ANALYSIS OF SOFTWARE QUALITY ASSURANCE PROFESSION IN SRI LANKAN IT INDUSTRY

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November 2015

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Dissertation submitted in partial fulfilment of the requirements for the degree Master of Business Administration in Information Technology

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Declaration

I certify that the thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university to the best of my knowledge and believe it does not contain any material previously published, written or orally communicated by another person or myself except where due reference is made in the text. I also hereby give consent for my dissertation to be made available for photocopying and for inter-library loans and for the title and summary to be available to outside organizations.

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Signature:

The above candidate has carried out research for the Masters Dissertation under my supervision.

Dr. H. M. N. Dilum Bandara Date:

Signature of the supervisor:

Abstract

Software Quality Assurance (SQA) is a profession which is fast growing within the Sri Lankan Information Technology (IT) industry. It is the fifth largest job category, according the 2013 ICT workforce survey by the Information and Communication Technology Agency (ICTA) of Sri Lanka. However, despite the importance of the profession, it faces many challenges like unrealistic project timelines, limited budget, lack of SQA specialists, etc. To thrive in the competitive business market, it is essential for the management to take necessary actions to overcome those challenges. The intention of this research is to support the improvement of the SQA profession by identifying the key challenges and providing suitable recommendations/suggestions to overcome those challenges. This study will help the SQA management to learn from experts, best practices and adopt the necessary suggestions to their SQA departments.

Qualitative research methodology was used for the research. Preliminary studies as well as two online surveys were conducted in year 2014 and 2015 to identify the key challenges faced by the SQA professionals. The preliminary study was conducted to identify all the key challenges faced by the SQA professionals in the Sri Lankan IT industry. With the results of the preliminary study, the two online surveys were conducted to filter out the top ten challenges. Online surveys were shared among 30 leading IT companies and 210 and 85 responses were received in 2014 and 2015, respectively. Time, Budget, Lower salary scale compared other IT professions, Lack of specialized SQA individuals, and Migration of experienced professionals are some of the key challenges identified during the two surveys. It was also observed that certain challenges were attributed to specific companies and software development methodologies. With the results of the survey, a set of follow up interviews was conducted with several senior SQA experts to obtain feedbacks for the survey findings, as well as gather their feedbacks and opinions on how best to address the identified challenges. Risk-base-test estimation, proper project planning including Quality Assurance (QA) and Quality Control (QC), and providing necessary on the job trainings were some of the suggestions made by the domain experts, which they have successfully tried while addressing those challenges.

This research delivers several valuable results that can be implemented into organizational SQA process by the SQA management. By implementing these suggestions, we expect improved SQA profession within the organization as well as the industry as a whole. Improved profession will consequently increase the reliability of the product/project; result in greater client/customer satisfaction as well as satisfaction and motivation of SQA staff.

Acknowledgment

I wish to convey my deep gratitude to all those who have supported me in completing my research study successfully on “Analysis to Improve Software Quality Assurance Profession in Sri Lankan IT Industry”.

First and foremost, I thank my supervisor Dr. Dilum Bandara for the guidance and support given throughout the research study. Also, my thank goes to Dr. Chandana Gamage, former head of CSE department for the encouragements and guidance and Dr. Malaka Walpola the course coordinator MBA in IT and all other faculty members in CSE department at the University of Moratuwa.

Further, the immense support I got from the software professionals who helped me by filling out the online surveys, participating interviews and discussions is greatly appreciated. Without your support, this study is not possible to complete successfully.

A special thanks to my father Mr. Gee Munige Jayawardena for helping me in proof reading the research report. Also, I would like to thank to my fellow batch mates Thilaan, Thilan and Ilhavanchi for the support and finding me the important research articles without hesitation, whenever necessary.

Very special thank should go to my father ‘Shirley’, mother ‘Geetha’, brother ‘Tharindu’, who always tolerant of the sacrifices that I had to make for the study a success.

My heartfelt appreciation should go to my loving wife Ayesha Jayawardena, for all the encouragements, care and unconditional support given to me throughout this research study.

The following research dissertation was completed with the help of the people known and unknown to me. Finally I wish to thank all those who helped me in many ways though their individual names are not mentioned above, but were instrumental in bringing this study a success.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

Abbreviation	Description
BA	Business Analysis
DB	Data Base
DEV	Development
HR	Human Resource
ICT	Information and Communications Technology
IT	Information Technology
KW	Knowledge Worker
MBA	Master of Business Administration
NASA	National Aeronautics and Space Administration
PMP	Project Management Professional
Q&A	Question and Answer
QA	Quality Assurance
QC	Quality Control
QMS	Quality Management System
SDLC	Software Development Life Cycle
SL	Sri Lankan
SQA	Software Quality Assurance
SRS	Software Requirement Specification
TFS	Team Foundation Server
UAT	User Acceptance Testing
UK	United Kingdom
USA	United State of America

CHAPTER 1 INTRODUCTION

1.1 Background

Software Quality Assurance (SQA) is one of the main elements of any ICT organization (Frankk, 2014). This is because; SQA is validating the adherence to software product standards, processes, and procedures. ICT business is very competitive today, especially in the global market. Thus, the organizations need to ensure the quality of the products they deliver to the customers to remain in the business as leaders in the industry. Undoubtedly, one product with low quality that could inconvenience the users is enough to affect the organization's ICT business. The standard SQA process may assist the ICT organizations to develop their products to maintain the quality at different stages throughout the production process. ICT product that has been developed with the standard SQA process will be of high quality, versatile, user friendly, hazel free and will require less intervention by the developer. Hence, most of the organizations are trying to follow a proper quality management plan to remove errors if any, in ICT products at the early stages of the development process. The organizations that are not following a proper SQA plan may face serious consequences in the business.

The main objective of the SQA is to maintain the excellent quality of the software product. Organizations should follow the established standards and procedures with the intention of achieving the best quality of the products they produce. The organizations know that the higher the quality of the products more the customer satisfaction they get. However, it has been identified that software quality issues can be experienced and seen more in the developing countries (AshfaqQazi et al., 2012).

Due to this reason, SQA communities of the Asian countries tend to perform frequent surveys, interviews and workshops to identify the challenges for bringing resolutions to improve the profession by bridging the existing knowledge and skill gap.

According to the results obtained, it can be concluded that there are challenges faced by the SQA professionals in SL IT industry and identified recommendations and

suggestions can be implemented to overcome those challenges. This fact was strongly highlighted during the interviews carried out with the SL SQA experts.

1.2 Motivation

As a Senior Quality Assurance (QA) Lead and having worked in dynamic environments for several years, I have noticed that SQA professionals in Sri Lankan IT industry face many challenges in their day-to-day work environment. These challenges have resulted in poor quality products/projects, inability to meet deadlines, conflict between development and SQA teams, low motivation among workforce, and high employee turnover. Consequently, if the SQA management in an organization cannot achieve the anticipated demand and expectation of the customers, it may reflect on the business and the reputation of the organization. Therefore, these challenges need to be dealt strategically by the SQA management.

One research study was conducted in Pakistan to find the quality factors and problem areas for open source projects in terms of project management aspects. It has identified the following six major issues related quality of the free software development projects (AshfaqQazi et al., 2012).

- Lack of specialists
- Lack of confirmation to standards
- Developer's attitude
- Unrealistic deadlines
- Team formation and compromise in quality
- Internal politics

With the above findings it is motivated to find out the challenges from the SQA profession perspective in Sri Lanka. Moreover, these finding may not be generalized to Sri Lanka as the Sri Lankan IT industry is more mature and have much wider global recognition than Pakistan (ATKearney, 2014). Researcher wanted to validate and compare the Pakistan finding with the Sri Lankan findings. It is believed when the profession's quality is improved; the value additions to the project/ organization will also increase. Therefore, the researcher believe such a study may assist SQA management and organizations in SL to understand the main challenges faced by the SQA professionals and to take necessary preventive and corrective actions to achieve the excellence in QA aspect of the software development.

1.3 Problem Statement

Majority of the software development companies in Sri Lanka have a separate department for Software Quality Assurance. Higher management is expecting to achieve the maximum customer satisfaction by ensuring the quality of the software development. But it is not an easy task, because there are many challenges like unrealistic project timelines, limited budget, and lack of QA specialists faced by SQA as profession.

So the research question would be:
What are the challenges faced by the SQA professionals in the Sri Lankan IT community, and how those challenges can be overcome?

1.4 Research Objectives

The research objectives for this study were as follows:

- To identify the top ten challenges faced by the SQA professionals in the Sri Lankan IT industry.
- To identify and present recommendation and suggestion to overcome the identified challenges.

1.5 Research Contribution

Qualitative research method was used to carry out the study by selecting a sample of SQA professionals in Sri Lankan IT industry. Semi structures questionnaires and interviews were used to gather the relevant information for this study. Preliminary study as well as two online surveys was conducted in year 2014 and 2015 to identify the key challenges faced by the SQA professionals. Interviews with the SQA experts and higher management were used to identify the suggestions to overcome the identified top ten challenges at the final phase of this study.

Study has identified the main challenges faced by the SQA community in Sri Lanka and the recommendations and suggestions to overcome those challenges from the management perspective. Two key findings are as follows:

- **Challenge 01**: Time
  Suggestion: Introducing 'Acceptance Test Driven Development' methodology. Similar to what test team does when practicing Test Driven

Development by using Acceptance Test Driven Development, test team writes the tests before the code. Instead of writing a specification as a static document, test team create an executable specification that will run the code to be written and that can be refactored and refined.

- **Challenge 02**: Budget

  Suggestion: When proposing the estimates, it is important to highlight all the identified risk factors to all project stakeholders. Deliverables, commitment that are given to client need to be justified. It is important for the QA manager to provide multiple options available and their pros and cons to senior management and let them pick the most feasible option.

According to the 2013 ICT Workforce Survey, 8% of the ICT workforce belongs to the SQA job category (SLICTA 2013). SQA has the potential to assist the higher management to achieve the product quality as well as the customer satisfaction. Therefore, we believe the successful implementation of proposed suggestions will be beneficial for the Sri Lankan IT firms to achieve the next level in the IT market.

1.6 Organization of Thesis

Chapter 2 presents the related work. Chapter 3 describes the research methodology with the conceptual frameworks to achieve the research objectives. Chapter 4 discusses how the data analysis was carried out. Finally, the Chapter 5 presenting the conclusions, recommendations, and future work.

CHAPTER 2 LITERATURE REVIEW

Software industry is about the developing, maintaining and publishing software products for different business domains. There are diversified professions involved in the industry while developing a product. Some of key professions are developers, quality assurance, business analysis, data base administrators, project managers and account managers. Among all those professions Software Quality Assurance (SQA) is becoming an emerging career in software industry. Hence, it is imperative to identify and explore what are SQA and the importance of SQA as a profession. SQA profession can be categorized into the knowledge worker community, since the Quality Assurance (QA) professionals always work using his/her knowledge.

The provision of services to new devices, new domains, and new methodologies in which to increase efficiency with software products has created many opportunities in the software development industry. With those new opportunities, software companies have to face a set of challenges to meet the win-win situation in the market. Indirectly, QA department within the organization has to face a set of challenges.

This chapter reviews the key terminology and related work on SQA profession and related challenges. Section 2.1 and 2.2 describe about SQA and importunacy of it. Section 2.3 explains the SQA as a profession and how they belong to the category of knowledge worker. Section 2.4 describes the role of management and leadership in SQA. Section 2.5 explains the challenges in SQA profession in previous studies. Finally, Section 2.6describes the related work done on overcoming methods for identified challenges related to SQA profession.

2.1 Software Quality Assurance

In developing software products and services, QA is the process of checking whether the product or service being developed is meeting the customer expectations. It is very difficult to define SQA ambiguously. Also, it is very difficult to depict the goals and functions of SQA. "*Closer examination reveals that the vast majority of them are concerned with quality assurance and for most authors that means testing developed code with some references to validation and verification*" (Fitzpatrick, 1996). As per

the previous statement, most of the people immediately talks about testing, verification and validation for the SQA topic.

It is very important to understand what makes the quality in software. "*There are many contributing factors, good requirements, well defined business, good business case, a strong architecture, having buy-in from all stakeholders, having a well-defined, documented and reviewed code, using a good process with milestones, having and using supporting processes and tools, such as configuration management."* (Sigrid, 2006)

"To ensure high quality software and achieve cost-effective software development and maintenance, software metrics should be applied during the entire software development cycle to measure and predict quality of software products." Basically software quality metrics can be used to improve the quality of the software product during different phases in software development life cycle (Huang et al. 1990).

SQA is monitoring the software engineering practices and techniques to guarantee the quality. Also, it measures the excellence and obtains objective evidence of the costs and benefits of various software development practices. SQA methods/techniques will be dependent on the target process or product. The ISO definition states that quality assurance is all those planned and systematic actions necessary to provide adequate confidence that an entity will fulfil requirements for quality (Quality Gurus, 2013). Following are a representative subset of quality definitions by several International organizations:

"*Quality comprises all characteristics and significant features of a product or an activity which relate to the satisfying of given requirements*" (Fitzpatrick, 1996).

"*Quality is the totality of features and characteristics of a product or a service that bears on its ability to satisfy the given needs*" (Fitzpatrick, 1996).

QA needs to be more focus on accelerating the customer satisfaction rather than finding and correcting the issues while delivering the software. It is always related to the other software attributes like reliability, maintainability, portability and usability.

According to IEEE, SQA is described as "*a planned and systematic pattern of all actions necessary to provide adequate confidence that an item or product conforms to*

established technical requirements. And a set of activities designed to evaluate the process by which the products are developed or manufactured. Contrast with: quality control" (NASA, 2010).

Stakeholders of a software product will always expect quality assurance; this is because all the other aspects are depending on this valuable factor. Like in software engineering, SQA also has its own life cycle to process. Requirement gathering, test design, test implementation, test execution and maintenance. As Barbara state historically there were two defined approaches. Those are the quality program and independent verification and validation.

SQA makes sure the project will be delivered to its intended client with previously approved specifications, standards and functionality. And its combination of the entire software development process, which includes software design, coding, source code control, code review, change management, configuration management and release management (Iqbal and Qureshi, 2012).

"*Testing is intended to show that a program does what it is intended to do and to discover program defects before it is put into use. When you test software, you execute a program using artificial data. You check the results of the test run for errors, anomalies, or information about the programs non-functional attributes (*Washington State University, 2014)*."* Basically testing ensures that the software product is good enough for use. Testing can be categorized into four main phases; Development testing, Test-driven development, Release testing, and User testing (Sommerville, 2011). Figure 2.1 shows the software testing process model that needs to be followed within an organization. This explains the end to end process of the quality assurance. It is essential to have a concrete process to ensure the better quality.

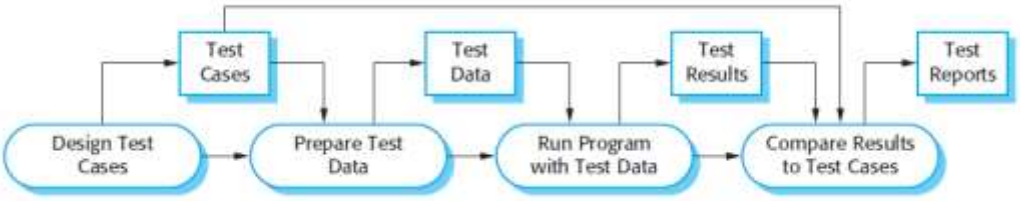

Figure 2.1: A model of the software testing process.

QA process is determined by organizational size, organizational culture, application criticality, time to market, and the software development process (Ichu and Nemani, 2011). Earlier QA was just a one phase of the software development life cycle. There was not a clear involvement from the beginning of the project life cycle. Recently QA has become an essential part of the software development process and it is involved from the beginning of the process. Basically, inclusion of QA in all phases of the Software Development Life Cycle (SDLC) would increase organizational economic status, and conceptual and economic perspective. Figure 2.2 shows all the SQA related characteristics (Greif, 2005). Software professionals have to ensure those characteristics exists in the tested product or a project.

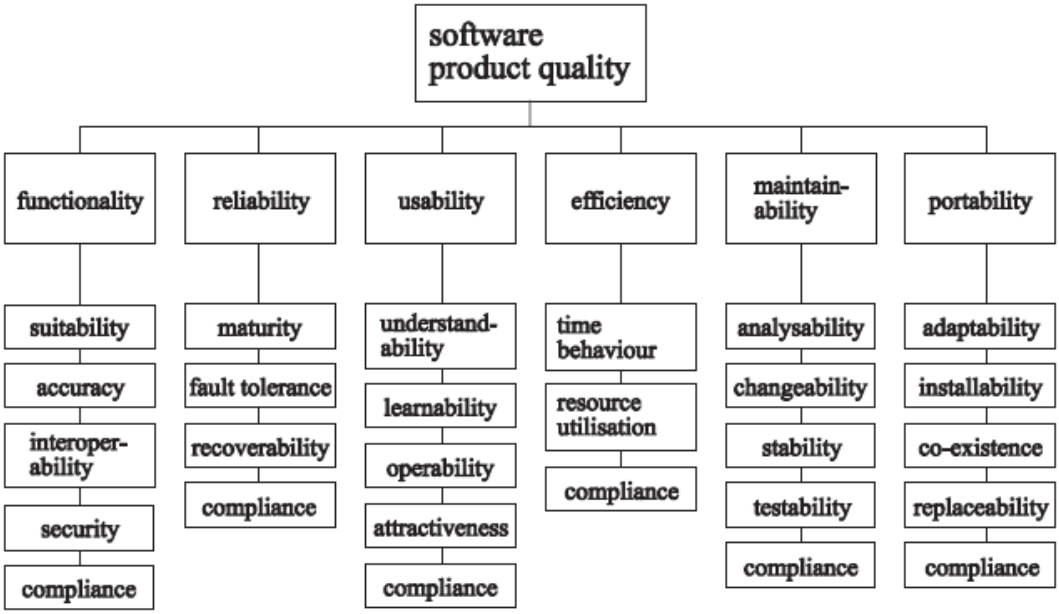

Figure 2.2: Software quality characteristics.

2.2 Importance of Software Quality Assurance

According to Iqbal and Qureshi (2012), *"Software quality is gaining much more interest these days as well as much more importance is being given to the production of high quality software products."*

Developing a decent software system is not an easy task. To produce a good software product, various types of software quality measurements need to be taken into the consideration. "*System complexity measurement plays a vital role in controlling and managing software quality because it generally affects the software quality attributes like software reliability, software testability and software maintainability. Software*

quality assurance needs to be addressed keeping in view the new strategies, tool, methodologies and techniques applicable to software development life cycle" (Nasib, 2005). According to Iqbal and Qureshi (2012), insecurely tested software system decreases the system reliability which is negatively impact to the software quality. Also they have mentioned that testing need to focus on maximizing customer gratification rather than just finding and resolving issues involved in delivered software system. The need for software to be error-free remained a challenge to the IT industry.

The objective of testing is to find problems and fix them to improve quality. Software testing consumes 40% of software development budget. There are four main objectives of testing: Demonstration, Detection, Prevention and Improving Quality (Tuteja and Dubey, 2012).

2.3 Software Quality Assurance as a Profession

SQA professionals are referred to software testers. Testers are the people who are trying to *break* the new product/functionality to help the design process. SQA professionals will closely inspect the product with developers and project managers to understand about what each product supposed to perform and their main features and end users of them. To achieve these, SQA professionals will follow many testing methodologies and processes. "*The ultimate goal is to iron out any bugs and improve the quality of the finished product."* Other than Software experience and knowledge, employers are expecting to have knowledge on following areas as well (totaljobs.com, 2013):

- A natural curiosity
- A good understanding of the software development process
- A good understanding of the business approach
- Good judgment skills
- Good writing skills (for documenting the process)
- Good communications and consultancy skills
- The ability to work in a team and as an individual
- Good presentation skills
- The ability to work under pressure and to tight deadlines

SQA team/department must be independent from development organizations to be successful. Software testing and quality is one extent in the software development chapter that still is not completely explored and understood. By understanding development and testing, building excellence software, and having proper and operative testing practices, we will better understand how to avoid affluent maintenance phase. Is it worth to develop a software system, without knowing it will be working as expected by all the stakeholders? Only solution is to test the system thoroughly and sufficiently to ensure the quality for some extent (Sigrid, 2006). According to Kitchenham Quality programs are based on identifying the appropriate processes for developing software, and inspecting the process to ensure compliance with those procedures.

In SQA, professional should understand what is built by the developers, how they are going to build it and currently what the system does. Also, the professional should have a thorough knowledge on requirements and specifications related to software being developed. Finally, the individuals should aware about how they can measure the variance of the current system when compared to the user requirements.

The Knowledge Worker (KW) is the creator of value for an organization in the new economy. His main assets will be knowledge. The people who think for living like architects, engineers, scientists and lawyers, are good examples for knowledge workers. Knowledge work differentiate from other form of work is its duty of problem solving that requires creative thinking. These people have to think creatively to solve the day to day problems. Due to this matter, this category of people has done more researches and literature reviews to achieve their objectives. A typically knowledge worker performs the following activities:

- Capture information and store it
- Discussing and making meaning
- Sharing the information

As mentioned by Peter Ferdinand Drucker in 1966, “The most valuable asset of a 21st century institution will be its knowledge workers and their productivity.” Drucker forecasted that the major changes in civilization would be brought about by information.

Knowledge workers are the major proportion of the workforce in present society. Knowledge work is based on activities that are information based, knowledge intensive and knowledge generation (Kochen, 1984). Therefore, a pure knowledge work is considered a knowledge generator who brings both inductive and deductive reasoning to complex problems to create new ways of looking at issues.

Complexity of work refers to the degree of interpretation or judgment. The uncertainty can arise because the work is occurring in new areas where operating methods are not yet defined, or where there will be too little information to predict something accurately or to draw meaningful conclusions about the most appropriate way forward. Ambiguity refers to situations where several possible different interpretations to a given problem may exist at the same time, leading to confusion. You cannot lead knowledge workers by telling them what to do. You must treat them with respect and dignity, and provide opportunities that they would not be able to have on their own.

2.4 Management/Leadership in Software Quality Assurance Profession

Management plays a major role in the SQA. It is the prime responsibility of the team managers to facilitate the team members and provide them the good working environment. Managers should motivate QA teams to achieve the highest quality a product can be achieved (Hribar et al., 2009). *"It is the responsibility of the IT leaders to minimize the organizational risk of software defects released into the production environment and at the same time manages costs and time-to-market as agreed upon with stakeholders"* (Ichu and Nemani, 2011). As per Ichu and Nemani (2011), defect find in the production can be a reason to introduce a problem to organization or individual. And that may end up with a disaster including the loss of life.

Leadership always needs to be on track about the quality of the software system being developed. From the starting point of a project, leadership should be focus on the quality aspects. Moreover, they need to involve testing professional from the start of the project. Furthermore, the leaders may periodically evaluate the QA metrics to have an idea about the current progress and need to alter the quality related processes to improve the quality more and more to achieve end user satisfaction. For this leadership has to take necessary decision at the right place and right time (Ichu and Nemani, 2011). Figure 2.3 shows the project completions effected by the critical

issues (AshfaqQazi, et al., 2012). It is explain how the critical elements like time, budget, professionals and environment affect the software quality and project completion.

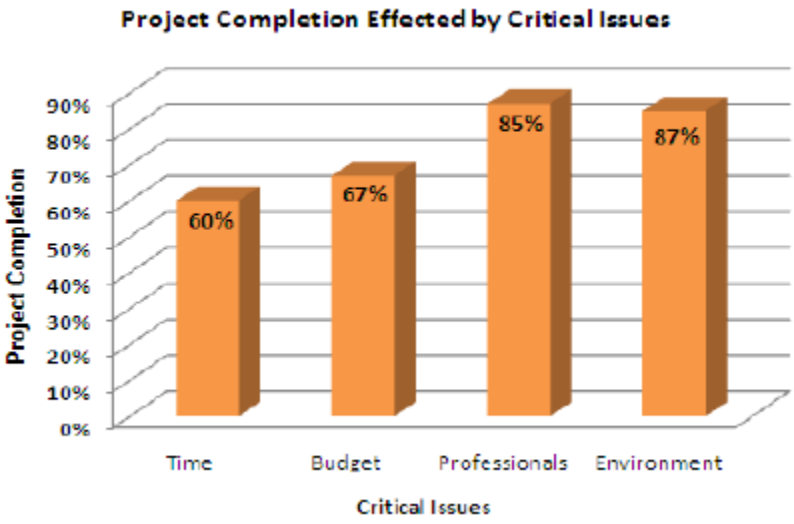

Figure 2.3: Project Completion Effected by Critical Issues.

Through a change management in the organization employees and higher managers are expecting a job satisfaction. Job satisfaction is important not only to employees but also for higher management of the organization. Job satisfaction increases productivity and decreases staff turnover significantly. Satisfied employees tend to be more productive, creative and committed to their employers than unsatisfied ones. There are number of definitions on job satisfaction. Locke and Lathan (1976) give a comprehensive definition of job satisfaction as pleasurable or positive emotional state resulting from the appraisal of one's job or job experience. Job satisfaction is a result of employee's perception of how well their job provides those things that are viewed as important. According to Mitchell and Lasan (1987), it is generally known in the organizational behavior field that job satisfaction is the most important and repeatedly considered attitude. Also, it has gained wider importance in organizational behavior field. Organizational culture influences employees both directly and indirectly. Hence, Emadi et al. (2012) gives a detailed explanation that, job satisfaction can be achieved through an organizational change management.

When people in an organization interacting in some kind of structured or organized approach to achieve a defined process can be defined as "Organizational Change"

(Senior and Fleming, 2006). There are various researches have done to investigate organizational change through various categories, e.g., incremental vs. transformative (Dunphy and Stace, 1988).Changes can be initiated by all parties in the defined process.

There is a requirement of organizational change management to overcome the challenges faced by the SQA community in Sri Lanka. Because Organizational change management is a useful tool to facilitate successful culture transformation by helping people to deal with unknown area and to ensure the outcome of the initiative is positive (Bridges and Mitchell, 2000).

2.5 Challenges in Software Quality Assurance

Fitzpatrick et al. (2004) identified the following set of challenges that are faced by those interested in software quality:

1. A definition of quality which focuses on measuring excellence.
2. That interpreting the term usability as meaning anything that impacts the end user is a more natural interpretation of the term usability.
3. That the broader view of quality dictates that a life cycle that focuses only on software development is insufficient and that a full end to-end software product life cycle is required as illustrated in the Software Quality Star mark II.
4. The expression QA does not fully address the need for quality management throughout the product life cycle.
5. New challenges are presented by the need for quality of WWW solutions.

According to Rosenberg (2002), SQA is facing too many challenges from the starting point of defining the quality of the software system. There must be a comprehensive understanding on what high quality software is, but the ending description is generally influenced by the environment of the software usage. And this phase is the most difficult and critical area that serious to the end result of the project. Even if we are developing software systems for our own use, we are in a tight situation under cost and time constraints. With the lowest cost, organization has to achieve the best quality. Some organizations face legal cases and lose important and critical clients. Not only will those, ultimately the business be going out from the business market

(Sigrid, 2006). Due to diverse environment, functionality, large size, complexity and massive user population software applications getting more complex.

