Prediction of Time, Cost and Effort needed for software organizations to transit from ISO 9001:2008 to ISO 9001:2015

A Survey

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ABSTRACT

**Context.** Several quality standards have been developed over the years in order to define quality metrics for an organization’s product and even processes. One of the famous standards among them is the ISO 9000 standards which started several years ago. Since its beginning, ISO standards have seen several upgrades. Currently ISO 9001:2008 is in use which is being upgraded to ISO 9001: 2015. Companies have to migrate to the new scheme within three years of the prescribed time in order to retain certification to the ISO 9001 standards. The present thesis is targeted at finding the expected changes and the work improvements in the context of software engineering.

**Objectives.** The main aim of the study is to find the expected changes and work improvements needed to migrate to the new version. This is done by fulfilling the following objectives, they are: analyze the expected changes and motivations for the changes in the new ISO 9001 version. Understand the required work and improvements needed for a software organization to successfully upgrade their certification to the new ISO 9001:2015 version. Predict the estimated cost/time/effort that could be incurred for organization to get certified to the forthcoming ISO version.

**Methods.** In order to meet the objectives, a literature review was done and the changes incorporated in the new scheme are identified. A survey was conducted in order to predict the impact of cost, time and effort on the new changes in moving to ISO 9001:2008 to ISO 9001:2015. The survey was sent only to software organizations as the context of this study is only restricted to quality in software engineering. The collected data was analyzed using bi-variate analysis and Friedman test on SPSS tool.

**Results.** From the literature review, the changes brought about in the new scheme were identified. These changes made were used in the survey questionnaire designed. The survey questionnaire was designed to investigate the expectations of the organizations on the time taken, cost incurred and the effort needed to implement these changes. A total of 63 responses were recorded from the survey.

**Conclusions.** From the analysis it was found that several key changes were identified in the new scheme when compared to the old one. From the survey responses, the cost needed for implementing the changes is expected to be moderate, the time needed is predicted as less than 1 year and the effort needed for implementing the changes was estimated to be more. Along with this, the document also holds clear results about clause by clause expected time, cost and effort estimates and the reasons for these assumptions.

**Keywords:** Quality management, Quality standards, Process Improvement, Business management, ISO 9001, ISO 9001:2008, ISO 9001:2015, Quality standards
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1 INTRODUCTION

1.1 Introduction

The concept of quality varies from one person's perception to the other. Quality also varies from one context to the other and maybe perceived differently under different circumstances. It is a degree or grade of excellence or worth, a characteristic property that defines the apparent individual nature of something or totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs. Recently, several organizations have taken up quality management systems in order to develop quality enhanced goods and services which is achieved by applying efficient quality management methods and principles [1]. The primary reason behind the need for adopting such methods might be either because of the customer pressure for certified quality products or maybe because the firms have notices the edge they would have in the market if their process or product is quality certified.

A standard, as defined by International Organization for Standardization (ISO), “is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose” [2]. ISO is a worldwide alliance for the growth of standardization and relevant activities in the world. These guidelines are the international understandings, which are published are ISO standards. ISO develops standards required by the market, which is done by experts from Industrial, Business and technical sectors. ISO standards harmonize the products and services to make Industries more efficient and assist in reducing International barriers [2] [3]. ISO standards are internationally decided based on general purposes in nature and these standards are not specific for a particular organization or product. ISO published several standards for different sectors; However ISO developed ISO 9000 series of standards (ISO 9001, ISO 9002 and ISO 9003) and ISO 9000-3 guidelines for software and IT industries among which ISO 9000, ISO 9126, ISO 9217 and ISO 15504 are the most appropriate standards which are suitable for software industry [4][5][6][7]. These standards provide necessary requirements and guidelines for developing an effective quality management system for organizations [8].

The ISO 9000 series of standards deal with the quality management systems and quality assurance standards. “These standards provide guidance and tools for companies and organizations to make sure that the products and services provided by them are reliable and persistently meet customer’s requirements, and that quality is consistently improved” [9]. The aim of these requirements is to control, monitor and correct the quality management system and the software development process [8]. In Europe the ISO 9000 family of standards are considered as the foremost necessary standards within the field of software quality management [10]. The standards which are included in the ISO 9000 family are: ISO 9001:2008, ISO 9000:2005, ISO 9004:2009 and ISO 19011:2011 [9].

- ISO 9000:2005 describes the fundamentals of quality management systems and define the terms related to the ISO 9000 series. It covers only the concepts and language.
- ISO 9004:2009 provides guidance to organizations to support the achievement of sustained success by a quality management approach. It
focuses on making the quality management system more effective and efficient [9] [10].

- ISO 19011:2011 provides guidance on auditing management systems, including the principles of auditing, managing an audit program and conducting management system audits, as well as guidance on the evaluation of competence of individuals involved in the audit process, including the person managing the audit program, auditors and audit teams [9]
- ISO 9001, 9001 and 9003 specifies a set of requirements and these standards are considered as models for the external quality assurance. Certifications and registrations are provided by demonstrating the conformance to these requirements [10].

ISO 9001 is the most popular standard for quality management which is being implemented by more than one million companies and organizations across 170 countries in the world [9]. The requirements of ISO 9001 standards when compared with the Capability Maturity Model (CMM) share relevant importance and concern toward the software quality management and software process management[8]. In this study the organizations in context of software engineering are taken into consideration. As a predecessor ISO 9001:2000 and ISO 9001:2008 specifies requirements for quality management systems [9][11]. The current ISO standard followed by software organizations for quality management is ISO 9001:2008 version, irrespective of the size of the organization, it is a standard practiced by organization in any field of work. Consistency, quality of products and services leads to customer satisfaction [12]. This is achieved by practicing the ISO 9001:2008 standard. Thus with improved customer satisfaction comes better business. Quality management principles such as strong customer focus, the motivation and implication of top management, the process approach and continual improvement are the cornerstones for this standard [10] [11].

Software organizations will be more effective if process are integrated with the quality management system which would help to meet the customer requirements[12].
Thus, process approach has been adopted in order to facilitate continuous improvement and in general can make the overall quality management system more effective in meeting the customer requirements [4]. For the conformation of the standard a software organization may decide to invite an independent certification body to verify that it is in conformity to the standard, but there is no requirement for this. Alternatively, it might invite its clients to audit the quality system for organization itself. Performing internal audits is one of the ways to check the functioning of the quality management system. Certain prerequisites for a quality management system are specified by the ISO 9001:2008 standard. These include for an software organization to exhibit its competence to produce products of consistent quality, thus leading to customer satisfaction and also demonstrate statutory and regulatory requirements [13]. The objective of the standard is to boost the satisfaction of customers and assure the customer of its quality. It also aims to meet statutory and regulatory conditions. All these requisites are common and generic to all software organizations, irrespective of size, product and type. In case any of the requirements are not applicable because of the nature of the product or its organization, it can be excluded [12].

All ISO standards are reviewed in every five years to organize if a revision is needed to keep it current and significant for the marketplace [7]. The current version of quality standards ISO 9001 which is from the year 2008, an update for the version has been released in the month of Sep-2015 which is expected to follow a new, higher level structure of standards to make it simple and easier to use in conjunction with other management system standards, with increased importance given to risk. In addition, the reinforcement of the requirements of the connection between quality management and business management will be a major change in the standard [7]. The future ISO 9001:2015 is expecting to be compatible with other management systems, for example, ISO 14001. Furthermore the standard will respond to the latest trends. ISO 9001:2015 has been recently revised and currently in the publication stage, Final stage of a six stages process as announced by the ISO organization [13][14].

![ISO 9001 Current Status](image)

**Figure 2:** ISO 9001 Current Status [13]

### 1.2 Problem Definition

The ISO 9001 quality standard has recently released its latest upgrade which is ready to strike all the fields by the end of the year 2015. Several major changes are being brought about in the new scheme which has to be elucidated for proper transitioning to the new scheme. The changes relative to the older version should be made explicit and the work improvements needed to certify to the new set of standards
forms crucial for many organizations, which are willing to make the switch to ISO 9001:2015. The work improvements and the time, effort and cost needed for implementing the changes should be estimated prior to the beginning of transition to the new ISO 9001:2015 version of standards, so as to make it clear for the organizations on how much of effort, time and cost is needed approximately.

1.3 Aims and Objectives

The main aim and intension of this study is to identify the changes and goals in the new ISO 9001 version. The study is also being aimed at distinguishing the work and furthermore changes that are required for an organization in order to upgrade their certification to the new ISO 9001 version.

To meet the aim of this study the following objectives must be fulfilled.

- To analyze the expected changes and motivations for the changes in the new ISO 9001 version.
- To understand the required work and improvements needed for an organization to successfully upgrade their certification to the new ISO 9001:2015 version.
- To predict the estimated cost/time/effort that could be incurred for organization to get certified to the forthcoming ISO version.

1.4 Research Questions

RQ1: What are the changes observed in ISO 9001:2015 standards when compared to ISO 9001: 2008 standards?

Motivation: Since a new version of the ISO 9001 standards are releasing, organizations who already use ISO 9001:2008 require the amendments in the new version to act accordingly.

RQ2: How would the changes affect an organization in terms of cost, effort and time while upgrading to ISO 9001: 2015 from ISO 9001:2008?

Motivation: Once the changes were identified then for the companies to migrate from ISO 9001: 2015 to ISO 9001:2008 would require extra effort, cost and time which are to be predicted.

1.5 Expected Outcomes

The expected outcomes of this research study are:

- The expected changes and the motivation for the changes in the new version of ISO9001:2015.
- The work and improvements required for an organization in order to successfully upgrade their certification to the new version of ISO standards.

Estimation of cost, time and effort for ISO 9001:2008 certified organizations to successfully upgrade their certification to the forthcoming ISO version.
2 RESEARCH METHOD

In this section the selection of appropriate research methodologies for answering the research questions are discussed. Before heading off to the selection of suitable research methodology for respective research question, this section provides a brief description of the available research methods which are suitable for software engineering [14][15].

2.1 Research Methodologies

Literature review, case study, survey and interviews are the most commonly used research methods in the field of software engineering. Every research method is used for distinct use as per the researchers need.

LITERATURE REVIEW:

Literature review is an examination of the research study that will be conducted in specific field of study. It is the selection of suitable documents and compelling assessment of these documents related to the proposed research work. It helps in attaining knowledge in the field of research. Literate review also helps in identifying other related works which are suitable for the research, recognizing the gaps in the current research. Literature review gives a structure to search and identify the research work which is related to specific topic[15].

SURVEY [16]:

There are several research methods which are used for conducting the research and collecting the required information, however one way that makes the research truly simple is survey. Survey is defined as a brief conference or discussion with individuals about a particular subject. The term survey is regularly used to signify the meaning of collecting information. Questionnaires, interviews and surveys are the specific types of survey research which are used for collecting the information. Online questionnaire is considered as the most effective method for collecting the information from a large scale in a short interval of time, whereas an interview takes more time and money. Besides, online questionnaires strengthen the researcher in many ways such as minimal contact with the respondent and the researcher, participants responses are promptly recorded into forms. Moreover, online questionnaires have the capacity to reach potential respondents by circulating the questionnaire through numerous channels, such as giving them out in individuals, utilizing snail mail, emails, forums, survey engines and communities. For example, Gorschek et al.[16], 3000 and more responses were received for the questionnaire which was posted by them.

CASE STUDY[17]:

Robert K. Yin defined case study research technique as an observational request that explores a contemporary wonder inside of its genuine connection; when the limits in the middle of marvel and setting are not unmistakably obvious; and in which numerous sources of proofs are used [18]. Case studies are generally used to perform top to bottom investigation of phenomenon focusing on specific area. It is hard to generalize the results which are obtained by the case studies and are context dependent. Case studies provide rich and in depth information required for the research and providing such rich and profound data are the main advantages of using case study as research methodology.
EXPERIMENTS[18]:

Experimental method is a systematic way of approach to the research work where one or more variable are manipulated, controlled and managed with by the researcher. There are two kinds of variables: Independent variables and dependent variables. Independent variables are the variables which can be manipulated by the researcher and dependent variables are variables which managed by. Experiments are mainly conducted when the state variables in the research are subjected to be changed, managed in order to produce a controlled work. Whereas, the state variables in a case study cannot be manipulated and controlled but, can be manipulated in an experiment which draws the main difference between a case study and experimental study.

2.2 Research Method Selection

Once the research questions were formed, the next stage was to identify a definite research method using which the research questions can be answered. For the research questions formed Literature review, Surveys and Interviews were selected. The research questions and the research methods used for each of them respectively are shown in the table below.

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Research Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation: Since a new version of the ISO 9001 standards are releasing, organizations who already use ISO 9001:2008 require the amendments in the new version to act accordingly.</td>
<td></td>
</tr>
<tr>
<td>RQ2: How would the changes affect an organization in terms of cost, effort and time while upgrading to ISO 9001:2015 from ISO 9001:2008?</td>
<td>Surveys. Surveys were used to gather opinions of different organizations which wish to migrate to ISO 9001:2015 from ISO 9001:2008.</td>
</tr>
<tr>
<td>Motivation: Once the changes were identified then for the companies to migrate from ISO 9001:2015 to ISO 9001:2008 would require extra effort, cost and time which are to be predicted.</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Research questions and Research methods

**Why Literature Review for RQ1?** For the first RQ, the changes between the two ISO standards are to be identified. These changes can be identified via Literature Review only. Literature review is conducted to get an insight on a particular topic. This is conducted by identifying various articles, journals, books etc. from the literature. So, Literature Review is the efficient way to answer to answer the first research question.

**Why Surveys for RQ2?** For this RQ, the cost, effort and time for migration are to be identified. Using surveys and interviews, they can be identified. Surveys are conducted only on ISO 9001:2008 certified software organizations who wish to migrate to ISO 9001:2015 and based on the changes, the cost effort and time are forecasted. The surveys and interviews results are analyzed and the cost, effort and time required for migration are predicted.
2.2.1 Literature Review

Literature review plays a vital role in identifying and getting knowledge on other researchers’ findings in a particular topic. In order to distinguish the current accessible material and to discover the solutions for the research questions, literature review has been conducted. The answers for the RQ1 which plays a pivotal role for this study has been addressed by using literature review. By keeping this in mind, the literature review for this study was conducted based on the guidelines portrayed in the article [14]. In this manner, it gives us a more extensive and exhaustive information about the study we have chosen and how best we could add to the current collection of learning[19][20].

