Interviews: The results for the interviews and the data analysis are reported in this part of the document. A clear analysis of the responses gathered from the interviews conducted is done and showcased.
Chapter 6: Discussions and Limitations: The results which are reported and analyzed in the document until now are discussed by mapping them with the literature present. In the further section of this part, the possible threats to validity are discussed.

Chapter 7: Conclusion and Future Work: The first sub section of this chapter details the conclusions drawn from the thesis and elaborates the contribution of this research work. The second part gives an account of the possible future work that can be done in the current field of study.

References: This charts the list of references used in the report.
2 Research Approach

This section of the document elucidates about the research method chosen and the motivation as to why it is the most appropriate research method in the present scenario. The section also clearly charts the details of how the chosen approach will lead to providing the answers for the research questions stated in chapter 1. The research approach defines the way the research is conducted, how the data is collected to interpret the results. The results and data analysis are discussed in the next chapters.

There are primarily three types of research methods. They are: (i) Qualitative research, (ii) Quantitative research and (iii) Mixed Method Approach[16]. In our present study we have selected the mixed method approach. The reasons and the motivation behind using this approach for the research will be discussed further in this chapter. Before that, let us see the difference between the three approaches.

(i) “Qualitative research is an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem.[16]” Qualitative research deals with non-numeric data focusing on individual meaning. Thus qualitative research helps in acquiring new knowledge and a broader perspective on the study[17][16]. There are different methods in the qualitative approach they are, Content Analysis, Interviews, Observation, usability test etc.[17].

(ii) “Quantitative research is an approach for testing objective theories by examining the relationships among the variables. These variables, in turn, can be measured, typically on instruments, so that numbered data can be analyzed using statistical procedures.[16]” Quantitative methods rely on numeric data from which the researcher infers results based on statistical analysis. Quantitative approach is basically gathering numerical data to explain a phenomenon using statistical methods[16][18].

(iii) “Mixed method research is an approach involving collecting both quantitative and qualitative data integrating the two forms of data and using distinct designs that may involve philosophical assumptions and theoretical frameworks.[16]” Mixed method approach can potentially capitalize by considering the pros of both qualitative and quantitative research approaches[19].

In the present study, in order to answer the research questions, survey method involving an online questionnaire with closed ended questions was chosen as the quantitative step of the mixed method approach. As part of the qualitative research interviews are planned with open ended questions. By doing so, legitimate and promising results can be obtained; thus contributing to the current field of study.

2.1 Mixed Method Approach

2.1.1 How and Why Mixed Method Approach?

Like already mentioned above, mixed method approach has both traits of quantitative and qualitative research approaches and taking the better of both the worlds would definitely lead to convincing and valid results. Using this approach we have exercised a convergent parallel process[16] in enquiring and obtaining the results. In this process both quantitative and qualitative data is converged or merged in order to provide a convincing and comprehensive results[16]. Here in this case, an investigation is being done in order to identify all the possible reasons governing the adoption and denial of TickITplus by the software organizations. By doing so, we would not only identify the selection criteria a company considers while selecting an SPI; but also we would get a brief outlook and an updated evidence of the factors that organizations are looking into while selecting an SPI.

In the present context, an online survey would restrict the results to only a set of factors, but our objective was to recognize all the factors that had influenced the
organizations for selecting/not selecting TickITplus. Hence, there was a need for more comprehensive and elucidative results and for achieving that there was a need to include the traits of qualitative approach as well [19][20]. Hence, a mixed method approach was the most ideal approach in reaching the aims and objectives of the thesis.

Here, in the present study we have employed a convergent parallel process in elucidating the results. We have opted this approach over parallel or sequential processes because, on doing a sequential or parallel process there might be chance of the results obtained in the interview influencing the results obtained in the survey which could possibly lead to bias in the result interpretation. Thus, we intend to conduct a literature review first and identify the possible factors that an organization looks into while selecting an SPI. Based on this the survey questionnaires and a set of questions for the interview are framed and are parallel done. Finally both the results are merged to give a comprehensive set of results by comparing and correlating the results obtained from both qualitative and quantitative methods. There is no formal method employed in merging the results gathered from the quantitative and qualitative methods. The results are merged by comparing and correlating the results from each approach.

2.2 Quantitative Research method: Survey

2.2.1 Why Online Survey?

An online survey with closed ended questions is one of the methods which fall under the quantitative approach. We intend to use this method for partly answering all the research questions. In the present context, an online survey serves the best in finding out how cost, quality and business form a reason in organizations selection criteria of TickITplus. We needed to gather and evaluate information from software organizations and TickIT/TickITplus auditors, thus a survey is just more than ideal in this case[21][22][23]. This type of survey is known as an exploratory survey[22].

There are other research methods in software engineering which were not suitable for our research. The reasons for excluding these methods are explained below:

In the present scenario it is important to consider several organizations or auditors perception regarding the reason behind software firms not opting TickITplus. In such a case, conducting an experiment is ruled out because an experiment needs a clear hypothesis and a clear idea of dependent and independent variables which isn’t possible in the present case[22][24].

A case study was another choice. A case study is usually taken up when we intend to examine a case or subject in depth. The same case may vary from one person or organization to other[24]. Here, we aim at finding all the possible reasons. If we conduct a case study, in the given time frame we would be able to only examine a couple or more organizations which would lead to incomplete results. Hence a case study isn’t preferable.

Action research is preferred when we wish to know the effect of an action[25]. In the current study, we are trying to find the reasons why organizations haven’t opted TickITplus. Thus, action research is not appropriate.

2.2.2 Survey Objectives

Before preparing a survey questionnaire and sending it to the respondents, it is important to define the objectives of the survey. The survey objectives help us in defining and identifying the scope of the survey. These objectives would be the foundation for implementing the survey in a more structured and proper way. The objectives laid down for the survey co-relate with the research questions and they are:
• Two separate survey questionnaires are designed to identify the reasons governing the selection and denial of TickITplus. One of them is directed at the organizations which were certified by following TickIT guidelines and the other questionnaire is targeted at the TickITplus certified organizations.
• Consider the target population who would answer the surveys, i.e., define the sample space.
• Make sure the survey doesn’t have too many questions and doesn’t take too long in order to get legitimate answers.
• Broadcast the survey to organizations which have adopted TickIT and TickITplus and also to certified TickIT/TickITplus auditors via e-mails and social networking organizations like LinkedIn.
• Collect responses and further analyze the results.

2.2.3 Implementing the Survey

Once the objectives of the survey are defined, the next step in this kind of research approach is planning the survey and then subsequently implementing it accordingly for proper results[26]. In this phase the first step is selecting the sample space and the second step is to design the survey questionnaire. Once the questionnaire is formulated, it is validated and the responses are collected. The collected responses are then analyzed for conclusions. However, in this section of the document we shall discuss until questionnaire validation and the analysis part is dealt in the later chapters.

2.2.3.1 Target Population and Sample Selection

Before selecting the sample space who would answer the survey questionnaire, it is really important to define the target population among which the sample is selected. A target population is the group or set of individuals to whom the survey is targeted at or to the set of people to whom the survey applies[26][27]. From the target population a sample is selected who can be potential respondents for the research. The sample is selected in such a way that their responses should be really very useful for the field of study and also the target population.

In the present context, the study is aimed at all the software organizations focusing on producing quality products and precisely to those organizations which are looking for an SPI to work with. TickIT and TickITplus auditors would also understand what the organizations are expecting from the scheme and hence they also form a part of our target population. The study is also targeted at the BSI council which has framed the guidelines for TickIT and TickITplus certification scheme; the results would help the researchers at the BSI council to improve the scheme based on the factors the organizations had an issue with. The research serves the organizations with a list of possible challenges they could face if they choose TickITplus. They would get a better idea of what all factors should be considered while selecting an SPI and what made the other organizations not opt for TickITplus.

Now, coming to the sample selection, we select a set or group of respondents whose answers would be very vital for the study. “A valid sample is a representative sample of the target population[26][27].” Kitchenham states that without a representative sample we cannot generalize the results to the defined target population. This means we need a set of individuals or organizations from our defined target population to answer the survey questionnaire. There are several sampling methods characterized between probabilistic sampling and non-probabilistic sampling[26][27]. Probabilistic sampling is one of the two types which uses a systematic approach to select the desired subset of the population and is used when the list of entire population is available[21][26]. Non-probabilistic sampling uses the non-systematic approach
where the list of the target population is not available and when systematic sampling is not possible. This is usually implemented by selecting the sample based on the researcher convenience by selecting respondents as per his convenience[21][26]. In the present research survey, the initial idea was to employ a systematic probabilistic sampling approach for selecting the sample space who would answer both the questionnaires. However, this was not possible for SQ1 as the list of TickIT certified companies was not available, thus a non-probabilistic sampling technique of convenient sampling was used in selecting the respondents from the target population. The respondents included TickIT, TickITplus auditors whose contact details were gathered from social networking sites like LinkedIn and Facebook. Information regarding few organizations which were TickIT certified and not TickITplus certified was obtained from the web and were approached. Since the list of organizations who were certified through theTickIT guidelines was not made available and could not be retrieved despite several attempts, the survey questionnaire targeted at those companies were directed to TickIT certified auditors and they were asked to answer the survey based on their interaction with the organizations. For the second survey questionnaire TickITplus organizations was obtained from the TickITplus website[10].

2.2.3.2 Designing the Questionnaire

After defining the target population and planning the sample space to which the survey questionnaire is distributed, the next step in survey is designing the survey questionnaire. The questionnaire is the most important step in preparing an online survey as it is the tool for collecting responses and results from the respondents. Any survey questionnaire will either have open ended questions or closed ended questions or a mix of both. While designing the questionnaire we made sure that the questions are in alignment with the research questions and objectives. The survey questionnaire had demographic and attitudinal questions[26]. The demographic questions included the basic information such as size of the organization, experience of the practitioner, country etc., and the attitudinal questions were framed in order to know the respondents opinions on TickIT and TickITplus. Like already mentioned, two survey questionnaires were formulated, one directed at TickIT certified organizations and TickIT auditors [SQ 1] and the other targeted at TickITplus certified organizations [SQ 2]. Both the survey questionnaires were dominated by closed ended questions where the respondents where provided with a question and a few options related to the question. The first survey questionnaire [SQ 1] had 16 questions which were grouped into 6 sections with each section having about 2 to 3 questions. [SQ1] was divided into basic, cost related, business related, documentation related, information and general sections. SQ1 was directed at finding the reasons behind organizations not moving to TickITplus and the questions were formulated to provide proper answers to RQ1 and RQ2. We weren’t able to get the list of all the TickIT certified organizations, hence the questionnaire was sent to TickIT auditors and few TickIT certified organizations which haven’t adopted TickITplus.

All the closed ended questions are accompanied with ordinal scales with levels yes, no, maybe or similar options depending on the type of questions. The ordinal scale was chosen over other scales like ratio or interval scale because of the low sample space and the data was not drawn from a normal distribution and it wouldn’t be possible to analyze the data using statistical methods.[28]

Similar to [SQ1], the other survey questionnaire [SQ2] also had questions grouped into sections. This set of questions were related to TickITplus certified organizations and their experiences with the implementation of the scheme. [SQ2] had a total of 15 questions categorized into demographic, cost, business, documentation, quality and general sections. The questionnaire was sent to all the TickITplus certified organization.
Both the questionnaires are introduced with an introductory message, explaining in brief the purpose of the survey and the survey contents so that the respondents would have an idea what kind of questions are asked and the approximate time taken to complete the survey (Appendix B). In order to get best possible answers, utmost care was taken in framing the questions.

2.2.3.3 Questionnaire Validation

Once the questionnaire was designed, it is crucial to validate the questionnaire and check if the questions were clear and not vague. The approximate time taken for the questionnaire was also calculated. In order to make sure the questions weren’t vague and would provide proper responses, leading to answering the research questions, it was reviewed by the supervisor who was an expert in the field of TckITplus. Once the supervisor approved the questionnaire, we have sent it to another TickIT auditor and asked her review, to ensure that the questionnaire would not be misunderstood. Further, in order to calculate the approximate time, both the survey questionnaires were sent to Master level software engineering students who had taken the Software Quality Management course and who were familiar with the topic of TickIT and TickITplus and gathered their reviews to predict the approximate time (Appendix A). Thus, the questionnaires were validated and we made sure that the surveys were easy to understand, concise and to the point for getting best results.[26][27]

Once the questionnaire was designed and validated it was broadcasted among the sample space via e-mails and social networking platforms like LinkedIn which had a closed group of TickIT/TickITplus auditors and practitioners. The online survey questionnaire was prepared with the help of google docs, through which a survey form was created. The survey questionnaires were scheduled for a span of 4 weeks from 2nd June 2015 to 30th June 2015. All the responses were collected in an excel sheet. The analysis and results of the survey are explained in the forthcoming chapters.

![Diagram showing the flow of events in conducting the survey](image)

**Figure 2:** Diagram showing the flow of events in conducting the survey
2.3 Qualitative Research Approach

2.3.1 Literature Review:

Once a field of research has been chosen, the first step is to explore related work that has already been done. Literature review is usually the preliminary step while conducting any research[16][31]. Literature review helps in identifying the similar work that has already been done in the chosen field of study. Thus, it gives us a broader and comprehensive knowledge about the topic and how best we could contribute to the existing body of knowledge. In the present study, where we are making an attempt to find the reasons behind why organizations haven’t opted TickITplus, the literature review forms backbone behind framing the questions for the survey and interviews. A literature review is used to identify the factors an organization would consider while opting an SPI or while transitioning from one SPI to other. The TickIT and TickITplus guidelines are also studied in order to know more about their concepts and the changes that have been brought about in the new scheme. The literature review in the current research provides a summary and brief understanding of the concepts of software process improvement, TickIT and TickITplus.

We have conducted the literature by following the principles stated by J Rowley and F Slack in their article “Conducting Literature reviews”[30] which was directed at guiding masters students. According to the article, literature review is carried out as a five-step process. The five steps are “scanning documents, making notes, structuring the literature review, writing the literature review and building the bibliography.”

- **Scanning documents** include gathering literature which is related to the topic and which are reliable. This is done by developing key terms and searching the databases like google scholar, Inspec, IEEE Explore etc. The key terms are used to frame search strings which are entered in the search engines to find relevant studies.

- Once the first step is completed it is followed by **making notes**. In this step the gathered literature is gone through and important information which can be potential answers to the research questions laid or which can contribute to the research design are noted.

- The next step is **structuring the literature review** which helps in building and understanding the important concepts. In this case, this step helps in understanding the factors considered while choosing an SPI and the concepts of TickIT and TickITplus.

- **Writing the literature review** is a key step which provides the summary of the field of research and the related study that has already been done and how we can utilize this information in contributing to the body of knowledge.

- **Building the bibliography** is about crediting and citing the research articles that have been chosen for the new research.

Thus, by following the aforementioned steps, we have conducted the literature review. The literature provides an estimate as to what are the reasons an organization considers while selecting an SPI. These factors in turn are used in preparing the questionnaire after co-relating the factors to the concepts of TickITplus. This forms the basis for preparing the questionnaire and validates the factors and hence the literature review in turn forms the base for answering all the three research questions.

2.3.2 Implementing the Interviews:

Interviews are another method which belongs to the Qualitative research approach. The reason behind choosing interviews as one of the research methods other than online-surveys because using online surveys we would be able to only validate
existing factors and check if they are the reasons behind organizations not opting TickITplus. But, the objective of the study is to find all the reasons that lead the organizations not to take up TickITplus. Thus, an interview with a couple of TickIT/ TickITplus practitioners of an organization would reveal factors other than the usual ones if any. This way we would get more reliable and concrete results for our research.