AshfaqQazi et al. (2012) analysed how to improve SQA in developing countries. They have conducted the research using the Pakistan software industry. They have identified the following are the main issues to be address with their study:

- Time (strict timelines for assigned tasks)
- Budget (unrealistic project budgets)
- Less use of quality standards (not using ISO, CMMI, etc.)
- Lack of specialists (not having proper testers/ test teams)
- Project durations (tight schedule to deliver the project)
- Compromise on quality due to less profit
- Developer's attitude (think only SQA responsible for quality)
- Team formation for requirements gathering (no QA representation for requirement gathering phase)
- Politics (influence on higher authorities to get highly paid)

Also, the authors have identified critical issues which are related to the Pakistan software industry as follows:

- Lack of specialties (not having proper testers/ test teams)
- Lack of conformance to standards (not using ISO, CMMI, etc.)
- Developer's attitudes (think only SQA responsible for quality)
- Unrealistic deadlines (tight schedule to deliver the project)
- Team formation and compromise on quality (no QA representation for essential software development phase)
- Internal politics (influence on higher authorities to get highly paid)

Moreover, Iqbal and Qureshi (2012) have also identified the following key problems:

- Shortcuts in testing
- Reduction in testing time
- Let go deliver now correct errors later attitude
- Poor planning and co-ordination

- Lack of users
- Involvement, poor documentation
- Lack of management support
- Inadequate knowledge of application environment
- Improper staffing
- Poor testability

2.6 Overcoming Software Quality Assurance Challenges

2.6.1 Solutions used by other countries

Kevitt (2008) identified the following quality principles need to be defined to proceed with a quality development process with SQA:

- The requirements must be agreed before the project can begin
- The roles and responsibilities of each team participant is defined
- The quality standards that must be adhered to for each deliverable is stated
- The methodologies for each team must be explained and agreed
- The milestones during the project are outlined in a project schedule
- The content of each deliverable must be clearly stated
- The entrance and exit criteria for each stage must be defined
- There should be business knowledge transfer during the discussion of the project and when the project teams are assembled, including the supply of all relevant documentation.
- Establish the development and testing environment for the offshore team (hardware, software, tools, licenses and data relevant to the project must be agreed upon and if necessary transferred to the offshore team)

Most of the researches conducted so far has introduced new QA models and techniques for discovering more defects and continue testing as a practice. But they have not comprehensively studied the difficulties and challenges associated with those newly introduce QA methods (JÄNTTI, 2008).

AshfaqQazi et al. (2012) has introduced some solutions for the identified issue areas to Pakistan software industry. Those suggestions are as follows:

- Developing CMMI model

- Certified and specialized SQA team
- Correct developer attitude
- Grip over domain knowledge
- No compromise on quality
- Avoid internal politics

In Figure 2.4, they are illustrating how the software success rate has improved considerably by adopting above recommendations (AshfaqQazi et al., 2012). Also, it is possible to have up to 95% success rate by implementing the above recommendations to resolve time, budget, professionals and environmental related project problems.

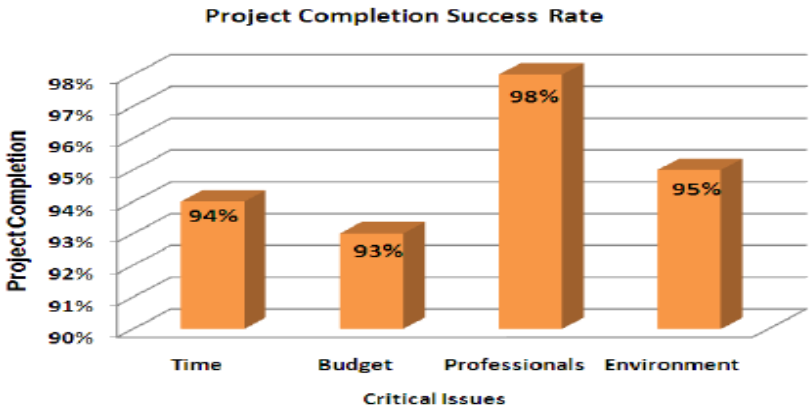

Figure 2.4: Project Completion Success Rate.

Iqbal and Qureshi (2012) identified following overcoming methods during their study for the Pakistan context:

- Time required for each phase of development must be following the schedule.
- Each member of testing team must focus on rules of testing as defined by the organization.
- Planning for testing must be considered in prior phases of software development.
- The concepts of joint application design and the group support system can be used for user involvement and are getting better acceptance in software development.

- Check the missing information throughout; avoid poor writing and ambiguity on user documentation and system documentation.
- Have an effective quality management structure.
- Testing team must have complete information of the functionalities of the software being tested, its users and the platform in which it is going to work.
- Appointment of correct team member for testing has great control on the achievement of testing.
- Software validation and verification techniques must be used to test software.
- Obtain requirements, functional design, and internal design specifications and schedule requirements.
- Testing team must identify application's higher-risk aspects, set priorities, and determine scope and limitations of tests.

2.6.2 Moving to Strategic Software Quality Assurance

By applying processes and disciplines, most of the QA challenges can be overcome. Also, it is essential to learn from the past experiences by collecting data related to those past projects. QA management can collect data related to fault origin, diagnosis and cost. By collecting these data QA management can raise the weak process areas and areas need to be improved with measurable benefits. "*Quality assurance becomes part of a real corporate plan with objective focus and accountable results – which called Strategic QA."* (Tavassoli, 2007)

As per Tavassoli (2007), Two best practices help implement Strategic QA;

- Enterprise-wide fault data collection is facilitated by rolling out an Enterprise Change management solution, which enables all teams to easily submit the right data through a web interface assists in analysis and generates the metrics and reports.
- Organizations should also standardize on common process and lifecycle rules so that data is consistent and the improvement initiatives are effective.

For a strategic quality assurance, it is essential to capture error and defect data across the organization. When the system/ project related issues are identified, need to capture the data necessary for the following QA metrics (Tavassoli, 2007);

- **Phase Containment Effectiveness (PCE)** is the ratio of faults captured in a phase. (represents how effective the process is at preventing problems from becoming defects)
- **Phase Screening Effectiveness (PSE)** is the ratio of prior escaped defects captured in each phase.

Following information is vital for decision making on strategic QA concept (Tavassoli 2007):

- Fault description.
- Category.
- The phase in which the fault was found (Requirements, Design, Code, Unit Testing, Integration Testing, System Testing, Customer, not classified).
- How the fault was found (peer review, visual inspection, design model simulation…).

Extra information can be retrieved later in the process, when the fault is verified and analysed (Tavassoli, 2007).

- The phase in which the fault was introduced (Requirements, Design, Code, not classified, Prior release, 3rd party).
- The phase in which the fault should have been detected.
- The cost of the fault.

CHAPTER 3 RESEARCH METHODOLOGY

This chapter describes the procedure used to conduct the survey and interviews, as well as analyse the data gathered through the surveys and interviews. Research methodology is described in Section 3.1. Section 3.2 describes the measurement and measures while Section 3.3 describes the sample design. Data collection methodology is described in Section 3.4.

3.1 Research Methodology

Figure 3.1 shows the research methodology used for study. Research problem was identified based on the literature review and analysis on Sri Lankan SQA community. Based on the literature survey and preliminary analysis a list of challenges were identified which are faced by the SQA community in Sri Lanka. 15 SQA professionals were used to test the clearness and validity of the preliminary questionnaire. To validate the identified challenges and to identify new challenges which are not captured through the literature review and analysis, preliminary survey was conducted as the next step. The output of the preliminary survey was used to identify the list of challenges and the commonly used methods to overcome those challenges. Based on these findings an online survey was created and launched in year 2014. To further validate the findings, the same survey was again conducted for a relatively smaller group of participants in 2015 as well. The findings from the 2014surveys were analysed and were taken as the input for the semi-structured interview questionnaire for the SQA higher management and industry experts. Interviews were conducted with the intention of finding the suggestions to overcome the identified challenges based on the experiences and expertise of the interviewed professionals. The output of the interviews was analysed and then used to build the framework as the final result of this research.

Qualitative content analysis research methodology was used to analyse the results of preliminary survey, online surveys and interviews. Selected methodology was useful in identifying important aspects of the contents and supporting arguments, as well as clear and effective presentation of results.

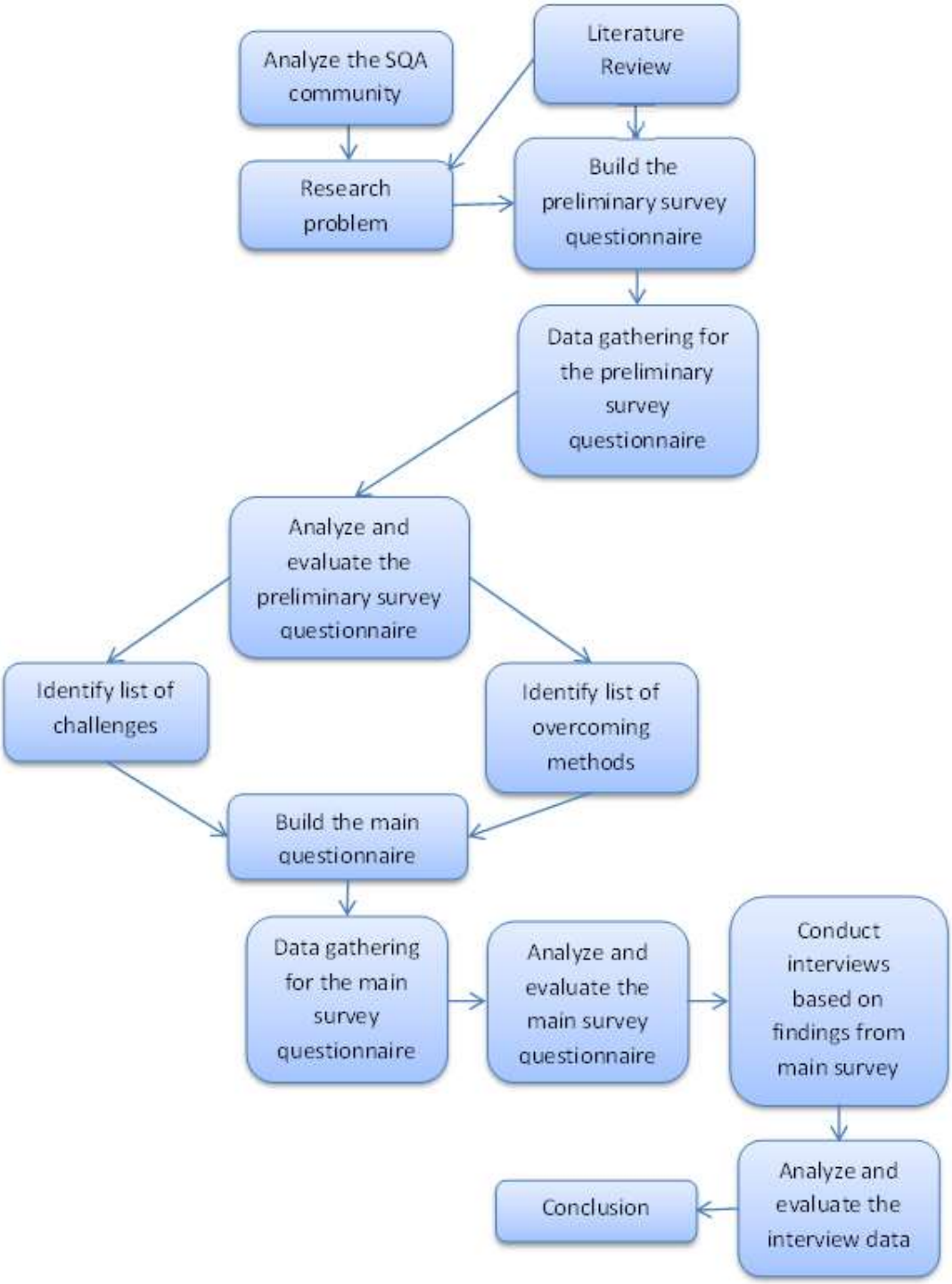

Figure 3.1: Research methodology.

3.2 Measurement and Measures

A pre survey was conducted with a limited audience to ensure the clarity and the validity of the questions to be used in the preliminary survey. The preliminary survey was then used to identify the key challenges as well as suggestions to overcome those key challenges. Specific questions used in the survey are listed in Appendix 1. As an

output of the preliminary survey, 16 challenges and 20 suggestions to overcome those challenges were identified. Identified challenges and suggestions were then included in the online survey questionnaire (see Appendix 2). A semi structured questionnaire was used for both the preliminary and online surveys. Table 3.1 lists the mapping of questions to key challenges and Table 3.2 lists the suggestions to overcome those challenges. Each questions in Table 3.1and 3.2 is designed elicit a 5-point Likert scale value from 'strongly agree' to 'strongly disagree'.

Table 3.1: Mapping of questions to challenges.

Challenge – Variable	**Scale**	**Measure**	**Question #**
Time	Likert	5 point scale	1.1
Budget	Likert	5 point scale	1.2
Lower salary scale compared to other IT professions	Likert	5 point scale	1.15
Lack of specialized SQA people	Likert	5 point scale	1.3
Migration of experienced SQA people	Likert	5 point scale	1.9
Lack of people management skills	Likert	5 point scale	1.10
Lack of understanding of the QA benefits from the higher management	Likert	5 point scale	1.16
Less SQA involvement in the requirement gathering phase	Likert	5 point scale	1.7
High turnover due to the industry competition	Likert	5 point scale	1.12
Lack of understanding about SQA oriented benefits for projects and organization from the professional	Likert	5 point scale	1.13
Less emphasis on quality standards	Likert	5 point scale	1.4
Compromise quality for certain customers	Likert	5 point scale	1.5
Difficulty in simultaneously serving multiple projects	Likert	5 point scale	1.11
Developers' negative perception on SQA contribution	Likert	5 point scale	1.6
Lack of desired level of expertise	Likert	5 point scale	1.14
Presence of internal politics	Likert	5 point scale	1.8

Table 3.2: Mapping of questions to suggestion to overcome challenges.

Challenge – Variable	Scale	Measure	Question #
Accept only feasible project deadlines and defer non-feasible deadlines	Likert	5 point scale	3.1
Provide proper SQA resources regardless of profit margin, e.g., people, tools, environments, etc.	Likert	5 point scale	3.2
Deploy process models like CMMI, ISO, etc.	Likert	5 point scale	3.3
Develop specialized SQA professionals by providing necessary technical training	Likert	5 point scale	3.4
Provide equal SQA priorities for all local and foreign projects without compromising on quality	Likert	5 point scale	3.5
Improve developer attitude by the organizing training sessions and workshops held by the management	Likert	5 point scale	3.6
Facilitate SQA representation on requirement gathering phase	Likert	5 point scale	3.7
Politics should not affect the quality of a software	Likert	5 point scale	3.8
Increased standard of living for the skilled SQA resources	Likert	5 point scale	3.9
Provide on the job trainings with the leadership on people management	Likert	5 point scale	3.10
Provide cross-domain trainings to serve multiple projects	Likert	5 point scale	3.11
Have a SQA pool of people to serve multiple projects	Likert	5 point scale	3.12
Have different SQA structures to serve multiple projects	Likert	5 point scale	3.13
Provide relevant reword, recognition and compensation to reduce turnover	Likert	5 point scale	3.14
Reduce SQA individual's lack of understanding of quality oriented by providing awareness	Likert	5 point scale	3.15
Recruit SQA people who have the necessary level of expertise	Likert	5 point scale	3.16
Introduce more SQA related training and exams	Likert	5 point scale	3.17
Keep the higher management informed by having weekly, monthly progress review or awareness meeting	Likert	5 point scale	3.18
Demonstrate quality improvements by using SQA metrics	Likert	5 point scale	3.19
Decrease dependencies in SQA (e.g., encourage developer testing prior to release to SQA)	Likert	5 point scale	3.20

Findings from the online survey were then used to identify the top ten challenges faced by the SQA professionals. Only the top 10 challenges are considered to limit the scope of the study. These findings were then further discussed with seven SQA

experts (who are heading the QA department of their company) in the form of semi-structured interviews (see Appendix 3). The discussions were also recorded for further reference with the agreement of the participants. These interviews were useful in further clarifying and interpreting the findings, as well as eliciting innovative ways of addressing the identified top 10 challenges.

3.3 Sampling Design

3.3.1 Population

The population that comes under this research is the SQA professionals in the Sri Lankan IT industry. According to the IT workforce survey conducted by the Sri Lanka Information and Communication Technology Agency (SLICTA) in November 2013, the overall IT workforce predicted for the year 2014 was 82,854 (SLICTA 2013). Out of this 40.8% of the professionals were in ICT companies, 47.1% were in non-ICT private sector, 7.8% were in government organizations and 4.2% were in BPO companies. As we are interested in the software development related QA professionals only the ICT companies are within the scope of the study. Hence, the selected population was approximately 33,918. Out of this population, 8% (see Figure 3.2) of the professionals are estimated to be in the SQA profession (SLICTA 2013). Hence, the specific population under the study is 2,714.

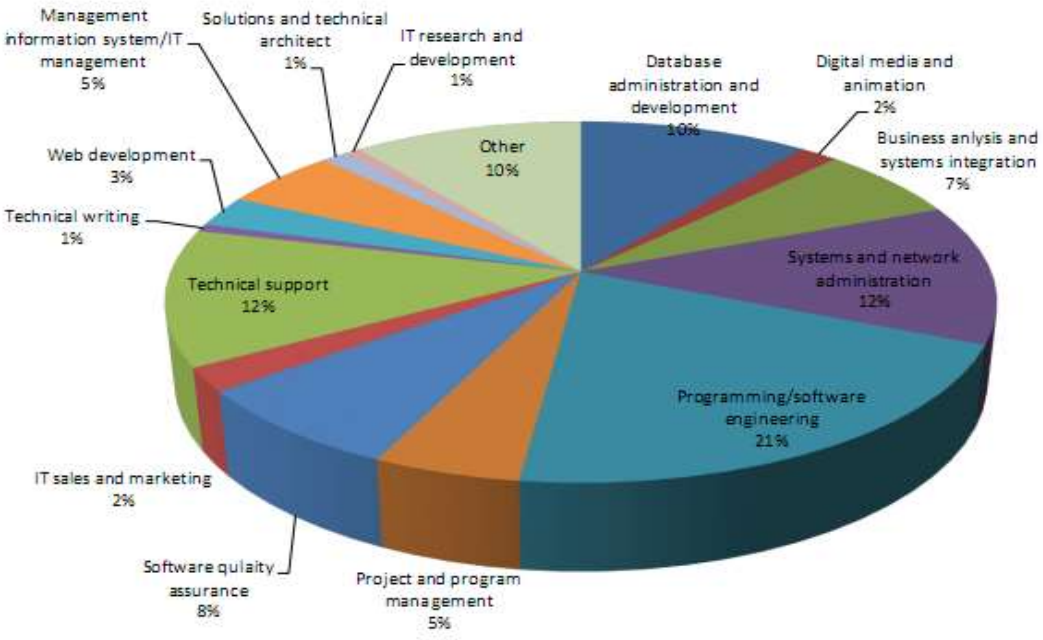

Figure 3.2: Overall IT workforce by job category.

3.3.2 Sampling Procedure

Initially, 15 SQA professionals (who working for five software development companies) were used to test the clarity and validity of the preliminary questionnaire related on the online survey. Once the questionnaire was tested, the online survey was shared with a random sample of SQA professionals selected from 25 local software development companies. While survey invitation was e-mails to known SQA professional in the community, those professional were also request to share the survey with their colleagues.

Sample size was selected such that to achieve a confidence level of 95%and confidence interval of 5. Based on these value 337 samples are required for the population of 2,714. Based on this the online survey was shared with more than 350 SQA professionals. However, only 210 responses were received, hence, the response rate is 62.3%. Semi-structured interviews were carried out with seven SQA industry experts, to find the methods/solutions to overcome the challenges identified through the questionnaire. These industry experts were contacted either through a known party or through self-introduction. Another online survey was also carried out in 2015 to further validate the findings. As the data analysis of 2014 survey was carried out in 2015, author wanted to make sure the SQA community has not experienced any major changes between the time of data collection and data analysis. 85 participants responded to the 2015 survey.

CHAPTER 4 DATA ANALYSIS AND INTERPRETATION

This chapter analyses the data collected through online questionnaire and interviews. The results of the preliminary survey were used to identify the main challenges faced by the SQA community in Sri Lanka. The results of the online main survey questionnaire were used to filter out the top ten challenges from the 16 challenges identified during the preliminary survey. At the same time the online survey results were used to validate suggestions provided to overcome those identified top ten challenges according to the views of the survey participants. Semi-structured interviews were analysed separately for key suggestions. Section 4.1 describes the data distribution for the preliminary and main survey. Section 4.2 provides the summery of the main survey results on top ten challenges and suggestions to overcome those top ten challenges.

4.1 Data Distribution

4.1.1 Preliminary Survey Results

As mentioned above, preliminary survey was conducted to identify the challenges faced by the SQA community in Sri Lanka. 15 participants from five companies were selected for the preliminary survey. The participants of this survey were categorized into four different levels in a typical organization. Table 4.1 depicts the distribution of the survey participants among the selected levels. Majority of the survey participants belong to the Engineer level. The participants of this survey were categorized into four different types of organizations. Majority of the survey participants represented organizations that are engage in both the product development and IT services (see Table 4.2). As seen in Table 4.3 participants were further categorized into three different types based on the target markets. Majority of the participants were representing the companies, who target both local and overseas markets. Further, participants were categorized into three groups based on size of their QA department. As see in Table 4.4 majority of the participants were working in a department which had more than 50 employees.

Table 4.1: Distribution of the organization levels in preliminary survey.

Level	Responses	Percentage
Executive Management	3	20%
Middle Management	3	20%
Tactical Management	4	27%
Engineer / Executive	5	33%
Total	**15**	**100%**

Table 4.2: Distribution of the organization type in preliminary survey.

Organization Type	Responses	Percentage
Product Development	4	27%
IT Services	4	27%
Both	7	47%
Total	**15**	**100%**

Table 4.3: Distribution of the target market in preliminary survey.

Target Market	Responses	Percentage
Local Market	4	27%
Overseas Market	4	27%
Both	7	46%
Total	**15**	**100%**

Table 4.4: Distribution of the department size in preliminary survey.

Size of the QA department	Responses	Percentage
Less than 10	3	20%
10 – 50	6	40%
More than 50	6	40%
Total	**15**	**100%**

The preliminary questionnaire included open ended questions to gather details related to challenges faced as a SQA professional and SQA profession. Based on the participants' comments, 16 categorizes of challenges can be identified. Table 4.5 summarizes the challenges which are faced by the SQA profession. Further, the questionnaire included open ended questions to gather details on suggestions to overcome the challenges mentioned above. Suggestions by participants can be

categorized into 20 groups and those are listed in Table 4.6. These identified challenges and suggestions to overcome the challenges were used as the input to the online survey questionnaire.

Table 4.5: Challenges faced by the SQA profession.

Challenges	Participant's Responses
Time	"Limited Time duration to complete tasks." "Inadequate Execution time." "N no of builds without proper plan." "QA has a limited time frame to complete a task."
Budget	"Limited budget for QA related activities."
Lack of specialized SQA professionals	"Keeping up to date knowledge on new technologies and how to provide SQA solutions to new trends." "The main challenge is to find QA Engineers who are highly technical and capable of working as team members and individual members." "Lack of automation and performance testing experts."
Less emphasis on quality standards	"Many are seemed to be not focusing on building the reusable frameworks and applying providences for modifications."
Compromise of quality for certain customers	"Managing the team to complete the task in time, without SQA."
Developers' negative perception on SQA contribution	"Some of the Medium size projects are usually bugs free and are less update with customer additional requirements. SQA contributions to such projects are not visible although the developers are not accountable for their work."
Repeated customer requirement variations orders	"Understanding the customer requirements to design the project to be bug free as much as possible." "Variations of Customer Requirement." "Difficulty in finalizing the customer requirements for repeated variation requests." "Finalizing the customer requirements after studying the variation orders." "Requirement changes in middle of the development without tester's knowledge." "Since the requirements are maintained by BA, there can be gaps between the receiver and the developer end and also if the requirements are not based line QA need to rework on the test documents to meet the updated requirement."
Presence of internal nonstandard practices	"Developers are always handing over the releases to QA without a proper signoff. But expecting an approval QA."
Migration of experienced SQA people	"Professionals tend to migrate to another country after getting considerable years of experience from the local companies."
Lack of HR management in the organization	"The organization recruit the professionals as and when necessary basis; client orientation"

Challenges	Participant's Responses
Ability to handle simultaneous tasks and multiple projects	"The main challenge is to find QA Engineers who are highly technical and who can work both in a team and independently." "Balancing the work load and the managing the team and finding time for all activities." "With my personnel experience it is found that utmost care has to be taken to avoid clashes when sharing resources for multiple projects..."
High demand for SQA engineers	"Talented and Technical QA Engineers tend to get more offers from other competitive companies. As a result the demands high."
Lack of understanding about SQA role in the projects.	"Building test optimization solutions and accelerators to gain competitive advantage over the other competitors." "Delivering the product on time with high quality."
Lack of desired level of expertise	"To maintain the quality in the expected level in complying with the rapid changes."
Lower emolument compared to other IT professions	"QA professionals are paid less, even if they provide valuable contribution to the project."
Neglecting the SQA role by the higher management	"Trying to rely on development team suggestions and approaches in most of the time which will lead to deliver incomplete successful QA task."

Table 4.6: Suggestions to overcome challenges faced by the SQA profession.

#	Suggestions
1	Accept only feasible project deadlines and defer non-feasible deadlines.
2	Allocate sufficient funds in the budget to provide proper SQA resources regardless of profit margin, e.g., people, tools, environments, etc.
3	Deploy process models like CMMI, ISO, etc.
4	Develop specialized SQA professionals by providing necessary technical training.
5	Provide equal SQA priorities for all local and foreign projects without compromising on quality.
6	Improve developer attitude by the organizing training sessions and workshops held by the management.
7	Facilitate SQA representation on requirement gathering phase.
8	Politics should not affect the quality of a software.
9	Increased standard of living for the skilled SQA resources.
10	Provide on the job trainings with the leadership on HR (people) management.
11	Provide cross-domain trainings to serve multiple projects.
12	Have a SQA pool of people to serve multiple projects.
13	Have different SQA structures to serve multiple projects.
14	Provide relevant reword, recognition and compensation to reduce turnover.

15	Reduce SQA individual's lack of understanding of quality oriented by providing awareness.
16	Recruit SQA people who have the necessary level of expertise.
17	Introduce more SQA related training and exams.
18	Keep the higher management informed by having weekly, monthly progress review or awareness meeting.
19	Demonstrate quality improvements by using SQA metrics.
20	Decrease dependencies in SQA.

4.1.2 Online Survey Results

The online survey was conducted to validate the two main objectives of this research has mentioned in Section 1.4.We limit the analysis to identify the following:

- Identify the top ten challenges faced by the SQA profession.
- Validate the suggestion made to overcome the above ten challenges.

As the study could not complete in year 2014, online survey was again conducted in 2015 to validate the whether the challenges and suggestions were the same for both the years. 210 responses were received during the year 2014 and 85 received in year 2015. Below analysis shows the values for 2014 and 2015 surveys separately.

Participants were categorized into four different levels in the organization. For both years, majority of the participants were in the Engineer/Executive level. This is an advantage for the researcher, because most of the challenges are faced during this age of the profession. In both years more than 50% of the participants were working as an engineer. Tables 4.7depict the distribution of the survey participants among the selected levels for 2014 and 2015.Participants were further categorized into four different types of organizations. Their distribution is depicted in Figure 4.8. In 2014 majority of the participants were involved in IT service oriented companies, whereas in 2015 61% of high participation was worked related to the companies providing both the Product Development and IT services. Participants were also categorized into three different types of target markets. Majority of the participants were working for an organization, where they are targeting the both local and overseas markets. The table 4.9depicts the distribution of the survey participants among the selected target market for both the years.

Table 4.7: Distribution of the organization levels in online survey in 2014 and 2015.

Level	2014		2015	
	Responses	Percentage	Responses	Percentage
Executive Management	13	6%	3	4%
Middle Management	25	12%	10	12%
Tactical Management	49	23%	15	18%
Engineer / Executive	123	59%	57	67%
Total	**210**	**100%**	**85**	**100%**

Table 4.8: Distribution of the organization type in online survey in 2014 and 2015.

Organization Type	2014		2015	
	Responses	Percentage	Responses	Percentage
Product Development	39	19%	13	15%
IT Services	92	44%	20	24%
Both	79	38%	52	61%
Total	**210**	**100%**	**85**	**100%**

Table 4.9: Distribution of the target market in online survey in 2014 and 2015.

Target Market	2014		2015	
	Responses	Percentage	Responses	Percentage
Local Market	7	3%	7	8%
Overseas Market	52	25%	11	13%
Both	151	72%	67	79%
Total	**210**	**100%**	**85**	**100%**

Further, as seen on Table 4.10 participants were categories into three groups based on size of their QA department. Majority of the participants were working in departments has more than 50 team members. Finally, the survey participants were identified by their gender to make sure the both the categories got the equal opportunity for participating the questionnaire. Table 4.11 depicts the distribution of the survey participants.