2.2.1.1 Planning of Literature Review

The exclusive purpose of this review is to identify the primary changes that are expected to be incorporated in forthcoming ISO 9001:2015 version and the work improvements required for organizations to upgrade their certifications to the newer version. ISO 9000 has been evolving since 1987 and Current version of ISO9001 is from 2008, ISO9001:2008. So, there exist a lot of research articles and books on ISO 9001 standards and its transitions. For answering RQ1, we have to identify the changes by comparing the draft ISO 9001:2015 and ISO 9001:2008 standard. This is In order to answer this RQ literature review was made to know the quality concepts, Importance of ISO standards, development process of ISO standards, and evolution nature of ISO 9000 standards. The ISO 9001:2008 and DIS 9001:2015 standards are also studied and compared in order to identify the changes. The literature review conducted in this study provides a summary and brief comprehension of the concepts of quality management system, history of ISO standards, Development process of ISO standards, ISO 9001 standards evolution, ISO 9001:2008 and ISO 9001:2015.

According to J Rowley and F Slack [20], the literature review for this study was conducted following the principles and guidelines presented in their article. In their article the principles and guidelines state that the literature review should be carried out in a five step procedure. The steps mentioned are:

- Step1- Scanning documents
- Step2- Making notes
- Step3- Structuring the literature review
- Step4- Documenting the literature review
- Step5- Building bibliography

In this way, by following the steps as mentioned above the literature review for this research was conducted. The findings of this literature review to identify the expected changes that would be incorporated in the forthcoming ISO 9001:20015 versions. The survey and interview questions are formulated based on the findings of this literature review.

2.2.1.2 Keywords for searching Literature

It is very important to form search keywords for finding a significant and productive materials in any literature review. The keywords are framed from the concepts of quality management systems and ISO 9000 standards in the context of software engineering. The keywords used for searching the literature review of this

2.2.1.3 Selecting Databases for searching Literature

The databases which are suitable and relevant for software engineering to conduct an exhaustive search have been selected for conducting the literature review[21]. The databases which are selected for this study are:

- Google scholar
- Inspec
- IEEE Explore
- ACM digital library
- Science direct
- Citeseer library
- Springer link

2.2.1.4 Literature selection criteria

To choose the relevant articles which are suitable for the research work, inclusion and exclusion criteria has been followed.

- **Inclusion criteria**
  - Literature reviews related to ISO standards and quality management system in the context of software engineering.
  - Peer-reviewed articles on ISO 9001 and its transitions. Survey’s findings from researchers
  - Online surveys on ISO 9001 and its certifications which are posted by the official ISO organization.
  - Books and ISO certified company articles about the ISO 9001, quality management systems and about its certification.
  - Articles and books which are published from 1987-2015 because ISO 9000 series was first published in the year 1987 and which are written in English.

- **Exclusion criteria**
  - Quality management articles which are not related to the field of software engineering.
  - Articles which explain about other ISO standards which are not related to ISO 9000 series.

ISO 9001 literature work and findings in other industries which does not belong to software industry.

2.2.1.5 Data Extraction process

The data extraction process for the literature review is done by reviewing the relevant articles which are selected for this study. The results for the RQ1 are obtained by reviewing and comparing both ISO 9001:2008 and DIS 9001:2015 standards.


2.3 Survey Design

2.3.1 Motivation for choosing Survey

Survey is considered as one of the quantitative method of approach. This method is used to answer the RQ2 of this study. Conducting online surveys is the best suitable method to find how much cost, time and effort is required for ISO 9001:2008 certified organizations to upgrade their certifications to the forthcoming ISO 9001:2015 version of standards. In order to accumulate the answers it is required to gather information from ISO 9001:2008 certified software organizations and quality managements auditors, thus survey is the best suitable method for finding the results[22][23][24].

The primary purpose of selecting survey from other research methods in software engineering is explained below:

Survey vs. Case study: Interview and questionnaires’ can be used as a data collection method for both Surveys and as well as in case studies. In this study it is very important to take the perceptions of several ISO 9001:2008 certified software organizations and quality auditors regarding the work improvements required for their organizations to upgrade to the upcoming ISO 9001:2015 version. Case studies produce rich descriptions and are intended to investigate a particular subject in-depth, yet it has constrained generality[24]. To fulfil the aim of this study (Collecting information from worldwide ISO 9001:2008 certified software engineering) survey is considered as the best suitable methodology because conducting a case study in this subject within the time frame only a couple or few findings would be extracted which leads to incomplete results for this study. By conducting surveys, we can gather information from large sample in less span and the responses from large sample helps in generalizing the conclusion. Thus, survey is the suitable methodology for this research.

Survey vs. Experiment: Experiments are generally conducted when the state variables are subjected to be changed for maintaining a controlled environment. This study requires perceptions from several ISO 9001:2008 certified software organizations which cannot be gathered by using experiments because experiments should have a clear view of the dependent and independent variables of this study which isn’t possible [22][24]. When compared to surveys it is hard to gather information from experiment within in limited time-span. Here, we need to gather the sensible information from commercial organizations, not from counterfeit setting. In addition, we can’t focus on a large sample in artificial setting and the gathered information from experiments exceedingly relies on upon the accessibility of experts to have the capacity to sum up the outcomes to an expansive population. In order to gather information from large number of contexts, surveys act as the best suitable and preferable research methodology for this study.

2.3.2 Survey Objectives

For conducting a survey, it is very essential to identify the objectives of the survey and the target sample on which the questionnaire will be posted for collecting the information. Neglecting to do these may prompt less information furthermore unessential information. In this survey, the main objective is to conduct the survey on ISO 9001:2008 certified software organizations and quality auditors who has good experience in the field of quality management system and ISO 9001 standards.
- Prepare Survey questionnaire to identify the required work improvements for software organizations to get certified to ISO 9001:2015 version.
- To estimate the cost required for organization to upgrade their certification.
- To estimate the time required to learn and implement the changes for their organizations to upgrade their certification.
- To estimate the effort required to learn the changes and implement those changes to upgrade their certification to forthcoming ISO 9001:2015 version.
- Considering the sample space who would take the survey i.e. ISO 9001:2008 certified software organizations and well experienced quality auditors.
- Verify that the survey doesn't have an excess of inquiries and doesn't take too long with a specific end goal to get required answers
- Responses are collected and then results are analysed.

2.3.3 Target population and sample space

Target population is the set of people to whom the thesis is directed[25][26]. In the present context the target population is all the software organizations which are looking for improving the quality of the process and product. The target population also considers the quality auditors will also get a brief idea regarding the time cost and effort needed to implement the new changes.

Sample space is small set or group of respondents selected from the target population who give the answers for the questionnaire. The selection of sample space is crucial for generalizing the results to the target population. Sampling techniques are characterized into probabilistic and non-probabilistic methods. The probabilistic approach is selected for sampling as a list of certified ISO 9001:2008 software organizations are made available on the web. The survey was also broadcasted to ISO auditors via social networking platforms mainly LinkedIn and Facebook, whose complete list was obtained from web.

2.3.4 Designing the Questionnaire

In this thesis work, the changes in the upcoming ISO 9001:2015 are identified and based on these findings the questionnaire is prepared for collecting the information. To fulfill the objectives of the survey method as stated in the previous section, target population and sample space have been selected for participating in the survey. Preparing online questionnaire is the important part in conducting the survey as it acts as the tool for collecting the required information from the respondents. Survey questionnaire consist of open ended questions or closed ended questions or a blend of both. Individuals from everywhere throughout the world can take part in the survey, as this is an online questionnaire and it is more essential to gather information from individuals present in different countries, this will be all the more intriguing also. Questionnaire was designed keeping in mind that the questions are designed to fulfill the objective of the research questions.

The questionnaire constructed for this study consists of both demographic and attitudinal type of questions[27]. The demographic question in the questionnaire consist of questions related to the basic information of the organization which include name of the organization, organization size, country, whether or not the organizations
are certified to ISO 9001:2008 standards and the country from which the organization is hails from. Further the questionnaire is divided into nine sections. Each section consists of the changes incorporated in the new standard with comparison to ISO 9001:2008 version of standard. The respondents were asked to answer the time taken, the cost incurred and the effort needed for learning and implementing those changes.

- **Section 1**: Consists of Organizational information which include organization name, country, size of the organization, and whether the company or organizations is certified to ISO 9001:2008 or not.
- **Section 2**: deals with the changes brought about in the clause 4 which is renamed as context of organization in ISO 9001:2015 standard.
- **Section 3**: deals the changes which are brought about in the clause 5 which is renamed as “Leadership” in the new version.
- **Section 4**: This section deals with the clause 6 of ISO 9001:2015 which is renamed as “planning” from “resource management”.
- **Section 5**: deals with the clause 7 of ISO 9001:2015 and the changes brought about in its sub clauses with comparison to the ISO 9001:2008 version of standard.
- **Sections 6**: The clause 8 named as “Operations” in ISO 9001:2015 deals with the planning and development of product and services.
- **Section 7**: The questions in this section points out at the changes in clause 9 (performance evaluation) and the time effort cost needed for implementing these amendments.
- **Section 8**: This section investigates the time, cost and effort needed to bring about the changes in the clause 10, Improvements.
- **Section 9**: This section consists consist of both closed ended and open ended question where the respondents can further give their opinions regarding the overall changes and the work improvements required for transiting from ISO 9001:2008 to ISO 9001:2015.

With this questionnaire I intend to find the estimated time, cost and effort needed to implement the changes.

**Scales**: As mentioned above each section was provided with three questions and predefined answers. The questions on time had four predefined answers which are: <1 year, 1-2 years, 2-3 years and >3 years. This is an interval scale with one year of intervals .The reason for choosing such interval scale is that the grace period allotted for transition from ISO 9001:2008 version to ISO 9001:2015 is 3 years. The questions on cost has three predefined answers which are: Low, Moderate and High. The cost factor depends on the organization and it is different for different organizations. This is the reason a nominal scale is chosen over the other scales. This is a nominal scale and the reason for choosing this. The questions on effort had two predefined answers namely more and less effort. This is a nominal scale and differs from organization to organization and depends on the factors such as organization size and the structural complexity of the organization.

2.3.5 Data analysis

The results gathered from the closed ended questions of survey conducted are analysed by using statistical methods and depicting the results with the help of bar graphs for drawing possible relationships. These charts and graphs will be used to analyse the data and also visualise the results.

For the open ended question in the survey grounded theory is used to analyse the responses. The Corbin and Strauss approach of grounded theory [28]is used. Codes/concepts which define the data are identified and using these codes a new theory
would be proposed. Before proposing theory, the codes are filtered so that only codes which are related to the research area are present. The proposed theory is the analysis of the open ended question.
3 LITERATURE REVIEW

3.1 Quality concepts and related research

The long term relationship between an organization and a customer is affected mostly by factors like achieving the right balance of reliability, market window of a product and cost, which also affect the profitability of the company [29]. These aspects are also in play even in cases where there are fewer competitors reigning the market, which has resulted in the growth of open source development. Quality is an important aspect in the modern day era where companies and competitors are just a mouse click apart. The quality aspect is important not only to websites or goods with either integrated or devoted modes of delivery of software, but also to investment commodities where different quality metrics are used to evaluate the suppliers[30].

In order to assure quality products, international guidelines have been scribed developed (e.g. ISO 9001 [31]) along with methods which can assess the software developers and their development process (e.g. SEI CMMI [32][33]). In order to identify and eliminate the risks during release, also most companies employ criticality prediction techniques [34] [35][36]. However, rather than focusing on quality management, much of the efforts are focused on rework and testing [37].

As in a larger scale, quality is delivering as per the commitments; there is a problem in software industry regarding quality as even though there are solutions to problems, knowing which solutions work are a huge task. Questions like what are the basic inherent principles that are applied in successful projects, which is good and which is better, what could be done and which is good enough in view of the huge market pressure and competition needs to be answered.[30]

A refined answer to these questions is that software quality is not just a task, but a habit embedded in the culture of organization, which can be visible in the manner of work of the people. Simply put, quality is sort of a habit, which is driven on the basis of objectives rather than beliefs. Basically, it is obtained when every individual in an organization is aware of his/her role to produce quality.[30]

In the article, Garvin[38] has clearly explained about the definitions of quality and made broad division work for building up what exactly quality means and how the product concepts such as effectiveness or market circumstances are affected by it. In this article Garvin has characterized five distinct definitions of quality: transcendental quality, user-based quality, product-based quality, assembling-based quality and utility based quality. Despite the fact that they characterize the same phenomenon of product quality, they differ tremendously. Garvin additionally discussed about the diverse definitions of what exactly quality is and why different people have distinctive opinions on what quality is.

The measurement of software quality is important considering various aspects and definitions of quality. Jørgensen[39] introduces three assumptions for software quality measurement. Firstly, there are no standard measurements for quality but for some environments there are measures. Next, quality measures which are used in large and accepted must have a greater level of research on them and thirdly, quality can be measured indirectly using quality indicators. Jørgensen[39] mentions that the software quality can be predicted or measured using quality indicators characteristics and attributes but there is no single measurement for quality.
Boehm and Turner’s[40] paper explain how the applicability of agile methodology on different environments and projects. Also they discuss about the applicability of plan-driven methods on the same factors. They have made a polar chart to distinguish between agile methods and plan-driven methods. According to Abrahamsson et al.[41], agile thinking has been developed because Software systems were delivered late with over budget and also they failed to meet the quality requirements. Therefore, it is seen that there has been an influence on quality characteristics based on the software development model chosen.

According to Guimaraes et al.[42], customer participation is important in improving specifications of the system and thereby improves the project quality. They also state that customer and supplier bond has an influence on the quality of the product.