There are three different types of interviews; they are structured interviews, unstructured interviews and semi-structured interviews[33][34]. In this research study, we have employed semi-structured interviews which are a combination of both structured and unstructured interviews. We have chosen this method because using this method we can have both specific questions and open ended questions[31].

**Designing the questionnaire:** Prior to approaching the organizations for interviews, a set of questions based on the literature review were formulated. The questionnaire comprised of both specific questions and open ended questions. It comprised of 6 subject related questions and demographic questions. The questions were related to the implementation of TickITplus, the costs factor, the understanding of the documentation, the concept of multiple standards being involved and the reasons behind their choice of selecting TickITplus and also the quality of the certification scheme.

The interviews were carried out in the following five steps:

**Step 1: Preparation:** Before conducting the interview, preparations were made by requesting the interviewee to participate in the interview. The interview had to be scheduled beforehand, hence an appointment had to be taken and the interview had to be scheduled. All the interviews were telephonic interviews and a set of questions were prepared prior to the start of questionnaire.

**Step 2: Introduction:** The interviewee was given a brief explanation about the objective of the thesis and also the process and rules of the interview. The interviewees were informed that their details will be kept anonymous so that they can express their opinion freely.

**Step 3: Gather general information:** The general information of the interview like the name of the company he/she is from, the size of the company, the size of the company using TickITplus, designation and experience as a quality professional.

**Step 4: Subject related questions:** After gathering the basic information, subject related questions were asked. There were 6 questions prepared beforehand and the interviewee was questioned one question at a time. Instant notes were made while the respondents were answering the questions and the same was notified to them so that they would narrate the answers a little slow. All the clarifications were done on the spot.

Step 5: **Transcription:** Since none of the interviews could be audio taped, transcription was done immediately after the interview so that no information is missed.

After transcribing the interviewee responses the transcripts were analyzed for extracting information and conclusions. The analysis part of the interview is explained in the later chapters of this document.

Thus, this is the detailed explanation of how the research was carried out and also the motivation of choices. The next chapter discusses the literature with respect to the current field of study.
3 **LITERATURE REVIEW**

The present study revolves around the concepts of software process improvement (SPI), the quality standards and the certification schemes, the factors considered by an organization while taking up an SPI or choosing a certification scheme in the ever advancing field of software engineering. Thus, before going further deep into the investigation of the reasons behind organizations not opting TickITplus, let us have an overall brief understanding of the concepts surrounding it, factors governing the selection of an SPI, the history of TickIT and the need for TickITplus’s inception.

3.1 **Software Process Improvement and Standards**

As the name suggests, software process improvement (SPI) is a method designed to improve the overall capability of a software organization to produce quality software by improving the quality of the software process. As already stated in chapter 1 of this document, as stated by Pressman in [4], an SPI is defined as a model designed to enhance an organizations overall ability to produce a quality product by improving the quality of the software development process involved in developing the software. Thus, process improvement plays an important role in delivering a quality product as the quality of a product is both implicitly and explicitly related to the process by which it is being produced[33][34][35].

In order to achieve this objective of improving software processes, several SPI initiatives have been developed and employed over the past three decades[3], [8], [34], [35]. Most of the software process improvement frameworks or maturity models have been framed based on the Shewhart Deming cycle[34]. The Shewhart Deming cycle states that an SPI should pass through these following stages, they are: establish an improvement plan, implement the new plan, measure the changed process and analyze the impact of those implemented changes[33], [34].

A number of maturity models and SPIs have been identified until now. In the article [36] the authors De Bruin et al., explain the main steps involved in framing an SPI model. The authors state that they could identify more than 150 maturity models across the globe of which the Capability Maturity Model (CMM) is one of the most famous schemes which was framed by the Software Engineering Institute (SEI) - Carnegie Mellon in the year 1986. Maturity models are designed to measure the capability of a particular domain on a maturity scale of 1 to 5. Since the inception of CMM, many other SPI initiatives have been developed on different domains which include the likes of Project Management Model in the early 90s which belonged to the project management domain, the process maturity model, Enterprise Architecture Maturity model, Capability Maturity Model Integration (CMMI) which is a combination of three legacy frameworks designed by the SPI. The authors De Bruin et al., in their systematic literature review describe the steps involved in formulating an SPI. According to the authors De Bruin et al., there are six phases involved in developing a generic SPI and they are: Scope, Design, Populate, Test, Deploy, and Maintain. In the first phase, the scope of the SPI is determined by defining the domain on which it would be operated. The design phase as the name suggests defines the architecture of the framework. The populate phase defines the heart of the framework involving what and how to carry out the improvement process. Once the model is populated it is tested and deployed in reality to verify its functioning. The main objective of these SPI initiatives is to promote continuous improvement and thus the final step is to maintain which deals with the maintenance of the model over time. [36]

In the systematic literature review conducted by Mohammad Zarour et al., the authors provided several evidences showing the best practices for the successful design
and implementation of a Software Process Assessment (SPA) [37]. The authors have collected a set of 29 primary studies, of which 22 were case studies about single and multiple organizations. Those case studies covered more than 194 organizations which gave convincing information about the best practices involved in designing an SPA. The author has categorized these practices into sections named method, tools, procedure, documentation and user practices.

In the article [38] authors Sharma et al., made a comparative analysis among few of the most famous maturity models that are in use currently. They have compared a total of four standards viz., the ISO series of quality standards, the world famous CMM model, SPIQ and ProPAM and also briefly described about few other SPI models like BOOTSTRAP and Six Sigma. They have expressed the advantages and disadvantages of the models comprehensively. The above stated models are the most sort after maturity models used by a lot of organizations.

**Software Process Improvement and ISO:** In our present research study we would focus more on the existing literature about the ISO 9000 series quality standards on software as both TickIT and TickITplus conform with the ISO quality standards[9]. The International Organization for Standards (ISO) has been in practice for more than twenty years and is used to continually improve quality of software process ever since it has come into existence. The current version of the ISO 9001 series is the ISO 9001:2008 standard and the ISO 9001:2015 version is all set to release by September 2015.

In the article [39], the authors describe the compliance of ISO 9001 in the software world. The authors state that ISO 9001:2008 forms the base of the quality management system. The authors also discussed about other similar standards like ISO/IEC 15504, ISO/IEC 27001, ISO/IEC 20000. The research aim was to integrate the aforementioned standards and ISO 9001:2008, thus implementing a multi standard compliant software process improvement program which can be closely affiliated to TickITplus because TickITplus also involves the concept of multiple standards. The authors have explained the challenges they have come across while implementing the process improvement initiative and the methods they employed in order to overcome those challenges. A total of 11 challenges were listed which were, Rapid growth, cultural distinctions, Inter process relations and dependencies, low priority of improvement tasks against software development projects, process audits, low motivation of the personnel, unavailability of a process asset library, uncertain roles and responsibilities, AS-IS analysis, if you don’t measure- you can’t improve and lack of a process management process. These In order to counter these challenges, the researchers have implemented a set of key practices. By implementing these practices they have produced a multi standard software process improvement model and investigated its functioning. However, they reported the need for further investigation for a more concrete approach of this sort.

The authors, Anne Mette Jonassen Hass et al., in their article [41] discussed the impact of ISO 9001 standards on the maturity of 25 software organizations across Denmark. Among these organizations, few of them were ISO certified while the rest of the organizations weren’t. The authors analyzed these 25 organizations to predict the impact of ISO 9001 standards. The authors have revealed that, the organizations which had an ISO certificate showcased a higher maturity level when compared to the organizations without an ISO certificate. The average maturity level shown by the companies which had an ISO certificate was identified as 2.25 while the maturity level of those organizations which did not have a certificate was around 1.25 on a scale of 5. Thus, research has identified that ISO 9001 certification has proven to show a positive impact in the maturity level of the organization.

Thus, from the literature review on SPI/SPA initiatives we could gather information of how an SPI is designed and the concepts involved. Literature also proves that there are several software process improvement models which have been
developed over the past two decades and all of them have got their own pros and cons functioning on a range of domains. Hence, an organization before selecting an SPI model should consider certain factors. These factors are identified in the following sub-section.

### 3.2 Factors considered while selecting an SPI

From the previous sub-section (3.1) we have identified that there are many SPI initiatives with a common aim of continuous process improvement and organization maturity. Now, for a software firm to select an SPI to serve their organizational needs is an arduous task. In order to simplify this, we have conducted a literature review to identify the factors that software organizations usually consider while selecting an SPI for their firm. This helped us in framing the survey questionnaire.

In the systematic literature review conducted by Michael Unterkalmsteiner and Tony Gorschek[34] they have provided a comprehensive study about the prominent evaluation strategies employed in evaluating an SPI and the success factors that define the success of an SPA. The authors have provided evidences from 148 primary studies. Based on the available literature, they have identified evaluation strategies and success factors of an SPA. A total of 11 evaluation strategies have been identified. The 11 strategies identified by Michael and Tony are: Pre-Post Comparison, Statistical Analysis, Pre-Post Comparison and survey, Statistical Process Control, Cost-Benefit Analysis, Statistical Analysis and survey, Phillip Crosby Associates’ Approach, Pre-Post Comparison and Cost-benefit analysis, Survey, Software Productivity & Analysis. Among these methods the pre-post comparison method was identified to be the most famous method. In this method a comparison of success indicators is done before and after implementing the SPA model. The research also unearths 7 success factors or metrics based on which the SPI is assessed. Thus, these success factors are the factors an organization would be considered while opting an SPI. The 7 factors as stated in the article are:[34]

- **Process Quality**: Indicates process quality independent of the product quality
- **Estimation Accuracy**: “The deviation between actual and planned values”
- **Productivity**: Performance of the productivity team.
- **Effort**: The amount of effort put in finishing the process.
- **Cost**: The cost incurred for implementing the process.
- **Time to market**: The time taken to deliver the product.
- **Return on Investment**: The cost benefit on implementing the process.
- **Customer Satisfaction**: Checking if the organization’s process and product has reached the customer’s expectation.

Sarah T. Meegan and W. Andrew Taylor [15] in their article explained the factors influencing a successful transition from ISO 9000 and TQM. In the research article the authors have presented the motivations behind a successful transition between the two SPI initiatives. The authors categorized the factors into three categories and they are:[15]

- **Coercion and Customer Pressure**: This factor indicates that the choice is based on the interest of a customer.
- **Enlightened motivations**: These factors do not include customer involvement. The organization takes up the scheme hoping for positive benefits like bringing more business.
- **Unenlightened motivations**: Adoption of an SPI without any proper condition or having it just for the sake of it is called unenlightened motivation. Quite
often such a factor pops up when the organization misunderstands or wrongly interprets the agenda of the scheme.

In the case study analysis conducted by DR Goldenson et al., [42] the authors have compared the transition from CMM to CMMI. In the article they have identified 7 different categories of performance measures based on which the comparison was made. The 7 different measures were namely process adherence, cost, schedule, productivity, quality, customer satisfaction and return on investment.

In an exploratory study[43], authors Mark Staples et al., studied the reasons behind why organizations do not adopt CMMI. In the study the researchers have established relations between the size of the company and the reasons behind the company not adopting CMMI. The reasons primarily considered in the study were, cost, time, already known gaps, applicability, no customer demands, using another SPI. Results have shown that the important reasons behind software organizations not taking up CMMI were distributed among cost, applicability, customer demands or using another SPI. The other reasons like already known gaps, risk of poor certification damaging business were not reported frequently when compared to the other factors.

In an article by Richard Francis named quality and process management: a view from the UK computing services industry[11], the author states that it is important to have a criteria or a basis for an organization before selecting an SPI model. In the article, the author analyses ISO 9001, TickIT, CMM, SPICE, ImproveIT and the concept of Total Quality Management (TQM). The author says that while selecting an SPI some organizations reasons could be objective like easy to maintain or productivity gain whereas few organizations factors would be subjective like customer satisfaction. The author, based on the case studies that were conducted among the companies in United Kingdom stated that organizations must consider the size, applicability, cost and time, quality of the process and product and customer satisfaction.

Thus based on the literature review conducted we have considered the most frequently reported reasons for selecting or transitioning to an SPI scheme. These results have been used in framing the set of questions for the survey questionnaire. However, it must be observed that all the articles considered above were different from one another and were operated under different scenarios. This leads to a possibility that there could be other factors as well which weren’t considered in the literature. In order to fill this gap we also provided open ended questions in the survey so that the respondents could provide answers appropriately. Thus, we have identified the following factors as potential contributors that would impact the decision making while selecting an SPI:

- **Cost**: This covers the costs required to implement the SPI. As stated in [11] “a small but expensive SPI might not be worthwhile; but a small and inexpensive method could serve the business”
- **Business related reasons**: Business related reasons include factors like customer confidence, hoping that getting certified by an SPI would bring more business.
- **Customer needs**: Based on the demand by a customer.
- **Return on investment**: A positive estimation in a cost benefit analysis could lead to a positive inclination for the scheme from the organization and in cases where there is no clear indication of proper economic benefits the odds of selecting an SPI would go down.
- **Documentation**: Reasons related to documentation are quite often ignored in most of the literature. We assume that documentation could play an important role in earning the organizations confidence. Documentation should be easily interpretable in order to get the confidence of the stakeholders. If the documentation is complex and not easy to comprehend then it could be one of the reasons for the organizations to not choose that scheme.
• **Process Quality:** Whether the implementation of the SPI improves the quality of the process and appropriately covers the organizational needs.

3.3 **TickIT - The end of a new beginning**

This sub section of the document introduces and gives a brief overview of TickIT, the main concepts, objectives of the scheme, certification, the history and information related to why and how it has started. All the information provided is based on the TickIT guidelines book named the TickIT guide[44] published by the British Standards Institution (BSI) and the Joint TickIT Industry Steering Committee (JTISC).

3.3.1 **History and the origin of TickIT**

As stated in the book of TickIT guidelines[44], the importance of ISO 9000 series has spread across the nations and has become a prominent source for requirements and guidance for quality management systems (QMS) in organizations. The acceptance of the standard saw a rise in the third party certification which was further reinforced when these certification bodies got recognized by national authorities like the United Kingdom Accreditation Service (UKAS).

The first publication of the ISO 9000 series, modelled on BS 5750, the UK Department of Trade and Industry (DIT) reviewed its relevance to the software needs and identified that there are several changes that should be brought about if it has to comply with the software needs. The suggested changes include:[44]

- The use of ISO 9001 as a harmonization route,
- The improvement of market confidence in third party QMS certification for the software sector.
- Professional practice amongst QMS auditors in the software sector.
- Publication of authoritative guidance material.

The result of this review has paved way in framing the TickIT guidelines in the year 1990 which had the following six elements.

- Infrastructure supporting TickIT
- Scope of TickIT
- TickIT accreditation procedures.
- TickIT certification procedures.
- TickIT auditor registration procedures.
- The use of TickIT guidance material.