Table 4.8: Distribution of the department size in online survey in 2014 and 2015.

Size of the QA department	2014		2015	
	Responses	Percentage	Responses	Percentage
Less than 10	33	16%	23	27%
10 – 50	60	29%	22	26%
More than 50	117	56%	40	47%
Total	**210**	**100%**	**85**	**100%**

Table 4.9: Distribution of the gender in online survey in 2014 and 2015.

Gender	2014		2015	
	Responses	Percentage	Responses	Percentage
Male	111	53%	41	48%
Female	99	47%	44	52%
Total	**210**	**100%**	**85**	**100%**

Next we analyse the identified challenges and potential solutions. Below two approaches were used to identify the key top ten challenges for the both the years:

- Percentage scale
- Weighted scale

In the percentage-based approach, both "Strongly Agreed" and "Agreed" were considered as "Agreed". Similarly "Disagree" and "Strongly Disagree" were considered as "Disagree". "Neither Agree nor Disagree" responses were considered as "Neutral". Figure 4.1 and 4.2 show the results for the year 2014 and 2015.

Following two figures used to identify the top ten challenges for 2014 and 2015. As per them, for both years top ten challenges have recorded more than 70% of agreeableness and less than 10% of disagree.

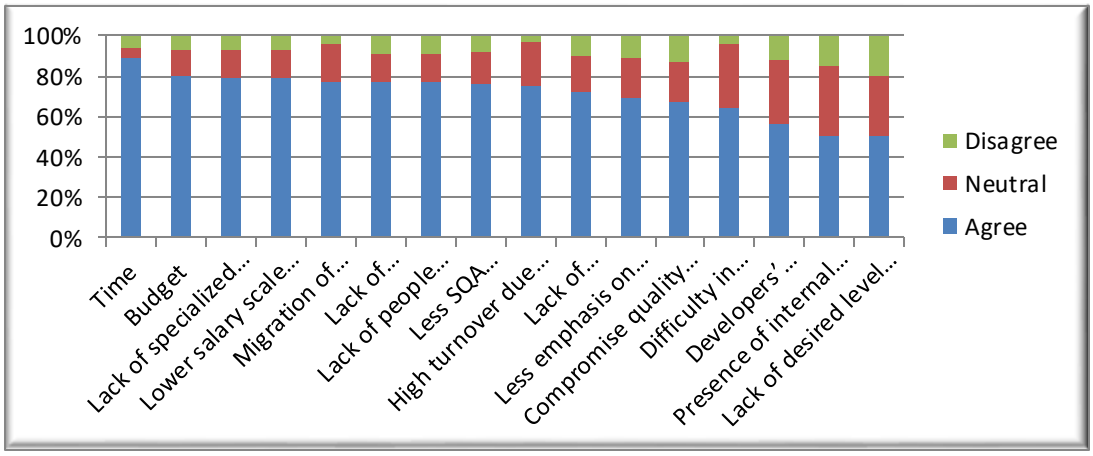

Figure 4.1: Percentage wise analysis on challenges in online survey 2014.

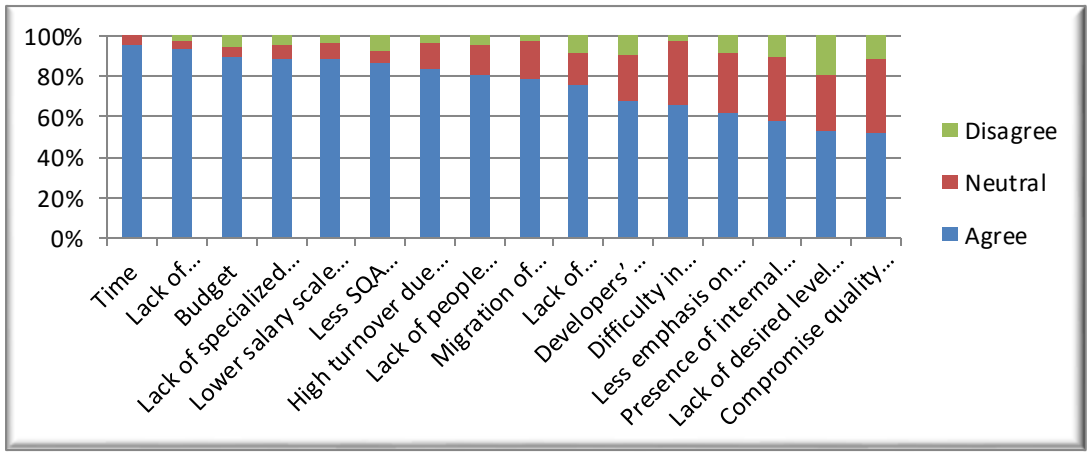

Figure 4.2: Percentage wise analysis on challenges in online survey 2015.

In the weighted scoring approach, weights for each Lickert's scale value is assigned as follows:

- Strongly Agreed – 5
- Agreed – 4
- Neither Agree nor Disagree – 3
- Disagree – 2
- Strongly Disagree – 1

Figure 4.3 and 4.4 show the weighted results for the year 2014 and 2015. This approach also showing similar results to the identified top challenges through the percentage scale approach. Latter part of the study, 'Strongly Agreed', 'Agree' and 'Neither Agree nor Disagree' was considered as 'Agree'. Also, 'Disagree' and 'Strongly Disagree' was considered as 'Disagree' for the ease of analysis. This is applied from the Figure 4.5 onwards.

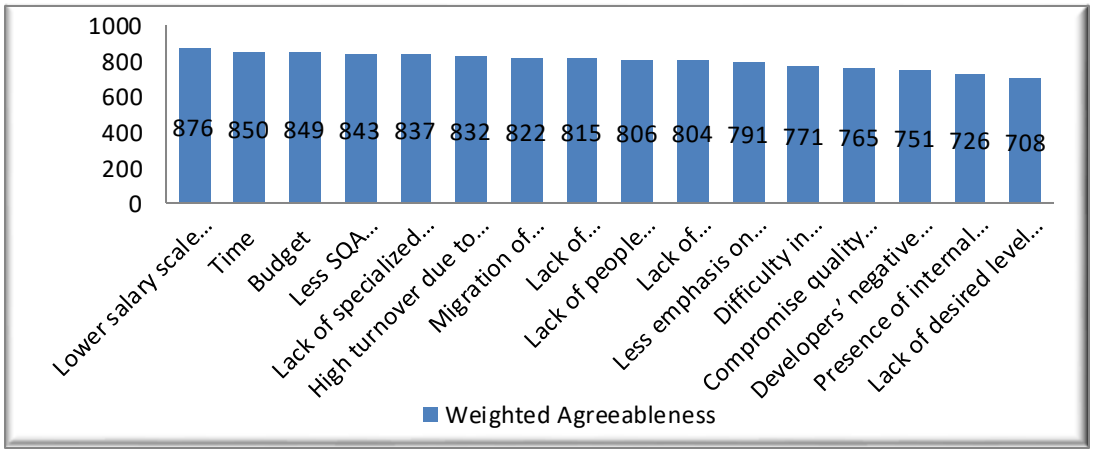

Figure 4.3: Weighted score analysis on challenges in online survey 2014.

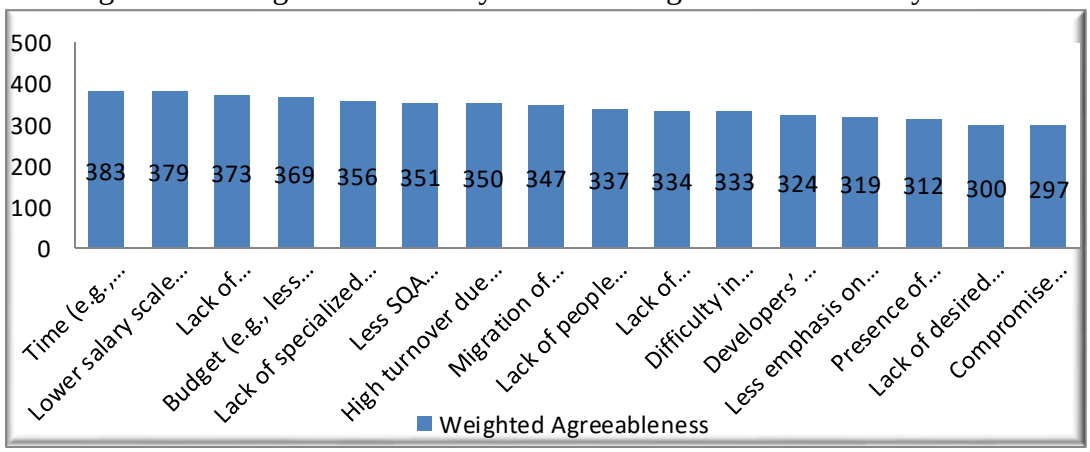

Figure 4.4: Weighted score analysis on challenges in online survey 2015.

4.1.2.1 Analysis based on Gender

As seen on Figure 4.5 and 4.6, top ten challenges identified by the males for both year 2014 and 2015 are similar. Even though positions and agreeableness percentage towards the challenges are different, top ten challenges remained same for both years. Table 4.17 showing the stack ranking for the male category for 2014 and 2015.

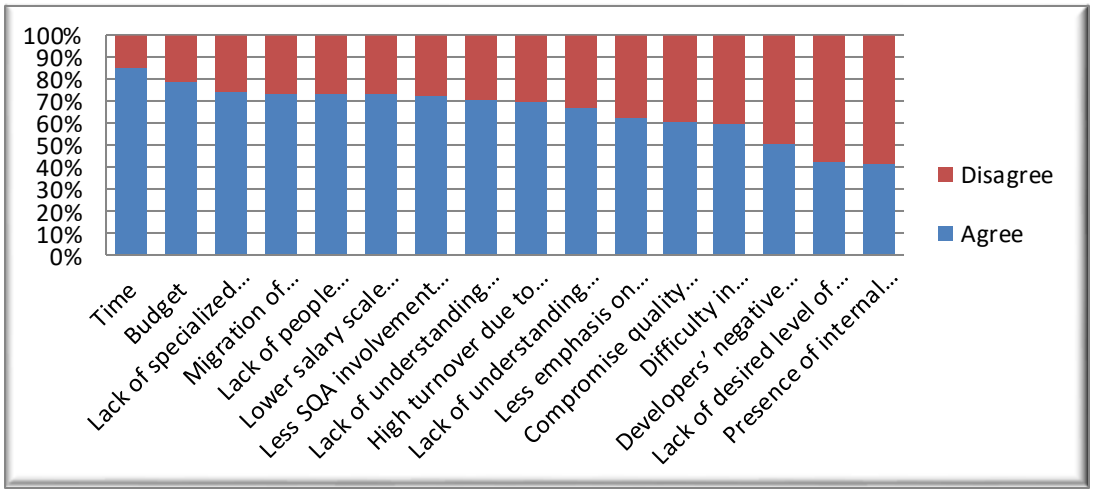

Figure 4.5: Distribution of challenges in 2014 for Male category.

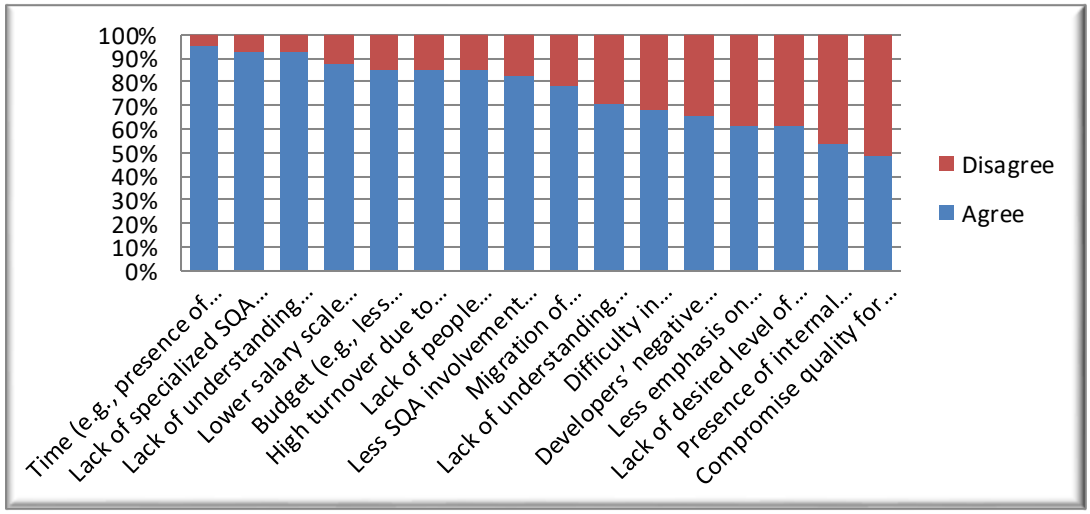

Figure 4.6: Distribution of challenges in 2015 for Male category.

Table 4.10: Ranking of challenges in 2014 and 2015 for males.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	2	5
Lack of specialized SQA people	3	2
Less emphasis on quality standards	11	13
Compromise quality for certain customers	12	16
Developers' negative perception on SQA contribution	14	12
Less SQA involvement in the requirement gathering phase	7	8
Presence of internal politics	16	15
Migration of experienced SQA people	4	9
Lack of people management skills	5	7
Difficulty in simultaneously serving multiple projects	13	11

High turnover due to the industry competition	9	6
Lack of understanding about SQA oriented benefits for projects and organization	10	10
Lack of desired level of expertise	15	14
Lower salary scale compared to other IT professions	6	4
Lack of understanding of the QA benefits from the higher management	8	3

Similarly female distribution is also similar for both the years. Even though positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for Female only distribution. Figure 4.7 and 4.8 showing the distribution of challenges for female category in 2014 and 2015, respectively. Table 4.18 shows the stack ranking for females.

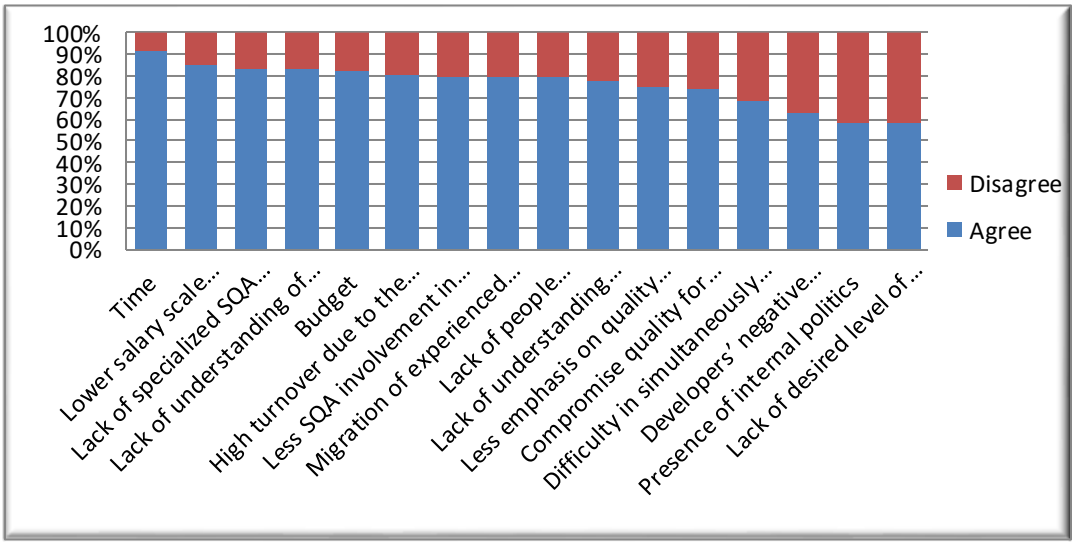

Figure 4.7: Distribution of challenges in 2014 for Female category.

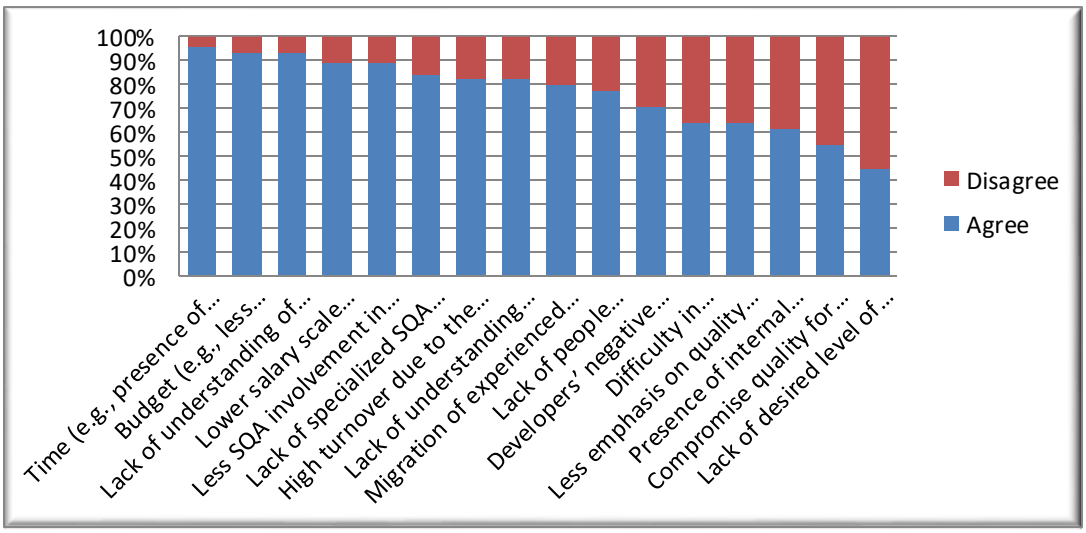

Figure 4.8: Distribution of challenges in 2015 for Female category.

Table 4.11: Ranking of challenges in 2014 and 2015 for female category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	5	2
Lack of specialized SQA people	3	6
Less emphasis on quality standards	11	13
Compromise quality for certain customers	12	15
Developers' negative perception on SQA contribution	14	11
Less SQA involvement in the requirement gathering phase	7	5
Presence of internal politics	15	14
Migration of experienced SQA people	8	9
Lack of people management skills	9	10
Difficulty in simultaneously serving multiple projects	13	12
High turnover due to the industry competition	6	7
Lack of understanding about SQA oriented benefits for projects and organization	10	8
Lack of desired level of expertise	16	16
Lower salary scale compared to other IT professions	2	4
Lack of understanding of the QA benefits from the higher management	4	3

When analyse both the Table 4.17 and 4.18, the top ten challenges remains the same and only the order go changed. Hence, this study has proven both male and female categories agreed to the identified top ten challenges.

4.1.2.2 Analysis Based on Organization Hierarchy

When analyse the *Engineer* distribution in 2014 and 2015, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for Female only distribution. Figure 4.9 and 4.10 showing the distribution of challenges for engineer category in 2014 and 2015 respectively. Table 4.19 depicts the stack rankings for the Female category in 2014 and 2015.

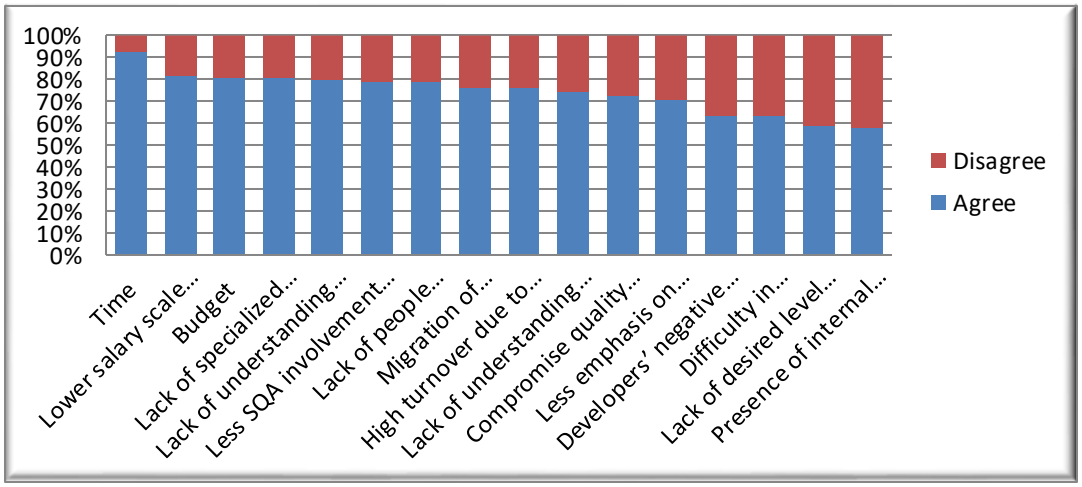

Figure 4.9: Distribution of challenges in 2014 for Engineer category.

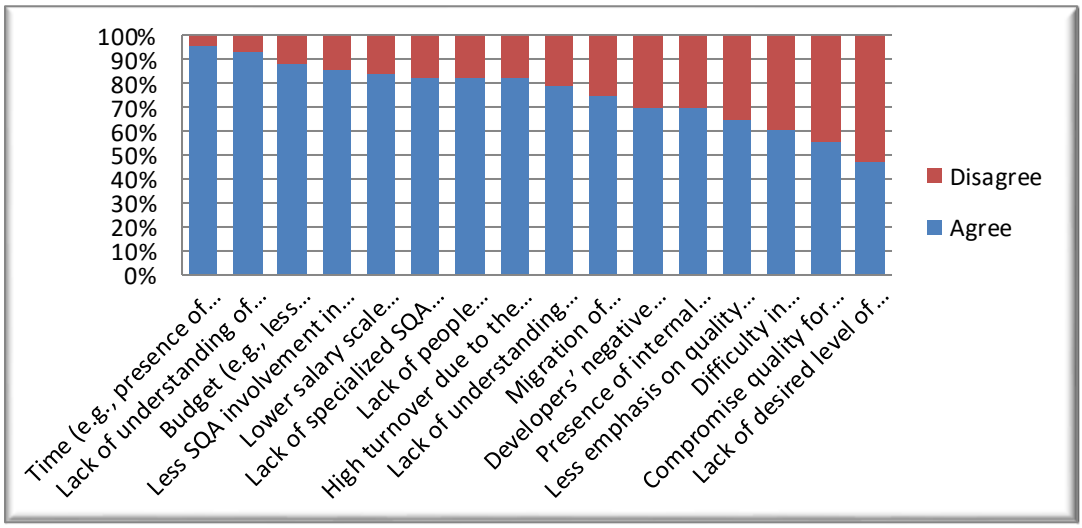

Figure 4.10: Distribution of challenges in 2015 for Engineer category.

Table 4.12: Ranking of challenges in 2014 and 2015 for Engineer category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	3	3
Lack of specialized SQA people	4	6
Less emphasis on quality standards	12	13
Compromise quality for certain customers	11	15
Developers' negative perception on SQA contribution	13	11
Less SQA involvement in the requirement gathering phase	6	4
Presence of internal politics	16	12
Migration of experienced SQA people	8	10
Lack of people management skills	7	7
Difficulty in simultaneously serving multiple projects	14	14

High turnover due to the industry competition	9	8
Lack of understanding about SQA oriented benefits for projects and organization	10	9
Lack of desired level of expertise	15	16
Lower salary scale compared to other IT professions	2	5
Lack of understanding of the QA benefits from the higher management	5	2

When analyse the *Tactical Management* distribution in 2014 and 2015, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for Tactical Management only distribution. Figure 4.11 and 4.12 showing the distribution of challenges for tactical management category in 2014 and 2015, respectively. Table 4.20 depicts the stack rankings for the Tactical Management category in 2014 and 2015.

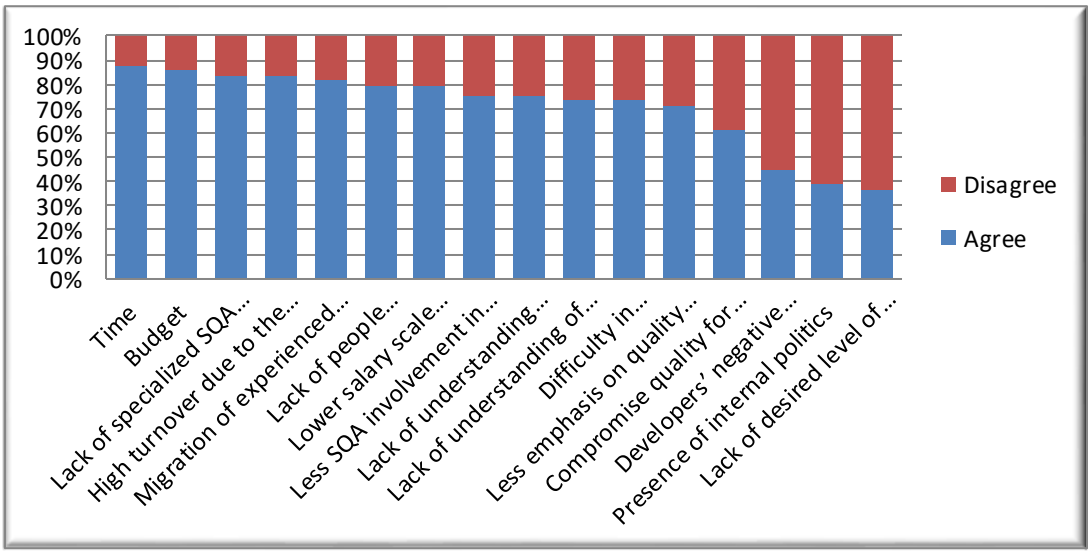

Figure 4.11: Distribution of challenges in 2014 for Tactical Management category.

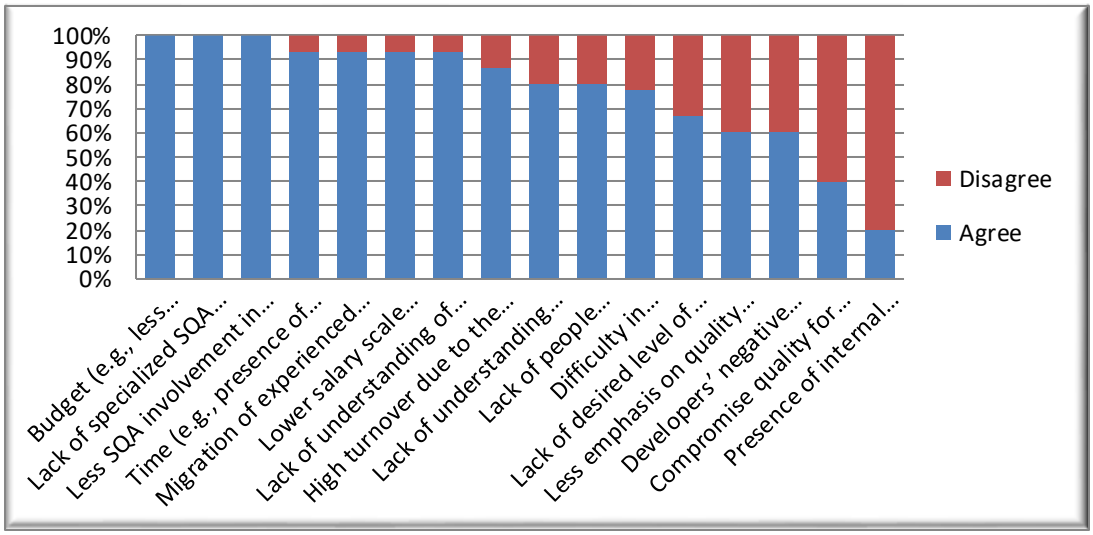

Figure 4.12: Distribution of challenges in 2015 for Tactical Management category.

Table 4.13: Ranking of challenges in 2014 and 2015 for Tactical Management category.

Challenge Description	2014 Rank	2015 Rank
Time	1	4
Budget	2	1
Lack of specialized SQA people	3	2
Less emphasis on quality standards	12	13
Compromise quality for certain customers	13	15
Developers' negative perception on SQA contribution	14	14
Less SQA involvement in the requirement gathering phase	8	3
Presence of internal politics	15	16
Migration of experienced SQA people	5	5
Lack of people management skills	6	10
Difficulty in simultaneously serving multiple projects	11	11
High turnover due to the industry competition	4	8
Lack of understanding about SQA oriented benefits for projects and organization	9	9
Lack of desired level of expertise	16	12
Lower salary scale compared to other IT professions	7	6
Lack of understanding of the QA benefits from the higher management	10	7

When analysing the *Middle Management*, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges

remained same for both years for Middle Management only distribution. Figure 4.13 and 4.14 show the distribution of challenges for middle management category in 2014 and 2015 respectively. Table 4.21 depicts the stack rankings for the Middle Management category in 2014 and 2015.