Based on the findings from the literature, it is understood that there are many instances in literature were software methods and quality are studied together and a connection is shown between them. Due to this, identifying the software process methods which have heavy impact on quality would be complicated and tedious. Different projects have different quality aspects and are connected to different software engineering concepts in some or the other level.

![Figure 3: Quality Management system in Organizations][30]

Figure 3 [30] explains quality management on an organizational layout, which includes a four tier model with respective responsibilities for achieving quality. It is a bottom up approach with respect to continuous feedback which enables the change of directions or decisions.
Figure 4: Product life cycle: Quality management system[30]

Figure 4 provides a mapping to various quality attributes to the important life cycle processes. In the left, the strategic decisions are made in order to implement the respective management system and to the right, implementation of processes related to quality is carried out. The product is improved in the further stages of evolution along with dedicated services and feedback from customer.

The major point to note is that having processes which are standardized and having them applied in a systematic manner ensures that not only people can be moved around to different projects with shorter learning periods, but also that quality can be achieved at its maximum efficiency. Identifying that quality requirements should be specified in quantitative terms is a major aspect in all the phases, which does not include “counting defects”. This primarily means that quality attributes like security, adaptability, maintainability, portability and so on must be quantified as an objective before product design [43].

This can be illustrated by an example. Consider a software system which might contain specific reliability control. Defining reliability only as achieving less than one failure in a month would be reactive and therefore, quality attributes must be focused on product and process needs to obtain the reliability. Customer needs and market requirements of the product must be stated in the strategy phase. The next phase is to identify the breakdown of the specified needs into components, product features and capabilities. Based on this, the fundamental quality process could be identified for by tailoring organizational processes such as product life cycle, project reviews and product specific testing rather than identifying the quality process for each project separately. Quality assurance can be performed in a systematic manner for the selected process and work products, as individual engineers could apply quality control. In the end, criterion for service request management and quality level of the subsequent releases along with the rectification of potential defects can be listed during evolution phase of product. One of the major uncertainties that arise is the manner in which quality needs and required effort and skill of people can be balanced. Various instances where observed where organizations had trimmed early requirements specification reviews on the basis of cost and time constraints, which has only resulted in increased follow on costs than the cut offs. Therefore, in order to understand the basic idea of achieving quality and improving business performance, the following words of Abraham Lincoln can be used “If someone gave me eight hours to chop down a tree, I would spend six hours sharpening it”[30].
3.2 Software Process Improvement Models and ISO 9001

Software Process Improvement, SPI is a framework modelled to build a quality software by enhancing the software process quality which improves the competency of the organization. According to Pressman in [44], SPI is modelled to enhance the overall potential of an organization to deliver a standardized product by upgrading the quality of their development process. Hence, for producing a quality product, process advancement plays a crucial role as product quality is directly linked to the process by which the product has been produced. Many SPI frameworks have been advanced and commenced to enhance the software processes [45] [46] [47].

Several SPI initiatives or models follow the Shewhart Deming cycle [47] which defines various stages of SPI, which are initiating a plan, executing it, measure the changed procedure and review their impact of the software process changed.

De Bruin et al [48] mentions the important stages in modelling SPI model. In this article the authors have analysed around 150 maturity models among which Capability Maturity Model, CMM developed by Software Engineering Institute, SEI was the prominent framework. Maturity models calculate the competency of a specific domain on a scale of 1 to 5. Several SPI frameworks have been developed on various domains since the commencement of CMM, like Project Management Models in project management domain, Enterprise Architecture Maturity model, Capability Maturity Model Integration, CMMI designed by SPI involving three legacy frameworks. De Bruin et al. have conducted a systematic literature review which explains various stages for framing a SPI. In this article the authors have described stages involved in framing a SPI which are Scope, Design, Populate, Test, Deploy, and Maintain. Scope of the SPI is framed by describing the domain of it. In the second stage which is design, the architecture of the framework is explained. The populate stage gives a framework for the process improvement. After this the model is tested and deployed to check its functioning. In the last stage the important objective of SPI, which is to advocate continuous maintenance of the product over the duration of time [48].

Mohammad Zarour et al., in their systematic literature review have shown many instances of best methods for good design 21 and implementation of a Software Process Assessment, SPA [49]. In this article have analysed 22 case studies which were about single and multiple organizations. The analysis of these case studies which involved more than 194 organizations have shown the best methods for designing an SPA. The methods involved have been classified into method, tool, documentation, and procedure and user practices.

Sharma et al., [50] have conducted a comparative analysis of the most used maturity models. Their study involved comparison of the ISO series of quality standards, CMM model, ProPAM and SPIQ. In this article the authors have also mentioned about several SPI models like BOOTSTRAP. The maturity models discussed in this article are the most used in organization and the authors have also mentioned the pros and cons of these models explicitly.

In this research the literature of ISO 9000 series quality standards on software has been discussed. The International Organization for Standards (ISO) has been involved for improving software process for more than two decades. The ISO 9001:2015 is the current version of the ISO 9001 series. The compliance of ISO 9001 was discussed in the article [51]. In this article the authors have mentioned that ISO 9001:2008 is the standard for quality management system. Several other standards like ISO/IEC 15504,
ISO/IEC 27001 have also been mentioned. This research was to consolidate the preceding standards with ISO 9001:2008. This is to implement a multi SPI which is related to TickITplus as TickITplus uses the concept of multiple standards. The challenges involved during the implementation of the SPI initiative have been discussed in this article. The authors have also mentioned about the practises they employed to overcome those challenges. The challenges which were mentioned 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. The authors have implemented several practices to overcome these challenges. Using these practices, the researches have formed a multi standard SPI model and have examined its functioning.

The impact of ISO 9001 standards on the maturity of several organization in Denmark have been discussed by Anne Mette Jonassen Hass et al., in their article [52]. Many of the software organization among them were ISO certified. The analysis made on these organizations predicted the impact of ISO 9001 standards. The prediction from this analysis was that the software organisations with ISO certification showed a greater maturity with the ones without an ISO certificate. The organization with an ISO certificate shown an average maturity level of 2.25 on a scale of 5 while the software organization without the certification was identified around 1.25. This research has concluded that the software organizations with ISO 9001 certificate showed a greater maturity level.

3.3 International Organizations for Standardization (ISO)

ISO is the world largest non-governmental organization that develops voluntary International standards, aiming at advancing good practices in organizations, helping them to end up more efficiently and effectively. The name International Organization for Standardization at first would have different acronyms in dialects (IOS in English, OIN in French institutionalization Organization International), whereby the authors selected the ISO position, which gets from the Greek ISOS, signifying "equal" institutionalizing thusly ISO word. Established in 1947, thereafter ISO have published more than 19500 international standards covering all the technological and business aspects worldwide. Today the Central secretariat is located in Geneva, Switzerland with 150 people and also members from 162 countries working full time.[53]

3.3.1 History of ISO

The history of ISO as available on the ISO website states the following [55]:

- The ISO was originated in 1946 when delegates from 25 countries gathered at the Institute of Civil Engineers in London and decided to create a new international organization "to facilitate international coordination and unification of industrial standards "(ISO 2013). This organization begun its initial operations in February 1947 with 67 technical committees.
- ISO’s first office (1949): A small private building in Geneva housed the very initial offices of ISO in 1949. The Central Secretariat had begun its first office in the early 1950’s with a staff of 5 members.
- ISO's first standard (1951): The first ISO standard, ISO/R 1:1951 Standard reference temperature for industrial length measurement was published in the
year 1951. This is now known as, ISO 1:2002 Geometrical Product Specifications (GPS) - Standard reference temperature for geometrical product specification after being reformed and updated numerous times.

- **The ISO Journal (1952):** Since its inception, a journal recording the monthly policies of technical committees, changes pertaining to administration in the organization had been published by the ISO in 1952.

- **ISO General Assembly – Stockholm (1955):** The 3rd General Assembly was held in Stockholm in the year 1955. With Henry St Leger as the Secretary General the ISO had 35 members and 68 standards by the beginning of 1955.

- **SI - International System of Units (1960):** The standard ISO 31 had been published in 1961 on quantities and units. (This has been later on replaced by ISO 80,000). Based on SI (System International Units), the ISO 31 was established. To reach worldwide uniformity in the unit system is the most primary objective of the SI system. One unit for each quantity was set out by the SI. The regulations on these units were established in ISO 80000.

- **ISO and developing countries (1961):** Many numbers of developing countries were in the ISO’s were in the international standardization work in the 1960’s. A committee DEVCO was established in 1961 aimed to develop country matters, in which correspondent membership was established in 1968, which allowed information about International Standardization work to the developing nations reducing the entire cost of full and complete membership. The popular option for many countries was correspondent membership. ISO had 49 countries as correspondent members in the year 2012.

- **Freight containers (1968):** ISO had been particularly active in Freight and packaging, changing the way goods travel across countries. The first standard on freight containers had been published in 1968.

- **The end of 'technical nationalism ' (1968):** In one of his first speeches as Secretary General of ISO in 1969, Olle Sturen said that technical nationalism will surely end with International Standardization.

- **Environment on the agenda (1971):** Air and water quality were the first two committees created in the environment field in the year 1971. In the recent years, groups of environmental experts joined these primary committees focusing on subjects including renewable energy and soil quality among many other environmental issues. An international focus: Olle Sturen, the Secretary General during the 1970’s focused on ISO as an international organization. Sturen visited member countries like Australia, Japan and China to ensure active participation which resulted in the representation of 25 nationalities in the early 1970’s.

- **ISO 9000 family (1987):** The most well-known and bestselling standards of the ISO were published in 1987 as ISO 9000 family.

- **ISO goes digital (1995):** The very first website of ISO came into existence in 1995 which later on went about to sell its standards online in the year 2000.

- **ISO 14001(1996):** ISO launched ISO 14001, its environmental management system in the year 1996 with the help of which organizations can identify and control their environmental impact.

- **New leadership - New technologies (2003):** Alan Bryden was appointed Secretary General in 2003. ISO expanded its work, under his 5 year term, to cover nivel technologies such as bio fuels and nanotechnology. Bryden’s active support of ISO’s social responsibility works led to the launch of ISO 26000 in 2010.

- **Information security (2005):** Securing the system and minimizing risks has become ever more important as businesses relied on information technology. As a result, ISO and IEC’s joint technical committee JTC1 launched ISO/IEC
27001, a management system standard on information security in the year 2005 which became one of its popular standards.

- **ISO's new offices (2007):** With almost 150 employees (a significant increase from the staff of 5 in the early 1950s) in the Central Secretariat, in 2007, ISO’s current offices are in La Voie Creuse, Geneva.

- **Simple, Faster, Better (2009):** ISO tackles another mission to be easier, speedier, better - to chop down standard development time and to better serve the needs of today's general public.

- **ISO 26000 (2010):** International standards published the guidelines for social responsibilities with the standard name ISO 26000 in the year of 2010. The Standard ISO 26000 was developed with one of the substantial and divergent groups, resulting in providing a true multi-stakeholder document.

**ISO (2012):** In 2012, ISO organization had 163 active members and had over 19,000 standards mentioned. Today, ISO standards has standards covered from all the aspects starting from business to technology [53].

![Figure 5 Breakdown of ISO standards (2012)](image)

### 3.3.2 ISO Quality Standards Development Process

ISO standards are developed in line with the principles of all-inclusive, deliberate agreements. This implies the perspectives of all interested parties are taken under consideration, including manufacturers, sellers and customers, consumer groups, testing labs, governments, engineering experts and research organizations. Since the process is extensive, norms are made to fulfill the industries and customers worldwide. The international quality control standard is the end result of settlement among the member bodies of ISO. It could be used intrinsically, or is also enforced through incorporation of quality control standards with national standards across different countries.

The ISO standard is a consensus document developed by following a six stage process by a committee of members who discuss and decide the inclusion of changes by the method of voting. After several stages of voting and getting consensus among the committee members an initial first draft is released. This draft is distributed among all the member bodies of ISO for a three-month vote and then a final text is prepared. This text is prepared taking into account the comments on the DIS and a final draft international standard (FDIS). This FDIS is again sent for another round of voting and the draft is then approved and the international standard is published by the Central Secretariat. These standards are developed by following a sequential six staged process by the technical committee and the subcommittees.
SIX stages process for standards development [54]

1. Proposal stage: In this stage, the necessity for a new International Standard in the subject is confirmed. Voting for the new work item proposal (NWIP) is done by committee using form 4 the committee. Voting is done using the electronic balloting portal. All the nominations for project leader are mentioned on the Form. Possible complications and concerns should be raised in this stage revolving around copyright, patents etc. For already published ISO standards which require revisions or amendments do not require this step.

2. Preparatory stage: Usually the working draft (WD) is prepared by a working group (WG) which is set up by the parent committee. Experts in the field generally form the WG and are presided by a Convener (usually the Project leader). Issues around copyright, licenses and conformity assessment are continuously assessed by the WG in this stage. Until the experts arrive at the best solution they can, successive WDs can be circulated. At this stage, the WG’s parent committee takes the decision of which stage to go to next (Committee stage or Enquiry stage) after reviewing the draft.

3. Committee stage: The members of the parent committee receive the committee draft (CD) which is circulated to them during this stage. The draft is commented upon, and if required, voting is casted using the Electronic Balloting Portal. In this stage also successive CDs can be circulated until agreeable satisfaction is reached on the technical content. When consensus has been achieved, the content is settled for submitting as a draft international standard (DIS).

4. Enquiry stage: The committee secretary submits the Draft International Standard (DIS) to ISO Central Secretariat. A time period of 3 months is given to all the ISO members to vote and comment on it. It is affirmed for accommodation as a Final Draft International Standard (FDIS) if a two-third (66%) dominant part of the P-members from the TC/SC are in support and not more than one-quarter of the aggregate number of votes cast are negative. If needed the FDIS stage can be included by the committee leadership, otherwise the approved DIS project goes straight to publication.