3.3.2 **The TickIT infrastructure**

The infrastructure of the TickIT scheme refers to the stakeholders involved in planning and maintaining the guidelines of the scheme[44]. The Joint TickIT Industry Steering Committee (JTISC) in coordination with the Swedish Association for Testing, Inspection and Certification (SWETIC) and the International Register for Certificated Authors (IRCA) is responsible for developing and maintaining the TickIT guidelines. Simultaneously, the scheme operations are taken care by the United Kingdom Accreditation Service, Swedish Board for Accreditation and Conformity Assessment and IRCA.
3.3.3 Scope of TickIT

Scope in this context means the scenarios where the TickIT framework can be applied. In the TickIT guidelines, 10 circumstances are stated where the scheme can be applied as stated in the TickIT guidelines, Issue 5.5. They are:[44][45]

✓ **Software product or service development:** “TickIT applies whenever software development is carried out and the software is incorporated irrespective of the medium on which the software is held.”
✓ **Internal software development:** “in-house software development which affects the quality of the final product.” “in-house software development related to the administration of an organization.”
✓ **Software replication:** TickIT is applicable to software replication activities where simple replication is done with care making sure that there are no errors during the activity.
✓ **Software related services:** “Applicable in cases of software related services where significant configuration management takes place.”
✓ **Facilities management:** “TickIT applies to circumstances where software development and/or maintenance and/or software configuration is part of the management contract.”
✓ **Computer operations services:** “Applies to computer operation services where applications or system software support, development and/or maintenance forms a part of the overall service offered.”
✓ **Systems integration services:** “Applies whenever a combination of software/hardware is involved.”
✓ **Peripheral services:** “TickIT is applicable to peripheral services (consultancy, commissioning installation, software or system sales etc.,) where software evaluation and/or selections form a part.
✓ **Software archiving and storage**
✓ **Subcontracting:** “Applies to subcontracting and associated integrated activities of prime contractors of systems that depend upon software for functionality.”

*Exclusions from TickIT scope:*
TickIT does not apply in circumstances where no software development is involved. Some of the examples are:[44][45]

✗ Software stock holding.
✗ Software sales.
✗ Installation of application software on personnel computers.
✗ Provision of data or parameter values by users of applications software.
✗ The operation of dedicated proprietary CD-ROM and diskette duplication machines when carried out as in isolated business activity.

3.3.4 Certification and Auditing

“Certification of compliance or third party assessment is carried out by an independent organization with reference to a standard.[44], [45]” The certification is carried out by following the inputs of: [45]

- ISO 9000:2000,
- ISO 9001:2000,
- ISO 9001:2008,
- ISO/IEC 90003:2004,
ISO/IEC 12207,
ISO/IEC 12207,
ISO/IEC 9126.

The process of examining all the activities of an organization which could possibly affect the quality of the product or service described in the declared certification scope is called certification audits [45].

A certificate of conformance to ISO 9001 is issued as an audit report if the quality management system is found to be compliant [45].

3.3.4.1 Types of audit

There can be three types of audits. They are: First Party audit, Second Party audit and Third Party audit [45].

First Party audit: When an organization carries out an internal audit, the process is referred to as a first party audit. Such an audit is usually carried out before a third party audits the organization’s quality processes. Internal audits are also done by an organization to maintain its certification [45].

Second Party audit: When an organization’s customer audits the company’s quality competence, it is called second party audit [45]. It is usually carried out before awarding the contract to the organization.

Third Party audit: An audit carried out by an external body, which are usually paid for by an impartial body is known as a third party audit [45].

3.3.5 Cost of certification

When implementing TickIT, the different costs that would occur from four sources: [45]

- The internal costs spent on quality management system set up, training costs and other fees paid to external consultants if made use of.
- The effort spent in preparing for the assessment.
- Fee paid to the certification body
- Effort needed to improve, operate and evolve.

Internal costs: This involves the major part of the costs incurred, which includes the time invested in defining, running and managing the QMS [45]. As stated in the TickIT guidelines, issue 5.5 the effort put in for the set up phase in an organization of 100 employees would take 200 person hours.

Audit Costs: The audit costs are distributed across two stages, the initial assessments and surveillance costs. The costs incurred depend on various factors like the size of the organization, number of sites involved and the complexity of the organization’s business. TickIT could be expensive than the normal ISO 9001 audits because of the varying fee structures of TickIT auditors based on the experience and other factors. There would be a further surveillance costs which would cost 30-40% of the initial assessment [45].

3.4 TickITplus and how it is different from its predecessor TickIT

This sub section of the document gives details about the newly formulated and in use TickITplus scheme. The concepts of TickITplus and the changes that have been brought about when compared to its predecessor TickIT.

Introducing TickITplus: TickITplus is a new scheme developed by JTISC on the strengths of the TickIT scheme and further improvising the scheme by including
several changes in accordance with the changing software field [10][9]. It was introduced in the year 2011, thus it is relatively a very young certification scheme trying to make its place in the software arena. The scheme is developed with a set of key goals, they are:[9]

- Adopting a full process driven approach to business systems management.
- Introduce capability assessment methods.
- Accommodate multiple requirement standards, e.g., ISO 9001, ISO/IEC 20000-1 (IT service management) and ISO/IEC 27001 (IT information security management).
- Strengthen the commitment to improvements.
- Regain customer confidence
- Enable collaborative assessments to take place more formally.

In addition to the software process improvement guidelines suggested in the TickIT guidelines, TickITplus also emphasizes on process capabilities defining five levels of maturity of an organization. The five levels are foundation, bronze, silver, gold and platinum[9]. By accommodating multiple standards the IT sector is now more diverse when compared to the previous scheme. This can be seen by the design of the scheme which allows different combinations of standards which initially includes ISO 9001.

*Why the switch from TickIT to TickITplus?:*

Complying with the ever changing nature of the software industry, the TickIT scheme had to make several changes to its existing scheme in order to meet the requirements of the stakeholders. The outdated TickIT scheme was most importantly addressing the cons within the classic software development areas and during the course of time the IT provision has increased in the field of operations across the software field[9]. Though there have been several changes to the initial version of TickIT introduced in the year 1990, the main objective and agenda of the scheme had been the same. The researchers and the standard makers which included the JTISC, BSI administration identified the need for a broader approach to the existing TickIT scheme. And also the tie up between ISO 9001 has majorly made the scheme requirements driven an put little focus on process driven approaches.[9] Adding to these, TickIT audits could only result in a pass or fail but the clients needed a more comprehensive report. Adding to the above points, reports suggest that several organizations have been making arrangements to make combined assessments. Thus, considering the above stated reasons a new scheme was designed which made an attempt to offer a more flexible, open and usable framework.

TickITplus has brought about the following key changes to address the above issues: [9]

- “Defined a core set of well-defined processes providing coverage for a range of organizational services.”
- “Adding the capability dimension to the TickIT scheme based on ISO/IEC 15504-2.”
- “Providing mappings between core processes and combinations of requirements and reference standards.”
- “By introducing the concept of formally trained practitioners within an organization to support ongoing improvements, promote higher levels of process capability and benefit from closer involvement in assessments.”

*Key features of TickITplus:* Some of the key features as discussed in the TickITplus kick start guide are:[9]
Accommodates for more professional business and quality systems planning and improvement.
Graded ISO 9001 certificates providing 4 organizational maturity grades.
Possibility of including multiple IT standards under a single accredited certificate such as ISO/IEC 20000 and ISO/IEC 27001.
A structural design for training auditors and practitioners.
Formal improvements planning and assessment.
Encouraging self and independent assessments.
Emphasizes role on systematic and on-going improvement.
Defined transition route that recognizes the TickIT investment.

Differences between TickIT and TickITplus: The following table gives a brief account of the prominent differences between the old and the new schemes as discussed in the book of guidelines [9].

<table>
<thead>
<tr>
<th>TickIT</th>
<th>TickITplus</th>
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<tbody>
<tr>
<td>Introduced 20 years back and provided only implementation guidance</td>
<td>Came into practice from the year 2011, answering the issues of the diverse software industry.</td>
</tr>
<tr>
<td>Aimed predominantly at software development</td>
<td>Included emphasis on improvement of IT processes covering all software related management, development and support and computer system related activities.</td>
</tr>
<tr>
<td>Linked directly to ISO 9001 providing just a pass or fail.</td>
<td>Now provides a detailed comprehensive report for better differentials in customer selection by adding a capability dimension with five graded levels based on the ISO/IEC 15504 standard.</td>
</tr>
<tr>
<td>It is a sector based scheme.</td>
<td>It is much of a requirements based scheme rather than guidance.</td>
</tr>
</tbody>
</table>

Table 1: Difference between TickIT and TickITplus.

3.4.1 Key Components of TickITplus

Along with the aforementioned features of TickITplus, there are three key elements which have been included in the new TickITplus scheme namely
(i) Base Process Library (BPL)
(ii) Process Reference Model (PRM)
(iii) Process Assessment Model (PAM)

(i). Base Process Library (BPL): It is considered as the most important element of the TickITplus scheme and consists of a series of process definitions [46]. There are 40 process definitions developed from ISO/IEC 12207 (Systems and software engineering – Software lifecycle processes) and ISO/IEC 15288 (Systems and software engineering – system lifecycle processes) and heavily influenced by ISO/IEC 15504-4 (Information technology – process assessment – guidance on use for process
improvement and process capability)[46]. The processes defined are based upon the practices being carried out, work products and outcomes. The forty processes are grouped into six process categories which are: [46]

- Organizational processes (ORG): focus is on organizational level activities.
- Project processes (PRJ): activities related to setting up and running projects.
- Technical processes (TEC): technical activities.
- IT specific processes (ITS): covering specific IT activities.
- Agreement processes (AGR): contractual, procurement and supply related activities.
- Maturity processes (MAT): Quantitative and improvement activities.

These process categories are classified by mapping them to one among the four defined set of classes (named type A, type B, type C and type M) according to their alignment with the source standards. It also defines the scope profiles of the scheme and the mapping of the defined set of processes to the scope of certification. There are eight scope profiles defined in the Base Process Library guidelines book. They are: [46]

- Information Management and Security
- Service Management
- Systems and Software Development and Support
- Project and Programme Management
- Corporate Strategy Planning and Management
- Legal and Compliance
- Product Validation, Quality and Measurement.
- IT Systems Engineering and Infrastructure.

The four types of process are classified on the basis of their activities and requirements[47]
Type A: The mandatory processes necessary for ISO 9001.
Type B/C: Dependent on the scope profiles by virtue of requirement, scope statement and scope references standards. Type B processes are required and type C are supporting.
Type M: Necessary for Gold and Platinum scopes.

Thus, BPL is used to describe the activities to be undertaken by an organization. This is done by defining a set of processes from which an organization can select the most applicable process and map an organization specific PRM.

(ii). Process Reference Model (PRM): The process review model is derived from the BPL and is produced and maintained by the organizations. An organization as part of the TickITplus certification process has to map the organizational processes with those processes defined in the BPL. The mapping could be one to one or many to many[47]. The organizational processes are called defined processes and the processes defined in the BPL are called generic processes for the sake of differentiating each other.

(iii). Process Assessment Model (PAM): The third component of the TickITplus scheme involves the PAM which is produced by the assessor but it also has the organization’s involvement[47]. It is also based on the BPL but is aligned accordingly with the PRM. It identifies the assessment process instances and brings together the
process performance and process capability indicators[47]. The PAM provides a comprehensive report of assessment and also elucidates to demonstrate the implementation of the defined processes[47].

Thus, these three components form the heart of the TickITplus scheme. With this, we now understand the main concepts, the important changes that have been brought about in the new scheme and how TickITplus is different from TickIT and why the JTISC had to formulate TickITplus. In the further sections, we shall look into the results and analysis of the conducted research.
4 Results and Data Analysis of Survey Questionnaires

This section of the document gives a comprehensive account of the results obtained from both the surveys. However, the analyses of gathered results are presented in the next chapter discussing how the results contribute in answering the research questions stated in the previous chapters. The section is divided into two subsections and each sub section is again divided into smaller sections. The first subsection, section 4.1 gives an account of the results, survey questionnaire design and the motivation behind the questions regarding how it would answer the research questions. Sections 4.2 will present the questionnaire design and the results of the second survey questionnaire.

4.1 Results and Data Analysis of Survey Questionnaire 1[SQ 1]

Before we present the results of the surveys and interviews, this section presents the questions framed and its motivation. The design of the survey questionnaire is specified in detail in this section, so that it would be easy for the reader to comprehend the motive of the question and the analysis made. Like already mentioned in the research approach chapter, two survey questionnaires have been framed with both open and closed ended questions. The first survey questionnaire [SQ1] is targeted at organizations which were certified by following the TickIT guidelines and the second questionnaire [SQ2] is targeted at the certified TickITplus organizations and TickITplus practitioners and auditors.

4.1.1 Designing Survey Questionnaire 1 [SQ1]

The first of the two survey questionnaires were primarily framed in such a way that the answers to the questions would provide answers to the first two research questions. The survey questionnaire [SQ1] is divided into six sections. Before the set of questions, the first page has a paragraph text introducing the respondent regarding the survey and the type of questions they would face. This would provide the respondent with all the information about the survey letting him decide if he should take the survey or not.

Section I: The first section is titled basic information and has 3 questions. The section gathers information regarding the respondent’s designation, experience in the field of quality management and the country in which the respondent is/has worked. These questions were asked to know the answers from different perspectives, for example from a TickIT auditor’s perspective or a quality assurance manager or the Chief Executive Officer’s perspective. The experience would give us information whether the answer is from a very experienced person or someone naïve and the country helps us to identify if the reasons differ from country to country.

Section II: The questions of this section were framed to gather the impact of cost behind companies not opting TickITplus. There are four questions where in the first three questions are multiple choice questions and the last question is a rating question on a likert scale. The first question investigates the respondents view on the costs incurred for implementing TickITplus with three options viz. very expensive, moderate and cheap. The second question was framed to check if the cost needed for training is high with options yes, no and maybe. Third question speaks of the respondent’s perception about the return on investment by implementing the scheme.
with options high, sufficient and low. The final question asks the survey taker to rate cost as a factor for not taking up TickITplus. The scale chosen was a likert scale where the respondent is asked whether how strongly agree or disagree using one of number of points from 1 to 5 on the scale[48]. The respondents should rate cost and expenditure as a factor for not taking up TickITplus where selecting 5 implies it is one of the most important reasons while option 1 means not at all an important factor.

Section III: This section has closed ended questions which would investigate business related reasons like customer confidence in the scheme, whether it was based on customer’s interest that they haven’t taken up TickITplus. Another question also helps in identifying the impact of yet to release ISO 9001:2015 version for not selecting TickITplus.

Section IV: This section holds the questions relating to the documentation provided by the TickITplus committee. It questions the respondents whether the provided documentation was sufficient or not and at the same time try to find out if this is one of the reasons for the organizations not to take up the new scheme. All the questions in this section are also closed ended

Section V: The last section of the survey covers a couple of general questions. The first one questions the respondent if they have any intentions to adopt TickITplus in the near future and the second was to find out if the transition and the news of TickITplus has reached the organizations or not. There is also an open ended question for the respondent to give his opinions more elaborately if he/she wishes to.

4.1.2 Results and Data Analysis of Survey Questionnaire [SQ1]

This section charts the details of the results gathered from the respondents for the first survey questionnaire [SQ1]. The questionnaire was broadcasted to the TickIT certified companies which haven’t taken up TickITplus and also to the TickIT auditors via e-mails and social media. The list of TickIT certified companies could not be traced and thus we have sent the questionnaire to TickIT auditors as well and not just organizations. Owing to the scarcity in contacts we could only gather 8 responses. The responses of the 8 respondents are reported below.

The data analysis of the gathered results is done by using the univariate analysis for all the questions. The possibility of comparing and cross tabulation of results is not possible in the present context because we cannot logically compare any two sets of results from the set of results gathered. Therefore a bivariate analysis cannot be made. The results are presented in tabular forms and the data analysis is portrayed by using pie charts and bar graphs wherever necessary.

4.1.2.1 Results of General Information

This holds the results of the number of respondents, their designations, their country of operation and experience in the field of quality management. The results are tabulated below.