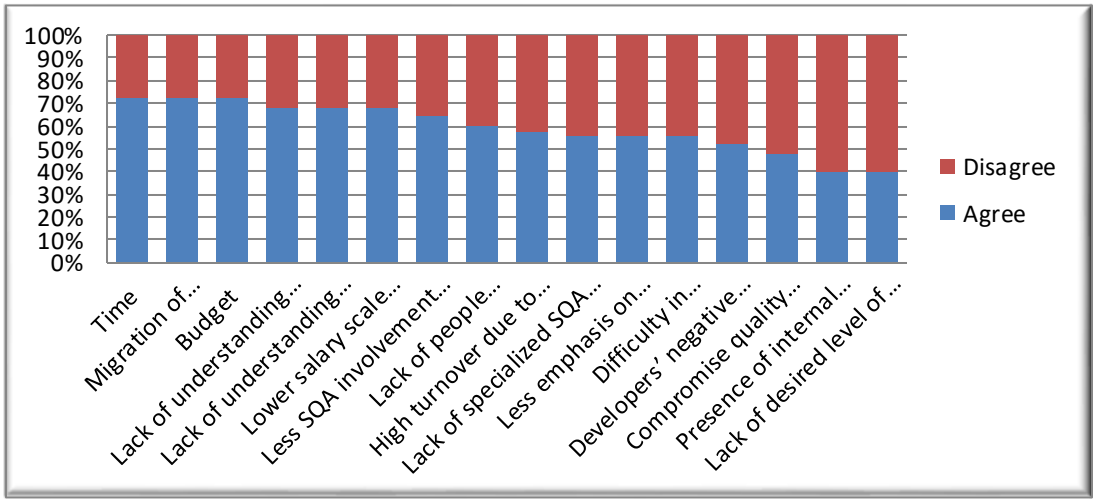

Figure 4.13: Distribution of challenges in 2014 for Middle Management category.

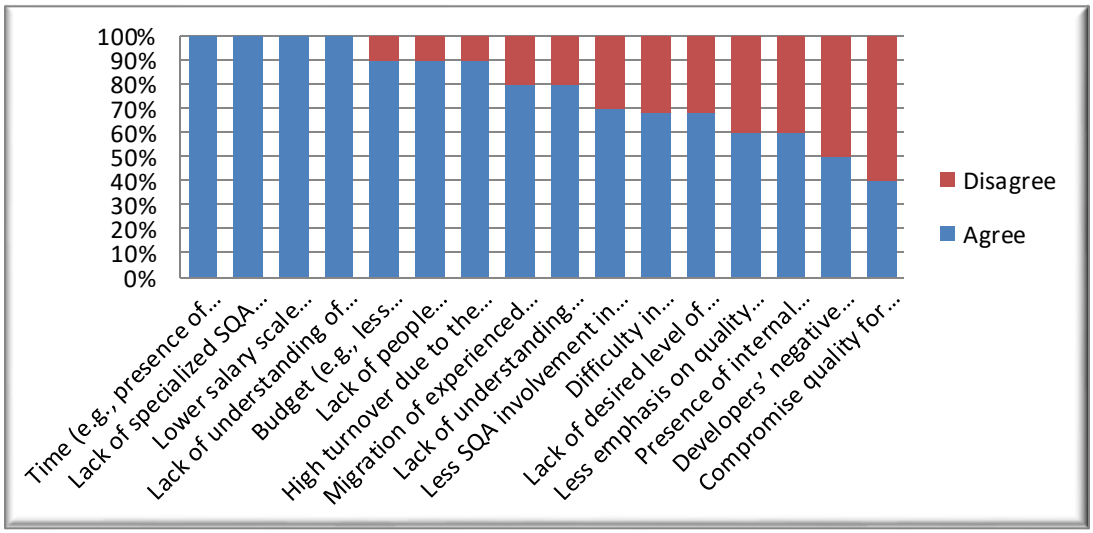

Figure 4.14: Distribution of challenges in 2015 for Middle Management category.

Table 4.14: Ranking of challenges in 2014 and 2015 for Middle Management category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	3	5
Lack of specialized SQA people	10	2
Less emphasis on quality standards	11	13

Compromise quality for certain customers	14	16
Developers' negative perception on SQA contribution	13	15
Less SQA involvement in the requirement gathering phase	7	10
Presence of internal politics	15	14
Migration of experienced SQA people	2	8
Lack of people management skills	8	6
Difficulty in simultaneously serving multiple projects	12	11
High turnover due to the industry competition	9	7
Lack of understanding about SQA oriented benefits for projects and organization	5	9
Lack of desired level of expertise	16	12
Lower salary scale compared to other IT professions	6	3
Lack of understanding of the QA benefits from the higher management	4	4

When analyse the *Executive Management* distribution, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for Executive Management only distribution. Figure 4.15 and 4.16 showing the distribution of challenges for executive management category in 2014 and 2015 respectively. Table 4.22 depicts the stack rankings for the Executive Management category in 2014 and 2015.

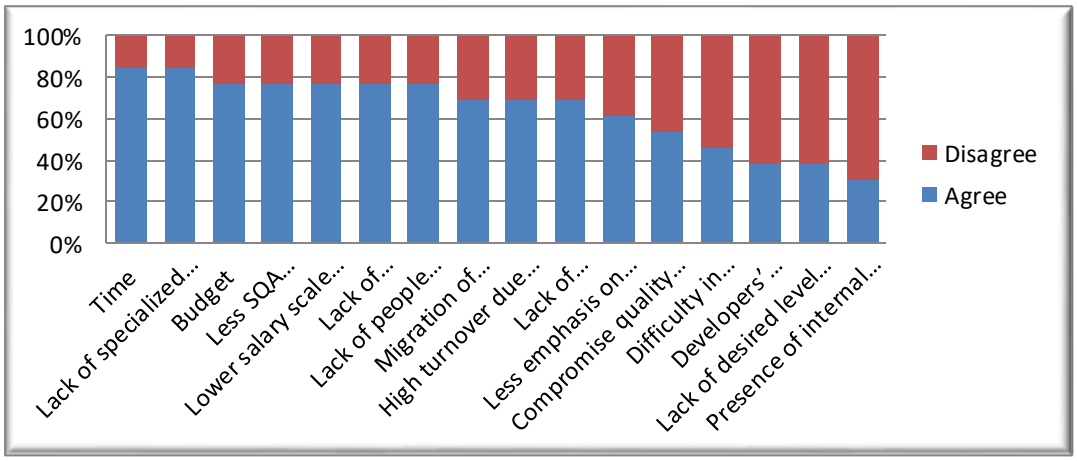

Figure 4.15: Distribution of challenges in 2014 for Executive Management category.

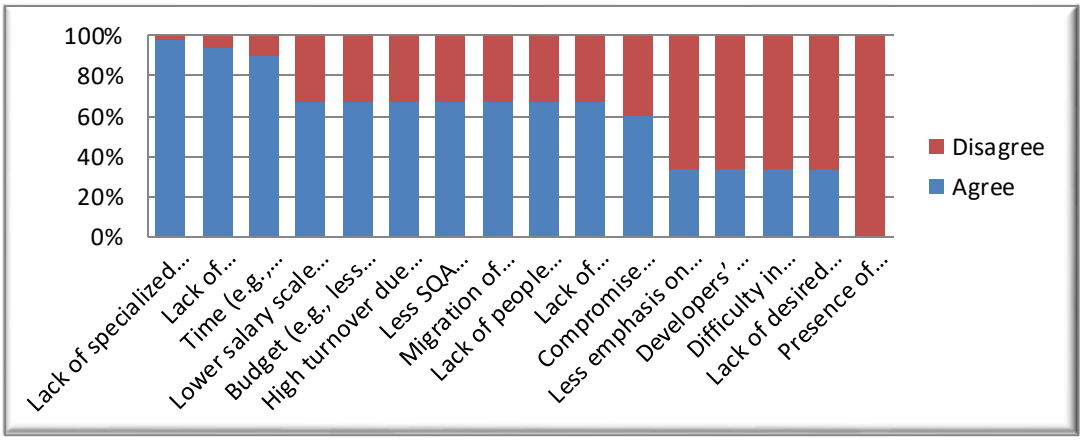

Figure 4.16: Distribution of challenges in 2015 for Executive Management category.

Table 4.15: Ranking of challenges in 2014 and 2015 for Executive Management category.

Challenge Description	2014 Rank	2015 Rank
Time	1	3
Budget	3	5
Lack of specialized SQA people	2	1
Less emphasis on quality standards	11	12
Compromise quality for certain customers	12	11
Developers' negative perception on SQA contribution	14	13
Less SQA involvement in the requirement gathering phase	4	7
Presence of internal politics	16	16
Migration of experienced SQA people	8	8
Lack of people management skills	7	9
Difficulty in simultaneously serving multiple projects	13	14
High turnover due to the industry competition	9	6
Lack of understanding about SQA oriented benefits for projects and organization	10	2
Lack of desired level of expertise	15	15
Lower salary scale compared to other IT professions	5	4
Lack of understanding of the QA benefits from the higher management	6	10

When analyse Table 4.19, 4.20, 4.21 and 4.22, the top ten challenges remains the same and only the order go changed. Hence, this study has proven all the organizational hierarchy level categories agreed to the identified top ten challenges.

4.1.2.3 Analysis based on Size of QA Department

When analyse the *QA department size less than 10* distribution in 2014 and 2015, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for department size less than 10 distribution. Figure 4.17 and 4.18 showing the distribution of challenges for male category in 2014 and 2015 respectively. Table 4.23 depicts the stack rankings for the Executive Management category in 2014 and 2015.

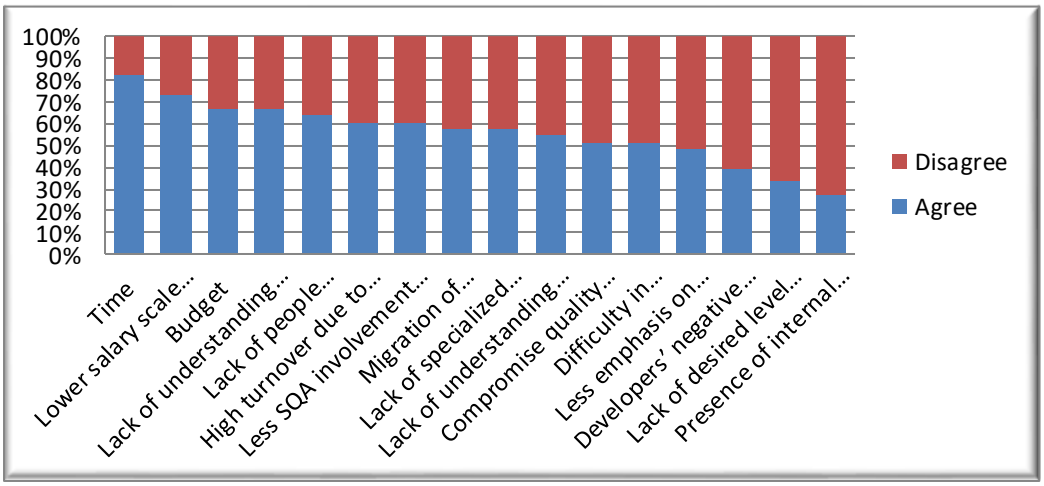

Figure 4.17: Distribution of challenges in 2014 for Size less than 10 category.

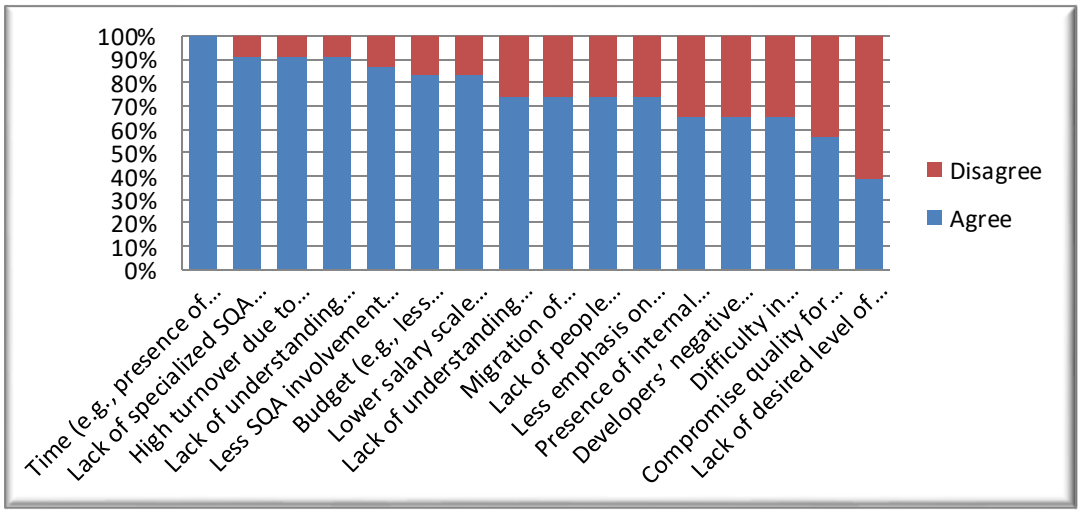

Figure 4.18: Distribution of challenges in 2015 for Size less than 10 category.

Table 4.16: Ranking of challenges in 2014 and 2015 for Size less than 10 category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	3	6
Lack of specialized SQA people	9	2

Less emphasis on quality standards	13	11
Compromise quality for certain customers	11	15
Developers' negative perception on SQA contribution	14	13
Less SQA involvement in the requirement gathering phase	7	5
Presence of internal politics	16	12
Migration of experienced SQA people	8	9
Lack of people management skills	5	10
Difficulty in simultaneously serving multiple projects	12	14
High turnover due to the industry competition	6	3
Lack of understanding about SQA oriented benefits for projects and organization	10	8
Lack of desired level of expertise	15	16
Lower salary scale compared to other IT professions	2	7
Lack of understanding of the QA benefits from the higher management	4	4

When analyse the *QA department size less than 50* distribution in 2014 and 2015, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for department size less than 50 only distribution. Figure 4.19 and 4.20 showing the distribution of challenges for department size less than 50 category in 2014 and 2015 respectively. Table 4.24 depicts the stack rankings for the department size less than 50 category in 2014 and 2015.

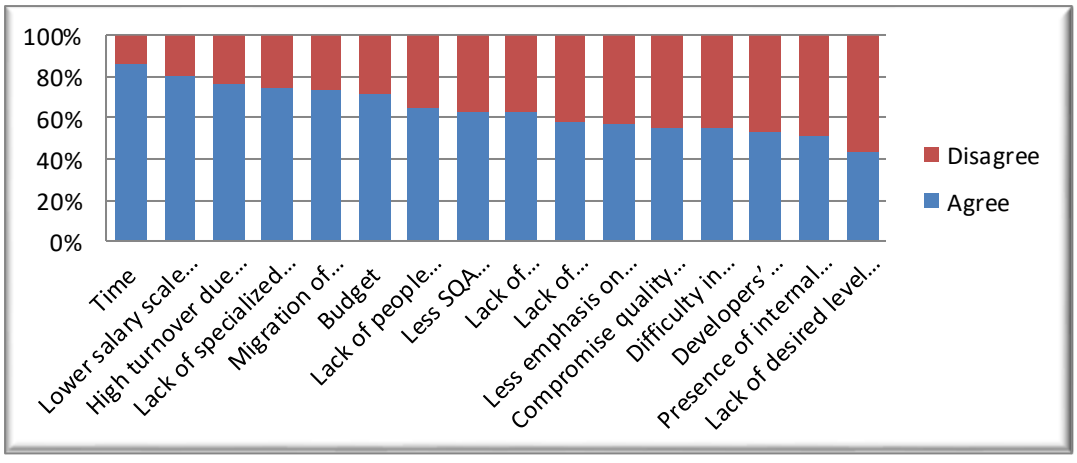

Figure 4.19: Distribution of challenges in 2014 for size less than 50 category.

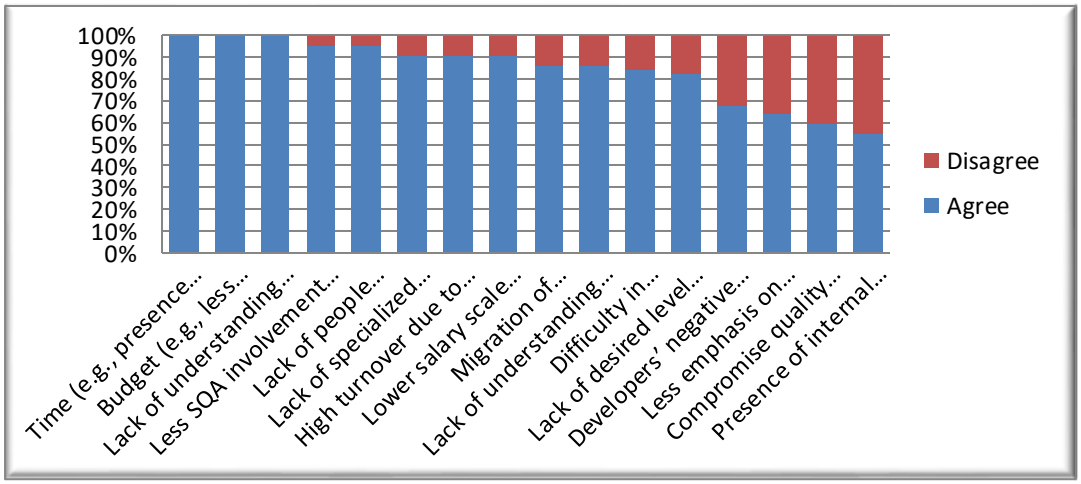

Figure 4.20: Distribution of challenges in 2015 for size less than 50 category.

Table 4.17: Ranking of challenges in 2014 and 2015 for Size less than 50 category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	6	2
Lack of specialized SQA people	4	6
Less emphasis on quality standards	11	14
Compromise quality for certain customers	12	15
Developers' negative perception on SQA contribution	14	13
Less SQA involvement in the requirement gathering phase	8	4
Presence of internal politics	15	16
Migration of experienced SQA people	5	9
Lack of people management skills	7	5
Difficulty in simultaneously serving multiple projects	13	11
High turnover due to the industry competition	3	7
Lack of understanding about SQA oriented benefits for projects and organization	10	10
Lack of desired level of expertise	16	12
Lower salary scale compared to other IT professions	2	8
Lack of understanding of the QA benefits from the higher management	9	3

When analyse the *QA department size more than 50* distribution in 2014 and 2015, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for department size more than 50 distribution. Figure 4.21 and 4.22 showing the distribution of challenges for

department size more than 50 category in 2014 and 2015 respectively. Table 4.25 depicts the stack rankings for the department size more than 50 category in 2014 and 2015.

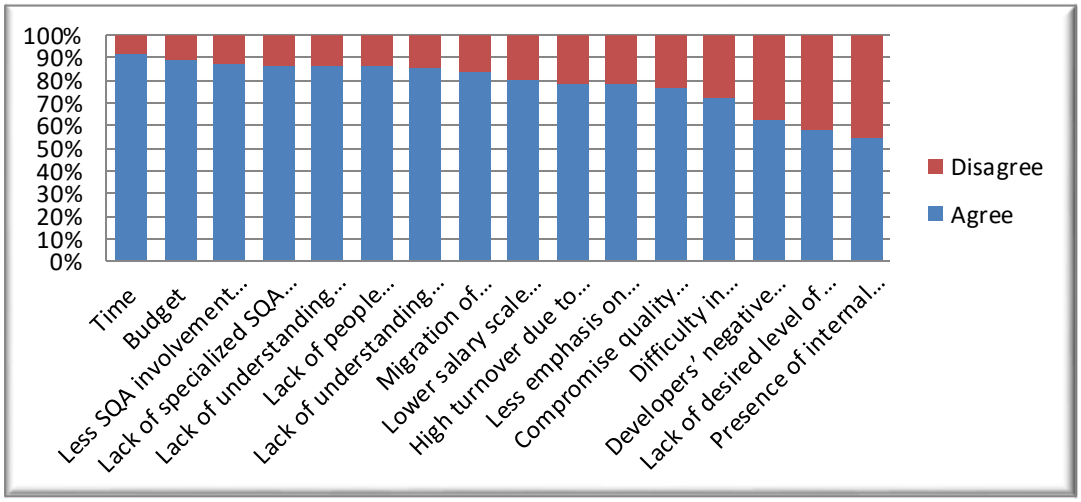

Figure 4.21: Distribution of challenges in 2014 for size more than 50 category.

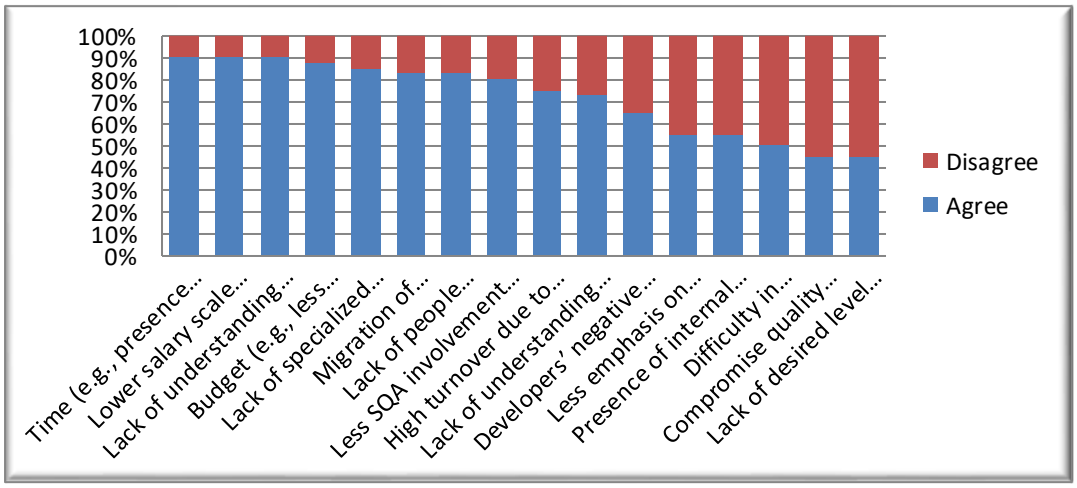

Figure 4.22: Distribution of challenges in 2015 for size more than 50 category.

Table 4.18: Ranking of challenges in 2014 and 2015 for size more than 50 category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	2	4
Lack of specialized SQA people	4	5
Less emphasis on quality standards	11	12
Compromise quality for certain customers	12	15
Developers' negative perception on SQA contribution	14	11
Less SQA involvement in the requirement gathering phase	3	8
Presence of internal politics	16	13

Migration of experienced SQA people	8	6
Lack of people management skills	6	7
Difficulty in simultaneously serving multiple projects	13	14
High turnover due to the industry competition	10	9
Lack of understanding about SQA oriented benefits for projects and organization	7	10
Lack of desired level of expertise	15	16
Lower salary scale compared to other IT professions	9	2
Lack of understanding of the QA benefits from the higher management	5	3

When analyse Table 4.23, 4.24 and 4.25, the top ten challenges remains the same and only the order go changed. Hence, this study has proven all the department size categories agreed to the identified top ten challenges.

4.1.2.4 Analysis Based on Company Type

When analyse the *Product Development* distribution in 2014 and 2015, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for product development distribution. Figure 4.23 and 4.24 showing the distribution of challenges for 'product development only' category in 2014 and 2015 respectively. Table 4.26 depicts the stack rankings for the product development category in 2014 and 2015.

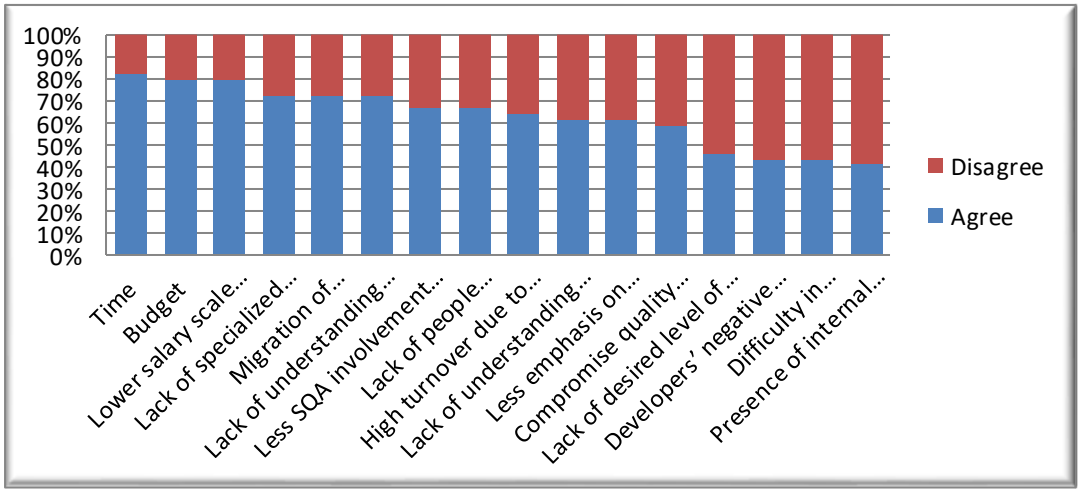

Figure 4.23: Distribution of challenges in 2014 for Product development only category.

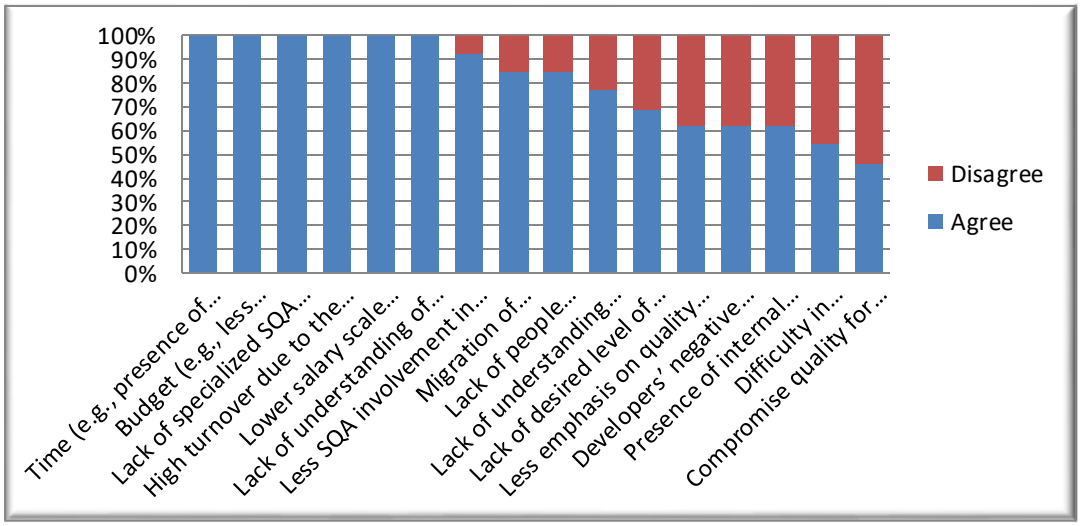

Figure 4.24: Distribution of challenges in 2015 for Product development only category.

Table 4.19: Ranking of challenges in 2014 and 2015 for product development only category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	2	2
Lack of specialized SQA people	4	3
Less emphasis on quality standards	11	12
Compromise quality for certain customers	12	16
Developers' negative perception on SQA contribution	14	13
Less SQA involvement in the requirement gathering phase	7	7
Presence of internal politics	16	14
Migration of experienced SQA people	5	8
Lack of people management skills	8	9
Difficulty in simultaneously serving multiple projects	15	15
High turnover due to the industry competition	9	4
Lack of understanding about SQA oriented benefits for projects and organization	10	10
Lack of desired level of expertise	13	11
Lower salary scale compared to other IT professions	3	5
Lack of understanding of the QA benefits from the higher management	6	6

When analyse the *IT services* distribution in 2014 and 2015, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten

challenges remained same for both years for IT services distribution. Figure 4.25 and 4.26 showing the distribution of challenges for 'IT service only' category in 2014 and 2015 respectively. Table 4.27 depicts the stack rankings for the IT services category only in 2014 and 2015.