5. Approval stage: The Final Draft International Standard (FDIS) is submitted to ISO/Central Secretariat (ISO/CS) by the committee secretary after being significantly revised following comments at the DIS stage. A two-month voting time is given to all ISO members. The technical comments which are received during this stage are no more considered, however enlisted for consideration during a future update of ISO standards.

The text is approved if a two-thirds majority of the P-members of the TC/SC is in favor and not more than one-quarter of the total number of votes cast are negative. In this stage if the approval criteria are not met, then the standard is alluded back to the
starting TC/SC for reevaluation in light of the specialized reasons which are received in backing of the negatives votes.

6. Publication stage: The final document for publication is submitted through the Submission Interface. The project leader’s responses to member body comments on the FDIS may be submitted by the secretary if the standard has passed through the Approval stage.

The final text is published by the ISO Central Secretariat as an International Standard with only minor editorial corrections.

3.4 Evolution of ISO 9001

In the year 1979, ISO organization sanctioned the formation for a Technical Committee to tackle all matters relating to the management and quality warranty. As of today, ISO / TC 176 has 94 countries as active members and 24 countries as spectators[53].

The committee came up with its first standards in 1987 with the title ISO 9000, the same organization was also responsible for its revision in 1994, resulting in ISO 9000: 1994 followed by again in 2000 called Standard ISO 9001: 2000[55][56][57].

The main of ISO 9001:1987 was to provide rules and requirements for a quality assured system implementation. It had three different levels based on the requirements. They are ISO 9001:1987, ISO 9002:1987 and ISO 9003:1987.

ISO 9001: 1987 – this was aimed at companies that created new products. This guaranteed the quality in design and development[56].

ISO 9002: 1987 – similar to ISO 9001:1987, even it was aimed to assure quality in design and development but for companies which do not create new products.

ISO 9003: 1987 - the focus of this provision was intended to ensure quality in the final inspection the finished product, and tended to compliance procedures, instead of the overall process production.

The first review was conducted in 1994. The amendment was made on the quality by taking preventive actions instead of checking the end product. This soon became a drawback as companies implementing these changes implemented numerous manual procedures which was a tedious task. Again in 1996 a new revision was made. These rules were converged in the second edition of ISO 9001 standards in 2000 under the name ISO 9001: 2000. All the three previous sub-standards of ISO were merged into one in this edition.

ISO 9001: 2000[56][58]

The new revision is made to add the customer satisfaction dimension. The standards are made for the organizations where they need to communicate with the customer and measure their satisfaction. This edition of standards is more flexible with the addition of more requirements.

The new requirements are as following:

- Communication with customers
- Identifying customer requirements
- Achieve customer requirements
- Monitor and measure customer satisfaction
- Achieve regulatory requirements
- Reach statutory requirements
- Support internal communication
- Provision of quality infrastructure
- Provide a quality work environment
- Assess the adequacy of training
- Monitor and measure processes
- Assess the adequacy of its quality system
- Identify and implement systemic improvements
- Improve the quality management system.

**ISO 9001:2008 and its application to Computer science**[59][11][60]

In 2008 the standards were revised and the name was changed to ISO 9001:2008. This version of standards introduced clarifications to the present necessities of ISO 9001:2000 and a few changes meant to enhance consistency with ISO 14001:2004. There were only minor changes in this edition[11].

0.1. General: Prepare the organization about the influence of the business environment and possible risks. All the question of compliance with regulatory and statutory requirements which should be met when referring to the product are clarified.

0.2. Process approach: It focuses on planning. It clarifies that the management of processes to produce output desired.

0.3. Relationship with ISO 9004: Identifying more clearly the effectiveness of the QMS and should focus more on the compliance with statutory requirements and regulations. Extends the concepts of the ISO 9004 goals.

0.4. Compatibility with other management systems: Updated version of ISO 14001.

1. Scope: The main concern was meeting regulatory requirements and statutory product, not limited to intentional product, but also considers the product purchased and the resulting intermediate stages of production.


3. Terms and Definitions: A "Supplier-client organization" supply chain and few deleted terms are integrated.

4.1. General requirements: Greater emphasis on determining the processes as part of planning of the QMS. Makes measuring processes a requirement for every case. Greater detail of the requirement on the control of outsourced processes

4.2. Documentation requirements: Autonomy for organizations to prepare the documents and records necessary to ensure the effectiveness of the processes.

4.2.3. States that the documents of external origin should be under control are for planning and operation of the QMS.
4.2.4 "Control of records" has been completely revised, and the "records designed to provide evidence of compliance with the requirements and effective operation of the QMS "are to be monitored.

6.2.1. General: added "note" stating that all the employees involved with the QMS must be competent.

6.2.2. Competence, awareness and training: This requirement has changed significantly. It became clearer, and the objective meet the necessary competencies for personnel affect conformity to product requirements, not limited to training.

6.3. Infrastructure: Included in the systems of information as part of the infrastructure.

6.4. Desktop: added note explaining the term "workplace".

7.2.1. Determination of product-related requirements: adequate text to improve understanding. Included "note" explaining the term "post-delivery activities."

7.3.1. Project planning and development: added "note" clarifying the application of review, verification and design validation.

7.3.3. Project outputs: added "note" clarifying the extent of the application output on the information for production and service provision.

7.5.2. Validation processes: Text simplification to make the application of requirements clearer.

7.5.3. Identification and traceability: Clarified that identification must be made to throughout product realization. In the second paragraph, there was a text adjustment.

7.5.4. Customer property: Clarified the "note" that customer property includes. Also, personal data.

7.5.5. Product preservation: Greater clarification of the requirement.

7.6. Control of measuring and monitoring equipment: Greater clarification of the requirement and text setting.


8.2.1. Customer satisfaction: added "note" with measurement possibility of examples of customer satisfaction.

8.2.2. Internal audit: Review of the order of the texts without changing the purpose. Distinction some terms and concepts (necessary actions and corrective actions).

8.2.3. Measurement and monitoring of processes: added "note" with clarification on the application requirement.

8.2.4. Measurement and monitoring product: Change the order of paragraphs without change on purpose. Term inclusion on the issue to the customer.

8.3. Product not control as: term Inclusion "where applicable".
8.5.2 and 8.5.3. Corrective action and preventive action: Clarified that the analysis of corrective action preventive refers to the analysis of the effectiveness of such actions.

The items not mentioned above have been same in the 2000 version also. Thus, the approach of ISO 9001:2008 is similar to that of ISO 9001:2000.

This approach is characterized by effective management of the activities that qualify organization and control of the interaction between processes, in which the methodology known for Safety

Plan-Do-Check-Act (PDCA) is applied to all processes. Through this approach processes organizations can achieve a detailed examination of each inherent process to its activity.

The ISO 9001: 2008 is based on a set of requirements, namely [10]:

1. Preamble and scope;
2. Normative References;
3. Terms and definitions;
4. of quality management systems;
5. Responsibility of management;
6. Resource management;
7. Product realization;
8. Measurement, analysis and improvement.

The organizations should also have the ability to explain the product to the customer and also look into the ongoing processes in improving system.

3.5 ISO 9001 revision

All ISO standards are reviewed in every five years to organize if a revision is needed to keep it current and significant for the marketplace [7]. The current version of quality standards ISO 9001 which is from the year 2008, an update for the version will be released by the end of 2015 and is available as a draft version which is expected to follow a new, higher level structure of standards to make it simple and easier to use in conjunction with other management system standards, with increased importance given to risk. In addition, the reinforcement of the requirements of the connection between quality management and business management will be a major change in the standard [7]. The future ISO 9001:2015 is expecting to be compatible with other management systems, for example, ISO 14001 furthermore the standard will respond to the latest trends. ISO 9001:2015 has recently been approved from the Final draft international stage (DIS) and has just reached the publication stage, sixth stage of a six stages process and is expected to be released in September 2015 as announced by the ISO organization [13].

The key feature changes include:

- All Management system Standards (MSS) include core text and a 10-clause structure.
- The approach to the process is more explicit and strengthened.
- Document and record are the two words that replaced the term documented information.
- Risk identification and mitigation addresses the prevention action throughout the standard.
• Purchasing and outsourcing is replaced by control of externally provided products and services.
• Opportunities for improvement have been given the most emphasis.
• Introduces a new high level structure which is a common framework for integrating other management system standards.
• Risk and opportunity management has been introduced.
• “One size doesn’t fit all” is the concept employed to make the standards more compatible with serviced and clear idea of the organizations context is necessary for nonmanufacturing users also.

Beneficial changes to 9001

- The language has been very much simplified which employs a common structure and simple terms.
- Organization’s strategy is primarily adhered to while creating the QMS policy and objectives.
- The concept of risk – based thinking has been followed.
- The involvement of leadership in the management system has been enhanced.
- Helps your organization in becoming a more reliable competitor in the marketplace.
- Improved quality management system to meet the customer needs and also helps in identifying the future needs of the customer.

Potential benefits to the user

- Planned results are the primary focus.
- Process control is improvised to provide better results.
- Documented information is much more flexible.
- Loyalty to the customers and customer retention to improve customer satisfaction.
- To build up reputation and image for greater credibility.

Key benefits of the common clause structure:

A new common format has been developed.

- To address the necessities of multiple management systems much more efficiently, same structure is employed for all ISO management system standards.
- Choice of integrating all management systems is provided.
- Core definitions are standardized.


High level structure (HLS) has been followed in the forthcoming ISO 9001:2015 version. The structure of the standard is as follows:

1. Scope
2. Normative references
3. Terms and definitions
4. Context of organization
5. Leadership
6. Planning
7. Support
8. Operations
9. Performance and evaluation
10. Improvements
3.6 Comparison of ISO 9001:2015 with ISO 9001:2008 and explanation of changes

ISO 9001:2015 is a common structure for every other management systems of ISO and is similar to Annex SL – the new high level structure. This type of common framework allows to keep consistency, regular various standards of management system, it helps in matching sub-class to the top level frameworks and the language across all the standards will be similar. For organizations it will be similar to consolidate their QMS into core business methods and it helps in getting more involvement from higher management. The Plan-Do-Check-Act (PDCA) cycle can be used to all the processes and to QMS. The diagram shows the relation between Clauses 4 to 10 and PDCA [61].
3.6.1 Key requirements of Quality Management system ISO 9001:2015

In this section the clauses are discussed in details along with changes when ISO 9001: 2015 is compared with ISO 9001:2008 [60][62].

### Clause 1: Scope
**Description:** The scope defines the borders for the future outcomes of the management system. These outcomes are related to a particular industry and the context of the organization.

**Changes:** This clause has minute changes when compared with ISO 9001:2008 version [60] [62].

<table>
<thead>
<tr>
<th>Table 2: Scope (1)</th>
</tr>
</thead>
</table>

### Clause 2: Normative References
**Description:** This clause is responsible for providing reference standards details and also the details of the relevant publications to that particular standard. Fundamental and vocabulary are referred as they provide important guidance.

**Changes:** No changes

<table>
<thead>
<tr>
<th>Table 3: Normative References (2)</th>
</tr>
</thead>
</table>

### Clause 3: Terms and Conditions
**Description:** This clause explains the details and definitions of a particular standard in detail apart from the formal definitions of the standard.

**Changes:** No changes

<table>
<thead>
<tr>
<th>Table 4: Terms and Conditions (3)</th>
</tr>
</thead>
</table>
Clause 4: Context of Organization

Description:
This new clause which incorporates the context of the QMS is a very important change that has come up when compared to the other changes that have been made. This new change facilitates to identify the factors in an organization that support quality management system.

As part of the clause, the first step is to identify the internal and external issues relevant to the context that could affect the output of the management system. Here, issue not only refers to the problems that the organization might have faced with the previous standards but also other crucial topics for the management system to address.

The second step involves identifying the “interested parties” that are relevant to an organization’s QMS. These parties might involve customers, suppliers and any stakeholders which can also change over the time.

Next, the scope of the QMS must be determined. This can be a small department of the organization or the whole organization. Outsourced functions or processes should also be considered in the organizational scope.

Finally, it is important to make sure that there is continual improvement of the QMS as per the requirements defined in the standard which needs the adoption of a process approach where the documented information could be supportive [61].

<table>
<thead>
<tr>
<th>Sub-Clauses 4.1-</th>
<th>Changes in Clauses:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding the organization and its context.</td>
<td>Clause 4.1: This clause is a new concept introduced in the DIS 9001:2015 with comparison to ISO 9001:2008 version. Clause 4.1 states that building an efficient Quality management system and fact based risk evaluation are influenced with the internal and external issues on an organization.</td>
</tr>
<tr>
<td>4.2-Understanding the needs and expectations of the interested parties.</td>
<td>Clause 4.2: Identify relevant requirements of interested parties. This clause is new concept in DIS 9001:2015 compared to ISO 9001:2008. The interested party’s requirements do not completely match with the organization’s ability to consistently provide products and services.</td>
</tr>
<tr>
<td>4.3-Determining the scope of the quality management system.</td>
<td>Clause 4.3 has been amended with what issues must be taken into consideration to determine the scope of the QMS. The needs must be documented if cannot be applicable.</td>
</tr>
<tr>
<td>4.4-Quality management systems and its processes.</td>
<td>As compared to the previous version the clause 4.4 has been modifies in terms of extended processes and need to determine several factors like inputs and outputs, Performance indicators, risks and opportunities [60] [62].</td>
</tr>
</tbody>
</table>

Table 5: Context of Organization (4)

Clause 5: Leadership

Description: The term “top management” refers to the person or a group of people who directs and controls the organization. This clause gives requirements for this top management. This top management is no more responsible for the QMS. The importance is increased on having a group of people owning QMS opposed to individual. The requirements in the clause demonstrate the leadership from the
highest level of management. The top management has more involvement in the system, ensuring that the requirements are articulated to the processes of the organization and that the policies are compatible with the organization's direction. The quality policy must be the driving source for the organization. Top management must be responsible for this and must be available for all the other people involved. Enhancing the customer satisfaction is also another responsibility, by identifying the upcoming risks and opportunities. They must demonstrate the consistency in the customer satisfaction. They must focus on the company's internal strengths and weaknesses and their effects on the product delivery and services. Top management must also work to understand the key risks in the processes and focus on handling them effectively. The clause essentially places requirements on top management to assign QMS tasks but to be responsible for its effectiveness [61].