<table>
<thead>
<tr>
<th>Total Number of Respondents</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designation</td>
<td></td>
</tr>
<tr>
<td>TickIT/</td>
<td></td>
</tr>
<tr>
<td>TickITplus auditors</td>
<td></td>
</tr>
<tr>
<td>Quality Assurance Manager/</td>
<td></td>
</tr>
<tr>
<td>Sw. Quality Management</td>
<td></td>
</tr>
<tr>
<td>Roles</td>
<td></td>
</tr>
<tr>
<td>Chief Executive Officer</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Experience in the</td>
<td></td>
</tr>
<tr>
<td>Software Quality Management Sector</td>
<td></td>
</tr>
<tr>
<td>0-5 years</td>
<td>5-10 years</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Country</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Sweden</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2: Respondents General Information
The above table (table 2) shows that among the 8 respondents there were 4 TickIT/TickITplus auditors, 3 respondents who were Quality assurance managers and who have taken up other quality management roles and 1 Chief Executive Officer. All the respondents had experience of more than 5 years of which 3 were had experience between 5-10 years, 4 had experience between 10-15 years and 1 had experience greater than 15 years. The responses came in mostly from the United Kingdom which had 4 responses from that country, 2 from Sweden and 1 each from India and the United States.

4.1.2.1 Data Analysis of Survey Respondents

The above set of results indicate that among the people who answered the survey, 50% of the responses have come from the United Kingdom, 25% from Sweden and the remaining fall under the other category. The respondents from Sweden have experience between 5-15 years, while those from the United Kingdom have varying experience levels from 5 years to more than 15 years. This is depicted in the graph below. It shows that majority of the respondents are from United Kingdom and Sweden.

![Figure 3: Summary of Respondents](image)

4.1.2.2 Results of Cost Related Reasons

The results of the respondents towards the second section of the questionnaire are presented in this section. The results are tabulated below.

<table>
<thead>
<tr>
<th>What do you think about the costs incurred for implementing TickITplus?</th>
<th>Very Expensive</th>
<th>Moderate</th>
<th>Cheap</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Do you think the training costs for implementing TickITplus are high?</td>
<td>Yes</td>
<td>Maybe</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>What do you think of the Return on Investment by using TickITplus?</td>
<td>High</td>
<td>Sufficient</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>
On a scale of 1 to 5, how do you rate cost and expenditure as a reason for not adopting TickITplus?

<table>
<thead>
<tr>
<th>Not at all (1)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Very Important (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

**Table 3: Cost Related Reasons**

The above table shows that 5 respondents felt that the costs for implementing TickITplus are very expensive and 3 thought they would be moderate. The training costs were perceived to be high by 4 respondents and 3 said maybe while 1 said no. The return on investment by using TickITplus was considered high by none of the respondents and were considered sufficient by 2 and 6 responses felt it would be low. For the last question, 4 respondents gave a rating of 4 to the question, 2 gave 3 and 2 gave 5, where in 1 means not at all a reason, 2 means a reason of low importance, 3 mediocre level of importance, 4 important and 5-very important reason.

4.1.2.2.1 Data Analysis of Cost related reasons

Among the respondents, 62.5% of them think that the implementation costs for TickITplus are very expensive and the remaining 37.5% think the costs would be moderate while none of the participants thought that TickITplus would not cost much.

**Figure 4: Summary of responses on cost for implementing TickITplus**

This makes it evident that most of the respondents (62.5%) from the survey feel costs incurred for implementing TickITplus are very expensive while not even a single participant has said it is cheap.

In another question where the respondents were asked to give their opinion on the training costs for TickITplus, 50% of them answered it as very expensive, 37.5% felt they are moderate and the remaining 12.5% answered it as cheap (Figure 4).

**Figure 5: Responses for training costs**
From the data collected, we observe that most of the respondent’s impression on the costs for training was very expensive. It shows that the cost of training is also one of the potential reasons for high costs incurred for the implementation of TickITplus.

For the question on the return on investment, the participants were provided with three options to choose from. They are: High, Sufficient and low. 87.5% of the participants answered low while 12.5% of the participants selected the sufficient option. This gives us an idea that, costs apart, return on investment is also another key factor that could have been the reason for not selecting TickITplus.

![Figure 6: Responses for Return on Investment](image)

For the final section of the question, where the respondents were asked to rate on a scale of 1 to 5 on cost and expenditure being a factor for not adopting TickITplus, it recorded an average rating of 4. This shows that the participants who took the survey perceived TickITplus to be expensive and therefore considered it as an important reason for not adopting TickITplus.

### 4.1.2.3 Results of Business Related Reasons

As part of this section, the survey takers answers in response to the question whether the lack of customer interest is the reason for not choosing TickITplus, 5 have said yes and 2 selected partly yes while 1 selected 1 as their response. The respondents have said that TickITplus is applicable for their projects and also all of the respondents are implementing another Software Process Improvement (SPI) model. 6 among the 8 respondents partly admit that the yet to release ISO standard has an impact on opting TickITplus while the other 2 respondents decline it. The table below holds the results for this section of the questionnaire.

<table>
<thead>
<tr>
<th>Is it the lack of customers’ interest to implement TickITplus certification one of the reasons behind not selecting it?</th>
<th>Yes</th>
<th>Partly True</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are you using another Software Process Improvement model?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is TickITplus applicable to your projects?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Table 4: Business Related Reasons Results

<table>
<thead>
<tr>
<th>Does the yet to release ISO 9001:2015 quality standard have an impact on not opting TickITplus owing to the fact that the relation between ISO 9001 standards and TickITplus is strong?</th>
<th>Yes</th>
<th>Partly Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

4.1.2.3.1 Data Analysis for Business Related Reasons

In response to the question, if lack of customer demand is one of the reasons for not selecting TickITplus, 62.5% of the respondents said yes, 25% have admitted that it is partly true and the rest of them have said no. Looking at the pie chart below (Figure 6), we can say that lack of customer’s interest in the scheme is one of the important reasons for not selecting TickITplus. Majority of the respondents have said that it is based on customer’s disinterest that they haven’t taken up the scheme.

![Figure 7: Results on customer demand](image)

From the tabular form above, it is clear that all the respondents were also using another SPI initiative simultaneously and also all of them have admitted that TickITplus is suitable for their projects. This means, the reason behind the survey participants not adopting TickITplus is purely based on their choice of interest and discretion and not because it is not appropriate for their organizational needs.

On investigating the respondents if the yet to release ISO 9001:2015 version has an impact on not opting TickITplus, 75% of the respondents said no and the remaining 25% said partly. From this, it is clear that, most of the survey participants suggest that the upcoming ISO scheme has no impact in the selection criteria of TickITplus.

4.1.2.4 Results of Reasons related to Documentation

The following table given below gives a brief account of the respondents’ opinion about the documentation provided by the TickITplus scheme designers. Five among the eight responses read that the document was too extensive while the remaining 3 felt it was sufficient. When asked if the documentation was difficult to understand, 3
felt it was very difficult, 4 felt it was moderate and the rest felt it was easy to understand.

<table>
<thead>
<tr>
<th>What do you think of the documentation provided by the TickITplus organization?</th>
<th>Insufficient</th>
<th>Too Extensive</th>
<th>Sufficient</th>
<th>Did Not Read</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>5</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is the documentation difficult to understand?</th>
<th>Yes, Very Difficult</th>
<th>Moderate</th>
<th>Easy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5: Documentation Related Reasons

4.1.2.4.1 Data Analysis for the Documentation Section

The respondents were provided with four choices to choose from to rate the documentation provided by the scheme developers. Among the participants, 62.5% of them have selected the too extensive option and the remaining 37.5% have chosen the sufficient option. This shows that the documentation provided is too extensive for the clients to read and understand.

![Figure 8: Responses for Documentation Provided](image)

In another question asked under this section, the respondents were asked if the documentation was difficult to understand, to which 37.5% have said yes, 50% of them felt that the documentation was moderate and the rest of the 12.5% of the participants found the documentation to be easily understandable.

![Figure 9: Difficulty level of Documentation](image)
4.1.2.5 Results of Other General Reasons

The results for few general reasons can further be analyzed with the help of results presented in the table below. The results and analysis of open ended questions are detailed in the further sections.

<table>
<thead>
<tr>
<th>Do you have plans of taking up TickITplus in the future?</th>
<th>Yes, only if the customer demands</th>
<th>Yes, after all the maturity levels come into use</th>
<th>Did not decide</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Were you aware of the changes that were being brought about?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>8</td>
</tr>
</tbody>
</table>

Table 6: Other General Reasons

Apart from the above two questions, there is also an open ended question in this section of the questionnaire.

4.1.2.5.1 Data Analysis of General Questions and Open Ended Questions

In the final section, when the respondents were presented with the question if they have plans of taking up TickITplus in the future, 87.5% of them have selected the option ‘yes, only if the customer demands’ and the remaining 12.5% have said they would consider the possibility of taking up TickITplus once all the maturity levels come into use. When enquired if they were aware of the changes being brought about all of the respondents said yes.

The analysis of open ended questions was done by providing a narrative explanation of the responses obtained. Initially, the idea was to conduct a formal data analysis using thematic coding but because of low rate of responses, the responses gathered were different from one another and it was not possible to identify frequently occurring terms and code them according to the principles of thematic coding[49].

Responding to the open ended question, one of the respondent said that “my company did not go with TickITplus as we didn’t know/understand if it would bring us more business and also to date no contracts have required TickITplus.”

The above response indicated that it wasn’t clear enough for the organization whether adopting TickITplus would enhance the chances of getting business and also the participant also mentions that there have not been any contracts which needed TickITplus until now which means there hasn’t been much response from customers towards TickITplus.

In another response, the survey participant has said that “Considering TickITplus as an expensive route to go down than its previous version (TickIT), we aren’t sure if there is perceived value for business and also from an internal perspective I think TickITplus processes should be more robust. Too extensive documentation was difficult to comprehend and was a major let down which has made us even more confused if there would be any benefit by choosing the scheme.”

The respondent has mentioned in his answer that the scheme needs to be more robust which means from the participant’s perspective the present scheme isn’t strong enough and also the documentation is too extensive and difficult to understand making it unclear for the participant’s organization whether to go for the new scheme. He/She has also mentioned that TickITplus is more expensive than TickIT but weren’t sure if
they would receive more business. These were the reasons highlighted by the respondent for not selecting TickITplus.

4.2 Results and Data Analysis of Survey Questionnaire 2 [SQ 2]

Similar to the previous sub section (4.1), this section is also further divided into two sub-sections. The first part gives an account of the design and motivation of the questions present in the questionnaire and the second part reports the results obtained. As already mentioned in the previous chapters, this questionnaire was designed considering the organizations which are TickITplus certified and were circulated to those organizations alone.

4.2.1 Designing the Survey Questionnaire [SQ 2]

Like already mentioned, this questionnaire was designed primarily to answer the third research question i.e., to identify the reasons behind organizations adopting the new TickITplus scheme. The questionnaire was also framed in such a way that the results gathered from this SQ2 would also give certain inputs to answer the first two research questions. The questionnaire is divided into a total of 6 sections with each section having few sections. Help text to answer the questions is provided wherever needed.

Section I: This section has three questions which gather the basic information of the organizations. The questions give information about the size of the organization, and the size of the organization using TickITplus and the country where the organization is located.

Section II: This section relates to the cost related questions. There are three questions designed to determine the costs incurred, the training costs and the return on investment by implementing the TickITplus scheme.

Section III: The respondent faces business related questions in this section of the questionnaire. The questions are framed in order to find whether the choice of selecting TickITplus was based on customer’s demand or not. A question also helps in investigating if the use of TickITplus appropriately covered their organizational needs.

Section IV: The fourth section of SQ2 holds questions which investigate whether the use of TickITplus has improved the organizations’ software process quality and also if the concept of multiple standards under one certification scheme has an added advantage. These questions are framed in order to know the experiences after implementing the scheme.

Section V: This has questions relating to the documentation provided by the TickITplus scheme designers. We made an attempt to investigate whether the provided documentation was sufficient and easy to understand and also if it elevated the changes that have been brought about and how they would benefit the organization. The questions in this section were framed to identify if the documentation provided was able to motivate the organizations to take up the scheme and also we wanted to see if we could develop any sort of relationship with the results we obtain from SQ1.

Section VI: The last section of the questionnaire is basically a general section with an open ended question giving the respondents an opportunity to add further comments related to the survey based on their interest and also a closed ended question to identify if the given transition time of 3 years was sufficient.

4.2.2 Results and Data Analysis of Survey Questionnaire 2 [SQ 2]

This sub section depicts the results gathered from conducting the survey. A total of 23 responses have been recorded in the scheduled survey period. The survey was
broadcasted to 70 companies which were TickIT plus certified via e-mails. The e-mail addresses of the concerned personnel who were responsible in the adoption of the scheme were gathered by contacting the organizations from their respective organization’s websites.

This section also presents the data analysis of the collected responses. The data is analyzed by using either univariate or bivariate analysis methods depending on the need. Bivariate analysis is used considering the possibility of a potential relationship with the size of an organization and the rest of the results obtained. Similar to the analysis of the previous questionnaire, it is done by using bar graphs and pie charts wherever necessary.

4.2.2.1 Results for Basic Information of Organizations

The survey was sent to 70 TickITplus certified firms of which 23 have responded. The results of the basic information of the organization are tabulated below in this section. Among the respondents most of the responses have come from the United Kingdom. As many as 18 organizations belonged to the UK, 3 from the Sweden and 2 from other locations. The respondents have stated their size of the organization in the following way, 5 small, 7 medium, 9 large and 2 huge organizations. Among these we have also gathered the information regarding the size of the organization using TickITplus. The responses were as follows, 11 small, 8 medium, 4 large and none of them fell under the huge category.

<table>
<thead>
<tr>
<th>Number of organizations contacted</th>
<th>70(100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of responses</td>
<td>23(~33%)</td>
</tr>
<tr>
<td>Size of the Organization</td>
<td></td>
</tr>
<tr>
<td>1-100(small)</td>
<td>5(~22%)</td>
</tr>
<tr>
<td>100-500(medium)</td>
<td>7(~30%)</td>
</tr>
<tr>
<td>500-2000(large)</td>
<td>9(~39%)</td>
</tr>
<tr>
<td>&gt;2000(huge)</td>
<td>2(~9%)</td>
</tr>
<tr>
<td>Size of the organizations using TickITplus</td>
<td></td>
</tr>
<tr>
<td>11(~48%)</td>
<td></td>
</tr>
<tr>
<td>8(~35%)</td>
<td></td>
</tr>
<tr>
<td>4(~17%)</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>18(~78%)</td>
</tr>
<tr>
<td>Sweden</td>
<td>3(~13%)</td>
</tr>
<tr>
<td>Other</td>
<td>2(~9%)</td>
</tr>
</tbody>
</table>

Table 7: Basic Information of organizations

4.2.2.1.1 Data Analysis for Summary of Responses

Of the 70 organizations that have been contacted, 23 companies have responded by answering the survey questionnaire which is ~33% response rate. Among the 23 organizations which responded back the division of the size of the companies is as follows: small (22%), medium (30%), large (39%) and huge (9%). Further the data of size of the organizations using TickITplus is also gathered which reported as follows: small (48%), medium (35%) and large (17%). It was observed that most of the responses belonged to the United Kingdom region. As much as 78% of the total responses came from the United Kingdom. Sweden stood in the subsequent position with a response rate of 13% and other countries contributed to the remaining 9%.
From the above pie-graph (Fig. 9), it is evident that most of the responses have come from the United Kingdom. This shows that the new TickITplus scheme is mostly used across the UK when compared to the other countries.

The stacked bar graph below (Fig. 10) shows the break-up of the data based on sizes and country.

![Figure 10: Summary of Responses based on Country](image)

4.2.2.2 Results for Cost Related Questions

The below table gives details about the results related to the costs incurred by implementing the TickITplus scheme. The perception of the respondents from the organizational perspective whether the costs incurred for implementing, training where very expensive, moderate or cheap. Another question showcases the results on the return on investment by using the scheme.