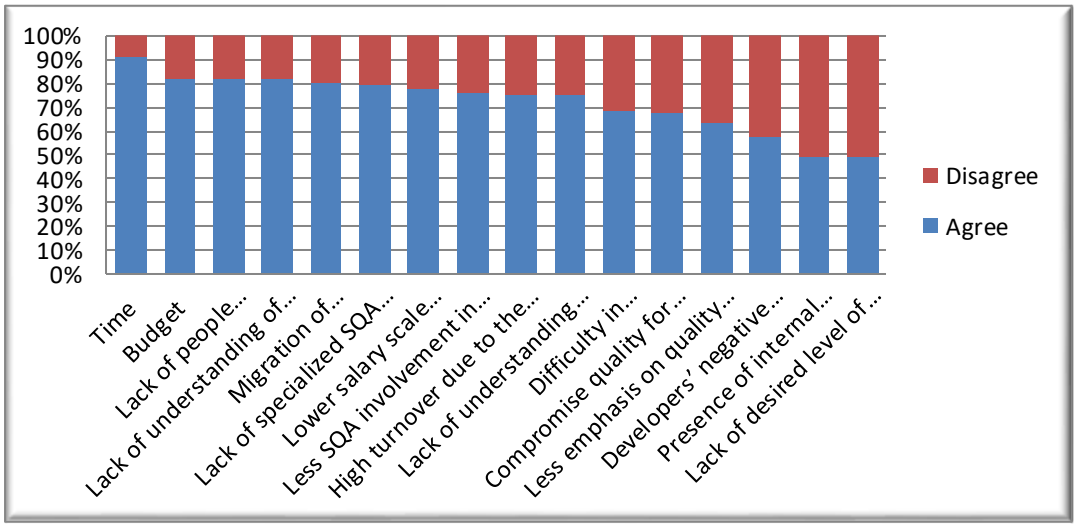

Figure 4.25: Distribution of challenges in 2014 for IT Service only category.

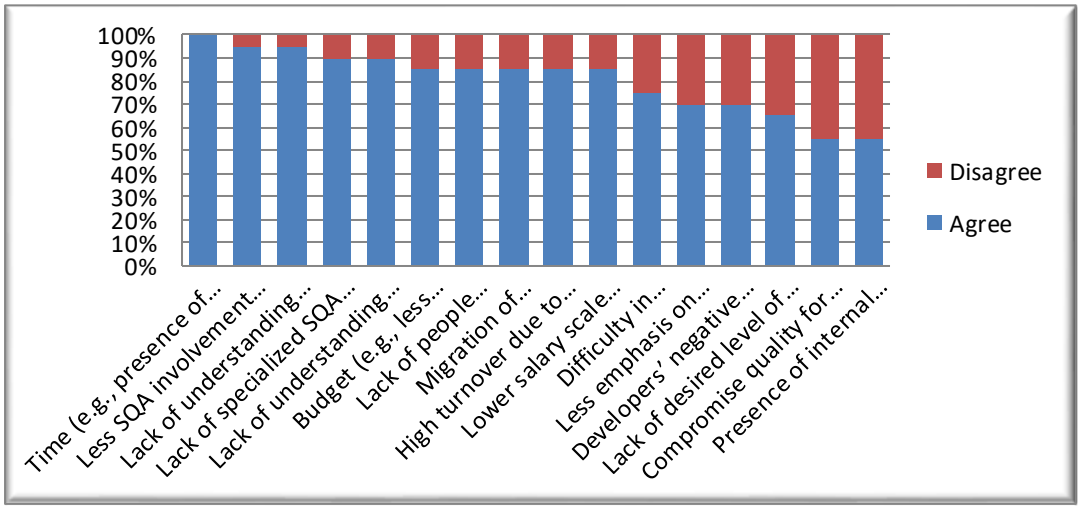

Figure 4.26: Distribution of challenges in 2015 for IT service only category.

Table 4.20: Ranking of challenges in 2014 and 2015 for IT service only category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	2	6
Lack of specialized SQA people	6	4
Less emphasis on quality standards	13	12
Compromise quality for certain customers	12	15
Developers' negative perception on SQA contribution	14	13
Less SQA involvement in the requirement gathering phase	8	2

Presence of internal politics	15	16
Migration of experienced SQA people	5	8
Lack of people management skills	3	7
Difficulty in simultaneously serving multiple projects	11	11
High turnover due to the industry competition	9	9
Lack of understanding about SQA oriented benefits for projects and organization	10	5
Lack of desired level of expertise	16	14
Lower salary scale compared to other IT professions	7	10
Lack of understanding of the QA benefits from the higher management	4	3

When analyse the *Product development and IT services* distribution in 2014 and 2015, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for product development and IT services distribution. Figure 4.27 and 4.28 showing the distribution of challenges for product development and IT services category in 2014 and 2015 respectively. Table 4.28 depicts the stack rankings for the product development and IT services category in 2014 and 2015.

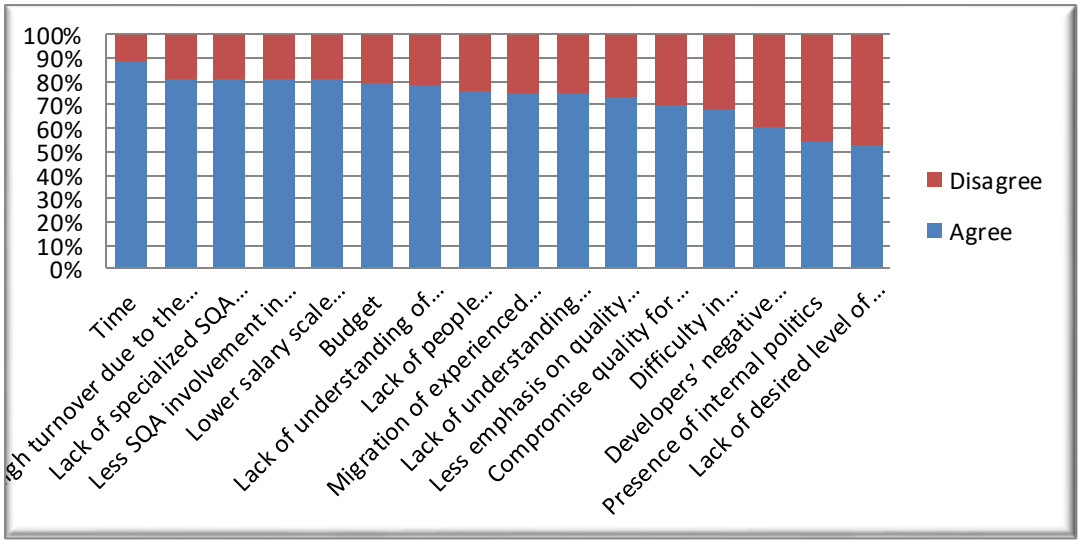

Figure 4.27: Distribution of challenges in 2014 for both Product development and IT service category.

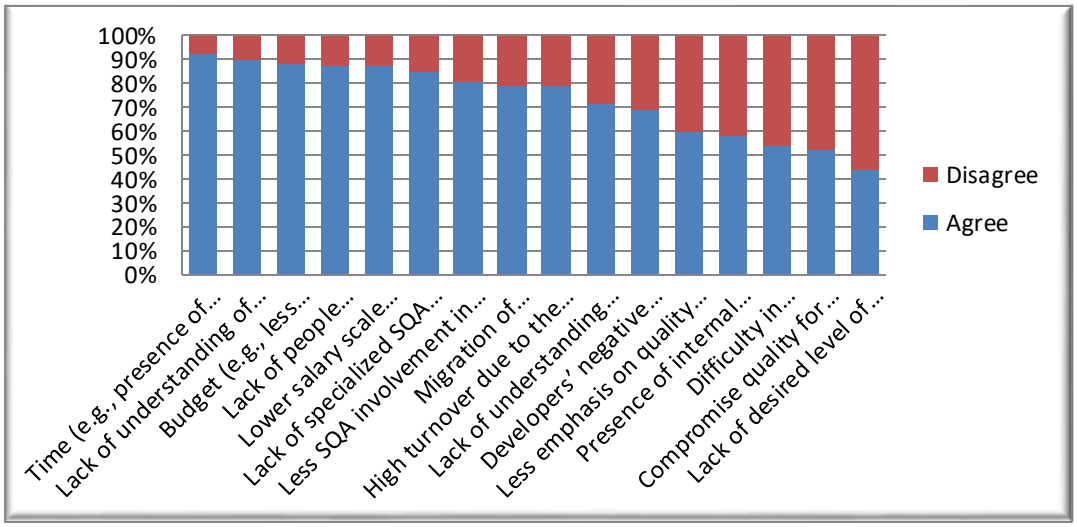

Figure 4.28: Distribution of challenges in 2015 for both Product development and IT service category.

Table 4.21: Ranking of challenges for product development and IT services category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	6	3
Lack of specialized SQA people	3	6
Less emphasis on quality standards	11	12
Compromise quality for certain customers	12	15
Developers' negative perception on SQA contribution	14	11
Less SQA involvement in the requirement gathering phase	4	7
Presence of internal politics	15	13
Migration of experienced SQA people	9	8
Lack of people management skills	8	4
Difficulty in simultaneously serving multiple projects	13	14
High turnover due to the industry competition	2	9
Lack of understanding about SQA oriented benefits for projects and organization	10	10
Lack of desired level of expertise	16	16
Lower salary scale compared to other IT professions	5	5
Lack of understanding of the QA benefits from the higher management	7	2

When analyse both the Table 4.26, 4.27 and 4.28, the top ten challenges remains the same and only the order go changed. Hence, this study has proven all the company type categories agreed to the identified top ten challenges.

4.1.2.5 Analysis Based on Target Market

When analyse the *Overseas Market Only* distribution in 2014 and 2015, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for overseas market only distribution. Figure 4.29 and 4.30 showing the distribution of challenges for product development and IT services category in 2014 and 2015 respectively. Table 4.29 depicts the stack rankings for the overseas market only category in 2014 and 2015.

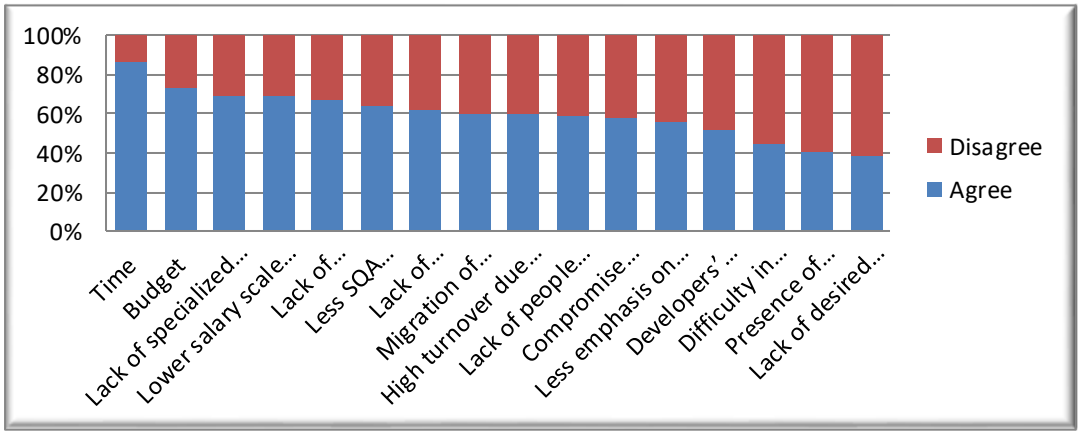

Figure 4.29: Distribution of challenges in 2014 for Overseas only category.

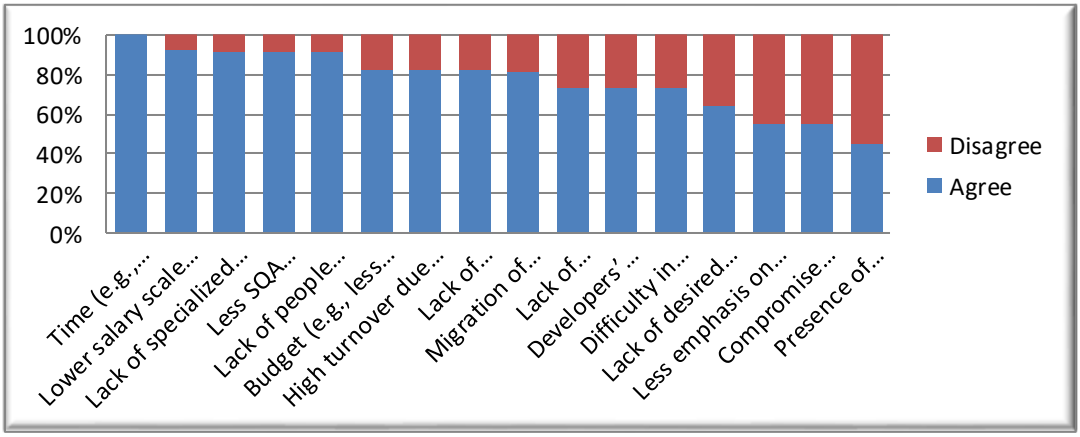

Figure 4.30: Distribution of challenges in 2015 for Overseas only category.

Table 4.22: Ranking of challenges for Overseas Only category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	2	6
Lack of specialized SQA people	3	3
Less emphasis on quality standards	12	14

Compromise quality for certain customers	11	15
Developers' negative perception on SQA contribution	13	11
Less SQA involvement in the requirement gathering phase	6	4
Presence of internal politics	15	16
Migration of experienced SQA people	8	9
Lack of people management skills	10	5
Difficulty in simultaneously serving multiple projects	14	12
High turnover due to the industry competition	9	7
Lack of understanding about SQA oriented benefits for projects and organization	7	10
Lack of desired level of expertise	16	13
Lower salary scale compared to other IT professions	4	2
Lack of understanding of the QA benefits from the higher management	5	8

When analyse the *Local Market Only* distribution in 2014 and 2015, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for local market only distribution. Figure 4.31 and 4.32 showing the distribution of challenges for local market only category in 2014 and 2015 respectively. Table 4.30 depicts the stack rankings for the local market only category in 2014 and 2015.

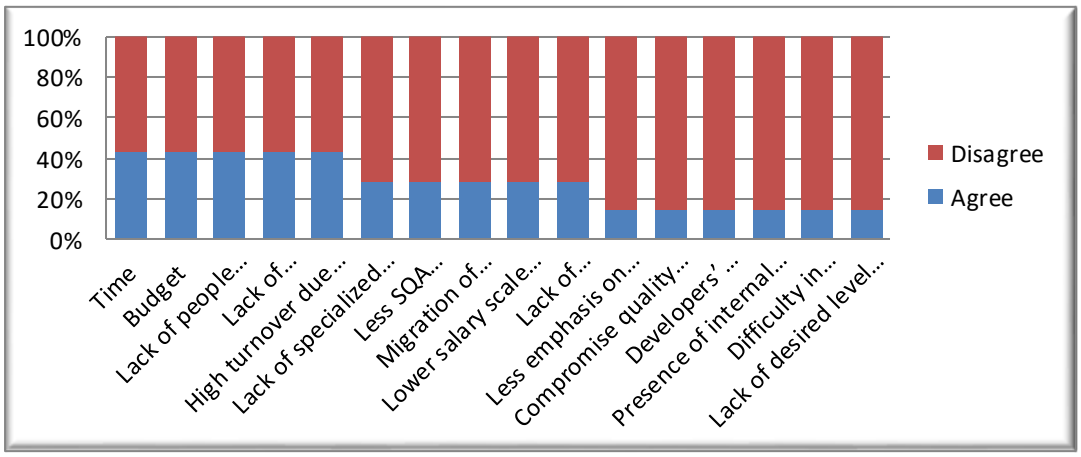

Figure 4.31: Distribution of challenges in 2014 for Local only category.

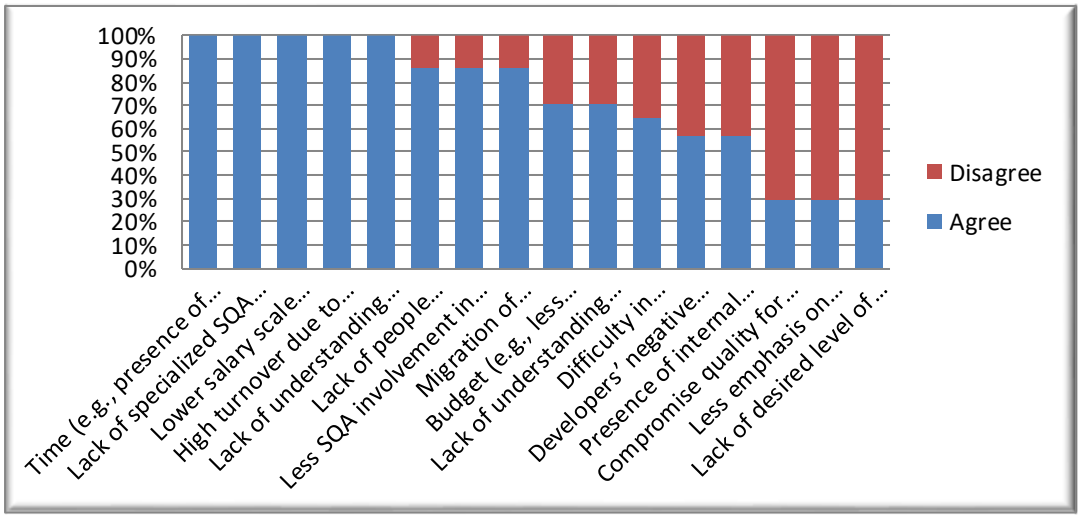

Figure 4.32: Distribution of challenges in 2015 for Local only category.

Table 4.23: Ranking of challenges in 2014 and 2015 for Local only category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	2	9
Lack of specialized SQA people	6	2
Less emphasis on quality standards	11	15
Compromise quality for certain customers	12	14
Developers' negative perception on SQA contribution	13	12
Less SQA involvement in the requirement gathering phase	7	7
Presence of internal politics	14	13
Migration of experienced SQA people	8	8
Lack of people management skills	3	6
Difficulty in simultaneously serving multiple projects	15	11
High turnover due to the industry competition	5	4
Lack of understanding about SQA oriented benefits for projects and organization	4	10
Lack of desired level of expertise	16	16
Lower salary scale compared to other IT professions	9	3
Lack of understanding of the QA benefits from the higher management	10	5

When analyse the *Overseas and Local market* distribution in 2014 and 2015, top ten challenges are similar to the general distribution identified for the year 2014 and 2015. Even the positions and agreeableness percentage towards the challenges are different; top ten challenges remained same for both years for overseas and local market distribution. Figure 4.33 and 4.34 showing the distribution of challenges for

overseas and local markets category in 2014 and 2015 respectively. Table 4.31 depicts the stack rankings for the overseas and local market category in 2014 and 2015.

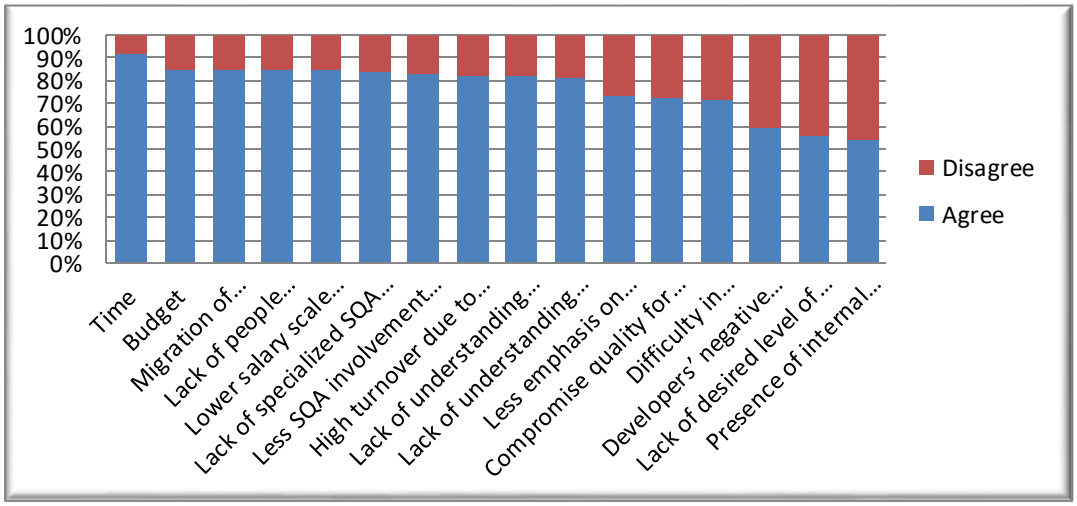

Figure 4.33: Distribution of challenges in 2014 for both Overseas and Local category.

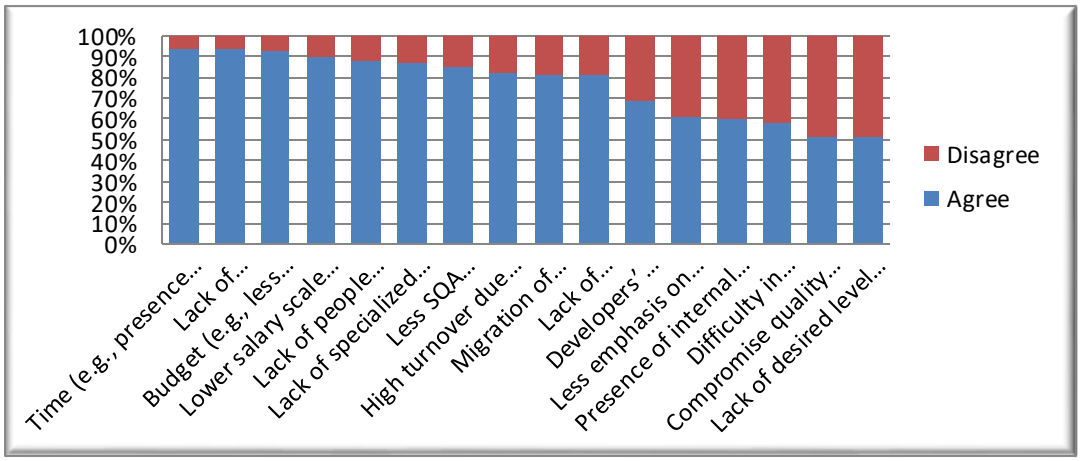

Figure 4.34: Distribution of challenges in 2015 for both Overseas and Local category.

Table 4.24: Ranking of challenges in 2014 and 2015 for Overseas and Local category.

Challenge Description	2014 Rank	2015 Rank
Time	1	1
Budget	2	3
Lack of specialized SQA people	6	6
Less emphasis on quality standards	11	12
Compromise quality for certain customers	12	15
Developers' negative perception on SQA contribution	14	11
Less SQA involvement in the requirement gathering phase	7	7
Presence of internal politics	16	13
Migration of experienced SQA people	3	9
Lack of people management skills	4	5

Difficulty in simultaneously serving multiple projects	13	14
High turnover due to the industry competition	8	8
Lack of understanding about SQA oriented benefits for projects and organization	10	10
Lack of desired level of expertise	15	16
Lower salary scale compared to other IT professions	5	4
Lack of understanding of the QA benefits from the higher management	9	2

When analyse both the Table 4.29, 4.30 and 4.31, the top ten challenges remains the same and only the order go changed. Hence, this study has proven all the target market categories agreed to the identified top ten challenges.

Identifying the top ten challenges faced by the Sri Lankan SQA community and the suggestions to overcome those challenges are important to create the final guidelines. Those guidelines help to improve the SQA community in Sri Lanka. Table 4.32 shows the summary of identified top ten challenges for both the year 2014 and 2015.

Table 4.25: Top ten challenges identified in 2014 and 2015.

#	**Challenges in 2014**	**Challenges in 2015**	**Ranking Difference**
1	Time (e.g., presence of unrealistic project deadlines	Time (e.g., presence of unrealistic project deadlines	0
2	Budget (e.g., less allocation of SQA people, tools, environments, etc.)	Lack of understanding of the QA benefits from the higher management	-5
3	Lower salary scale compared to other IT professions	Budget (e.g., less allocation of SQA people, tools, environments, etc.)	+1
4	Lack of specialized SQA people (e.g., performance, automation, security testers)	Lack of specialized SQA people (e.g., performance, automation, security testers)	0
5	Migration of experienced SQA people	Lower salary scale compared to other IT professions	+2
6	Lack of people management skills (e.g., team, client management)	Less SQA involvement in the requirement gathering phase	-2
7	Lack of understanding of the QA benefits from the higher management	High turnover due to the industry competition	-2
8	Less SQA involvement in the requirement gathering phase	Lack of people management skills (e.g., team, client management)	+2
9	High turnover due to the industry competition	Migration of experienced SQA people	+4

10	Lack of understanding about SQA oriented benefits for projects and organization	Lack of understanding about SQA oriented benefits for projects and organization	0

4.1.2.6 Analysis on identified top ten challenges

"Time" is considered as the most important challenge and it was same for both the years. In 2014, 89% of the respondents agreed that 'Time' is a challenge for the SQA community, while in 2015 it has increased to 95%. Only 6% disagree for the same in 2014 and it has reduced to 0% in 2015. When considering the 'Time' challenge, this is not limiting to the SQA community. Time has become a challenge due to the presence of unrealistic project deadlines. Based on the respondents' thoughts, this is a challenge across the company. Figure 4.35 and 4.36 show the distribution of the agreeableness towards *Time* as a challenge in year 2014 and 2015. The key suggestion made to overcome this challenge was to "Accept only feasible project deadlines and defer non-feasible deadlines." 80% and 88% of the respondents agreed to the suggestion made by the researcher in year 2014 and 2015. Table 4.1 shows the distribution of the agreeableness towards the researcher's suggestion to overcome the challenge. Figure 4.37 and 4.38 show the gender wise distribution of the agreeableness towards 'Time' as a challenge in year 2014 and 2015. Figure 4.39 and 4.40 show the organization level wise distribution of the agreeableness towards 'Time' as a challenge in year 2014 and 2015. Figure 4.41 and 4.42 show the size of the QA department wise distribution of the agreeableness towards 'Time' as a challenge in year 2014 and 2015.

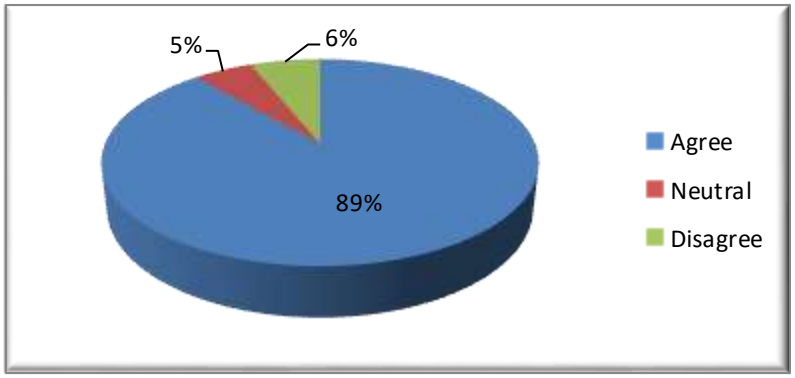

Figure 4.35: Extent to which participants agree "Time" as a challenge for 2014.

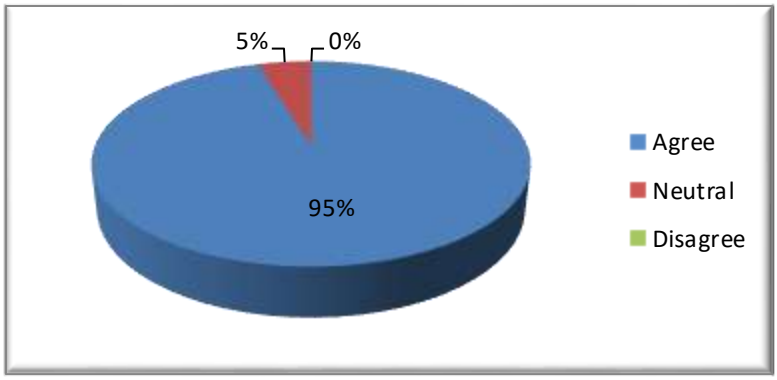

Figure 4.36: Extent to which participants agree "Time" as a challenge for 2015.