<table>
<thead>
<tr>
<th>Sub–Clauses</th>
<th>Changes in Clauses [60][62]:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1-Leadership and commitment.</td>
<td>Clause 5.1.1: The leadership should stand accountable for the effectiveness for quality management, ensure the integration of QMS into the business processes, promote the use of process approach and risk based thinking, support relevant management roles and promote improvement.</td>
</tr>
<tr>
<td>5.2-Quality Policy</td>
<td>Clause 5.1.2: The clause is almost the same from the previous version but with some slight extensions. Top management should ensure customer satisfaction through addressing risk opportunities and focusing on meeting customer requirements.</td>
</tr>
<tr>
<td>5.3-Organization roles, responsibilities and authorities.</td>
<td>Clause 5.2: Explain the requirement explicitly to apply the policy. The clause is very similar to the one in the previous version but that auditors could challenge the top management regarding the compatibility of the policy. Clause 5.3: Relevant roles for defining responsibility and authority for ensuring processes are delivering their intended outputs should be defined explicitly. Also, the top management will assign and manage specific management issues [60][62].</td>
</tr>
</tbody>
</table>

Table 6: Leadership (5)

### Clause 6: Planning for Quality Management System.

**Description:**
Planning is one of the important part of ISO 9001. Nowadays, planning is ensured to be considered with Clause 4.1 ‘context of the organization’ and Clause 4.2 ‘interested parties’. The first clause is related with risk assessment and the other with risk treatment. While evaluating the procedure to select risks and opportunities they need to consider the impact of them on confirmation of products and services. Examples for opportunities are new product launches, geographical expansion, new partnerships, or new technologies. In any organization risks and opportunities are to be addressed with a plan, implement and integrate them to the organizations management system processes and to analyze the potency these actions. In this clause one of the key feature is to provide quality objectives which can be measured. This clause is similar to Clause 5.4 of the 2008 version but is more precise. Quality must be directly related with quality policy, confirmation of product and services and in improving the customer satisfaction. This clause also mentions that selection of changes should be done in systematic way. The effects of changes need to be identified, to select who is involved and the resources need
to be given to overcome those changes [61].

<table>
<thead>
<tr>
<th>Sub-Clauses</th>
<th>Changes in clauses [60][62]:</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1- Actions to address risks and opportunities</td>
<td>Clause 6.1: This clause presents a new concept compared to the earlier version. The risks and opportunities need to be addressed and actions should be taken based on requirements identified in 4.1 and 4.2. Also, the effectiveness of these actions should be evaluated. The effect on the conformity of the products and services must be considered.</td>
</tr>
<tr>
<td>6.2-Quality objectives and planning to achieve them</td>
<td>Clause 6.2: The clauses in this are made clear and extended better as compared to the previous version. Objectives should be established for processes relevant to QMS such that they are monitored, communicated, updated and in line with the customer requirements, products and services conformity. Another being how the objectives are achieved.</td>
</tr>
<tr>
<td>6.3-Planning of changes</td>
<td>Clause 6.3: Changes to the QMS should be made in a planned manner and should be addressed in clauses 6.3, 7.1.6, 8.1 and 8.5.6. This clause provides an extension to the requirements like purpose of change, allocation of resources, their allocation and reallocation.</td>
</tr>
</tbody>
</table>

Table 7: Planning for quality management system (6)

**Clause 7: Support**

**Description:**
The suitable resources, people and infrastructure for achieving objectives of an organization are stated in clause 7. This clause mentions an organization should mention and give resources to start, implement, manage and enhance QMS. Clause 7 ensures that it covers both internal and external QMS resources. Combining Clauses 6.1, 6.2, 6.3 and 7.6 from 2008 builds Clause 7.1 and it has 5 sub-clauses. It also contains several other requirements like statutory and regulatory. The infrastructure requirement and environment for process operation are covered in sub sections. To include personnel or training resources monitoring and measuring have been changed. Quality knowledge involves with competence, awareness and communication requirements of QMS. Individuals may not know the quality policy but they must know how they contribute and affect. An important requirement of an organization is to maintain the knowledge held by it. This intern ensures the conformation of products and services. This can be the knowledge kept by a personnel or can be an intellectual property of an organization. Organizations must know if the present knowledge they possess is enough while changing the plans and whether any additional knowledge is required. “Document information” is a new requirement which replaces the references to “documents” and “records” in 2008 standard. Organizations must know the documentation required to control QMS and it varies among organizations because of size and complexity. Control of access to the documents is also given major emphasis as there is an increased priority of security in organizations. There is also a need to keep a backup for the systems in place whenever IT systems crash [61].

<table>
<thead>
<tr>
<th>Sub–Clauses</th>
<th>Changes in clauses [60][62]:</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1-Resources</td>
<td>Clause 7.1: Resource considerations should now include: internal resources, external providers, people, monitoring and measuring resources and external communication.</td>
</tr>
<tr>
<td>7.2-Competence</td>
<td>Clause 7.1.6: The clause is new to the latest version of 2015. The requirements are wide with primarily</td>
</tr>
</tbody>
</table>
**7.3-Awareness**

mentioning the necessity to obtain the knowledge resources that would ensure the smooth run of processes.

**Clause 7.3:** When compared to the 2008 edition the focus and requirements have been extended. The focus that was limited to requirements in the earlier version broadened in the latest version.

**Clause 7.4:** The main change in this clause compared to the 2008 version is that the external communication is also considered. Another change being the additional concepts of what, when and how to communicate.

**Clause 7.5.1:** The use of documented information for the QMS have been included in the quality manual. With no much amendments the important changes are that the quality manual is not required and mandatory procedures have been removed. The documentation is still required.

**Clause 7.5.3:** Documented information now explicitly includes access, confidentiality and integrity.

<table>
<thead>
<tr>
<th>7.4-Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7.5-Documented information</strong></td>
</tr>
</tbody>
</table>

---

**Table 8:** Support (7)

<table>
<thead>
<tr>
<th>Clause 8: Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td>This clause is to achieve the customer requirements and designing products and services with implementing plans and processes of an organization. This clause is similar to Clause &amp; of 2008 version but has increased importance on process control with emphasis on the planned changes and to examine the results of unintended changes and resolving the severe effects. This version of the standard gives importance to the use of subcontractors and outsourcing to a vast level which can be defined by the requirement to set rules for monitoring the performance of the involved clients and also maintain record of these selection criteria. ‘Requirements for products and services’ are covered in this clause which is almost similar to 2008 version. This clause mentions communication with respect to contingency actions required and treatment of customer property. For communication with “potential” customer’s new requirement is included which brings new features and solutions to the market. Several other requirements are mentioned like standards of method the organization follows, resources needed for the design of products and services and the effects of failure because of the nature of products. Another clause is mentioned which describes post-delivery activities such as maintenance programs and activities for disposal of products. Organizations must look into the risks involving with product, service and any other statutory requirements while examining these activities [61].</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub –Clauses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8.1:</strong> Operation control and planning</td>
</tr>
<tr>
<td><strong>8.2:</strong> Determination of requirements for products and services.</td>
</tr>
<tr>
<td><strong>8.3:</strong> Design and development of products and services.</td>
</tr>
<tr>
<td><strong>8.4:</strong> Control of extremely provided products and services.</td>
</tr>
<tr>
<td><strong>8.5:</strong> Production and service</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Changes [60][62]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clause 8.2.1: Customer communications, property, and contingency actions are now linked to explicit considerations</td>
</tr>
<tr>
<td>Clause 8.2.2: The claims for products and services being offered should be substantiated</td>
</tr>
<tr>
<td>Clause 8.3: Design and development of products and services are simplified</td>
</tr>
<tr>
<td>Clause 8.3.2: Customers are involved as a part of the design process and the design and development process has been restructured to allow for a process orientated approach</td>
</tr>
<tr>
<td>Clause 8.3.3: Need for internal and external resources,</td>
</tr>
<tr>
<td>Clause 8: Provision</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>8.6: Release of products and services.</td>
</tr>
<tr>
<td>8.7: Control of nonconforming process outputs and services.</td>
</tr>
</tbody>
</table>

**Table 9: Operation (8)**

**Clause 9: Performance evaluation**

**Description:**
This clause in the new standard covers several concepts which are featured in the clause 8 of the previous version of standard. Performance evaluation mainly covers the requirements for measurement, monitoring, analyzing and evaluation. The needs which should be measured and the methods employed for analyzing the data are considered in this clause. This clause now gives more importance to the information that is related to the customer perspective of viewing an organization. Information on customer perception should be effectively solicited by the organizations. This can be accomplished is several ways by conducting customer satisfaction surveys, analyzing the share market and through complaints registered. This clause now show an explicit requirement of how the data analysis and data evaluation is carried out in an organization, particularly as a need for improving the quality management system. Internal audits should likewise be directed and this is to a great extent unaltered from those in the 2008 version. This clause also mentions the ‘audit criteria’ and make sure that the audit results are submitted to relevant management. Additional requirements are also included to consider the
changes in the issues related to the quality management system [61].

<table>
<thead>
<tr>
<th>Sub –Clauses</th>
<th>Changes in Clauses [60][62]:</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1: Monitoring, measurement, analysis and evaluation.</td>
<td>Clause 9.1.1: Identifying the needs and methods to be used in monitoring and measuring replaces the requirement for planning which was included in 8.1 ISO 9001:2008 (clause 8.1).</td>
</tr>
<tr>
<td>9.2: Internal audit</td>
<td>Clause 9.1.3: For analysis and evaluation of management review when using results as inputs have specific requirements now. New requirements in this clause include actions to address risks and effective implementation of planning.</td>
</tr>
<tr>
<td>9.3: Management review</td>
<td>9.3.1: The outputs of the management review shall include decisions and actions related to: should consider “adequacy of resources” and “issues concerning external providers” in detail apart from improving on the whole by reducing the statue of risks.</td>
</tr>
</tbody>
</table>

Table 10: Performance Evaluation (9)

<table>
<thead>
<tr>
<th>Clause 10: Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td>This clause stresses on the need for identifying the areas where they could be improvement such as improved processes to enhance customer satisfaction. It is also important to check for the areas where there could be potential improvement keeping in mind the changing requirements in the software field. Some new corrective action requirements are included in this clause although there are no preventive action requirements. While reacting to the nonconformities by controlling and correcting them appropriately is the first step, identifying if there are similar nonconformities is the second step. The scope of continual improvement clause has further been extended to suitability and adequacy of the QMS but it doesn’t specify how it is achieved [61].</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub –Clauses</th>
<th>Changes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1: General</td>
<td>Clause 10.1 is a new clause and is similar to clause 8.5 in 9001:2008 which point outs the areas where improvements are expected.</td>
</tr>
<tr>
<td>10.2: Nonconformity and corrective action</td>
<td>Clause 10.2.1 When nonconformity occurs, including those arising from complaints, the organization shall AND clause 10.2.2 The organization shall retain documented information as evidence.</td>
</tr>
<tr>
<td>10.3: Continuous Improvement</td>
<td></td>
</tr>
</tbody>
</table>

Table 11: Improvement (10)
4 RESULTS

This section of the document deals with the results of the survey and the analysis of the survey results. The summary of the literature review and survey responses are mentioned followed by their analysis.

4.1 Summary of Literature Review

The literature review was conducted to find the changes in the ISO 9001:2008 standards and ISO 9001:2015 standards. Many new clauses were added and some were modified. Following table illustrates the refined version of all the tables 2-11 and this formed the base for the survey questionnaire.

<table>
<thead>
<tr>
<th>Sections and Clauses changes</th>
<th>Changes Explained</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Clause 4.1] is a new concept compared to ISO 9001:2008 versions and states that: Building an efficient Quality management system and fact based risk evaluation are influenced with the internal and external issues on an organization.</td>
<td></td>
</tr>
<tr>
<td>[Clause 4.2] a new concept which states that organizations shall monitor and review information about interested parties and their relevant requirements.</td>
<td></td>
</tr>
<tr>
<td>Compared to the ISO 9001 2008 edition the requirements in the [clause 4.3] are amended based on the issues considered while defining the scope of QMS.</td>
<td></td>
</tr>
<tr>
<td>The process requirements are extended by determining the input-output, Performance indicator, Assigning process responsibilities, Risks. [Clause 4.4]</td>
<td></td>
</tr>
<tr>
<td>[Clause 5.1] The new version represents extended expectations to the top management which results in accounting the effectiveness of the QMS.</td>
<td></td>
</tr>
<tr>
<td>[Clause 5.3] The new version details the responsibilities, roles and authority within the QMS. This clause is slightly amended through ensuring: processes delivery and QMS maintenance.</td>
<td></td>
</tr>
<tr>
<td>[Clause 6.1] This is a new notion added to the ISO 9001:2015 version which</td>
<td></td>
</tr>
</tbody>
</table>
Deals with contemplating which actions are for addressing risks and opportunities

[Clauses 6.2.1 & 6.2.2] are an extension to the previous version (ISO 9001:2008). They mention the need to account for applicable requirements and for their monitoring, communication and upgradation. Clause 6.2.2 accounts for the achievement of these objectives.

[Clause 6.3] Any requirements required regarding the plan in changes to the QMS are mentioned by this clause. These requirements include: Resource availability, the allocation of responsibilities, authorities and taking considerations of risks.