<table>
<thead>
<tr>
<th>What is your perception over the costs incurred for implementing TickITplus?</th>
<th>Very Expensive</th>
<th>Moderate</th>
<th>Cheap</th>
</tr>
</thead>
<tbody>
<tr>
<td>15(65%)</td>
<td>6(26%)</td>
<td>2(9%)</td>
<td></td>
</tr>
</tbody>
</table>
What do you think of the training costs for implementing TickITplus?

<table>
<thead>
<tr>
<th></th>
<th>Very Expensive</th>
<th>Moderate</th>
<th>Cheap</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10(43%)</td>
<td>9(39%)</td>
<td>4(18%)</td>
</tr>
</tbody>
</table>

What do you think of the Return on Investment (ROI) by using TickITplus?

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Low</th>
<th>Sufficient</th>
<th>Didn’t do an ROI assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>3(12%)</td>
<td>4(18%)</td>
<td>16(70%)</td>
</tr>
</tbody>
</table>

Table 8: Results for Cost Related Questions

4.2.2.2.1 Data analysis of Responses for Cost Related Questions

Among the 23 people who have taken the survey, 65% of them have said that the costs for implementing TickITplus was very expensive, 26% found the cost moderate as in not too expensive nor cheap. The remaining 9% felt it was not expensive and cheap. This data is cross-tabulated with the size of the organizations from the previous section and analyzed in an attempt to find a possible co-relation between the data. This data is presented in the tabular form below and the same is depicted using a stacked bar graph.

<table>
<thead>
<tr>
<th>Size</th>
<th>Very Expensive</th>
<th>Moderate</th>
<th>Cheap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (1-100)</td>
<td>8</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Medium (100-500)</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Large (500-2000)</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Huge (&gt;2000)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 9: Cross Tabular Analysis for Cost Related Questions

From the above table and graph, it is visibly clear that most of the small and medium sized organizations found the scheme very expensive. Among the organizations which found the scheme cheap were those organizations whose size of the organization using TickITplus was between 500-2000 and the overall size of the organization was >2000, i.e., huge. Thus, based on the responses gathered, while the small and medium sized organizations perceived the costs incurred to be very expensive, the huge organizations reckoned it to be cheap.
For the next question, a similar analysis was taken up by considering the size and the participant’s opinion on the training costs and it was noticed that most of the small and medium sized organizations thought that the training costs were expensive and moderate and the large organizations perceived the costs to be cheap. The details of the same are reported in the table below.

<table>
<thead>
<tr>
<th>Size</th>
<th>Very Expensive</th>
<th>Moderate</th>
<th>Cheap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (1-100)</td>
<td>8</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Medium (100-500)</td>
<td>2</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Large (500-2000)</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Huge (&gt;2000)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 10: Cross Tabular Analysis for Training costs

Among the 4 companies which responded saying the training costs were cheap, all the 4 of them were organizations which had 500 to 2000 people (large). Most of the small companies responded saying training costs were very expensive while the medium sized organizations reported the costs as moderate.

For the question on Return on Investment (ROI), 70% of the respondents have said that the organization hasn’t conducted any ROI analysis as yet.

An open ended question was also included in this section, asking the respondents whether they have considered the cost parameter while selecting TickITplus and also asked them if they had anything else to speak about cost factor, to which five of them have answered. The participants have mentioned the following in their responses: the organization has presumed TickITplus to be an expensive affair but we had to be TickITplus certified based on customer’s demand. One of them had responded saying, “although we predicted it would be expensive, the cost incurred was higher than what we had expected and also the time taken for the process took longer than initial predictions thus increasing the cost and effort needed for completing the certification process.” Most of the participants said that they being newly certified, they haven’t yet conducted a formal ROI analysis. One of them commented about the training costs saying, “There weren’t many training organizations in India who could train the people, this made it difficult and expensive as we had to get a certified third party auditor.”

4.2.2.3 Results for Business Related Questions

The business related questions section provides the results whether the choice of taking up TickITplus was based on the customers’ demand and had it not been for the customers’ requirement wouldn’t they have selected the scheme. This section also gives the results about whether TickITplus has appropriately covered the
organizational needs. The details of the results are formulated in the below tabular form.

<table>
<thead>
<tr>
<th>Was it based on customer demand that you chose TickIT plus certification?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>16(70%)</td>
<td>7(30%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Had it not been for customer's demand, would you have opted TickIT plus?</th>
<th>Yes</th>
<th>No</th>
<th>Maybe</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>13</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are you using any other Software Process Improvement Model?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Do you think the auditing process of TickIT plus has appropriately covered your needs?</th>
<th>Yes</th>
<th>Partly</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>13</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Table 11: Results for Business Related Questions

4.2.2.3.1 Data Analysis for Questions related to Business

The data analysis for this section is done by using the univariate analysis method as a logical cross tabular analysis cannot be established for the questions. In response to the question, if it was based on customer’s demand that an organization has taken up TickITplus, 70% of the participants have said yes and the remaining have answered no.

![Customer Demand as a reason for opting TickITplus](image)

Figure 14: Customer Demand as a reason for opting TickITplus

The graph above (Fig. 13) clearly depicts that 70% of the respondents have adopted TickITplus based on customer demand. In the following question, participants were questioned if they would have adopted TickITplus if the customer didn’t ask them to then most of the respondents have said no (57%) and 13% of the participants have said maybe and the rest said yes. To the question if their organization are using any other software process improvement model, all of them have answered yes. In another question from this section, where the participants were asked if the use of TickITplus has covered their needs appropriately, very few of them have said yes (26%) while most of them (57%) felt the scheme has only partly covered their needs and the rest say it wasn’t up to the mark by selecting no (17%). This shows that the organizations are not all pleased with the scheme.

4.2.2.4 Results for Quality Concerned Questions

Majority of the respondents answered that using TickITplus has shown improvement but wasn’t satisfactory. Similarly, the concept of the scheme being based on multiple international standards has not shown a great impact on the quality of the process is what most of the respondents had said. A more clear result set is tabulated in the below table.
Did the use of TickITplus improve the quality of your software process?

<table>
<thead>
<tr>
<th>Yes, there has been a considerable improvement</th>
<th>There was improvement but not satisfactory</th>
<th>No, there was no notable improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>12</td>
<td>9</td>
</tr>
</tbody>
</table>

The concept of having the scheme based on multiple international standards (9001, 20000, 27001). Does it have a positive impact on the quality of the process?

<table>
<thead>
<tr>
<th>Yes, to a great extent</th>
<th>Mediocre level of impact</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>19</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 12: Results for Quality Concerned Questions

4.2.2.4.1 Data Analysis for Quality Concerned Questions

This section was basically included to get a short feedback on whether the implementation of TickITplus has shown a positive impact on the organization’s software process. Considering this question, 52% of the respondents said that there was improvement but not satisfactory and another 39% of the participants have said that there was no notable improvement. This proves to be major concern as the participants who felt there has been considerable improvement were to less. A cross tabular analysis was made with the size of the organizations and the result is depicted in the graph below.

Figure 15: Cross Tabular Analysis between size and impact of the scheme

From the above graph (Fig. 14) we can see that all of the medium sized organizations have experienced some sort of satisfactory improvement in the quality while most of the small organizations claim that most of the organizations haven’t. Based on the data gathered it can be said that medium sized organizations have seen some benefit from the scheme when compared to the other organizations.

One of the key enhancements that the TickITplus guide boasts about is the provision of getting certified to multiple standards. Upon asking the survey respondents about the impact of this attribute, most of them (83%) have said that it has had an average level of impact. This represents that the change has made an impact to a certain extent on the improvement of process quality.
4.2.2.5 Documentation Related Questions’ Results

The results related to the respondents’ perception about the documentation provided by the TickITplus scheme developers is tabulated in the below table. Most of the respondents have stated that the documentation was too extensive. Further, the results are elucidated in the table below.

<table>
<thead>
<tr>
<th>What do you think of the documentation provided by the TickITplus organization?</th>
<th>Insufficient</th>
<th>Too Extensive</th>
<th>Sufficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>16(70%)</td>
<td>7(30%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Was the provided documentation difficult to understand?</th>
<th>Yes, Very Difficult</th>
<th>Moderate</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>12</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Was the documentation clear enough in elevating the changes that have been brought about in TickITplus and how it would benefit your organization?</th>
<th>Yes</th>
<th>Partially</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>15</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Table 13: Results for Questions Related to Documentation

4.2.2.5.1 Data Analysis for Questions Related to Documentation

For the question on the participant’s perception about the content in the documentation provided 70% of them answered saying it was too extensive and the rest 30% of the participants felt the documentation was sufficient. For the query, if the documentation was difficult to understand, 52% of the participants responded saying that the documentation was moderate i.e., it was neither difficult nor easy to understand. It was most of the respondents’ (65%) opinion that the documentation was only partially clear in elevating the changes that have been brought about and how it would benefit the organization. This information implies that the documentation provided was too extensive making it difficult for the organizations to actually notice the advantages the scheme offers.

4.2.2.6 Other General Questions

The section has two questions, one of which is an open ended question. The results and data analysis of the open ended questions are explained in this section. The other question investigates whether the given time period of 3 years was sufficient for the adoption and transition to the new scheme for which many of the respondents have said yes.

Few of the respondents have provided further inputs into the implementation and choice of selection of the new TickITplus scheme. A total of 6 respondents have responded to this question providing us with more data and information.

4.2.2.6.1 Data Analysis for Open Ended Questions

The analysis of open ended questions was done by providing a narrative explanation of the responses obtained. Initially, the idea was to conduct a formal data analysis using thematic coding but because of low rate of responses, the responses gathered were different from one another and it was not possible to identify frequently occurring terms and code them according to the principles of thematic coding[49].

In one of the responses, the participant had said the following: “The level of effort required to implement the significant change from the basic TickIT to the single
The respondent presents the drawback mentioning about the effort required to move to TickITplus from TickIT as excessive. This was even more observed because the choice of moving to TickITplus wasn’t based on customer demand and that the customer wasn’t aware of the scheme or the overhead as product cost.

In another response from one of the respondent, the following information regarding TickITplus was mentioned: “We at our organization have no intention to proceed no further than foundation level due to the added cost, and also we haven’t yet considered renewing it at the end of our current certification cycle. The alignment to ISO 9001 is very poor in a number of places requiring the organization to increase the complexity and overhead of our quality management system.”

In his response, the respondent explicitly mentions that the alignment to ISO 9001 is very poor in a number of places which has made the organization’s quality management system more complicated. He has also specified that their organization has no plans of moving up the maturity level because of the added costs which signifies the expenditure incurred for implementing TickITplus.

From another participant’s perspective, he has put forth his opinion by adding the following comment: “More time should have been put on marketing, packaging and simplifying the terms and concept. It is still not understandable for a software company why TickITplus should be adopted. And also, not many of our customers are not aware of TickITplus. Well, considering cost, we have seen it as complicated - that is unfortunately the biggest obstacle in my view.”

From the above answer he/she is pointing out at the documentation provided saying it could have been framed in a more easier way by simplifying the terms and costs. The participant also adds in the response that cost factor has been their organization’s biggest obstacle. He has also mentioned about marketing the scheme more as most of the customers are not aware of TickITplus which made it further difficult to find business.

Based on the opinions of the remaining respondents, they had mentioned about the choice of selecting TickITplus and mentioned that they were certified to ISO 9001 through TickIT and had taken up TickITplus so as to not lose the certification. Speaking of costs, one of them has said the following, “We see it as a necessary cost of doing business. Although we haven’t noticed any improvement yet, I think the emphasis on improvement means it is likely to pay for itself in the long run.” Further, in a similar response from one of the respondents, the following information in addition to the survey responses was added: “I think the TickITplus scheme has been a shock to the companies system, whilst so far an improvement in quality has been difficult to see, the realization of what is really required seems to have dawned at last and I expect to a dramatic change over the next year. Once it becomes possible to move up the capability levels, I expect that there will be great improvement as we start to measure process effectiveness.” Here both the respondents’ mention that getting certified was viewed as necessary costs from the organization’s perspective which means they would lose business if they didn’t get certified to TickITplus. Considering the impact of the scheme, the participants elucidates that there hasn’t been any notable improvement as yet but are expecting there would be an improvement in the future.

Further, the results and data analysis of the interviews are detailed in the next chapter.
5 RESULTS AND DATA ANALYSIS OF INTERVIEWS

This section of the document provides the data analysis of the results obtained from conducting the interviews.

5.1 Interviews

As mentioned in the previous chapter, this section presents the results and the data analysis of the interviews conducted. A total of three interviews were conducted with three different respondents from different organizations. All the respondents belonged to TickITplus certified organizations from the United Kingdom. All three interviewees were asked a set of questions similar to the survey questionnaire 2. The questions were directed with an expectation to provide more evidence to the responses of the results from the questionnaire and also correlate to the results of the survey questionnaire 1. Additionally, the interviews also give a brief insight towards the challenges faced while implementing TickITplus, the advantages and disadvantages that were identified while implementing the scheme.

The interviews were conducted telephonically followed by a few follow up emails for certain general information. The interviewees were promised full anonymity for genuine results. A set of questions were framed for the interview and further they were posed with a few spontaneous questions whenever needed.

5.1.1 Interview Questions and their motive

Like already mentioned the questionnaire was framed in order to complement the survey questionnaire 2 and also to able to correlate the interview responses with the first questionnaire. The questions designed were semi structured and could evolve based on the responses of the interviewee.

5.1.1.1 How is TickITplus different from other schemes

This question was framed in order to know the respondent’s perception of why their organization has selected TickITplus, thus it proves to be a potential contribution towards answering third research question (RQ3).

5.1.1.2 Information and Documentation provided about TickITplus

This question was also designed to complement the survey responses regarding the documentation provided by TickITplus. It was also framed to gather more concrete details on whether the documentation provided was convincing enough and if they thought it would bring in more business.

5.1.1.3 Costs incurred for Implementing and Maintaining

The question was asked to know the costs incurred for implementing and maintaining the scheme. They were also questioned if they felt it was expensive or not. Respondents were also asked to consider training costs and were also investigated if they have calculated the Return on Investment and whether it was commendable. Thus, going by the description it is clear that this question was framed in order to provide support to the survey responses of SQ2 and also provide inputs to SQ1.
5.1.1.4 Main reasons behind choosing TickITplus

This question was framed to provide strong answers to the third research question. The interviewees were also asked if they have conducted any formal assessments like cost to benefit analysis, survey analysis etc., before selecting this scheme.

5.1.1.5 Challenges while implementing TickITplus

This question was framed in order to find the difficulties that the organization might have faced while implementing TickITplus. This would give us few potential set of challenges and thereby might help in providing inputs as to why many organizations haven’t adopted TickITplus.

Apart from the above set of questions, the respondents were also asked few general questions like, size of the organization, size of the organization implementing TickITplus, interviewee’s role in implementing TickITplus, country and experience in the field of Software Quality Management/ Assurance.

5.1.2 Introduction to Interviewee 1

The first interviewee has worked for over 25 years and has taken up several quality roles in the software engineering sector. He has 15 years of Software Quality Management experience and also experience in implementing TickIT. His role in implementing TickITplus is that he has led the implementation. He was responsible for evaluated the benefits of transitioning from TickIT to TickITplus, prepared business justification, prepared PRM and coordinated training and deployment across applicable teams. The interview took 27 minutes of time.