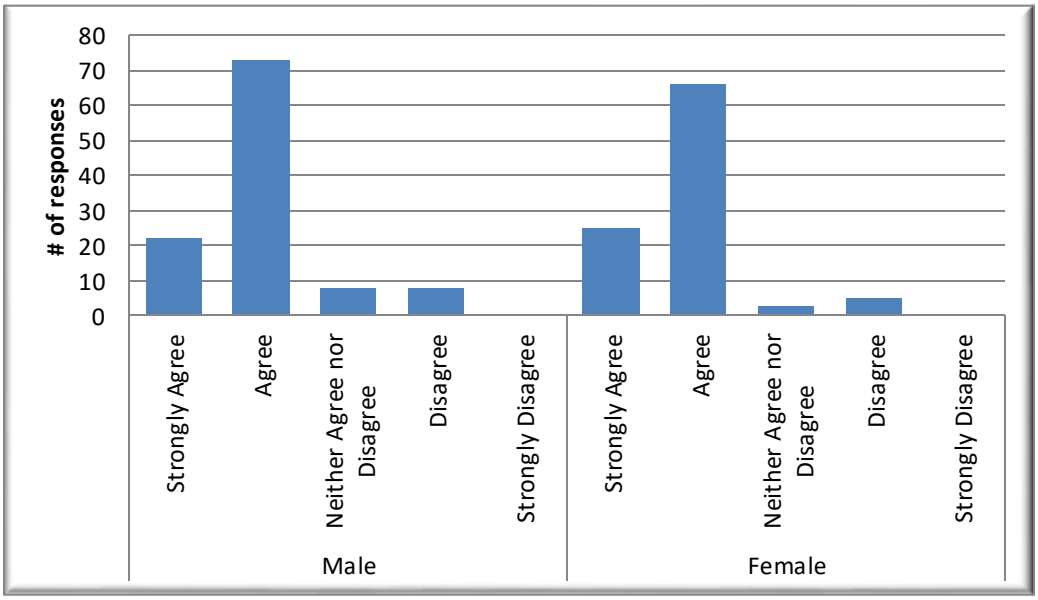

Figure 4.37: Gender-wise analysis on distribution of "Time" in online survey 2014.

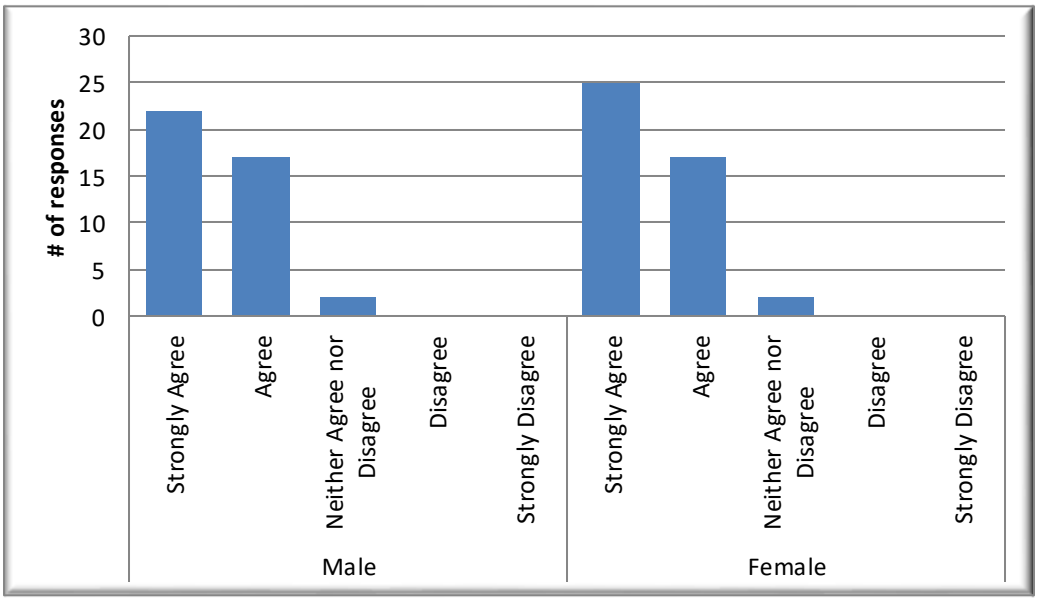

Figure 4.38: Gender wise analysis on distribution of "Time" in online survey 2015.

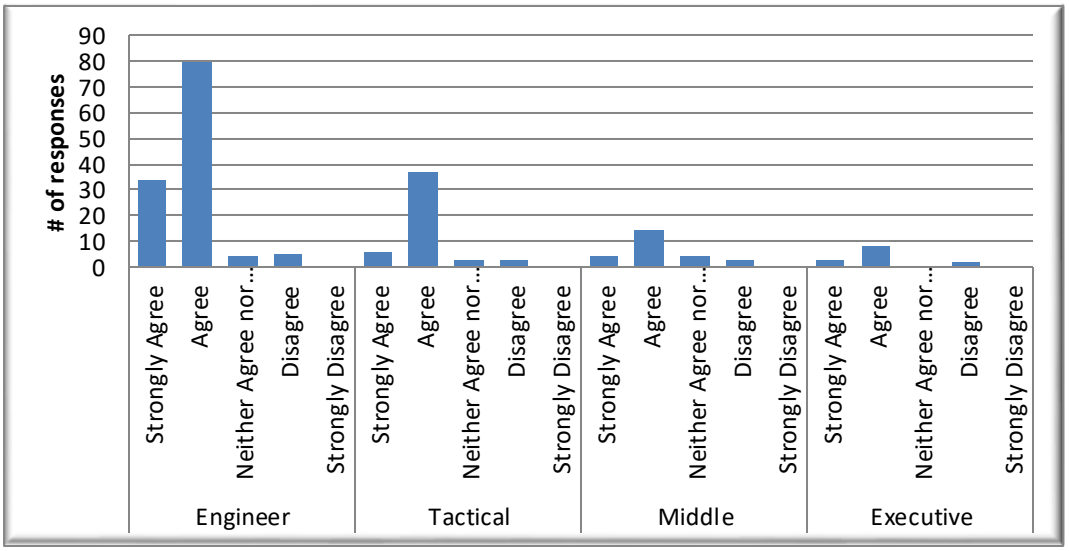

Figure 4.39: Organization level wise analysis on distribution of "Time" in online survey 2014.

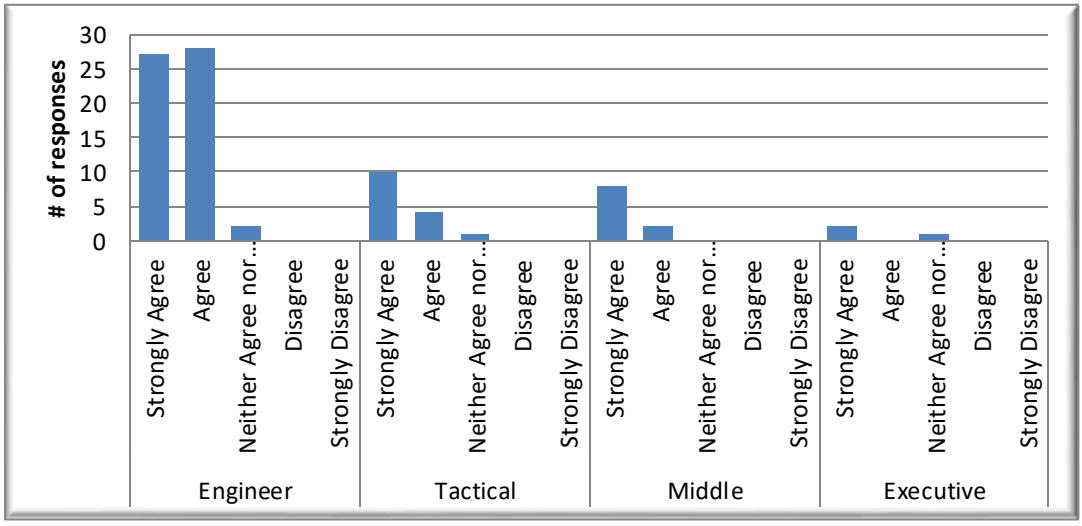

Figure 4.40: Organization level wise analysis on distribution of "Time" in online survey 2015.

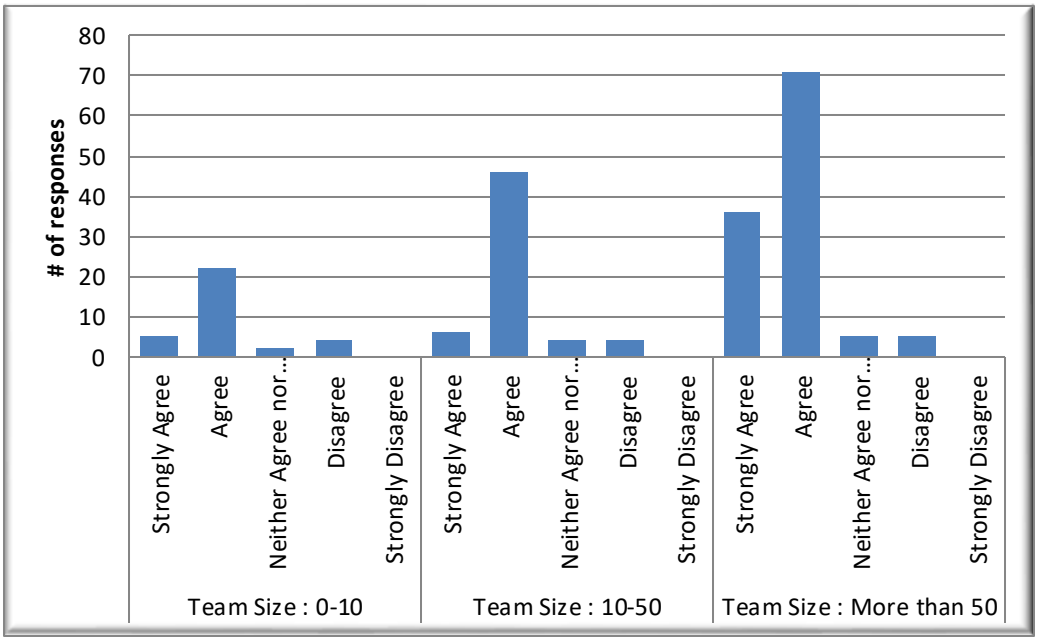

Figure 4.41: Size of the QA Dept wise analysis on distribution of "Time" in online survey 2014.

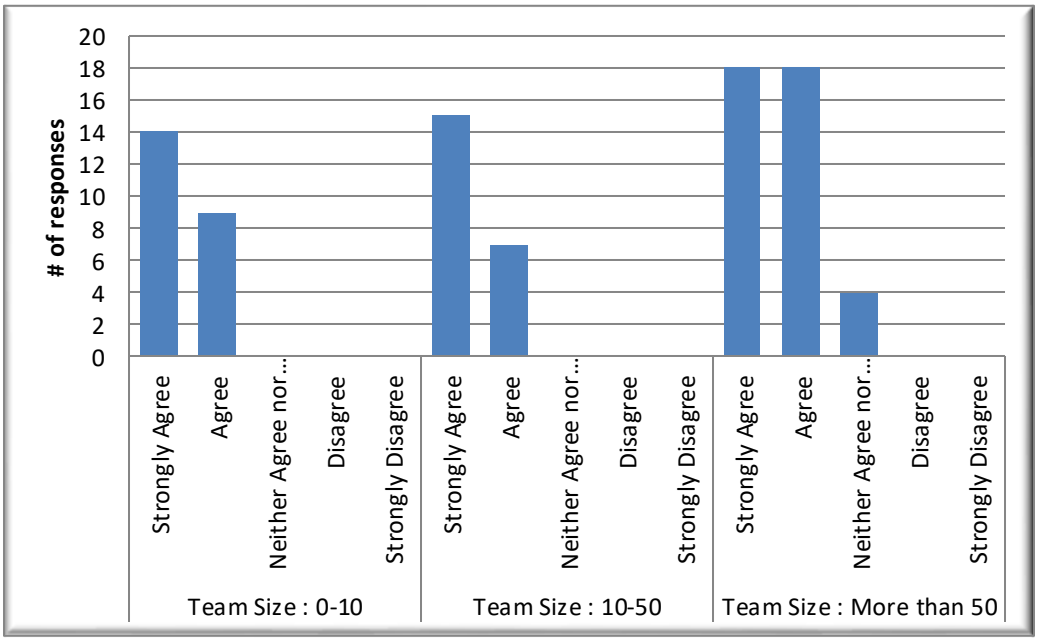

Figure 4.42: Size of the QA Dept wise analysis on distribution of "Time" in online survey 2015.

"Accept only feasible project deadlines and defer non-feasible deadlines." was the researcher's suggestion to over the challenge on 'Time'. Table 4.33 shows the distribution of the agreeableness towards the researcher's suggestion to overcome the challenge.

Table 4.26: Distribution of suggestion made to overcome 'Time' challenge.

	Year 2014			Year 2015		
Solution Description	**Agree**	**Neutral**	**Disagree**	**Agree**	**Neutral**	**Disagree**
Accept only feasible project deadlines and defer non-feasible deadlines.	80%	15%	5%	88%	10%	2%

Challenge on *Budget* having a different standings and distribution across the 2 years analysed. In 2014, 80% of the respondents are agreed that 'Budget' is a challenge for SQA profession and it is standing at second place in top ten positions. Even 89% of the respondents are agreed this challenge, it is standing at the third position in top ten position. The reason behind this challenge is the management tend to invest less budget on SQA related activities. Also, there is a low demand for investing different SQA tools, separate test environments, etc. As per a respondent's comment, most of the testing budget now investing to new development projects based on the higher management's prioritization. But 7% in 2014 and 6% in 2015 respondents think that, Budget is not a challenge for SQA profession. Figure 4.43 and 4.44 show the distribution of the agreeableness towards *Budget* as a challenge in year 2014 and 2015. The suggestion made to overcome this challenge in online survey was 'Provide proper SQA resources regardless of profit margin.' 80% and 92% of the respondents agreed to the suggestion made by the researcher in year 2014 and 2015. Figure 4.45 and 4.46 show the gender wise distribution of the agreeableness towards 'Budget' as a challenge in year 2014 and 2015. Figure 4.47 and 4.48 show the organization level wise distribution of the agreeableness towards 'Budget' as a challenge in year 2014 and 2015. Figure 4.49 and 4.50 show the size of the QA department wise distribution of the agreeableness towards 'Budget' as a challenge in year 2014 and 2015.

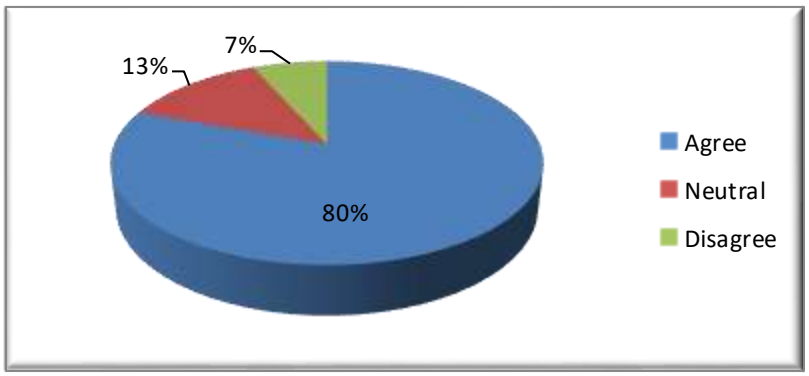

Figure 4.43: Extent to which participants agree "Budget" in online survey 2014.

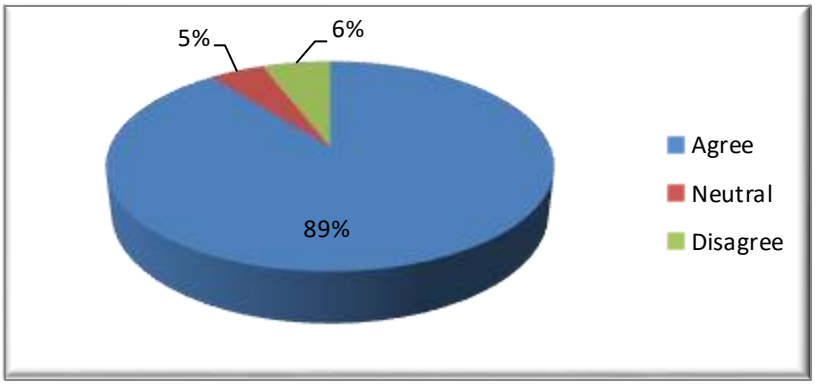

Figure 4.44: Extent to which participants agree "Budget" in online survey 2015.

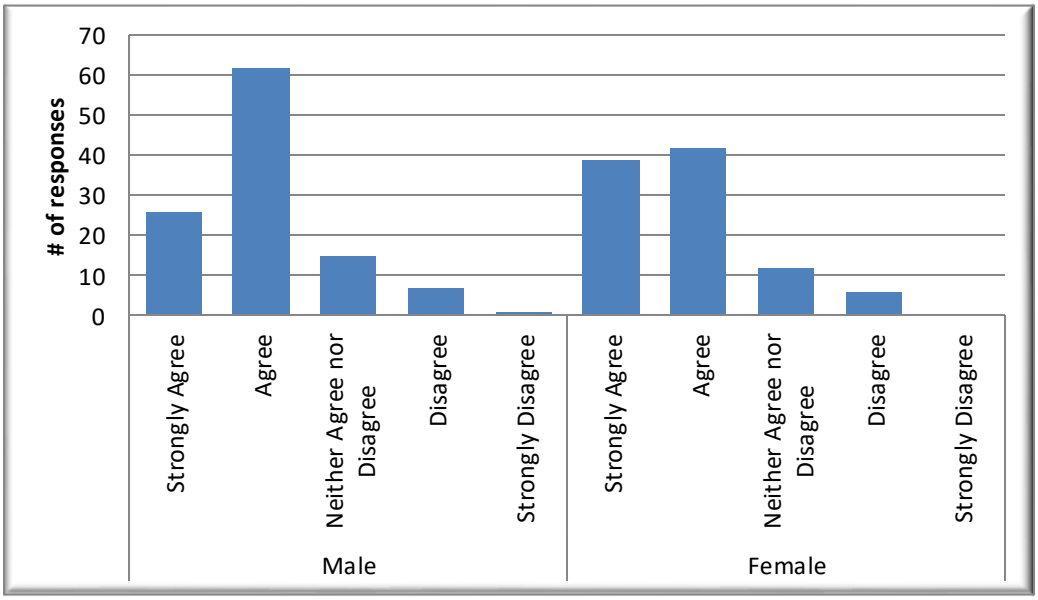

Figure 4.45: Gender wise analysis on distribution of "Budget" in online survey 2014.

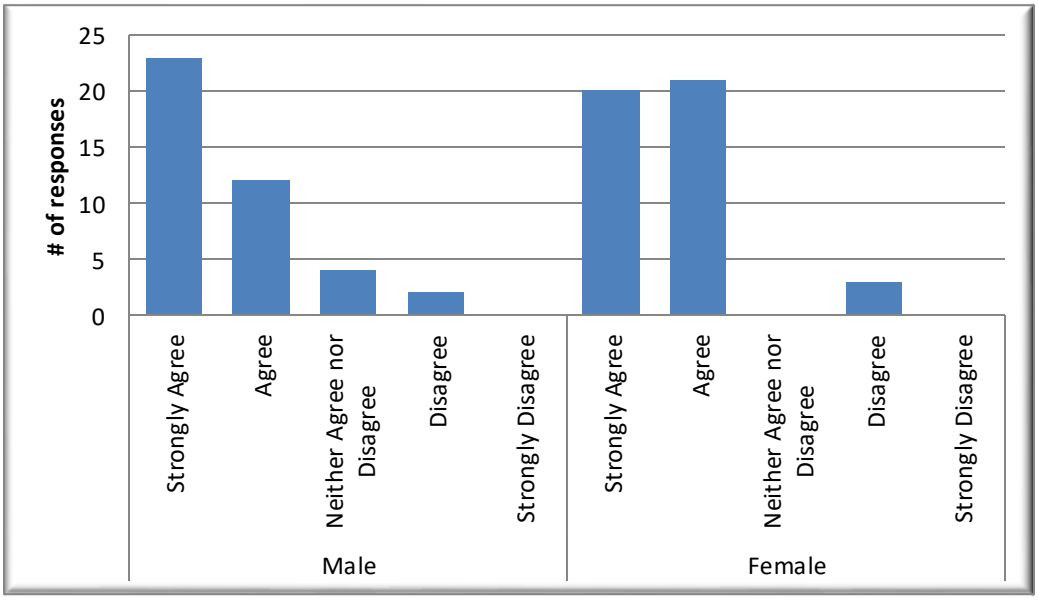

Figure 4.46: Gender wise analysis on distribution of "Budget" in online survey 2015.

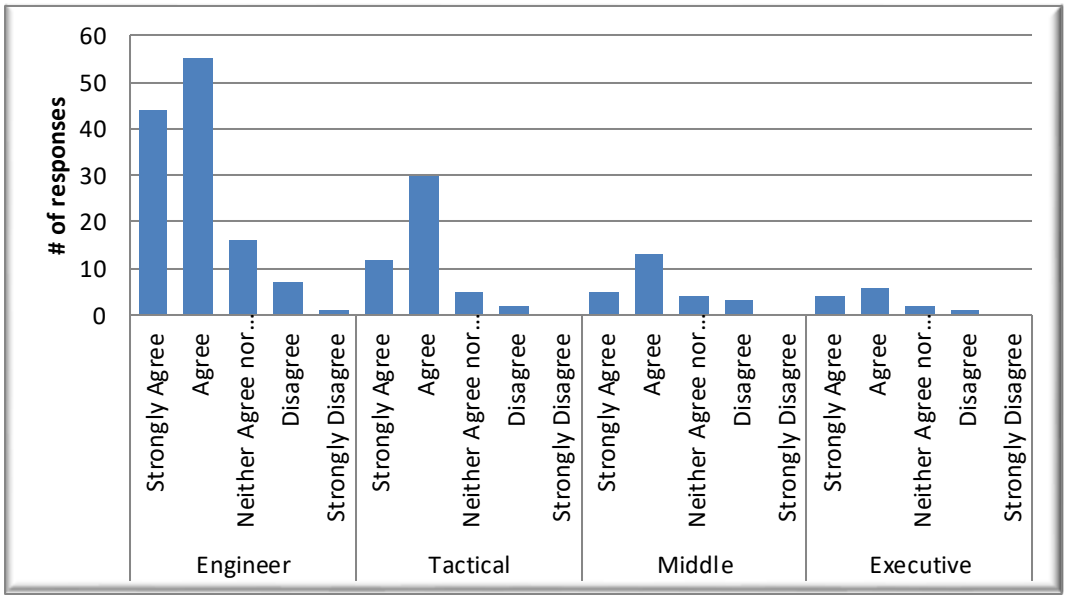

Figure 4.47: Organization level wise analysis on distribution of "Budget" in online survey 2014.

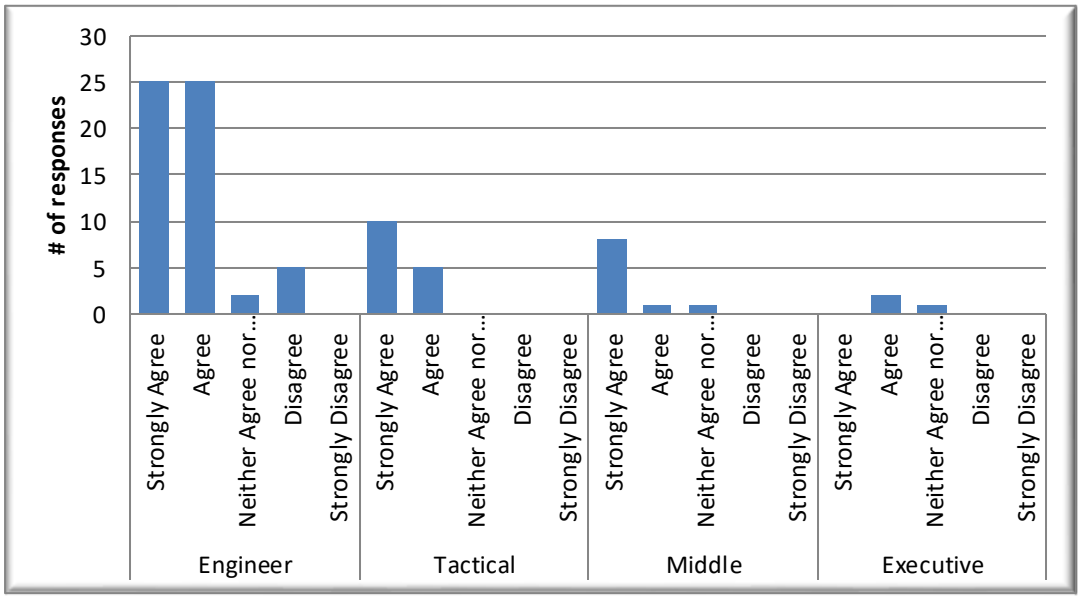

Figure 4.48: Organization level wise analysis on distribution of "Budget" in online survey 2015.

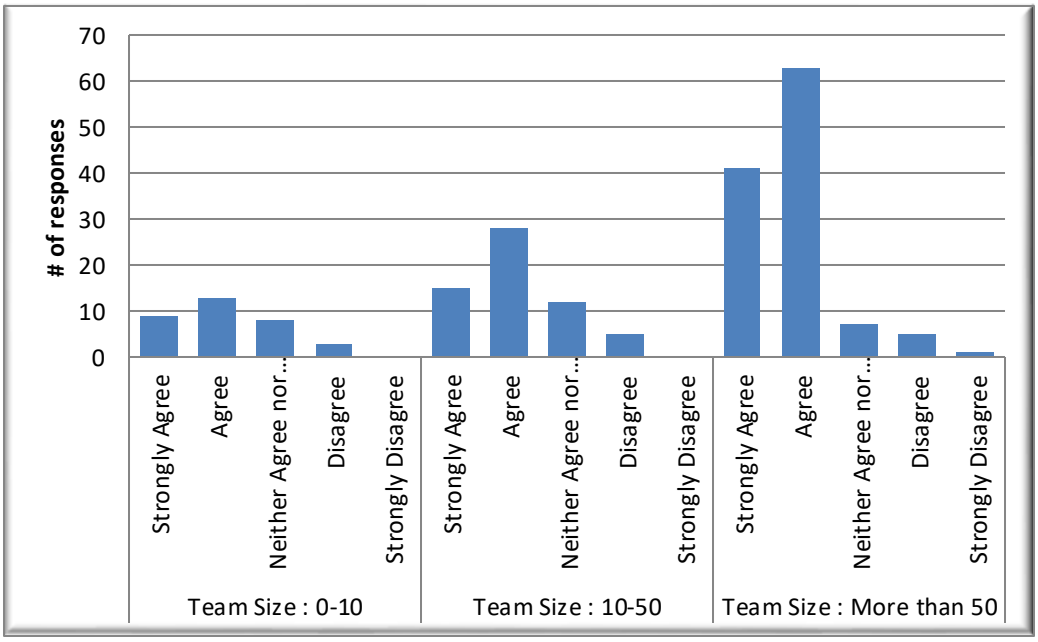

Figure 4.49: Size of the QA Dept wise analysis on distribution of "Budget" in online survey 2014.