<table>
<thead>
<tr>
<th>Clause 7.1.1</th>
<th>When compared to the ISO 9001:2008, the ISO 2015 mentions the need to consider external resources. An explicit reference is mentioned in this direction.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clause 7.1.6</td>
<td>This is a new clause introduced in the ISO 2015 which is associated with assuring the organization has or will obtain adequate knowledge about handling any changes in the business environment. This clause mentions that the organization must have all necessary knowledge to the required extent of depth to handle any changes.</td>
</tr>
<tr>
<td>Clause 7.3</td>
<td>Although a part of this clause is covered in the ISO 9001:2008, this clause extends other parameters in ISO 9001:2015. These parameters include &quot;quality policy&quot; and &quot;the implications of not conforming to the quality management system requirements&quot;.</td>
</tr>
<tr>
<td>Clause 7.4</td>
<td>This clause mentions a few significant changes and add-ons. This includes, the aspect of who, when and how to communicate. Another change is considering external communication along with the existing internal communication.</td>
</tr>
<tr>
<td>Clause 7.5.1</td>
<td>A few modifications from previous version are that no mandatory</td>
</tr>
</tbody>
</table>
procedures are required and a quality manual is not required. However, the documentation is still required with information about multiple elements such as scope, processes, quality policy and so on.

<table>
<thead>
<tr>
<th>7. Product Realization</th>
<th>8. Operation</th>
</tr>
</thead>
</table>

[Clause 8.1] “Control of changes” and “control of outsourced processes” have been added in this clause but contents and requirements are similar with Clause 7.1 in previous version.

Handling customer property and contingency actions are added in the new version [clause 8.2.1] when compared with clause 7.2.1 in ISO 9001:2008.

Clause 8.3.1 Points out the scheduling of design and developmental process.

Clause 8.3.2 Auditors should consider customer involvement and necessary documented info in the design and development process.

Clause 8.3.3 Auditors should consider, need for internal and external resources, risks and the level of control of the stakeholders on the design and development process.

Clause 8.4.1 This clause explicitly considers the involvement of external provisions including outsourced processes.

Clause 8.4.2 Apart from purchased products, verify that external provided processes, products and services do not affect the organization.

Clause 8.5.3 Auditors should verify that the control belongs to not only customers but also suppliers.

Clause 8.5.5 Auditors must make sure that necessary post-delivery activities is taken into account by the organization.

Clause 8.5.6 States that unplanned changes should be done in a controlled
Table 12: Summary of Literature review

4.2   Results of the Survey Conducted

The survey was broadcasted via emails to the ISO 9001:2008 certified organizations and was also published on social networking sites like Facebook and LinkedIn. There were closed groups with members who were related to the ISO standards implementation in software organizations. Only such groups were selected so that reliable responses can be gathered.

The results gathered from the survey questionnaire are reposted in this sub section of the document. A total of 63 responses were gathered from the survey which was scheduled for four weeks of time.
Section 1: Organizational Information

The results for this part of the questionnaire are presented in the table below:

<table>
<thead>
<tr>
<th>Organization Size</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>28</td>
<td>29</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Certified to ISO 9001:2008</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 13: Organizational Information

Like mentioned, 63 responses were recorded for the survey of which almost equal percentages of small (44%) and medium (46%) sized organizations have responded. Among them 50 companies (79%) of the organizations were certified to ISO 9001:2008 and the rest were not. The responses have come from all over the world covering around 23 countries.


This section deals with the changes brought about in the clause 4 which is renamed as context of organization in ISO 9001:2015 standard of which 32 respondents reported that it would take less than a year for learning and implementing these changes. Among the remaining, 19 of them have selected the option 1-2 years and the remaining of them have said it would take 2 to greater than 3 years for the implementation. Majority of the respondents thought the cost for implementing the change would be moderate (60%), i.e., neither high nor low but most of them (79%) have reported saying the effort needed would be more.

<table>
<thead>
<tr>
<th>Time</th>
<th>0-1 year</th>
<th>1-2 years</th>
<th>2-3 years</th>
<th>&gt;3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>32</td>
<td>19</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>38</td>
<td>19</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effort</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 14: Clause 4: Context of Organization

Section 3: “Clause 5: Leadership” (ISO 9001:2015)

The clause 5 is estimated to be finished within a span of 1 year by most of the organizations which have responded to the survey. A total of 36 out of the 63 have responded by saying the same. The estimation of cost for completing the cost was predicted to be moderate by 46% of the respondents and 39% of them perceived it as low. The effort needed was estimated by 62% of the survey respondents as more. All these details are presented in the table below:

<table>
<thead>
<tr>
<th>Time</th>
<th>0-1 year</th>
<th>1-2 years</th>
<th>2-3 years</th>
<th>&gt;3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>36</td>
<td>12</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
<td>29</td>
<td>25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effort</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>39</td>
<td>24</td>
</tr>
</tbody>
</table>

Table 15: Estimate for clause 5: Leadership

For clause 6, the survey results for the probable time needed was considered 0-1 year by most of the participants of the survey. 58% of them have selected 0-1 year as their choice to complete this clause. Most of them opted the moderate choice for the cost incurred. 71% of them have said that the effort would be more to implement the changes.

<table>
<thead>
<tr>
<th>Time</th>
<th>0-1 year</th>
<th>1-2 years</th>
<th>2-3 years</th>
<th>&gt;3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>34</td>
<td>15</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>11</td>
<td>34</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>45</td>
<td>18</td>
</tr>
<tr>
<td>Moderate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 16: Estimate for planning

Section 5: “Clause 7: Support” (ISO 9001:2015)

<table>
<thead>
<tr>
<th>Time</th>
<th>0-1 year</th>
<th>1-2 years</th>
<th>2-3 years</th>
<th>&gt;3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>36</td>
<td>9</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>8</td>
<td>35</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effort</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>More</td>
<td>22</td>
<td>41</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 17: Estimate for clause 7: support

From the above tabular form, it is clear that more than 50% of the respondents think the time needed for implementing the change is less than a year. Similarly, the cost was expected to be moderate by 35 among the 63 who have responded to the survey. Most of the respondents felt that the effort needed would be less.


<table>
<thead>
<tr>
<th>Time</th>
<th>0-1 year</th>
<th>1-2 years</th>
<th>2-3 years</th>
<th>&gt;3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>30</td>
<td>19</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>11</td>
<td>33</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effort</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>More</td>
<td>46</td>
<td>17</td>
</tr>
<tr>
<td>Less</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 18: Estimate for operations clause

The operations clause is expected to be complemented by a year’s time by 30 respondents among the 63 of those who have replied. Cost needed for implementing was considered moderate by most of them. The effort estimate for implementing the changes is predicted to be more by many of the organizations.

Section 7: “Clause 9: Performance evaluation” ISO (9001:2015)

The table 19 holds the information regarding the time, cost and effort needed to implement clause 9 of the newly designed scheme. Just like the previous clauses this clause is also estimated to be done within one year’s span by many organizations. Cost is also looked as moderate by many organizations. The effort estimated is looked as more by majority of the respondents.

<table>
<thead>
<tr>
<th>Time</th>
<th>0-1 year</th>
<th>1-2 years</th>
<th>2-3 years</th>
<th>&gt;3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>32</td>
<td>16</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>------</td>
<td>----------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>32</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effort</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>44</td>
<td>19</td>
</tr>
</tbody>
</table>

Table 19: Estimate for Performance Evaluation

Section 8: “Clause 10: Improvements” (ISO 9001:2015)

<table>
<thead>
<tr>
<th>Time</th>
<th>0-1 year</th>
<th>1-2 years</th>
<th>2-3 years</th>
<th>&gt;3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35</td>
<td>18</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</td>
<td>26</td>
<td>26</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effort</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>46</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 20: Estimate for Improvements

The table 20 presents the results for the time, cost and effort estimate expected by the organizations across the world. The time needed is expected as below 1 year by most of the survey participants. The cost estimate was estimated to be either low or moderate by many of them. Most organizations assume the effort needed would need more.

Section 9: “Overall changes” (ISO 9001:2015)

Considering the overall estimates for time, cost and effort needed to implement all the changes, the results are presented in the table below. It is perceived by many of the organizations that the time taken for completing all the changes is 0-1 year. A total of 52% of have reported the same. Speaking of cost, most of them think the costs incurred to implement the new changes are moderate. The effort estimate for implementing all the changes is predicted as more by the survey respondents. All these results are clearly elucidated in the table 21.

<table>
<thead>
<tr>
<th>Time</th>
<th>0-1 year</th>
<th>1-2 years</th>
<th>2-3 years</th>
<th>&gt;3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>33</td>
<td>15</td>
<td>11</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9</td>
<td>32</td>
<td>22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effort</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>41</td>
<td>22</td>
</tr>
</tbody>
</table>

Table 21: Estimate for Overall Changes

4.3 Extracting codes from Survey responses (Open Coding)

After receiving the survey responses for the open ended question, it was analyzed using Grounded theory. Grounded theory is a qualitative data analysis method used to analyze data and propose new theory based on the data[28]. In the initial stage of grounded theory, the codes are identified from the available data. Codes/Concepts are words pertaining to a part of the data. Each code has a significance in the context of the data. All the results from the survey’s open ended question are gathered and are stored in a single file. Now this file is used to identify the codes.

The codes are identified manually by reading each and every line of the responses. Whenever a line related to the question is found, the whole line is marked with a code. The code should be in such a way that using it the sentence can be identified and
pointed. Analysis with grounded theory starts as soon as the first response is obtained. Initial codes are identified from the initial survey responses.

For the open ended question in the survey, the analysis was performed to obtain the detailed description for the Cost, Time and Effort estimation given by the respondent. The response contains Overall Cost, Effort and Time required for migration along with or without a reason for the same. This is analyzed by coding all the responses. The responses are coded manually and the resultant codes are as following in the below table.

**CODES:**

<table>
<thead>
<tr>
<th>Leadership</th>
<th>Documentation</th>
<th>Annex SL-high level structure</th>
<th>Organization Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Level Management</td>
<td>Risks and Opportunities</td>
<td>Quality Management System</td>
<td>Organizing business process</td>
</tr>
<tr>
<td>Senior Management</td>
<td>Risk based thinking</td>
<td>Continuous process improvement</td>
<td>Internal Audits</td>
</tr>
<tr>
<td>Training</td>
<td>Corrective and Preventive actions</td>
<td>Process oriented approach</td>
<td>Gap analysis</td>
</tr>
<tr>
<td>Workshops</td>
<td>Registration fee</td>
<td>Consolation fee</td>
<td></td>
</tr>
</tbody>
</table>

Table 22: Codes obtained from analysis

4.4 Filtering and Sorting the Codes

Now that we have the codes, the next stage was to filter duplicate codes or related codes and categorize the codes in such a way that each code falls into either Cost, Effort or Time category. This sorts the code and based on the codes filtered the theory is proposed.

After categorizing the codes each category as following:

**Time**

- Documentation
  - High level structure
  - Organizing business process
  - Risk based thinking
  - Process oriented approach
  - Gap analysis
  - Corrective and preventive actions

Figure 9: Time based Codes
In this way the codes are filtered and are sorted into the categories. The explanation of these categories and their codes are explained in section 5.2.
5 ANALYSIS AND DISCUSSIONS

5.1 Survey Result Analysis

Based on the survey results, by doing quantitative statistical analysis, possible relationships between different sets of information gathered is done using bi-variate analysis. In bi-variate analysis a cross-tabular analysis is done by comparing data from one table to the data of another table. Here, time, cost and effort are compared with the size of the organization and a relationship has been established. In this process the results for the estimate tables of each section are compared with the size of the organizations to establish relationships among both the data. This section of the document shows the analysis made from the results of each section of the survey questionnaire.

Further, in order to obtain a mathematical significance to the data gathered and the results stated, Friedman’s test has been used. The Friedman’s test is implemented by taking the help of an automatic tool named SPSS has been used for accurate and proper estimates. Friedman’s test was considered because the scale used in the survey was Likert scale ranging from low to high and is best suitable in the present case [63][64].

Analysis of section 2:
The Second section demonstrated the predicted estimates recorded for implementing the changes as suggested in the clause 4 and the time needed to implement the changes, the cost expected and the effort estimated. The tabular columns and the graphical represents clearly that most of the small organizations feel the time taken for the small and medium sized organizations to be less than a year and most of the large organizations stated that it would take 2 to 3 years.

<table>
<thead>
<tr>
<th>Size/Time</th>
<th>&lt;1 year</th>
<th>1 to 2 years</th>
<th>2 to 3 years</th>
<th>&gt;3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>21</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Medium</td>
<td>10</td>
<td>14</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Large</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 23: Time analysis for Section-2

Figure 12: Time analysis for Section-2
Considering cost and effort, most of the organizations large, medium and small found the costs to be moderate and the effort needed is more. The details are presented in the tabular columns and the graphs.

Table 24: Cost/Effort analysis for section-2

<table>
<thead>
<tr>
<th>SIZE/ Cost</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>4</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Medium</td>
<td>0</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>Large</td>
<td>2</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size/ Effort</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>Medium</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>Large</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 13: Cost/Effort analysis for Section-2

Section 3: Similarly on analyzing the results of the leadership clause, quite similar to the previous sections, it was identified that most of the small and medium sized organizations thought that the time taken would not exceed an year. Regarding the cost, all the organizations felt the cost for the changes would be moderate while the effort was considered to be more by the medium sized organizations and less by small organizations.

Table 25: Time analysis for Section-3

<table>
<thead>
<tr>
<th>SIZE/TIME</th>
<th>&lt;1 year</th>
<th>1 to 2</th>
<th>2 to 3</th>
<th>&gt;3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>36</td>
<td>12</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Small</td>
<td>13</td>
<td>7</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Medium</td>
<td>21</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Large</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Figure 14: Time analysis for Section-3
Section 4: By analyzing the results of the leadership clause, quite similar to the other two sections, the estimated time taken to implement the new changes was less than a year’s span according to the small and medium sized organizations. The estimated cost was reported to be moderate while the effort needed was estimated to be more by majority of the medium sized organizations and less by most of the small organizations.
Section 5: The results from this section of the questionnaire suggest that the results for the time needed are similar to those of the previous section results. When it comes to cost estimate it was noticed that the medium sized organizations reckoned the costs to be moderate while the small sized ones think the costs would be low. The effort needed was reported as less by both medium and small sized organization.
Section 6: The cross tabular analysis of the clause named support is done and the details are presented in the tables below. Further, the analysis is also predicted by depicting the same in the form of bar graphs.
Section 7: Most of the small organizations said that the time needed for incorporating these changes is expected to be between <1 yearyear while the medium sized organizations thought the time estimate would be 1 to 2 or 2 to 3 years. Most of the organizations reported the estimated cost as moderate and the estimated effort was considered more by the organizations of all the sizes.