5.1.3 Introduction to Interviewee 2

Started as a software engineer, the respondent has then moved to the quality department in the year 2007. She has qualified as a lead TickIT auditor. Through BSI, she became involved in the TickITplus implementation and qualified as a TickITplus Foundation level Practitioner in 2011. As a project manager in the implementation of TickITplus, she has also led the company she is working for through the transition to TickITplus in October 2013. The interview went on for 22 minutes approximately.

5.1.4 Introduction to Interviewee 3

The third interviewee is currently working as a quality manager at her software firm. She has started of her career as a lead tester in 2001 and later in the year 2005 moved to the quality management field in software engineering. Over the past 14 years of her career she has been part of several projects and has assisted in improving quality. She has led the team during their organization’s transition from TickIT to TickITplus. The interview was 18 minutes long.

5.2 Results and Data Analysis of Interviews

From the introduction of the three interviewees we can see that all of them are well experienced and are a part of the organization which was once certified based on the TickIT guidelines. Like already mentioned, they were telephonic interviews followed by a few follow up mails. The transcripts were hand written while interviewing the respondents as the respondents did not accept to take down audio transcripts. As
mentioned in the research approach chapter (chapter 2) it was a semi structured interviews with a possibility of questioning the interviewees in between to clarify certain things, if needed. The authors have provided elaborate answers for all the questions which are briefed below.

The analysis of the interviews follow a thematic model called thematic analysis. Braun and Clarke define thematic coding as a method for identifying, analyzing and reporting themes in a set of data[49][50]. Thematic analysis and grounded theory are one among the most used data analysis methods is empirical research. Grounded Theory is difficult to perform by novice researchers[50] and also it looks for relationships with the process of constant comparison, the comparison is continued until we reach a saturation[49]. In the present context, owing to lack of experience in the research field and also because we aren’t comparing but trying to investigate and find reasons for not selecting/selecting TickITplus, thematic analysis is appropriate as a qualitative data analysis method.

We have followed a step by step approach to analyze the collected data. The step by step process not only gives concrete analysis but also helps in validating the data appropriately and can produce reliable conclusions. As suggested in the article by Anne Lacey and Dona Luff[49], qualitative data analysis is carried out in the following steps:

- Transcription
- Organizing the data
- Familiarization
- Coding
- Themes

5.2.1 Transcription, Organizing and Familiarizing with Data

Transcription refers to jotting down or taking notes in hand written, audio or video transcripts of what the interviews say. All the data transcripts were maintained without missing out any text in order to avoid bias[49]. The transcripts were hand written and not audio or video transcribed. The reason for not going for audio or video transcription is that, the interview participants’ reluctance. By not taking audio notes it was a blessing in disguise because I had to pay more attention while taking down the notes and by doing so, most of the clarifications were cleared simultaneously. This phenomenon is also supported in the article[51] by EJ Halcomb et al., Therefore all the transcripts were hand written.

The next step following transcription was organizing data. The data collected from the three respondents were organized for easy retrieval of data during analysis. The responses were separated from one another and the interviewees were given labels. The interviewees were labeled INT1, INT2 and INT3.

Familiarization of the data has been initiated since the very beginning. The transcripts were read several times for a clear understanding of the data collected. After these three steps, the next two steps form the heart of the analysis which interprets the results giving concrete conclusions.

5.2.2 Coding and Themes

Coding was done after transcription of the data, organizing the data and getting familiar with the data in hand. The process of identifying codes was done manually by examining the transcripts. Each question was coded separately. The codes were identified by highlighting each code with a different color (Figure). Once the codes were identified, similar and relevant codes were grouped to themes. This section identifies and finds the themes and the further analysis about the identified themes is made in the next sub section (Section 5.5).
As seen in the above figure, each code is highlighted using a different color and are further grouped and categorized into themes. This way, the unstructured data was analyzed to more concrete and proof driven results.

### 5.2.2.1 Codes and themes identified for Question 1:

A total of 10 codes have been identified. The frequency of each code has varied from one another. Only those codes which were relevant to the research and those which were frequently occurring are selected. Here, relevance means that part of text is identified from the literature. The codes are then categorized into themes. The below tables show the details of the codes identified, the criteria for selecting the codes and the themes into which they were categorized.

<table>
<thead>
<tr>
<th>Codes Identified</th>
<th>Code Inclusion Criteria</th>
<th>Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>TickITplus</td>
<td>Frequency, Relevance</td>
<td>Multiple themes</td>
</tr>
<tr>
<td>CMMI</td>
<td>Frequency</td>
<td>Choice of selecting TickITplus</td>
</tr>
<tr>
<td>TickIT</td>
<td>Frequency, Relevance</td>
<td>Choice of selecting TickITplus</td>
</tr>
<tr>
<td>Standard</td>
<td>Frequency</td>
<td>Choice of selecting TickITplus</td>
</tr>
<tr>
<td>ISO 9001</td>
<td>Frequency, Relevance</td>
<td>Choice of selecting TickITplus</td>
</tr>
<tr>
<td>Expectations</td>
<td>Frequency</td>
<td>Effectiveness of the scheme</td>
</tr>
<tr>
<td>Met</td>
<td>Frequency</td>
<td>Effectiveness of the scheme</td>
</tr>
<tr>
<td>Customer requirement</td>
<td>Frequency, Relevance</td>
<td>Choice of selecting TickITplus</td>
</tr>
<tr>
<td>Improvement</td>
<td>Frequency</td>
<td>Choice of selecting TickITplus</td>
</tr>
<tr>
<td>Certification</td>
<td>Frequency</td>
<td>Choice of selecting TickITplus</td>
</tr>
</tbody>
</table>

**Table 14: Code and Themes for Question 1**

Based on the codes, two themes have been developed into which the codes are divided into, they are: choice of selecting TickITplus and the effectiveness of the
scheme. All the codes identified either relate to the choice of selecting TickITplus or speak about the effectiveness of the scheme.

5.2.2.1 Analysis for responses given to question 1

A total of 10 codes were identified which are categorized into 2 themes, here in this section, the significance and the grouping of the codes into the themes are elucidated. The themes, like already specified were identified to be effectiveness of the scheme and choice of selecting TickITplus.

Effectiveness of scheme: The codes, ‘TickITplus’ ‘expectations’ and ‘met’ are grouped under this theme. Among the three interviewees, two of them have said that, “there has not been any noticeable improvement as yet and I don’t think it has met our organization’s expectations.” However, one among the two who have said that the scheme hasn’t met the organization’s expectations has also mentioned that as they were still in the early stages to come to a conclusion they expect the scheme to be more productive in the future. One of the respondents has said that the scheme has met their organization’s expectations.

Choice of Selection: The codes TickITplus, TickIT, CMMI and ISO were categorized under this theme as the interviewees were either referring or comparing TickITplus to rest of the aforementioned codes. Two of the interviews have mentioned that they have compared TickITplus with CMMI in choosing TickITplus as their scheme. One of the interviewee has also mentioned that they have selected TickITplus over CMMI based on two reasons as it was their customer’s demand and the other being cost. She has stated that, “TickITplus (ISO 9001) is definitely more expensive to implement than TickIT was, but it still does not have the level of overhead that CMMI would, even to get to level 2.” The interviewee says that TickITplus is expensive than TickIT but relatively less expensive when compared to CMMI. In another statement made by one of the participant, he commented by saying, “As we are certified against TickIT when it was being obsolete we felt it was the natural progression to go for TickIT plus.” Here the interviewee states that they have adopted TickITplus as they were TickIT certified before and felt that it was natural to move to the new scheme, as on not doing so the organization would lose their existing TickIT certification.

5.2.2.2 Codes and Themes for question 2

Similar to what has been done to question 1, codes and themes were identified accordingly with the same code inclusion criteria. This question was framed in relation with the documentation and information provided and to investigate whether it was easy to understand and convincing enough for them to select the scheme. The below tabular form showcases the results of codification and themes developed from the codes.

<table>
<thead>
<tr>
<th>Codes Identified</th>
<th>Code Inclusion Criterion</th>
<th>Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documentation</td>
<td>Frequency, Relevance</td>
<td>About documentation</td>
</tr>
<tr>
<td>Business</td>
<td>Frequency</td>
<td>Business related</td>
</tr>
<tr>
<td>Good</td>
<td>Frequency</td>
<td>About documentation</td>
</tr>
<tr>
<td>Clear</td>
<td>Frequency</td>
<td>About documentation</td>
</tr>
<tr>
<td>Confidence</td>
<td>Frequency, Relevance</td>
<td>Business related</td>
</tr>
<tr>
<td>Future, early days</td>
<td>Frequency</td>
<td>Business related, About Documentation</td>
</tr>
<tr>
<td>Customers</td>
<td>Frequency</td>
<td>Business related</td>
</tr>
<tr>
<td>Information</td>
<td>Frequency, Relevance</td>
<td>About documentation</td>
</tr>
</tbody>
</table>

Table 15: Codes and Themes for Question 2
8 codes were identified based on the responses from the three interviewees which were categorized into two themes namely “about documentation” and “Business related”.

5.2.2.2.1 Analysis for Question 2

All the codes were either categorized into the ‘Business related’ theme or ‘About Documentation’ theme.

Business related: Two among the three interviewees have said that when they have decided to adopt TickITplus, they haven’t considered whether or not TickITplus would bring more business. One of them said that they had considered moving to TickITplus as a necessary step and would atleast retain existing customers and also would increase customer confidence. One of the three has also mentioned that it was clear from the documentation that the benefit from TickITplus would be realized over the long run. These statements gave rise to the codes business, customers, future and confidence under this theme as they were speaking about finding more business in the future.

About Documentation: The usage of words like good and clear while speaking about the documentation by two of the users made them fall under this theme. Two of the three interviewee’s have direct specified their opinion on the documentation provided as good and clear. In another instance where the word good was used was when the other interviewee has stated that the documentation provides good details of the framework and also the clear description of the introduction of capability assessment concepts.

5.2.2.3 Codes and themes for Question 3

The text was color coded similar to how it was done previously in order to identify codes. A list of 16 codes was identified based on the responses. These codes were further grouped into five themes named ‘comparing costs’, ‘calculate costs’, ‘costs incurred’, ‘about ROI’ and time and effort.

<table>
<thead>
<tr>
<th>Codes Identified</th>
<th>Code Inclusion Criteria</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>TickITplus</td>
<td>Frequency, Relevance</td>
<td>Multiple Themes</td>
</tr>
<tr>
<td>TickIT</td>
<td>Frequency, Relevance</td>
<td>Comparing costs</td>
</tr>
<tr>
<td>Cost</td>
<td>Frequency, Relevance</td>
<td>Comparing costs</td>
</tr>
<tr>
<td>Expensive</td>
<td>Frequency, Relevance</td>
<td>Comparing costs, Costs incurred</td>
</tr>
<tr>
<td>Calculate</td>
<td>Frequency, Relevance</td>
<td>Costs incurred, About ROI</td>
</tr>
<tr>
<td>Implement</td>
<td>Frequency, Relevance</td>
<td>Costs incurred</td>
</tr>
<tr>
<td>Maintain</td>
<td>Frequency, Relevance</td>
<td>Costs incurred</td>
</tr>
<tr>
<td>Reasonable</td>
<td>Frequency</td>
<td>Costs incurred</td>
</tr>
<tr>
<td>Happy</td>
<td>Frequency</td>
<td>Costs incurred</td>
</tr>
<tr>
<td>Assuming</td>
<td>Frequency</td>
<td>Costs incurred</td>
</tr>
<tr>
<td>Business</td>
<td>Frequency</td>
<td>Costs incurred</td>
</tr>
<tr>
<td>Return On Investment</td>
<td>Frequency, Relevance</td>
<td>About ROI</td>
</tr>
<tr>
<td>Longer</td>
<td>Relevance</td>
<td>Time and effort</td>
</tr>
<tr>
<td>Train the trainer</td>
<td>Relevance</td>
<td>Costs incurred</td>
</tr>
<tr>
<td>Increase</td>
<td>Frequency</td>
<td>Costs incurred</td>
</tr>
<tr>
<td>More</td>
<td>Frequency</td>
<td>Costs incurred</td>
</tr>
</tbody>
</table>

Table 16: Codes and themes based on cost factor
5.2.2.3.1 Analysis of Cost Related Questions

The codes identified are divided into 4 themes depending on what the codes mean. Here, the description and significance of the identified themes are explained. TickITplus is categorized into all the 4 themes since, the whole discussion is about TickITplus and it is obvious it is occurred quite frequently during the interview.

Costs incurred: Majority of the codes identified are categorized under this theme. All the three respondents were specifically speaking about the costs incurred and their perspective from an organizational point of view. One of them has said the following in the interview: “I think that if TickITplus is embraced and used to drive improvement, then it can be very valuable and cost effective, but if a company regards it as a ‘maintaining a tick in the box’ exercise, then it will be expensive and difficult to sustain considering the frequent audits and the additional costs associated in maintaining it.” In the statement, the respondent from their organizational perspective clearly explains that the costs incurred for implementing TickITplus can be appropriate and useful but if an organization plans to maintain it then it can be a burden. When the participant was asked if they have considered the cost parameter while considering TickITplus and what their assumptions of the price where, the participant responded by saying that they had considered TickITplus as a necessary cost and thought they would lose few of their key customers. Although there hasn’t been any great level of noticeable improvement as of now, they are assuming that there would be considerable level of improvement as they move up the maturity level. In another response for the same question, another interviewee cites by saying: “We are happy with associated costs assuming that there is a benefit to the company, internally and via increased business.” Thus, it is clear from their responses that the organizations are hoping to reap benefits in the future though they haven’t seen any improvement as yet. In another response to the question regarding the training costs, one of them cited that they predicted the cost for training to be high and in order to minimize the costs they have adopted a concept called ‘train the trainer’, where a couple of personnel from the organization get trained as certified practitioners and train a set of people internally by transferring the knowledge. This proves that the organization has predicted the costs incurred for training to be high which has pushed them to take up such cost cutting steps. When the interviewee’s were asked if they have conducted any cost-benefit analysis before adopting TickITplus and if they have conducted any ROI assessment, all of them have answered by saying no.

5.2.2.4 Coding and Themes for reasons for selecting TickITplus

From the coding process, 13 codes have been identified based on the frequency of the appearance and relevance to the research. Further, they were grouped into one single theme named choice of selection as shown in the tabular form below.

<table>
<thead>
<tr>
<th>Codes Identified</th>
<th>Code Inclusion Criteria</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>TickITplus</td>
<td>Frequency, Relevance</td>
<td>Choice of selection</td>
</tr>
<tr>
<td>TickIT</td>
<td>Frequency, Relevance</td>
<td>Choice of selection</td>
</tr>
<tr>
<td>Cost and Time</td>
<td>Relevance</td>
<td>Choice of selection</td>
</tr>
<tr>
<td>Effective framework</td>
<td>Relevance</td>
<td>Choice of selection</td>
</tr>
<tr>
<td>CMMI</td>
<td>Frequency</td>
<td>Choice of selection</td>
</tr>
<tr>
<td>ISO 9001</td>
<td>Frequency</td>
<td>Choice of selection</td>
</tr>
<tr>
<td>Certification</td>
<td>Frequency</td>
<td>Choice of selection</td>
</tr>
<tr>
<td>Customer requirement</td>
<td>Frequency, Relevance</td>
<td>Choice of selection</td>
</tr>
<tr>
<td>Formal analysis</td>
<td>Frequency, Relevance</td>
<td>Choice of selection</td>
</tr>
<tr>
<td>Felt</td>
<td>Frequency</td>
<td>Choice of selection</td>
</tr>
</tbody>
</table>
5.2.2.4.1 Analysis for the question on the Choice of Selection of TickITplus

The interviewee respondents were faced with a question on why they have embraced TickITplus. All of the respondents had one answer in common which is ‘based on customer demand’. The respondents have mentioned explicitly the importance of customer involvement in selecting TickITplus. However, on questioning whether they would have moved to TickITplus had it not been for customer’s demand then one of the respondents had said no as they weren’t sure if the new scheme would bring them more business. However, the response cited by another was different from the above reason as he said that: “The adoption of TickITplus was considered to be complimentary to our existing approach. It adds value by articulating what good practise looks like from a software process perspective.” The other two respondents have also said that the choice of transitioning to TickITplus was seamless as they were certified to TickIT and wanted to retain it, rather than losing it. Apart from these reasons, two among the three participants have also mentioned that TickITplus offers certification to ISO 9001:2008 whereas other schemes like CMMI, SPICE etc... Another reason which was mentioned by the respondents but weren’t seen in all or atleast two of the responses were cultural fit, wherein the scheme’s objectives matched the organization’s cultural aspects.