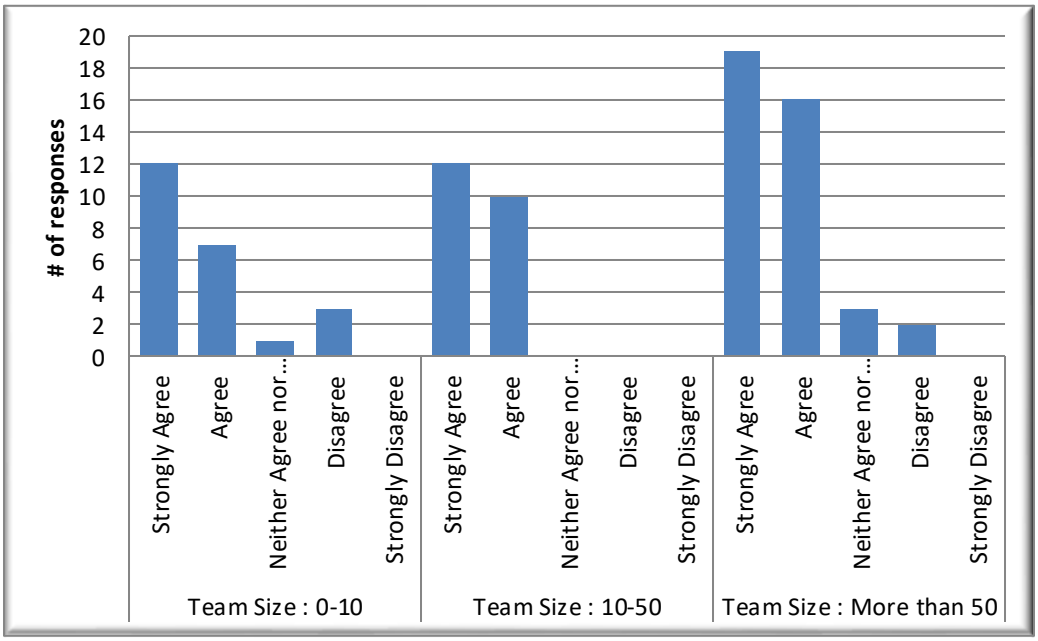

Figure 4.50: Size of the QA Dept wise analysis on distribution of "Budget" in online survey 2015.

'Provide proper SQA resources regardless of profit margin.' was the researcher's suggestion to over the challenge on 'Budget'. Table 4.34 shows the distribution of the agreeableness towards the researcher's suggestion to overcome the challenge.

Table 4.27: Distribution of suggestion made to overcome 'Budget' challenge in online survey 2014 and 2015.

	Year 2014			Year 2015		
Solution Description	**Agree**	**Neutral**	**Disagree**	**Agree**	**Neutral**	**Disagree**
Provide proper SQA resources regardless of profit margin.	80%	15%	5%	92%	6%	2%

In 2014, challenge on *Lower salary scale compared to other IT professions* was standing third place while having 79% of agreed responses. But in 2015, it has dropped to fifth position with the 88% agreed responses. Even the percentage of the agreeableness is high in year 2015 it is standing in a lower position. Somehow, this is a debatable point when discuss with the different level of SQA professionals and managers. But 7% in 2014 and 4% in 2015 respondents think that, Low Salary Scale is not a challenge for SQA profession. Figure 4.51 and 4.52 show the distribution of the agreeableness towards *Lower Salary Scale* as a challenge in year 2014 and 2015. 84% and 88% of the respondents agreed to the suggestion made by the researcher in year 2014 and 2015. Figure 4.53 and 4.54 show the gender wise distribution of the agreeableness towards *Lower Salary Scale* as a challenge in year 2014 and 2015. Figure 4.55 and 4.56 show the organization level wise distribution of the agreeableness towards *Lower Salary Scale* as a challenge in year 2014 and 2015. Figure 4.57 and 4.58 show the size of the QA department wise distribution of the agreeableness towards *Lower Salary Scale* as a challenge in year 2014 and 2015.

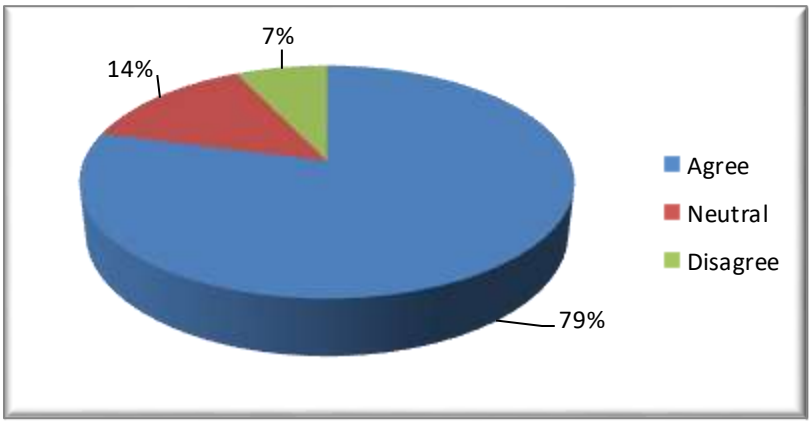

Figure 4.51: Extent to which participants agree "Low Salary Scale" in online survey 2014

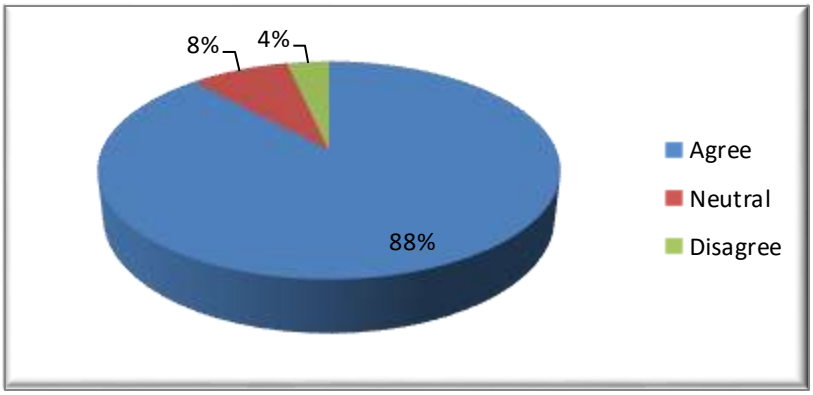

Figure 4.52: Extent to which participants agree "Low Salary Scale" in online survey 2015.

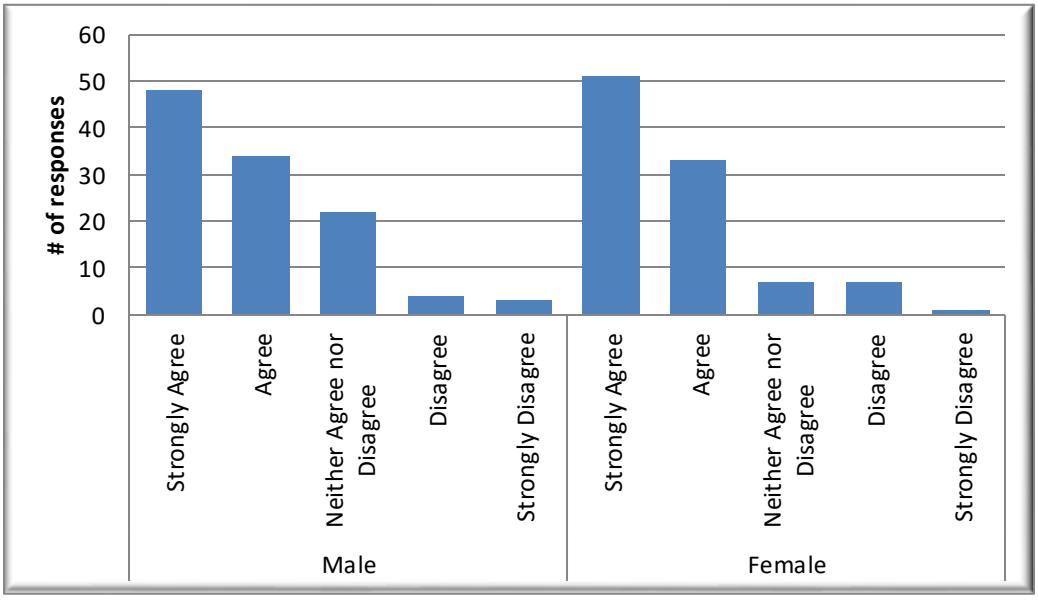

Figure 4.53: Gender wise analysis on distribution of "Lower Salary Scale" in online survey 2014.

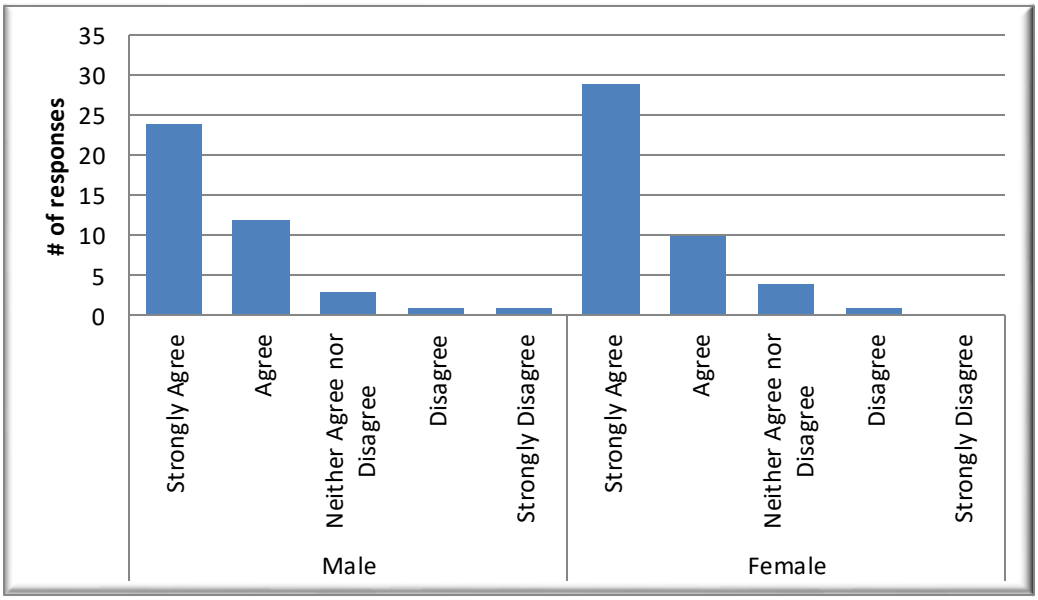

Figure 4.54: Gender wise analysis on distribution of "Lower Salary Scale" in online survey 2015.

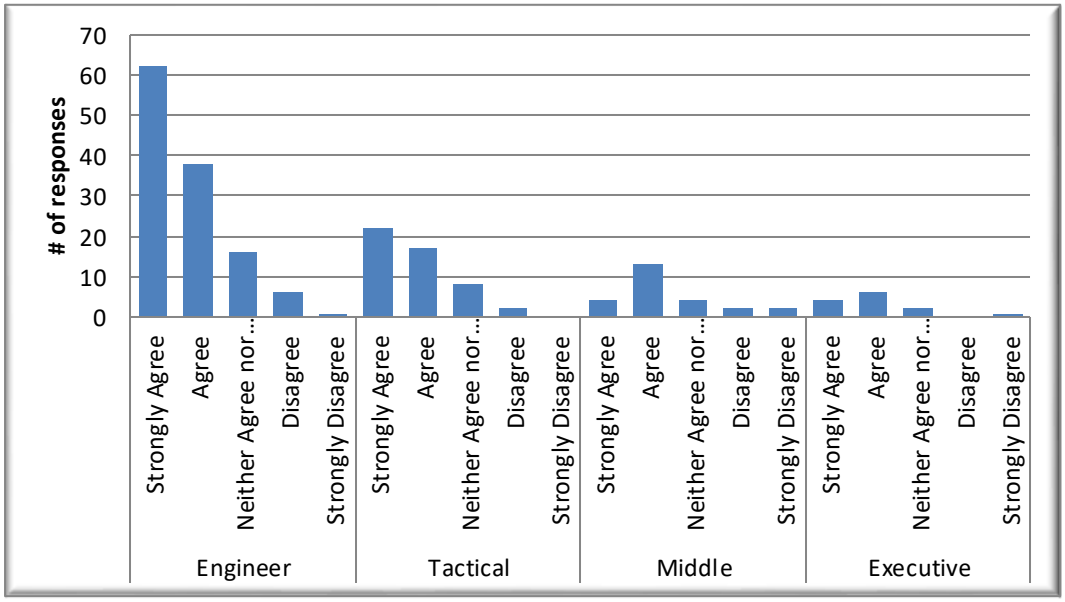

Figure 4.55: Organization level wise analysis on distribution of "Lower Salary Scale" in online survey 2014.

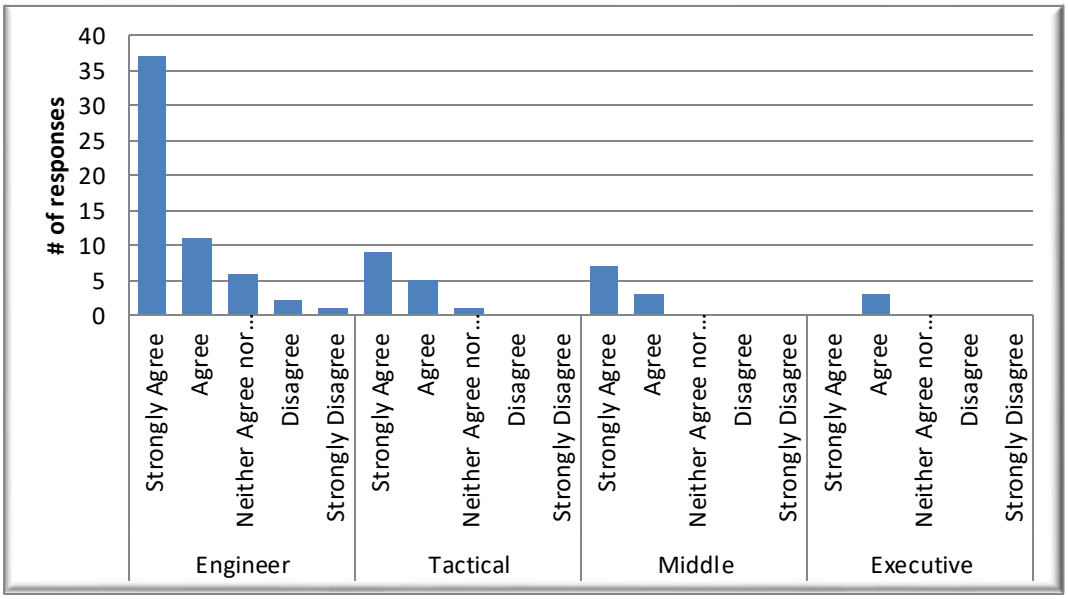

Figure 4.56: Organization level wise analysis on distribution of "Lower Salary Scale" in online survey 2015.

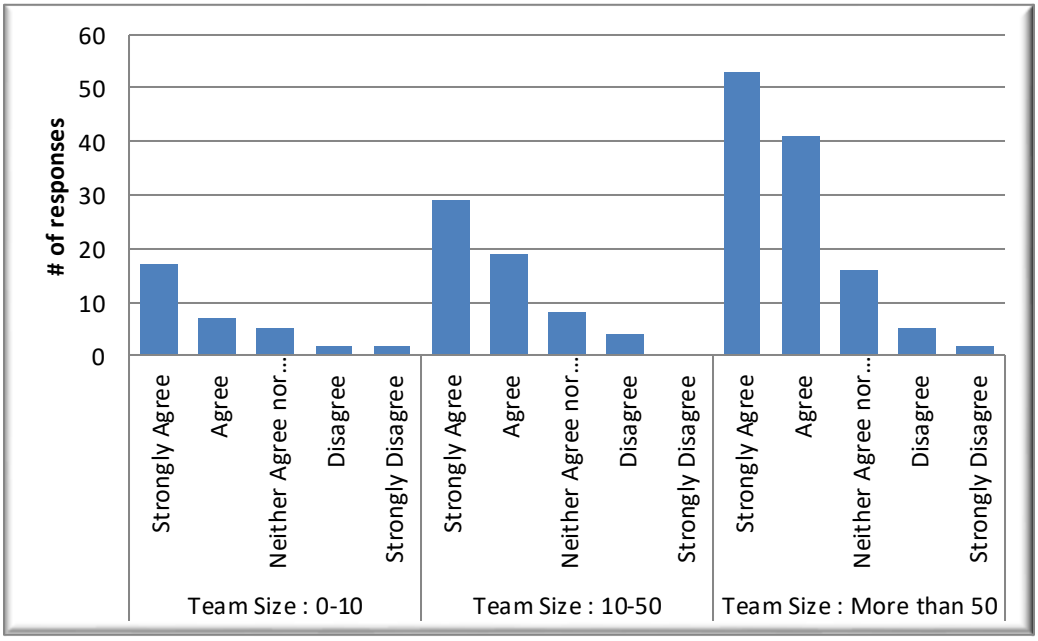

Figure 4.57: Size of the QA Dept wise analysis on distribution of "Lower Salary Scale" in online survey 2014.

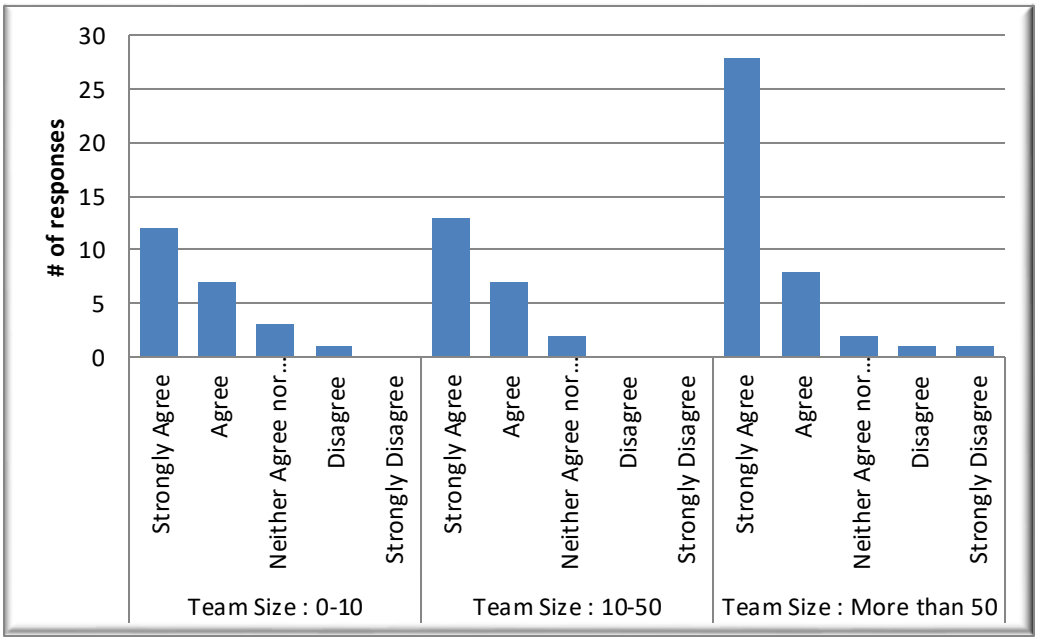

Figure 4.58: Size of the QA Dept wise analysis on distribution of "Lower Salary Scale" in online survey 2015.

The suggestion made to overcome this challenge in online survey was 'Recruit SQA people who have the necessary level of expertise.' Table 4.35 shows the distribution of the agreeableness towards the researcher's suggestion to overcome the challenge.

Table 4.28: Distribution of suggestion made to overcome 'Low Salary Scale' challenge in online survey 2014 and 2015.

	Year 2014			**Year 2015**		
Solution Description	**Agree**	**Neutral**	**Disagree**	**Agree**	**Neutral**	**Disagree**
Recruit SQA people who have the necessary level of expertise.	84%	11%	5%	88%	12%	0%

Lack of Specialized SQA is standing at the forth rank in 2014 and 2015 on the top ten challenges faced by the SQA professionals. As per the respondent's comments, there is a low resource availability for the specialized QA activities. In present, customers are more focused on non- functional activities than functional activities. Due to this matter, QA department should contains performance, security, automation specialized team members. But still the Sri Lankan SQA community not having required number of resources to cater the above requirement. Hence, 78% of respondents have selected 'Agreed' in 2014 and 88% in 2015. Still, 8% in 2014 and 5% in 2015 respondents

think that, lack of specialized SQA is not a challenge for SQA profession. Figure 4.59 and 4.60 shows the distribution of the agreeableness towards *lack of specialized SQA* as a challenge in year 2014 and 2015.Figure 4.61 and 4.62 show the gender wise distribution of the agreeableness towards *Lack of Specialized SQA* as a challenge in year 2014 and 2015. Figure 4.63 and 4.64 show the organization level wise distribution of the agreeableness towards *Lack of Specialized SQA* as a challenge in year 2014 and 2015. Figure 4.65 and 4.66 show the size of the QA department wise distribution of the agreeableness towards *Lack of Specialized SQA* as a challenge in year 2014 and 2015.

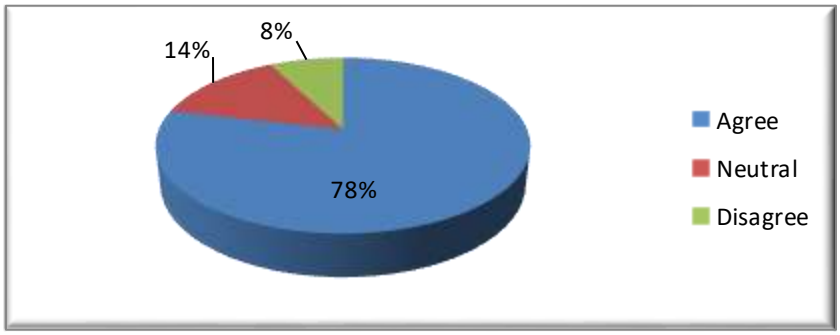

Figure 4.59: Extent to which participants agree "Lack of specialized SQA" in online survey 2014.

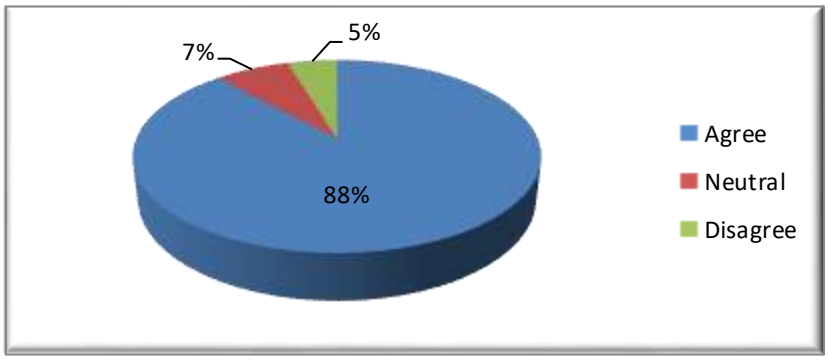

Figure 4.60: Extent to which participants agree "Lack of specialized SQA" in online survey 2015.

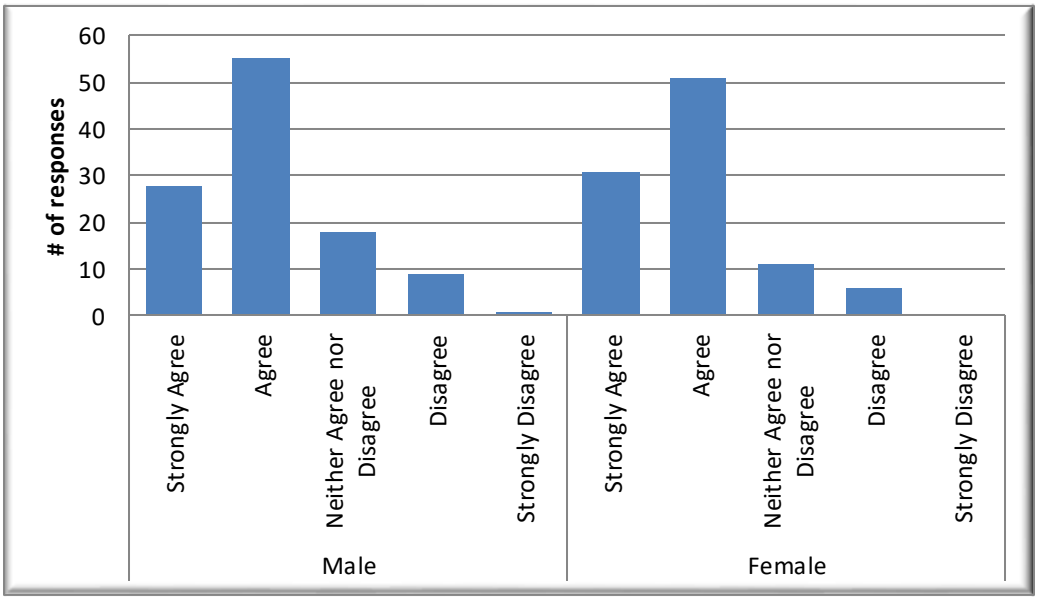

Figure 4.61: Gender wise analysis on distribution of "Lack of Specialized SQA" in online survey 2014.

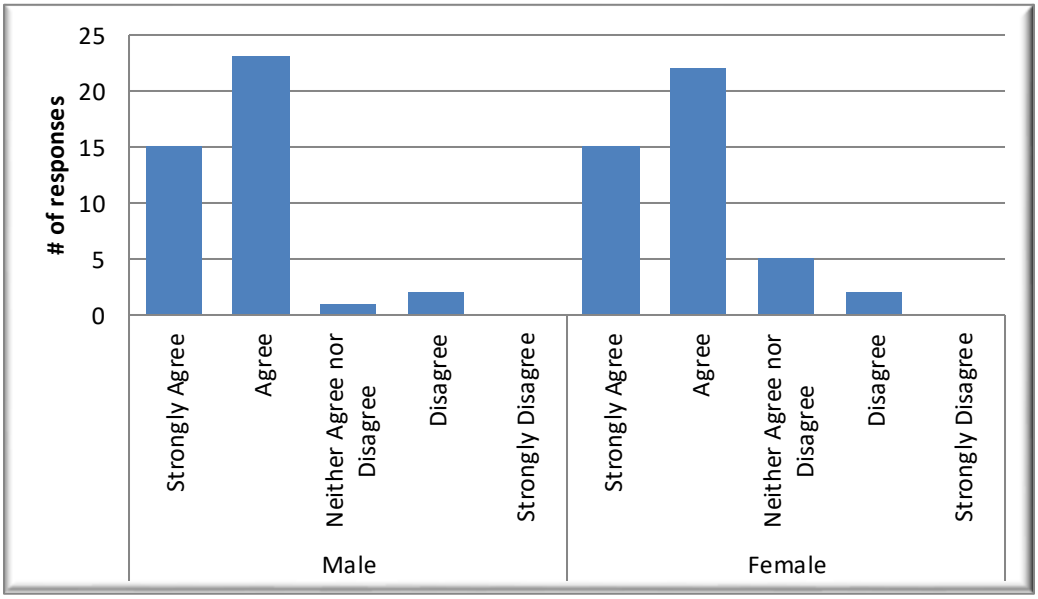

Figure 4.62: Gender wise analysis on distribution of "Lack of Specialized SQA" in online survey 2015.

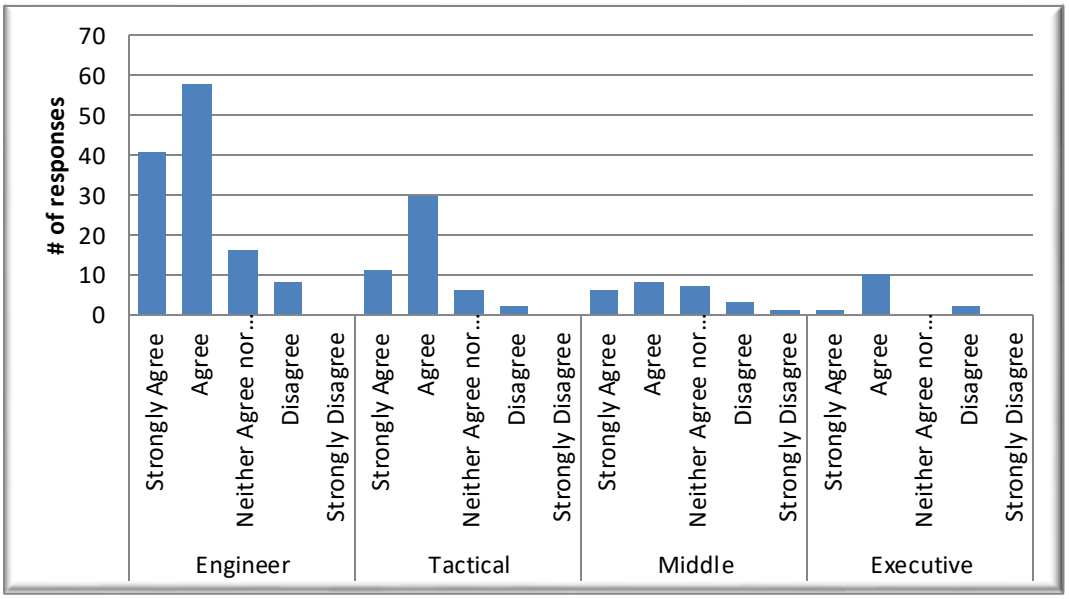

Figure 4.63: Organization level wise analysis on distribution of "Lack of Specialized SQA" in online survey 2014.