<table>
<thead>
<tr>
<th>Size/Cost</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>4</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Medium</td>
<td>5</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>Large</td>
<td>2</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size/Effort</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Medium</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>Large</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 32: Cost/Effort analysis for Section-6

<table>
<thead>
<tr>
<th>Size/Time</th>
<th>&lt;1 year</th>
<th>1 to 2 years</th>
<th>2 to 3 years</th>
<th>&gt;3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>19</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Medium</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Large</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 33: Time analysis for Section-7
Section 8: The analysis of the results of the clause named operations is quite similar to the previous section (section 7). These results are presented in the tabular form and the graphs.

### Table 34: Cost/Effort analysis for Section-7

<table>
<thead>
<tr>
<th>Size/Cost</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>4</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Medium</td>
<td>2</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Large</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size/Effort</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Medium</td>
<td>18</td>
<td>11</td>
</tr>
<tr>
<td>Large</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

### Figure 23: Cost/Effort analysis for Section-7

### Table 35: Time analysis for Section-8

<table>
<thead>
<tr>
<th>Size/Time</th>
<th>&lt;1 year</th>
<th>1 to 2 years</th>
<th>2 to 3 years</th>
<th>&gt;3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>13</td>
<td>10</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Medium</td>
<td>16</td>
<td>8</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Large</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Figure 24: Time analysis for Section-8

### Table 36: Cost/Effort analysis for Section-8

<table>
<thead>
<tr>
<th>Size/Cost</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>7</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Medium</td>
<td>3</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Large</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size/Effort</th>
<th>More</th>
<th>Less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td>Medium</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>Large</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>
5.1.1 Data Analysis using Friedman’s test

The results gathered for estimating the time taken, possible costs incurred and effort needed to implement the changes and attain ISO certification are considered and Friedman’s test is conducted. By using the Friedman’s test the respondents’ perception is calculated statistically and a mathematical significance is established to represent the overall time, cost and effort needed to transit from ISO 9001:2008 to ISO 9001:2015. The cumulative effort is then compared to the survey responses gathered for the overall time, cost and effort needed to implement the changes.

The Friedman test is a significant test used to compare more than two related samples without making any assumptions with the underlying distributed data and is also called Friedman’s’ two way analysis of variance. The test is conducted by using the SPSS tool developed by IBM for statistical analysis of data [63][64].

<table>
<thead>
<tr>
<th>Survey Sections</th>
<th>Responses</th>
<th>Responses for Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2(Clause4)</td>
<td>3(Clause5)</td>
</tr>
<tr>
<td></td>
<td>4(Clause6)</td>
<td>5(Clause7)</td>
</tr>
<tr>
<td></td>
<td>6(Clause8)</td>
<td>7(Clause9)</td>
</tr>
<tr>
<td></td>
<td>8(Clause10)</td>
<td></td>
</tr>
<tr>
<td>Total Responses</td>
<td>63(100%)</td>
<td>63(100%)</td>
</tr>
<tr>
<td></td>
<td>63(100%)</td>
<td>63(100%)</td>
</tr>
<tr>
<td>Time</td>
<td>&lt;1 year</td>
<td>1-2 years</td>
</tr>
<tr>
<td></td>
<td>31.00(49%)</td>
<td>19.00(30%)</td>
</tr>
<tr>
<td></td>
<td>36.00(57%)</td>
<td>12.00(19%)</td>
</tr>
<tr>
<td></td>
<td>34.00(53%)</td>
<td>15.00(23%)</td>
</tr>
<tr>
<td></td>
<td>36.00(57%)</td>
<td>9.00(14%)</td>
</tr>
<tr>
<td></td>
<td>30.00(47%)</td>
<td>19.00(30%)</td>
</tr>
<tr>
<td></td>
<td>36.00(57%)</td>
<td>16.00(25%)</td>
</tr>
<tr>
<td></td>
<td>35.00(55%)</td>
<td>18.00(28%)</td>
</tr>
<tr>
<td>Cost</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>6.00(9.52%)</td>
<td>38.00(60.31%)</td>
</tr>
<tr>
<td></td>
<td>8.00(12.69%)</td>
<td>29.00(46.03%)</td>
</tr>
<tr>
<td></td>
<td>11.00(17.40%)</td>
<td>34.00(53.90%)</td>
</tr>
<tr>
<td></td>
<td>8.00(12.69%)</td>
<td>35.00(55.55%)</td>
</tr>
<tr>
<td></td>
<td>11.00(17.46%)</td>
<td>33.00(52.38%)</td>
</tr>
<tr>
<td></td>
<td>7.00(11.11%)</td>
<td>32.00(50.79%)</td>
</tr>
<tr>
<td></td>
<td>11.00(17.40%)</td>
<td>26.00(41.26%)</td>
</tr>
</tbody>
</table>

Table 37: Contingency table for time

Table 38: Contingency table for cost
The above contingency tables (Tables: 37, 38, and 39) hold the raw data gathered from the survey respondents. Table 37 holds the data of the time required for implementing the changes for each clause. Similarly, table 38 and table 39 hold the data for the cost and effort needs for each clause. This raw data is provided as input to the SPSS tool and the Freidman test is conducted.

### Descriptive Statistics

<table>
<thead>
<tr>
<th>Time</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimu</th>
<th>Maximu</th>
<th>25th</th>
<th>50th (Median)</th>
<th>75th</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME: &lt;1 year</td>
<td>7</td>
<td>34.00</td>
<td>2.51661</td>
<td>30.00</td>
<td>36.00</td>
<td>31.00</td>
<td>35.0000</td>
<td>36.00</td>
</tr>
<tr>
<td>TIME: 1-2 years</td>
<td>7</td>
<td>15.428</td>
<td>3.77964</td>
<td>9.00</td>
<td>19.00</td>
<td>12.00</td>
<td>16.0000</td>
<td>19.00</td>
</tr>
<tr>
<td>TIME: 2-3 years</td>
<td>7</td>
<td>11.142</td>
<td>4.05909</td>
<td>7.00</td>
<td>19.00</td>
<td>7.0000</td>
<td>11.0000</td>
<td>12.00</td>
</tr>
<tr>
<td>TIME: &gt;3 years</td>
<td>7</td>
<td>3.4286</td>
<td>1.51186</td>
<td>2.00</td>
<td>6.00</td>
<td>2.0000</td>
<td>3.0000</td>
<td>5.0000</td>
</tr>
</tbody>
</table>

Table 40: Descriptive Statistics for TIME

<table>
<thead>
<tr>
<th>COST</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimu</th>
<th>Maximu</th>
<th>25th</th>
<th>50th (Median)</th>
<th>75th</th>
</tr>
</thead>
<tbody>
<tr>
<td>COST: High</td>
<td>7</td>
<td>8.8571</td>
<td>2.11570</td>
<td>6.00</td>
<td>11.00</td>
<td>7.0000</td>
<td>8.0000</td>
<td>11.0000</td>
</tr>
<tr>
<td>COST: Medium</td>
<td>7</td>
<td>32.4286</td>
<td>3.95209</td>
<td>26.00</td>
<td>38.00</td>
<td>29.0000</td>
<td>33.0000</td>
<td>35.0000</td>
</tr>
<tr>
<td>COST: low</td>
<td>7</td>
<td>21.5714</td>
<td>3.30944</td>
<td>18.00</td>
<td>26.00</td>
<td>19.0000</td>
<td>20.0000</td>
<td>25.0000</td>
</tr>
</tbody>
</table>

Table 41: Descriptive Statistics for COST

<table>
<thead>
<tr>
<th>Effort</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimu</th>
<th>Maximu</th>
<th>25th</th>
<th>50th (Median)</th>
<th>75th</th>
</tr>
</thead>
<tbody>
<tr>
<td>More Effort needed</td>
<td>7</td>
<td>41.7143</td>
<td>9.28645</td>
<td>22.00</td>
<td>50.00</td>
<td>39.0000</td>
<td>45.0000</td>
<td>46.0000</td>
</tr>
<tr>
<td>Less effort needed</td>
<td>7</td>
<td>21.2857</td>
<td>9.28645</td>
<td>13.00</td>
<td>41.00</td>
<td>17.0000</td>
<td>18.0000</td>
<td>24.0000</td>
</tr>
</tbody>
</table>

Table 42: Descriptive statistics for EFFORT

The Friedman test was used to calculate the variance between each choice provided to the respondents and the overall cumulative time, cost and effort needed to
implement the changes. Further, the standard deviation (variance) and the mathematical significance of the obtained values are depicted by using the mean rank. Hence, the variance and the mean rank were calculated for time, cost and effort needed to implement the changes.

<table>
<thead>
<tr>
<th>Time</th>
<th>Mean Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 year</td>
<td>4.00</td>
</tr>
<tr>
<td>1-2 years</td>
<td>2.86</td>
</tr>
<tr>
<td>2-3 years</td>
<td>2.14</td>
</tr>
<tr>
<td>&gt;3 years</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Table 43: Mean ranks for Time**

<table>
<thead>
<tr>
<th>COST</th>
<th>Mean Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>2.07</td>
</tr>
<tr>
<td>Moderate</td>
<td>2.93</td>
</tr>
<tr>
<td>High</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Table 44: Mean ranks for COST**

<table>
<thead>
<tr>
<th>Effort</th>
<th>Mean Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>More</td>
<td>1.86</td>
</tr>
<tr>
<td>Less</td>
<td>1.14</td>
</tr>
</tbody>
</table>

**Table 45: Mean ranks for Effort**

The above listed tables (Table 43, 44 and 45) give details of the mean ranks obtained after conducting the Friedman’s test. In table 43, time taken to implement the changes was ranked highest with a mean rank of 4.0 and this implicates that the overall time taken to implement the changes is less than an year as per the Friedman’s test. Similarly for the cost predicted to implement the changes from the organizational perspective, moderate was ranked the highest with a mean rank of 2.93. The effort needed to make the changes in the clauses is considered to be more since it received a mean rank of 1.86.

Further, as part of the survey the respondents were presented with another question which queried about the overall time, cost and effort needed to implement all the changes under section 9 of the survey questionnaire. The results of this section are presented below.

**Section 9:** The overall estimate for implementing all the changes is summarized in this section. From the results, it is visible that most of the small and medium sized organizations perceive the time taken to implement all the changes would be less than a year. Considering the cost, majority of the small and medium sized organizations have reported by selecting that the costs incurred would be of moderate level. Respondents have replied to the effort estimate by replying that it would take more effort which was reported by all the organizations of all the sizes. All these are displayed in the tables and graphs below.
In the discussion part of this section comparative analysis is made between the Freidman test results and the analyzed survey results of section 9.
5.2 Analysis of the open-ended question in the Survey

From the codes identified it can be seen that the list of codes affecting each of Cost, Effort and Time. Some codes affect multiple categories while some affect only one category according to the responses. This section clearly explains the significance of each code which was identified using grounded theory (Section 4.3 and 4.4 of the document). A descriptive analysis of the extracted codes is provided below which explains their implications towards the time, cost and effort needed to implement the changes.

The parameters due to which the Cost, Effort and Time is affected are:
1. Leadership: The involvement of leadership and their styles affect the cost during migration. The change in leadership style would require trainings and workshops which affect the cost and effort directly.
2. Documentation: Organization documents the new standards as per their structure and hierarchy which requires time and effort.
3. High Level structure: requires time, effort and cost. The earlier ISO 9001:2008 had 8-level structure which was modified as 10 level structure in ISO 9001:2015 which requires all the parameters for its implementation.
5. Organizing business process: Affects cost, time and effort. After migration the company’s business process would affect the migration for which restructuring requires time, effort and cost.
6. Gap Analysis and Corrective and preventive actions: Requires time and effort. Gap analysis is the analysis made by the organization to know where they stand and also the gaps in the organization. Corrective and preventive actions are required to maintain quality. This also affects cost.
7. Top level Management: Requires Cost and Effort. All the senior management require transition into the new ISO standards which require cost and effort.
8. QMS (Quality management System): Requires Cost and Effort.
9. Continuous improvement: Requires effort. The organization needs to improve the QMS from time to time which requires effort.
10. Risk based thinking and opportunities: Risks should be handled and mitigated if necessary. This requires cost, effort and time.

5.3 Discussion

This section of the document discusses the results gathered and the data obtained from analyzing it. An attempt is made to correlate and compare the analyzed data. The analyzed data obtained from the Friedman’s test, cross tabular analysis and from grounded theory are compared to give a comprehensive and concrete prediction of the time taken, cost incurred and the effort needed to implement the changes for the companies to transit from ISO 9001:2008 standard to ISO 9001:2015. Further, correlation to the literature is made although there is only little literature in the similar context.

Co-relation of analyzed data for time: From section 5.1, it is evident that the most of the respondents have estimate that the time taken to implement a single clause would only be less than an year. Similarly, we can see that from the Friedman’s test the time taken for implementing the overall changes was less than an year since the mean rank was highest for that particular option. This is further validated by cross checking this result with that of section 9 of the survey questionnaire where majority
of the companies have estimated that all the clauses can be fulfilled within an year’s time. It is also convincing from the data obtained by analyzing the results of the open ended answers that reasons like documentation, high level structure, risk based thinking, corrective and preventive actions etc., are few of the key reasons stated by the respondents. Literature and the accreditation boards also say that there are benefits like improved business costs, improved risk and opportunity management, reduced risk of transition, reduces costs etc., when companies attempt to transit to a new standard at an early stage [65][66][67].

Co-relation of analyzed data for cost: Similarly, it is evident from the data obtained that the companies are expecting moderate costs to implement the changes. From the analyzed survey responses of the first 8 sections it is clear that most of the respondents perceive that the cost needed to implement the new changes is moderate. However, for clause 9 and clause 10 the respondents think that the time taken would be low. They have also supported these claims in their open ended answers by commenting that transiting early to the standard would require lesser costs than that of a delayed transition. This is also supported by the literature [65] [66]. The reasoning provided by the respondents in their comments for expecting moderate costs was that because predicting the internal costs was a little difficult and hence they are expecting moderate expenses to implement the changes. Similar findings were also observed in the literature [67][8]. Coming to the overall cost for implementing the changes, it is seen that respondents are expecting moderate expenditure to implement the changes. Similar results were also observed from calculating the overall possible costs to implement the changes where a mean high rank was calculated for the moderate option.