5.2.2.5 Coding and themes for challenges faced while implementing TickITplus

A total of 11 codes were identified and listed in the table below. All the codes were pointing at one single point of the challenges the organization has faced and hence all the codes are grouped under one theme named ‘challenges faced’.

<table>
<thead>
<tr>
<th>Codes Identified</th>
<th>Code Inclusion Criteria</th>
<th>Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>TickITplus</td>
<td>Frequency, Relevance</td>
<td>Challenges faced</td>
</tr>
<tr>
<td>TickIT</td>
<td>Frequency, Relevance</td>
<td>Challenges faced</td>
</tr>
<tr>
<td>Challenges</td>
<td>Frequency, Relevance</td>
<td>Challenges faced</td>
</tr>
<tr>
<td>Transition</td>
<td>Frequency, Relevance</td>
<td>Challenges faced</td>
</tr>
<tr>
<td>Overhead</td>
<td>Frequency</td>
<td>Challenges faced</td>
</tr>
<tr>
<td>Complexity</td>
<td>Frequency</td>
<td>Challenges faced</td>
</tr>
<tr>
<td>People</td>
<td>Frequency</td>
<td>Challenges faced</td>
</tr>
<tr>
<td>Work</td>
<td>Frequency</td>
<td>Challenges faced</td>
</tr>
<tr>
<td>Predict</td>
<td>Frequency</td>
<td>Challenges faced</td>
</tr>
<tr>
<td>Process gaps</td>
<td>Relevance</td>
<td>Challenges faced</td>
</tr>
<tr>
<td>Staff</td>
<td>Frequency</td>
<td>Challenges faced</td>
</tr>
</tbody>
</table>

Table 17: Coding and themes for choice of selecting TickITplus

All the codes point out to one theme named ‘choice of selection’. Thought the theme is the same, the codes are different. These will be further elaborated in the analysis section.
5.2.2.5.1 Analysis of question on Challenges Faced

Based on the analysis of the responses for the question about the challenges faced by the organization while implementing TickITplus, a total of 11 codes were identified which all refer to one theme i.e., challenges faced.

Challenges faced: From the answers of the respondents, there was one common challenge cited by all the three interviewees, which is the lack of appropriate staff and personnel to perform the work. From one of the participant’s perspective, she has said that: “The biggest challenge when transitioning was getting process gaps closed, since structurally the company found it difficult to release people who were appropriate to carry out the work.” The respondent here mentions the closing of the process gaps as their organization has felt that alignment of TickITplus with ISO 9001 was loosely packed requiring their company to increase complexity. Based on other responses from the participants of the interview few other challenges were also identified which included perceived complexity in the documentation provided, where the participant has said that it was difficult for them to understand the requirements and the overhead of adopting TickITplus while transition. One of the respondents has also said that they couldn’t complete the process within the estimated time. When asked if these challenges were something which your organizations have expected, all the respondents have said that though they were predicted prior to the selection of the scheme, the full impact was undermined.
6  **DISCUSSION AND LIMITATIONS**

This part of the document provides a comprehensive discussion of the results extracted after the data analysis. Further, the analyzed results are validated if they are in coherence with those findings from the literature. This way we not only present a clear discussion of the results but also validate them.

6.1  **Discussion and Validation**

This section throws light on the analyzed survey and interview results. The agenda of this part of the document is to discuss the results and relate them to the literature. It also discusses the coherence between the survey results and the interview results. By doing so, it not only strengthens the results and analysis of the research but also validates them. One of the crucial components of underlying the concept of mixed method research approach is triangulation[52]. The process of using two or more research methods in generating fuller and more reliable information is known as data validation through triangulation method[49][52].

6.1.1  **Discussion of Results Gathered**

As part of the discussion, firstly the questions from the questionnaire and interview are mapped with the research questions of the survey. The second leg of the discussion deals with mapping the results with the results from the literature review. This way, a comprehensive set of answers are provided in answering the research questions stated and also the responses are validated simultaneously in the course of this two-step process.

6.1.1.1  **Mapping of survey and interview questions to the research questions**

As already mentioned in chapter 1 (Introduction) of the document, three research questions were framed and an attempt is made to answer those questions by following a mixed method research approach including both qualitative and quantitative research methods. Here, in this section a mapping between the survey questionnaire [SQ1], the second survey questionnaire [SQ2] and also the interviews are done with the research questions (RQ) and also with the literature gathered.

6.1.1.1.1  **Mapping survey questions and responses of SQ1 with the research questions**

A table is created for this purpose which holds the details of the question, the response and the RQ which it is intended to answer. Each question is given an ID for further reference.

<table>
<thead>
<tr>
<th>ID</th>
<th>Question from SQ1</th>
<th>Response</th>
<th>Research Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.1</td>
<td>Demographic questions</td>
<td>Majority TickIT personnel from UK</td>
<td>RQ1 and RQ2</td>
</tr>
<tr>
<td>1.2.1</td>
<td>Perception on overall cost</td>
<td>Very Expensive</td>
<td>RQ1</td>
</tr>
<tr>
<td>1.2.2</td>
<td>Perception on training costs</td>
<td>Very Expensive</td>
<td>RQ1</td>
</tr>
<tr>
<td>1.2.3</td>
<td>Return on Investment</td>
<td>Low</td>
<td>RQ1</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td>Rating</td>
<td>Research Question</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>--------</td>
<td>-------------------</td>
</tr>
<tr>
<td>1.2.4</td>
<td>Cost factor being a reason for not selecting TickITplus</td>
<td>4/5- Important</td>
<td>RQ1</td>
</tr>
<tr>
<td>1.3.1</td>
<td>Lack of customer interest a reason</td>
<td>Yes</td>
<td>RQ2</td>
</tr>
<tr>
<td>1.3.2</td>
<td>Using another Software Process Improvement model</td>
<td>Yes</td>
<td>RQ2</td>
</tr>
<tr>
<td>1.3.3</td>
<td>Applicability of TickITplus</td>
<td>Yes</td>
<td>RQ2</td>
</tr>
<tr>
<td>1.3.4</td>
<td>Impact of ISO 9001:2015 on selecting TickITplus</td>
<td>No</td>
<td>RQ2</td>
</tr>
<tr>
<td>1.4.1</td>
<td>Perception on the documentation provided</td>
<td>Too Extensive</td>
<td>RQ2</td>
</tr>
<tr>
<td>1.4.2</td>
<td>Understandability of documentation</td>
<td>Moderate</td>
<td>RQ2</td>
</tr>
<tr>
<td>1.5.1</td>
<td>Plans of taking up TickITplus in the future</td>
<td>Yes, only if the customer demands</td>
<td>RQ2</td>
</tr>
<tr>
<td>1.5.2</td>
<td>Open ended questions</td>
<td>-</td>
<td>Partly RQ1, RQ2 and RQ3</td>
</tr>
</tbody>
</table>

**Table 19: Mapping SQ1 to the Research Questions**

In the above table, we have the questions from the questionnaire and the answers they are being related to. The questions particularly answer the first two research questions. Further, we discuss the coherence of the results with the literature available on the factors considered while selecting a software process improvement (SPI) model.

### 6.1.1.1.2 Mapping survey questions and responses of SQ2 with the research questions

Similar to how it was done for SQ1, a mapping is done for the questions of SQ2 with the research questions. The tabular column below charts the responses obtained from the questionnaires and the research question to which the question contributes.

<table>
<thead>
<tr>
<th>ID</th>
<th>Question from SQ2</th>
<th>Response</th>
<th>Research Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.1</td>
<td>Demographic questions</td>
<td>TickITplus certified organizations which belong to small, medium and large sized organizations</td>
<td>RQ1, RQ2 and RQ3</td>
</tr>
<tr>
<td>2.2.1</td>
<td>Costs for implementing TickITplus</td>
<td>Small organizations-Very expensive</td>
<td>RQ3 and partly RQ1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium organizations- mostly moderate and very expensive Large organizations-cheap</td>
<td></td>
</tr>
<tr>
<td>2.2.2</td>
<td>Training costs</td>
<td>Between moderate and very expensive</td>
<td>RQ3 and partly RQ1</td>
</tr>
<tr>
<td>2.2.3</td>
<td>Return on Investment</td>
<td>Did not do an ROI assessment</td>
<td>RQ3 and partly RQ1</td>
</tr>
<tr>
<td>2.3.1</td>
<td>Customer demand</td>
<td>Yes</td>
<td>RQ3 and partly RQ2</td>
</tr>
<tr>
<td>2.3.2</td>
<td>If not customer demand</td>
<td>No, wouldn’t have taken up TickITplus</td>
<td>RQ3 and partly RQ2</td>
</tr>
<tr>
<td>2.3.3</td>
<td>Any other SPI</td>
<td>Yes</td>
<td>Partly RQ2, RQ3</td>
</tr>
<tr>
<td>2.4.1</td>
<td>Did the scheme cover the organizational needs</td>
<td>Partly yes</td>
<td>Partly RQ2, RQ3</td>
</tr>
<tr>
<td>2.4.2</td>
<td>Was process quality improved</td>
<td>No satisfactory improvement</td>
<td>Partly RQ2, RQ3</td>
</tr>
<tr>
<td>2.4.3</td>
<td>Certification to multiple</td>
<td>Mediocre level of impact</td>
<td>Partly RQ2, RQ3</td>
</tr>
</tbody>
</table>
standards under one scheme | RQ3
---|---
2.5.1 Perception on the documentation provided | Too extensive | Partly RQ2
2.5.2 Understandability of documentation | Moderate | Partly RQ2
2.5.3 Was documentation clear in motivating changes | Partially | Partly RQ2, RQ3
2.6.1 Open Ended Question | - | Partly RQ1, RQ2 and RQ3

<table>
<thead>
<tr>
<th>ID</th>
<th>Question from Interview</th>
<th>Research Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>How is TickITplus different from other certification schemes</td>
<td>RQ3</td>
</tr>
<tr>
<td>3.2</td>
<td>Information and documentation about TickITplus</td>
<td>RQ3 and Partly RQ2</td>
</tr>
<tr>
<td>3.3</td>
<td>Perceptions on costs incurred for implementing the scheme</td>
<td>RQ1 and RQ3</td>
</tr>
<tr>
<td>3.4</td>
<td>Reasons for selecting TickITplus</td>
<td>RQ3</td>
</tr>
<tr>
<td>3.5</td>
<td>Challenges faced while implementing</td>
<td>RQ3</td>
</tr>
</tbody>
</table>

Table 20: Mapping SQ2 questions to Research Questions

6.1.1.1.3 Mapping of Interview questions with research questions

This sub part maps the interview questions to the respective research questions it intends to answer. The table below holds the data of the same.

<table>
<thead>
<tr>
<th>ID</th>
<th>Question from Interview</th>
<th>Research Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>How is TickITplus different from other certification schemes</td>
<td>RQ3</td>
</tr>
<tr>
<td>3.2</td>
<td>Information and documentation about TickITplus</td>
<td>RQ3 and Partly RQ2</td>
</tr>
<tr>
<td>3.3</td>
<td>Perceptions on costs incurred for implementing the scheme</td>
<td>RQ1 and RQ3</td>
</tr>
<tr>
<td>3.4</td>
<td>Reasons for selecting TickITplus</td>
<td>RQ3</td>
</tr>
<tr>
<td>3.5</td>
<td>Challenges faced while implementing</td>
<td>RQ3</td>
</tr>
</tbody>
</table>

Table 21: Mapping of Interview Questions to Research Questions

6.1.1.2 Coherence between the results gathered from Survey and Literature

In the quench of answering the research questions, the following factors were identified which influence the selection of an SPI. The following section explains the coherence between the results from the literature review and the results obtained from conducting the survey and interviews.

6.1.1.2.1 Cost as a reason

The following factors related to cost were identified from the survey and interviews:

- Cost was identified to be one of the most crucial factors in not adopting TickITplus.
- Training costs were considered to be moderate.
- Interviews with experienced professional hint that the cost of implementing the scheme was reasonable but continuous maintenance of the scheme by conducting frequent audits made it an expensive affair.
- The Return of Investment was not yet measured by most of the companies.

Based on the literature reviewed it was analyzed that many articles cited cost as a potential factor that is considered by a software organization while selecting an SPI[11], [15], [34], [43]. As stated in the document, [11] “a small but expensive SPI might not be worthwhile; but a small and inexpensive method could serve the
business” it is clear that if an organization finds the scheme expensive then there can be fair chances of rejecting it. Based on the results gathered from the online questionnaire and interviews, like mentioned in the above sections several questions concerning the cost factor were mentioned of which questions 1.1.1; 1.2.1 to 1.2.4 of SQ1 provide results pertaining to the perception of possible costs that could be incurred by implementing TickITplus. Basing on the responses analyzed from these questions we infer that the organizations felt that the scheme was very expensive and also there is a possible low return on investment as most of the respondents have said the same and also gave a rating of 4/5 (important) and stated expensive costs as a reason for not moving to TickITplus. As part of the costs most of the organizations haven’t taken up TickITplus felt that the costs for training were very expensive. When enquired from the organizations which have moved to TickITplus (question 2.2.1, 2.2.2 of SQ2) the small sized organizations found the costs very expensive and the medium sized organizations considered the costs to be in between moderate and very expensive while the large organizations answered by saying the costs were cheap. The break up was same for training costs as well. Majority of the organizations haven’t conducted any return on investment assessment as yet. From the interviews, two out of three respondents have said that the costs for implementing the scheme are moderate but it would burn a hole in the organization’s budget for maintaining it because of the frequent audits.

Thus, from the above discussion about the cost factor, it can be said that the scheme was considered to be very expensive by most of the organizations and also low return on investment. This has resulted in one among the factors that made the organizations not to go for TickITplus.

Among those organizations which have implemented TickITplus, most of the small and medium sized organizations felt the costs incurred were expensive while the large organizations considered the costs as not expensive. In the interviews conducted one of the participant has said that they have considered TickITplus as necessary costs and did not think whether it is expensive or cheap while one of the organizations adopted TickITplus as a complimentary scheme to their existing scheme for improving customer confidence and also stated that the costs were low compared to CMMI.

6.1.1.2.2 Business and Other Reasons

Apart from the scheme being expensive, few other reasons were also elucidated by the survey and interview participants, which are listed below.

- Low customer demand has been one of the most reported reasons in the research conducted.
- The scheme couldn’t convince organizations that by getting certified to TickITplus it would bring more business.
- Responses indicate that extensive documentation was provided but the content was not difficult to understand.
- There wasn’t any impact of ISO 9001:2015 release on the selection of TickITplus.
- Few responses also indicated the limited number of training facilities provided made it difficult to find the right people for the right job.
- Few respondents from the open ended answer suggested that there are several places where the alignment to ISO 9001:2008 was missing.

From the literature on the factors considered while selecting an SPI, apart from cost, few more potential reasons have been identified that the organizations could have considered while they had the choice of moving to TickITplus. As part of the business and other related factors customer needs, documentation, information and process
quality were identified to be plausible reasons for opting or not opting a software process improvement initiative [11], [15], [34], [43], [53]. When the participants were faced with the question whether the choice of selecting TickITplus was based on their customer’s demand, majority of the respondents from both the survey questionnaires have answered yes. Considering the interview responses, all the respondents have said that the organization being certified to TickITplus was the requirement of their key customers and contracts. One of the respondents has also said that they have adopted TickITplus. This shows that customer demand is also one of the reasons for organizations to take up TickITplus. The respondents who have answered SQ1 have said that lack of customer demand was also the reason behind not moving to TickITplus. In the open ended question provided, one of the respondent has answered saying they haven’t selected TickITplus not only because it is expensive but also because of it is not clear as to whether it would bring them more business or not. Almost all the respondents have answered that their organization is also using another SPI initiative; this can also be another reason for not taking up TickITplus.

When enquired about documentation most of the respondents from both the surveys have answered by saying it was too extensive but not too difficult to understand. The survey respondents answered to the question if the documentation was clear enough in elevating the advantages and changes from the previous version of the scheme by saying yes. In response to similar question, the interview respondents have said that it was clear from the information provided that there will be benefits which would be realized in the long run. The responses gathered for the questions related to improvement in process quality suggest that although there has been improvement in the quality of the process, it was not satisfactory. From this we can say that the documentation was extensive but cannot be considered as a factor for the organizations not selecting TickITplus.

Along with expensive costs, low return on investment, low customer demand, few more reasons were mentioned by the respondents in their answers to the open ended questions and the interviews for not selecting TickITplus, like the alignment with ISO 9001 was poor in lot of places, the documentation provided was confusing, not many TickITplus training facilities outside the United Kingdom making it difficult for the organizations to gather appropriate people to take up the scheme.

Hence these were the reasons that were identified and validated for the organizations not moving to TickITplus.

6.1.1.2.3 Factors for selecting TickITplus and challenges faced

- Despite mentioning the scheme was expensive organizations have taken up TickITplus based on customer demand.
- Few of the organizations considered TickITplus as necessary costs.
- Companies haven’t yet conducted an exclusive return on investment analysis
- The fact that they were certified to TickIT and not transitioning to TickITplus would discard the TickIT certification too. This reason motivated the companies to take up TickITplus.
- TickITplus certifying organizations based on the ISO standards was also a reason identified.
- Lack of people was the major challenge the companies have faced in the transition from TickIT to TickITPlus.
- Filling the process gaps because of several changes that have been brought about was another hallenge reported by the interviewees.
Similar to finding the reasons for not selecting TickITplus, the survey and interview responses are also mapped for relating the coherence with the literature review responses. As already mentioned, the factors considered while implementing TickITplus are: expenses incurred, customer demand, return on investment, process quality, documentation and information [3], [11], [15], [53].

Based on the analysis of survey and interview responses, it was identified that majority of the organizations found the scheme very expensive. Despite bearing the costs as a major challenge, they had transitioned to TickITplus based on their customer’s requirement. Some of the organizations in the response to the open ended question in the survey questionnaire has mentioned that, the costs are very expensive and moving to TickITplus not based on customer request has brought them further financial issues. From the analysis of results, it was clear that the organizations have insisted the impact of customer’s demand in their choice of selecting the new scheme. Apart from this, few other reasons were also expressed in the open ended questions and interviews behind the reason for selecting TickITplus. They are; certification to ISO 9001 standard, improving customer confidence, lesser overhead than CMMI model, cultural fit, a good framework. Although these factors were less mentioned, they were few of the factors which the respondents have mentioned in their answers.

Pertaining to the challenges, this question was asked only to the interview participants. All the three participants have said that during the transition, one of the major challenges were to find appropriate people to do the work. Like mentioned in the articles [53], [54] lack of people and resources have been suggested as the major challenges faced in implementing TickITplus. The interview participants have also mentioned that understanding the requirements as a one of the challenges as they found the documentation provided too extensive and confusing.

Therefore, this discussion has led to answering the third research question and also partly provided inputs to the first and second research question.

Henceforth, a comprehensive discussion of the analyzed results has been made and also the validation is done simultaneously by relating the coherence of the results gathered with the results present in the literature. By doing so, the concept of triangulation method is satisfied by collecting information from more than two research methods.

6.2 Threats to Validity

There are four types of validity threats for survey research as discussed in the article [55] by C. Wohlin et al., viz., internal threats, external threats, construct validity and conclusion validity.

6.2.1 Internal Validity

The internal validity threats deal with those factors which might show an impact on the relation between the process and the output. The factors influencing the internal validity threats include the tools used for data collection, the selection of the participants and maturation[55]. The tool used i.e., the survey questionnaire was designed after being reviewed for several times by the researcher and the supervisor and refining the content, the quality and the readability of the questionnaire. A pre-test was also conducted where-in the survey was sent to a set of students pursuing masters in Software Engineering and who were aware of TickIT and TickITplus. Based on their responses(Appendix) regarding the time taken to complete the survey the questionnaire was further refined to the finest and thus eliminating the internal threat.

The selection of the respondents’ threat was mitigated for the respondents of SQ2 by carefully contacting the TickITplus certified organizations and contacting the concerned personnel involved in the selection of the scheme. However, the selection of respondents for SQ1 did not follow the same process as it was not possible to gather
the information of the firms which were certified based on the TickIT guidelines. A list of once certified TickIT auditor contacts were gathered and were contacted through mail and also the questionnaire was posted in a closed group of TickIT and TickITplus on a social networking platform LinkedIn. Hence care was taken in the selection of respondents for getting valid and reliable responses and mitigating the threat.

6.2.2 External Validity

External validity relates to the threat pertaining to generalizing of the results to the whole set of population[55]. This threat was mitigated by selecting the sample very similar to that of the population. It is observed from the results that the respondents for both interviews and survey questionnaire were well experienced with a minimum experience of more than 5 years in the field of Quality management, TickIT and TickITplus fields. Another evidence is that the selection of sample was from diverse settings as the responses were from organizations of varying sizes and various countries thus showing the possibility of generalizing the data to a greater population beyond the population selected.

6.2.3 Construct Validity

Due to lack of contacts and resources, interviews for personnel from organizations which have not taken up TickITplus could not be conducted. Due to lack of people who were eligible and interested to take part in the interview could not be contacted this threat could not be mitigated. Had these interviews been conducted the results would have been more concrete. However, this threat was partly mitigated by designing the second survey questionnaire [SQ2] and interviews in such a way that they also provide potential answers to the first two research questions. However, this threat could not be completely mitigated.

6.2.4 Conclusion Validity

Conclusion validity concerns with the ability to draw conclusions from the data extracted[54]. The reliability of data extracted from the literature review could be a potential threat as it is not a systematic literature review but this threat is mitigated by adopting the mixed method approach where more than two research methods have been used to find a more comprehensive set of factors. By doing so, even if few factors were missed they were identified and reported from the survey and interviews.

Another threat is the small set of responses. This threat could have been mitigated provided there was more time and resources to seek and contact for more organizations. However, the survey is complemented with interviews which have inferred concrete conclusions based on the information gathered.
7 CONCLUSION AND FUTURE WORK

This section of the document discusses the research conclusions drawn and the possible future work that could be done in the field. The research conclusion revisits the research questions and provides answers to the questions framed.

7.1 Research Contributions

Here, the research questions are answered based on the results obtained after analysis and validation with the results extracted from the literature.

It must be noted that despite TickIT being quite prominent across the globe and has been in the field of software quality management over the past two decades a lot of research was not done. Now, the scheme is obsolete giving way to its successor TickITplus which has come into use only 3 years back There has been no or very less research done on TickITplus owing to the fact that it is new and hasn’t been used much across the software industry since only 70 companies have started using it until now. Thus, this thesis contributes to the body of knowledge of software process improvement initiatives by discussing this scheme and trying to ignite new ideas to improve the scheme into a better one.

What impact does cost have for the organizations not to transfer or take up TickITplus?

- The cost factor plays an important role in not selecting TickITplus as it is found to be expensive by the organizations.
- From the results of the survey and interviews it can be said that the new TickITplus scheme is considered very expensive by most of the organizations. These responses were not just received from those who have not implemented the scheme and not based on their assumptions, but was also acknowledged by those organizations who have implemented it, providing more strength to the claim that the scheme is very expensive.
- Based on the information from the literature it is clear that high costs would indeed show a negative impact on the selection of TickITplus.
- Adding to this, the results have also suggested low return on investment as another reason for not selecting TickITplus. However, the responses suggest that the costs occurred for training costs were moderate and the cost for maintaining the scheme by practicing frequent audits was realized to be very expensive.
- Although extensive analysis was not made corresponding to the influence of organization’s size on the factors, it was observed that large sized organizations made the switch to TickITplus as to retain the TickIT certification and also as a complimentary certification.

How do quality and business form a reason for the companies not to adopt TickITplus and also what other reasons stopped the companies from taking up TickITplus?

- Low customer demand is also a major factor involved in organizations not selecting TickITplus.
- The results gathered show that there is very less demand for the scheme from customers and many organizations did not take up the scheme owing to high costs and low customer demand.
Results also say that among the organizations which have taken up TickITplus have adopted it prominently based on customer’s requirement and had it not been for that reason those organizations wouldn’t have opted for it. This bolsters the importance of customer requirements in selecting TickITplus.

Besides this, results have also suggested that most of the organizations did not believe that adopting TickITplus would bring them more business. This made it more confusing for the firms whether or not to consider TickITplus and eventually decided against it.

However, although documentation provided was considered too extensive by most of the respondents, it was observed that the understandability of the document was not too difficult. Hence, documentation doesn’t fall in the list of reasons for not selecting TickITplus.

Apart from these reasons, poor alignment with ISO standards, not many TickITplus training resources outside the UK, lack of awareness among the client’s customers were also reported by few of the participants as potential reasons.

What are the main reasons that drove the organizations migrate to/select TickITplus and what were the challenges they have faced while implementing TickITplus?

- One of the most crucial reasons for the organizations to move to TickITplus was identified to be customer’s requirement. It was stressed by most of the participants in the research that they have taken up TickITplus based on customer interest and had it not been for that reason, they wouldn’t have moved or taken up TickITplus as an SPI.
- Respondents have also said that the scheme assesses maturity levels pertaining to the ISO standard which was found to be attractive. Results also suggested that the switch from TickIT to TickITplus was made because the organization was TickIT certified and did not want to lose it.

Along with these answers, a few less stated reasons were also identified like cultural fit, good framework, less overhead than CMMI as reasons for choosing to move to TickITplus.

- Speaking of the challenges faced, the interview participants have said that finding appropriate people for the work has been a potential challenge their organizations have faced.
- They have also mentioned that the understanding requirements from the documentation were also difficult to grasp. It was also cited that filling the process gaps during the course of transition has been a challenge which prolonged the time taken beyond the scheduled time basically because of lack of personnel.

Hence, these were the answers that were extracted from the research conducted.

7.2 Future Work

Despite TickIT being a very famous SPI initiative across the globe and was being followed by more than 1000 companies, not much research was done on the schemes. Now, TickITplus, its successor is put into act which hasn’t been adopted by many organizations. This thesis has made an attempt in identifying the factors which made the organizations not to opt TickITplus. Similarly, the challenges are also gathered from the interview respondents and reported. There is a possibility of doing a research on how these factors can be rectified in order to make the scheme more attractive to the clients.
Further, the results from the interviewees suggest that they are hoping for better results and improvement in the long run. A short survey can be conducted after some time when all the maturity levels defined under TickITplus come into use and check the effectiveness of the scheme.

The present research gives an overview of the small, medium and large sized organizations and the reasons. Further, work can be done by concentrating on only one of the type of organizations and know their experiences by conducting a case study and then validating using a survey for a more clearer understanding of the field. Similarly, focusing on a single domain or category of companies like Web applications, defense, telecom products etc., could also give rise to interesting research findings.

As part of the present thesis there were results from interviews where the participants have said that TickITplus was found to be cheaper than CMMI. Investigating the truth behind this, a comparative analysis can be done between CMMI and TickITplus and present results.
REFERENCES


APPENDIX A

Validating the Online Questionnaire:

Before sending the questionnaire to the selected sample, the quality of the questions, understandability and time taken to answer the questionnaire were checked by sending it to 10 Software Engineering students who had knowledge about TickIT and TickITplus. The students were asked to take the survey first and at the end of the survey they were asked to answer three questions about the survey. They are: Understandability, time taken and comments (if any). The results of this survey are tabulated below.

<table>
<thead>
<tr>
<th>Understandability</th>
<th>Easy</th>
<th>Moderate</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ 1</td>
<td>6</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>SQ 2</td>
<td>6</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Time Taken</td>
<td>0-5 minutes</td>
<td>5-10 minutes</td>
<td>10-15 minutes</td>
</tr>
<tr>
<td>SQ 1</td>
<td>3</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>SQ 2</td>
<td>2</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>

From the above table it is clear that 70% of the respondents took 5-10 minutes of time to finish each of the survey and 60% of the participants have said that the survey was easy to understand and comprehend. However, two among the 10 have said that one of the questions in survey questionnaire1 [SQ1] was a little confusing as the sentence formation was not appropriate and that was rectified and the questionnaire was finalized.
APPENDIX B

Welcome Notes of SQ1 and SQ2

Welcome Note for Survey Questionnaire 1 [SQ1]:

As part of my research work in the area of quality standards and certification schemes for software industry, I have framed this survey questionnaire directed towards finding why you/your organization hasn't migrated to TickITplus.

The survey questionnaire is divided into 6 sections. The first section is just to know about your organization. Though it is an anonymous survey we would want to know about your role and experience in association with TickIT/TickITplus. Further, the next 4 sections are cost, business, documentation and information related questions. The last section is an open question for you to add comments if you wish to. If you are a TickIT auditor, kindly fill in the responses based on your interaction with the software firms and organizations. So, please fill in the survey by adding as little or as much detail as you wish. Your response would be a great asset to my research work in finding the reasons which in turn would be used to modify and develop the present TickITplus certification scheme as per the organizational needs.

Thanks in Advance.
Navneet Chamala,
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+46-767956305

Welcome Note for Survey Questionnaire 2 [SQ2]:

As part of my research work in the area of quality standards and certification schemes for software industry, I have framed this survey questionnaire directed towards finding your reasons behind selecting the scheme and the experiences on implementing TickITplus.

The survey questionnaire is divided into 5 sections. The first section is just to know about your organization. Further, the next 3 sections are cost, business and documentation related questions. The last section is an open question for you to add comments if you wish to. So, please fill in the survey by adding as little or as much detail as you wish. Your response would be a great asset to my research work in finding the reasons which in turn could be used to modify and develop the present TickITplus certification scheme as per the organizational needs.

Thank you for participating in the survey. Your feedback is important.

Thanks in Advance.
Navneet Chamala,
Blekinge Institute of Technology, Sweden.
navneet.7293@gmail.com
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Sample Screenshot of Questionnaire on Google Docs.

Survey Questionnaire on tickITplus

* Required

II. Cost Related Questions

What is your perception over the costs incurred for implementing tickITplus? *
- Very expensive
- Moderate
- Cheap

What do you think of the training costs for implementing tickITplus? *
- Very Expensive
- Moderate
- Cheap

What do you think of the Return on Investment by using tickITplus? *
- High
- Sufficient
- Low

Please leave a comment regarding the cost factor of implementing tickITplus. *

If you have anything to add related to the cost factor, please feel free to fill in the text box below.