Co-relation of analyzed data for effort: From the data analyzed, the effort needed to implement the changes is related to the size of the company. This claim is also complemented from existing literature which shows proofs to similar claims[8]. From the bi-variate analysis, it is observed that few clauses had varied perceptions based on the size of the company. While all kind of organizations predicted that the effort needed for implementing clauses 4,6,8,9 and 10 to be more the remaining clauses received varied responses. It was observed that small organizations are expecting lesser effort to implement clause 5 where-as the medium and large organizations think it would need more effort. Similarly, for clause 7 small and medium sized organizations are expecting low effort whereas the large sized organizations are assuming it would require more effort to implement this clause. Further, the effort on a whole to implement all the changes was perceived to be more by all the kinds of organizations. This is also supported by the results from the Friedman’s test.
6 CONCLUSION AND VALIDITY THREATS

Conclusions, threats to validity and limitations are discussed in this section. The changes were identified between the two standards and for migration be successful the Cost, Effort and time parameters are predicted.

6.1 Answering the Research Questions

**RQ1:** What are the changes observed in ISO 9001:2015 standards when compared to ISO 9001: 2008 standards?

**Answer:** From the Literature review, the changes between the ISO 9001:2008 and ISO 9001:2015 standard are observed and are tabulated in the results. From the table 12, it can be seen that many clauses have either been changed completely or updated as per new requirements for the organizations. These changes are to be incorporated by an organization while migrating to ISO 9001: 2015 quality standards.

**RQ2:** How would the changes affect an organization in terms of cost, effort and time while upgrading to ISO 9001: 2015 from ISO 9001:2008?

**Answer:** Based on the identified changes and the new inclusions that were made, a survey questionnaire was designed with closed ended questions and one open ended question. These responses were analyzed by using bi-variate analysis and also by using Friedman’s test to provide a mathematical significance to the results.

It is observed that the organizations are expecting the time needed to transit from the old standard to be less than an year. It was observed from the comments that the respondents find it more advantageous to transit at an early stage as it would cut down costs and time to transit.

Considering the expected costs to implement the clauses it is perceived by the respondents that it would take a moderate amount of cost as a whole. Here, the terms low, moderate and high for the costs were based on the user’s perception since it would vary from one organization to other based on the size of organization and other factors. Based on the comments given for the open ended questions it is inferred that the costs are considered moderate due to the unpredictability of the internal costs and also the lack of knowledge of the new standard. However, some of the respondents have said that there can be a decrease in the costs incurred over time.

The overall effort needed to implement the changes is predicted to be more by most of the organizations of all kinds. Apart from clause 5 (Leadership) and clause 7 (Support) the remaining clauses are expected to require more effort to implement the changes by all kinds of organizations. For clause 5: Leadership, the small sized organizations are expecting a lower effort and for clause 7: Support, medium sized organizations are expecting the required effort to be low. This shows that the effort needed to implement the changes is related to the size of the organization.

Thus, comprehensive answers have been provided to both the research questions. The questions are answered by rigorously analyzing the data both theoretically and statistically providing a mathematical significance to the data analyzed. Therefore the possible predicted cost, time and effort needed to implement the changes are identified. However, there are a few limitations to the research which are explained in the below section.
6.2 Limitations of the Research

In the current research only surveys are used as Research method. The responses for the open ended question in the survey are very few. This makes the analysis of the responses not so reliable. At first place Interviews were also planned to identify the Cost, Effort and Time parameters for migration. This would have improved the analysis of the cost, effort and time required for migration. The survey responses have not been in sync.

6.3 Threats to validity

This section of the document gives an account of the potential threats that the study could possibly encounter for it’s a fact that no research is ever perfect. Threats are divided into four types; they are internal, external, construct and reliability [15].

6.3.1 Internal threats to validity

Internal validity threats are the possible effect on the relationship established between treatment and outcome [18]. The internal threats deal with maturation, instrumentation and selection. Survey questionnaire is the instrument here and the questionnaire was properly validated and reviewed before sending it to the respondents in order to avoid this threat. Care was taken to see to it that the questionnaire wasn’t too long. The selection of respondents was made by posting the survey in relevant groups and through e-mails and all the participants volunteered. Thus, this threat was mitigated.

6.3.2 External threats to validity

These threats relate to the generalizing of the results to the rest of the target population [18]. To ensure that this threat is mitigated, the respondents were invited through mail and exclusive ISO groups on the social media. Moreover, the results obtained from the survey were from different countries and organizations of different size.

6.3.3 Construct validity

Construct validity refers to putting into use the right method for the study. In this research we have chosen survey to collect the results as we needed organizational perceptions. Hence, the survey was compared to all other possible alternatives before taking it up to make sure that it is the most appropriate method to answer the research questions. Further, the choice of methods selected was motivated by citing articles in order to mitigate this method. However, conducting interviews could also have been effective in gaining results but due to lack of resources this couldn’t take place. Thus, this threat is only partially mitigated.

6.3.4 Conclusion Validity

This usually occurs because when there is a possibility of incorrect conclusion. This threat usually occurs because of instrumental flaws, respondent bias, or improper sample selection [18]. This threat was mitigated by making sure that the online questionnaire was easy to understand and also reviewed by the supervisor. The responses were made anonymous in order to avoid any bias and thus mitigating the threat.
7 FUTURE WORKS

From the analysis it was found that several key changes were identified in the new scheme when compared to the old one. From the survey responses, the cost needed for implementing the changes is expected to be moderate, the time needed is predicted as less than 1 year and the effort needed for implementing the changes was estimated to be more. In future, we can plan to calculate the approximate estimates instead of a nominal values. This can be done for the present transition or any future transitions if needed.

Further, the same research can be repeated in order to get a more concrete picture of the time taken to transit from standard to the other.
REFERENCES


APPENDIX

Screenshot of the survey as posted online

Introduction:


As part of my research work in the area of quality standards and certification schemes for software industry, I have framed a set of questions based on the changes mentioned in the draft international standard of ISO 9001:2015 version with comparison to ISO 9001:2008 version of standard. The questionnaire asks questions about the expected work improvements (Time, Cost and Effort) required for organizations in order to successfully upgrade their certification to the new version.

The survey questionnaire is divided into sections. The first section is just to know about your organization. Further, sections contains clause by clause identified changes and related questions. Completion of this survey will take approximately 5-10 minutes of your time.

Thank you very much for your time and support. Your feedback is important.

Thanks in Advance,
Dilip Somaraju,
Blekinge Institute of Technology, Sweden.
+46-767957332
+91-9000488567

Please start with the survey now by clicking on the Continue button below.

Continue »

*Required

Organizational Information

Name of the Organization

Country *

Size of your organization? (Number of persons) *
- Small
- Medium
- Large

Is your company/Organization currently certified to ISO 9001:2008? *
- Yes
- NO

[Buttons: « Back  Continue »]

*Required


* [Clause 4.1] States that: Building an efficient Quality management system and fact based risk evaluation are influenced with the internal and external issues on an organization.

* [Clause 4.2] Which states that organizations shall monitor and review information about interested parties and their relevant requirements.

[Clause 4.3] The requirements are amended based on the issues considered while defining the scope of QMS.

* [Clause 4.4] The process requirements are extended by determining the input-output, Performance indicator, Assigning process responsibilities, Risks.


1) According to you what is the expected "Time/Cost/Effort" needed for organizations to learn and implementing the above amendments? *

TIME

- 0-1 year
- 1-2 years
- 2-3 years
- >3 years

COST ESTIMATION *

- High
- Moderate
- Low

EFFORT ESTIMATION *

Person-Months

- More Effort needed
- Less Effort needed

» Back  » Continue »
Section 2


*Required

Clause 5: Leadership

*(Clause 5.1) The new version represents extended expectations to the top management which results in accounting the effectiveness of the QMS.

*(Clause 5.8) The new version details the responsibilities, roles and authority within the QMS. This clause is slightly amended through ensuring processes delivery and QMS maintenance.

2) According to you what is the expected "Time/Cost/Effort" needed for organizations to learn and implementing the above amendments?*

TIME
- 0-1 year
- 1-2 years
- 2-3 years
- >3 years

COST ESTIMATION *
- High
- Moderate
- Low

EFFORT ESTIMATION *
Person-Months
- More Effort needed
- Less Effort needed

© Back  © Continue ©
Section 3:


*Required

Clause 6: Planning

[Clause 6.1] This is a new notion added to the ISO 9001:2015 version which deals with contemplating which actions are for addressing risks and opportunities.

[Clauses 6.2.1 & 6.2.2] are an extension to the previous version (ISO 9001:2008). They mention the need to account for applicable requirements and for their monitoring, communication and upgrading. Clause 6.2.2 accounts for the achievement of these objectives.

[Clause 6.3] Any requirements required regarding the plan in changes to the QMS are mentioned by this clause. These requirements include: Resource availability, the allocation of responsibilities, authorities and taking considerations of risks.

3) According to you what is the expected "Time/Cost/Effort" needed for organizations to learn and implementing the above amendments?

TIME
- 0-1 year
- 1-2 years
- 2-3 years
- >3 years

COST ESTIMATION *
- High
- Moderate
- Low

EFFORT ESTIMATION *
Person-Months
- More Effort needed
- Less Effort needed
Section 4:

Clause 7 "Support"

7.1.1* Mentions the need to consider external resources. An explicit reference is mentioned in this direction.

7.1.6* Which is associated with assuring the organization has or will obtain adequate knowledge about handling any changes in the business environment. This clause mentions that the organization must have all necessary knowledge to the required extent of depth to handle any changes.

7.3* This clause extends other parameters in ISO 9001:2015. These parameters include "quality policy" and "the implications of not conforming to the quality management system requirements".

7.4* This clause mentions a few significant changes and add-ons. This includes, the aspect of who, when and how to communicate. Another change is considering external communication along with the existing internal communication.

7.5.1* A few modifications from previous version are that no mandatory procedures are required and a quality manual is not required. However, the documentation is still required with information about multiple elements such as scope, processes, quality policy and so on.


4) According to you what is the expected "Time/Cost/Effort" needed for organizations to learn and implementing the above amendments?

TIME
- 0-1 year
- 1-2 years
- 2-3 years
- >3 years

COST ESTIMATION
- High
- Moderate
- Low

EFFORT ESTIMATION
- More Effort needed
- Less Effort needed
Section 5:

Clause 8: "Operations"

• [Clause 8.1] "Control of changes" and "control of outsourced processes" have been added in this clause but contents and requirements are similar with Clause 7.1 in previous version.

• Handling customer property and contingency actions are added in the new version [clause 8.2.1] when compared with clause 7.2.1 in ISO 9001:2008.

• [Clause 8.3.1] Points out the scheduling of design and developmental process.
• [Clause 8.3.2] Auditors should consider customer involvement and necessary documented info in the design and development process.
• [Clause 8.3.3] Auditors should consider, need for internal and external resources, risks and the level of control of the stakeholders on the design and development process.

• [Clause 8.4.1] This clause explicitly considers the involvement of external provisions including outsourced processes.
• [Clause 8.4.2] Apart from purchased products, verify that external provided processes, products and services do not affect the organization.

• [Clause 8.5.3] Auditors should verify that the control belongs to not only customers but also suppliers.
• [Clause 8.5.4] Auditors must make sure that necessary post delivery activities is taken into account by the organization.
• [Clause 8.5.6] States that unplanned changes should be done in a controlled way.

5) According to you what is the expected "Time/Cost/Effort" needed for organizations to learn and implementing the above amendments?

TIME
- 0-1 year
- 1-2 years
- 2-3 years
- >3 years

COST ESTIMATION
- High
- Moderate
- Low

EFFORT ESTIMATION
- More Effort needed
- Less Effort needed
Section 6:

Clause 9: "Performance Evaluation"

- [Clause 9.1.2] Organizational views and opinions on product and services are also fulfilled Effort required for views and opinions.
- [Clause 9.1.3] Earlier only analysis now evaluation also included-time, effort and skill required for evaluation. New requirements required to show that the planning has been successfully implemented.
- [Clause 9.3.1] The outputs of the management review shall include decisions and actions related to should consider “adequacy of resources” and “issues concerning external providers” in detail apart from improving on the whole by reducing the statue of risks.

6) According to you what is the expected "Time/Cost/Effort" needed for organizations to learn and implementing the above amendments? *

TIME
- 0-1 year
- 1-2 years
- 2-3 years
- >3 years

COST ESTIMATION *
- High
- Moderate
- Low

EFFORT ESTIMATION *
Person-Months
- More Effort needed
- Less Effort needed
Section 7:

Clause 10: "Improvements"

[Clauses 10.1] is a new clause and is similar to clause 8.5 in 9001:2008 which points out the areas where improvements are expected.

[Clauses 10.2.1] When nonconformity occurs, including those arising from complaints, the organization shall AND clause 10.2.2. The organization shall retain documented information as evidence.

7) According to you what is the expected "Time/Cost/Effort" needed for organizations to learn and implementing the above amendments? *

TIME
- 0-1 year
- 1-2 years
- 2-3 years
- >3 years

COST ESTIMATION *
- High
- Moderate
- Low

EFFORT ESTIMATION *
- Person-Months
- More Effort needed
- Less Effort needed
Overall Changes
What is the cumulative estimated time, cost, and effort required for organizations to learn and implement the changes in order to upgrade their certification to ISO 9001:2015 version of standard?

**TIME**
- 0-1 year
- 1-2 years
- 2-3 years
- More than 3 years

**COST ESTIMATION**
- High
- Moderate
- Low

**Effort estimation**
- More effort needed
- Less effort needed

Motivate your choice for above selected choices.