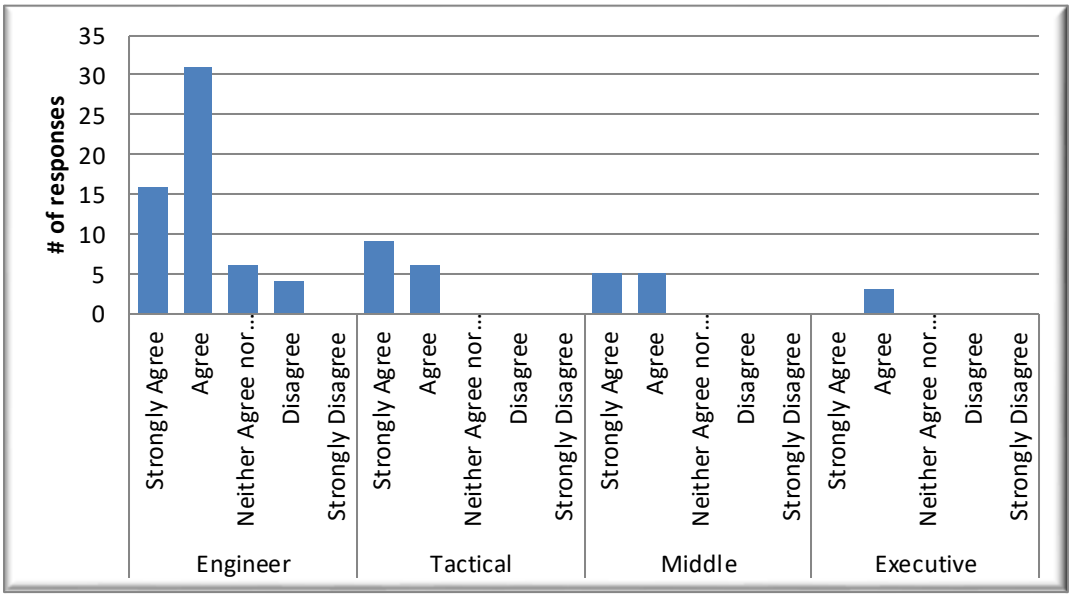

Figure 4.64: Organization level wise analysis on distribution of "Lack of Specialized SQA" in online survey 2015.

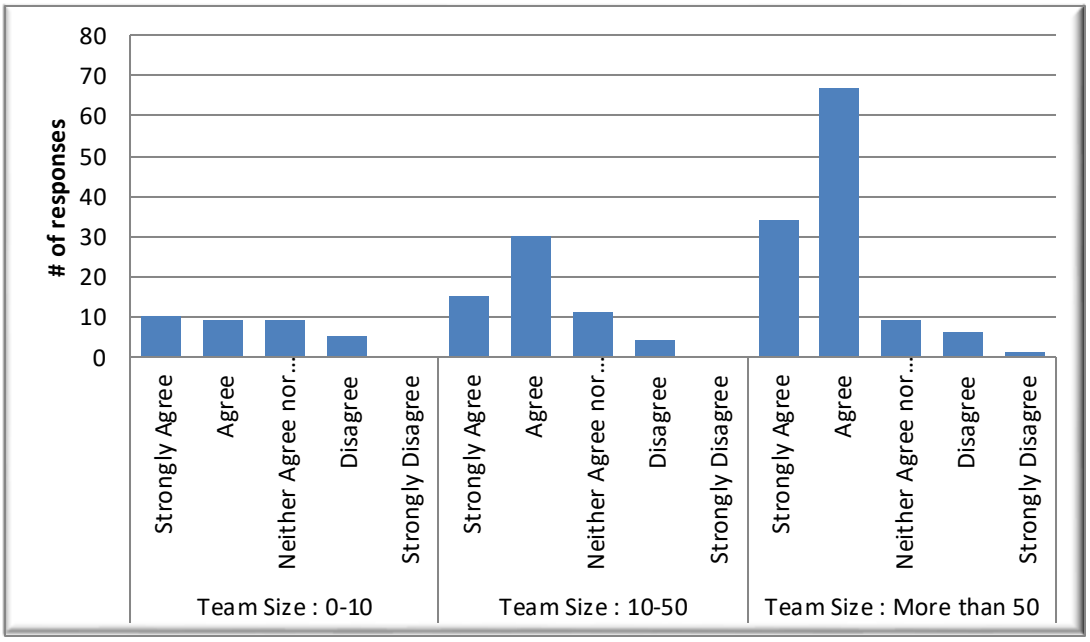

Figure 4.65: Size of the QA Dept wise analysis on distribution of "Lack of Specialized SQA" in online survey 2014.

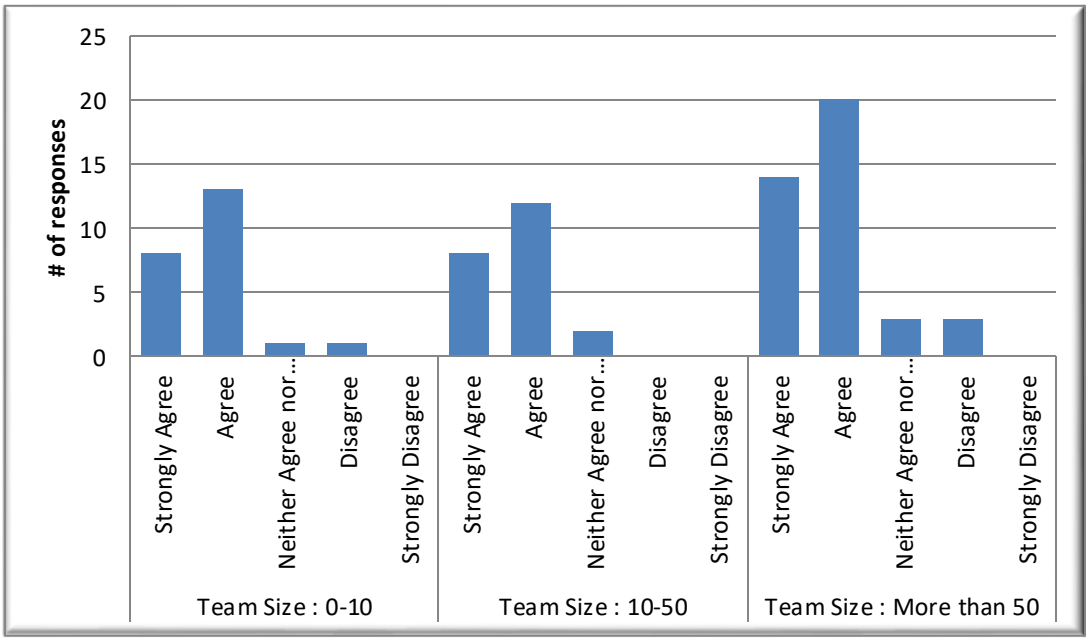

Figure 4.66: Size of the QA Dept wise analysis on distribution of "Lack of Specialized SQA" in online survey 2015.

The suggestion made to overcome this challenge in online survey was 'Develop specialized SQA professionals by providing necessary technical training.' 98% and 99% of the respondents agreed to the suggestion made by the researcher in year 2014

and 2015. Table 4.36 shows the distribution of the agreeableness towards the researcher's suggestion to overcome the challenge.

Table 4.29: Distribution of suggestion made to overcome 'Lack of Specialized SQA' challenge in online survey 2014 and 2015.

	Year 2014			Year 2015		
Solution Description	**Agree**	**Neutral**	**Disagree**	**Agree**	**Neutral**	**Disagree**
Develop specialized SQA professionals by providing necessary technical training.	98%	2%	0%	99%	1%	0%

Migration of experienced SQA is standing at the fifth rank in 2014 and ninth rank in 2015 on the top ten challenges faced by the SQA professionals. Now a days it has become a trend to migrate to another country by branding the individual's skills. Also, there is a high number of job opportunities for experience SQA people in countries like Australia, New Zealand, Canada, UK and USA. Due to this high demand, SL SQA management facing a great difficulty to retain SQA professionals as well as other professionals in Sri Lanka. Hence, 77% of respondents have selected 'Agreed' in 2014 and 79% in 2015. Still, 4% in 2014 and 3% in 2015 respondents think that, migration of experienced SQA professionals is not a challenge for SQA profession. Figure 4.67 and 4.68 show the distribution of the agreeableness towards 'lack of specialized SQA' as a challenge in year 2014 and 2015.Figure 4.69 and 4.70 show the gender wise distribution of the agreeableness towards 'Migration of experienced SQA' as a challenge in year 2014 and 2015. Figure 4.71 and 4.72 show the organization level wise distribution of the agreeableness towards 'Migration of experienced SQA' as a challenge in year 2014 and 2015. Figure 4.73 and 4.74 show the size of the QA department wise distribution of the agreeableness towards 'Migration of experienced SQA' as a challenge in year 2014 and 2015.

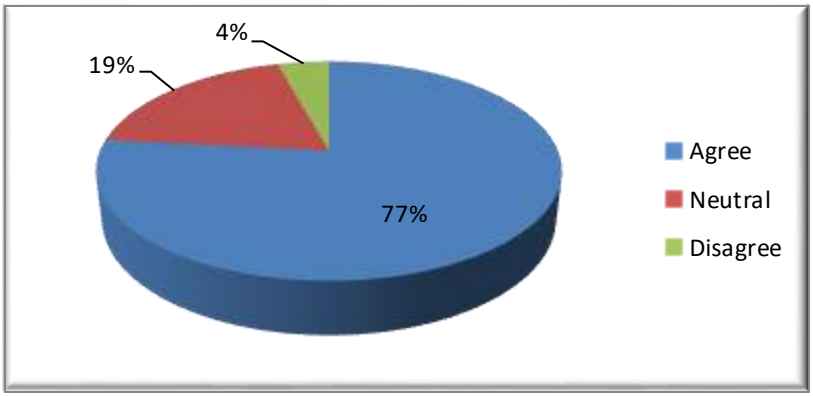

Figure 4.67: Extent to which participants agree "Migration of experienced SQA" in 2014.

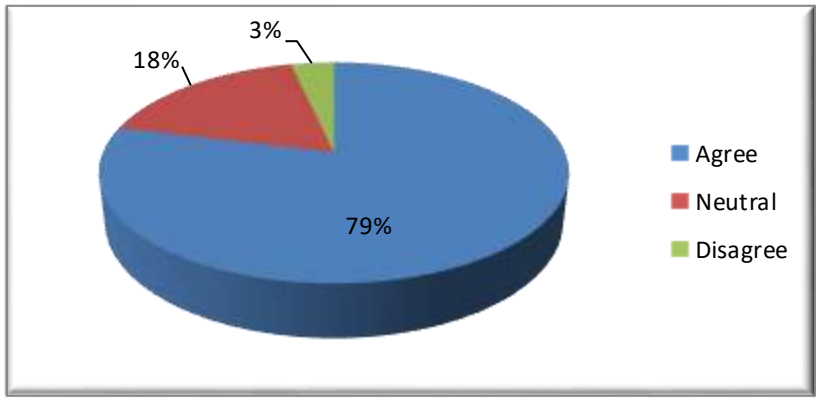

Figure 4.68: Extent to which participants agree "Migration of experienced SQA" in 2015.

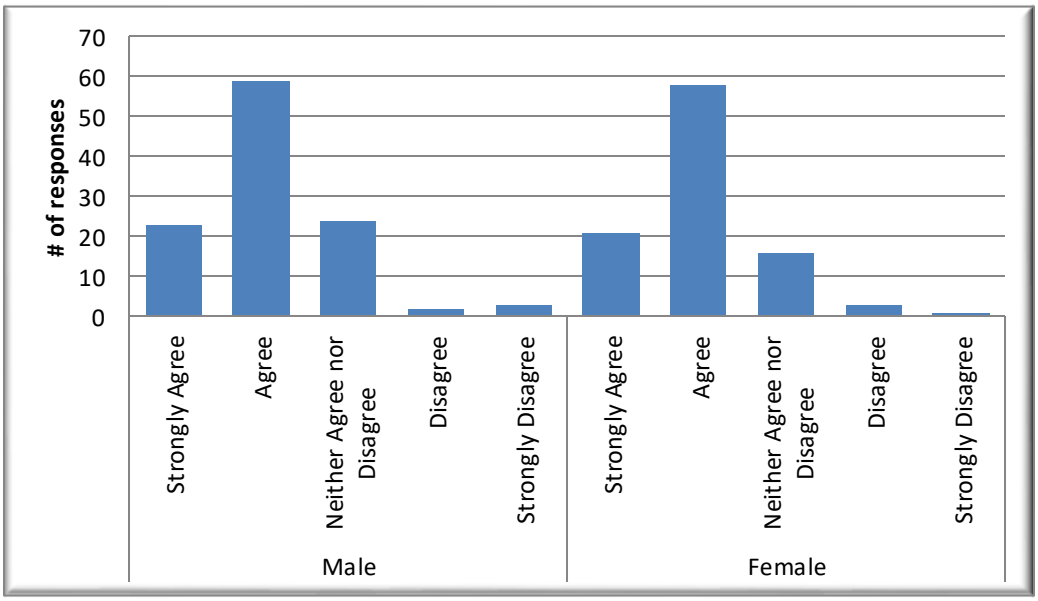

Figure 4.69: Gender wise analysis on distribution of "Migration of experienced SQA" in online survey 2014.

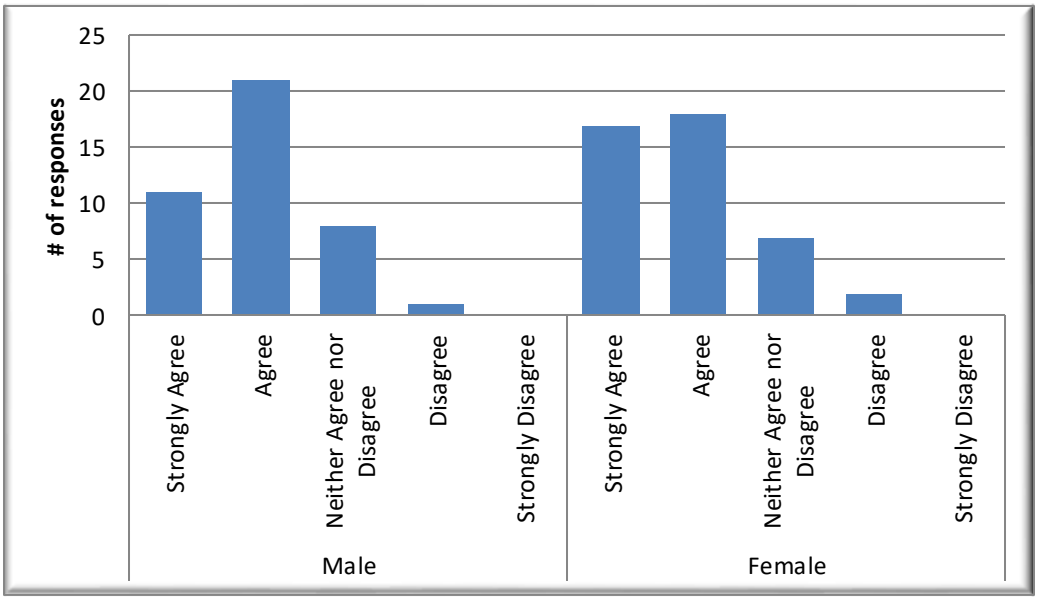

Figure 4.70: Gender-wise analysis on distribution of "Migration of experienced SQA" in 2015.

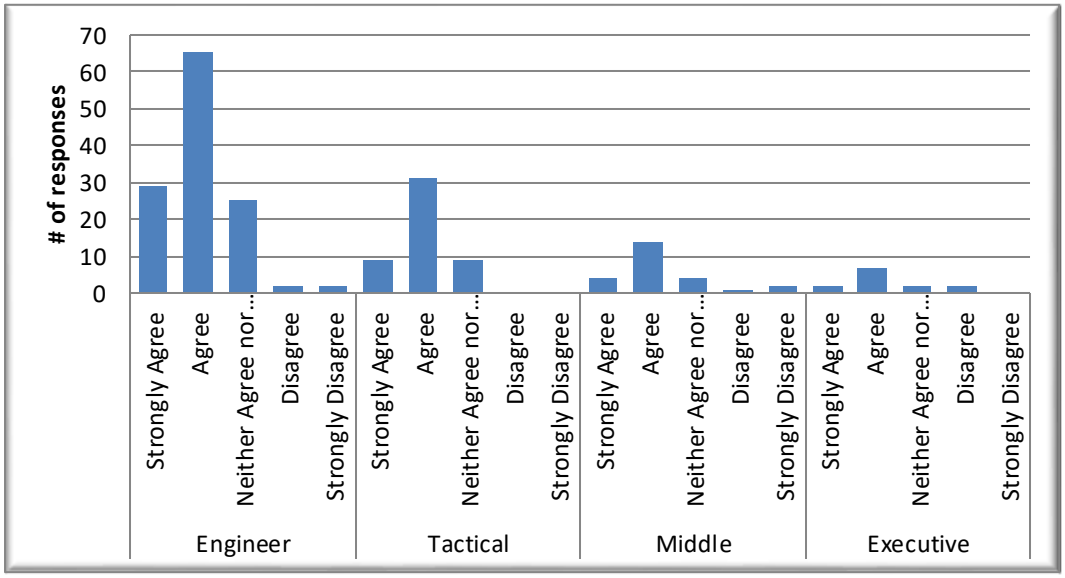

Figure 4.71: Organization-level wise analysis on distribution of "Migration of experienced SQA" in 2014.

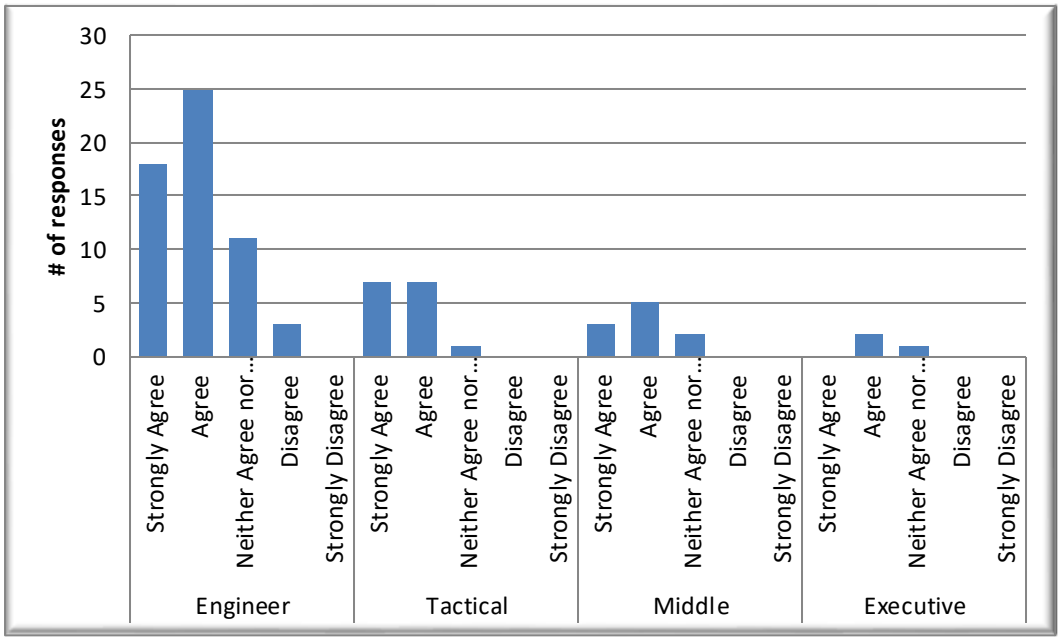

Figure 4.72: Organization level wise analysis on distribution of "Migration of experienced SQA" in online survey 2015.

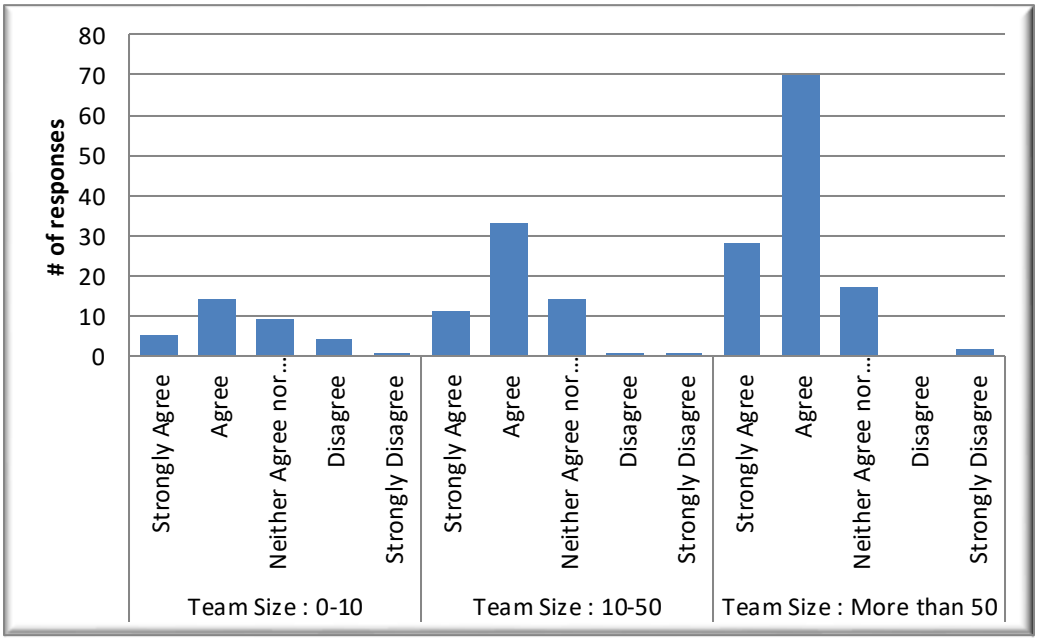

Figure 4.73: QA department wise analysis on distribution of "Migration of experienced SQA" in online survey 2014.

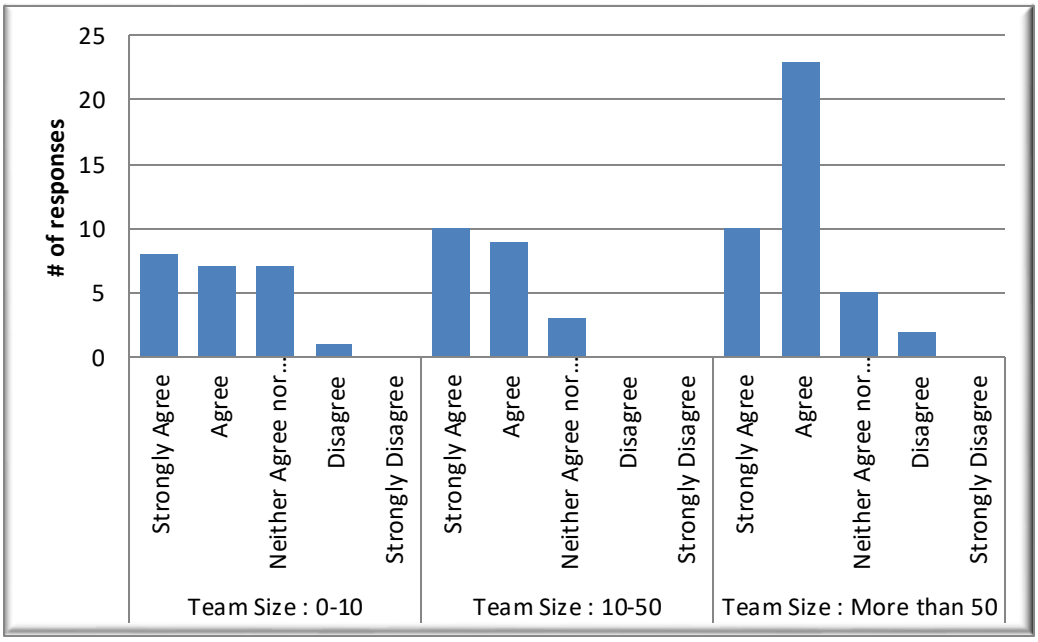

Figure 4.74: Size of the QA Dept wise analysis on distribution of "Migration of experienced SQA" in online survey 2015.

The suggestion made to overcome this challenge in online survey was 'Increased standard of living for the skilled SQA resources.' 91% and 95% of the respondents agreed to the suggestion made by the researcher in year 2014 and 2015.Table 4.37shows the distribution of the agreeableness towards the researcher's suggestion to overcome the challenge.

Table 4.30: Distribution of suggestion made to overcome 'Migration of experienced SQA' challenge in online survey 2014 and 2015.

	Year 2014			Year 2015		
Solution Description	**Agree**	**Neutral**	**Disagree**	**Agree**	**Neutral**	**Disagree**
Increased standard of living for the skilled SQA resources.	91%	7%	2%	95%	4%	1%

Another challenge is *Lack of People Management Skill*s. This is special and it has different distribution in 2014 compared 2015. This challenge is ranked as sixth in 2014 and eighth in 2015. It is not an easy task to manage people, teams and clients in IT industry. Because everyone's expectations are high, due to their greater commitment. Most of the managers fail in this subject; even they have greater technical skills and capabilities. Hence, 77% of respondents have selected 'Agreed' in

2014 and 81% in 2015. Still,9% in 2014 and 5% in 2015 respondents think that, lack of people management skills is not a challenge for SQA profession. Figure 4.75 and 4.76 show the distribution of the agreeableness towards 'Lack of People Management Skills' as a challenge in year 2014 and 2015.Figure 4.77 and 4.78 show the gender wise distribution of the agreeableness towards 'Lack of people management skills' as a challenge in year 2014 and 2015. Figure 4.79 and 4.80 show the organization level wise distribution of the agreeableness towards 'Lack of people management skills' as a challenge in year 2014 and 2015. Figure 4.81 and 4.82 show the size of the QA department wise distribution of the agreeableness towards 'Lack of people management skills' as a challenge in year 2014 and 2015.

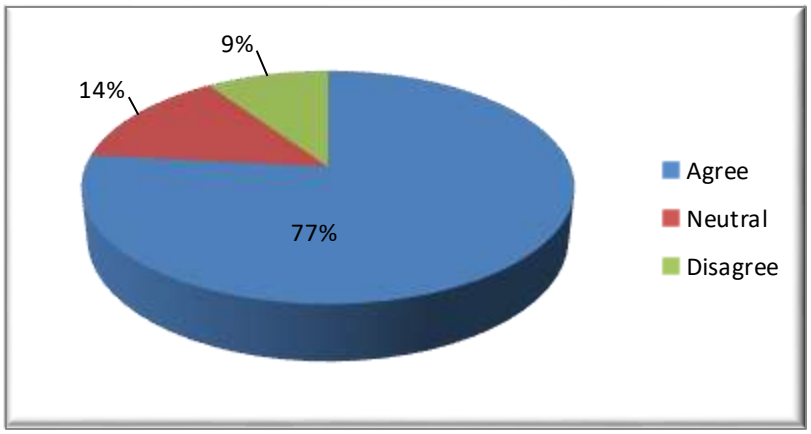

Figure 4.75: Extent to which participants agree "Lack of people management skills" in online survey.

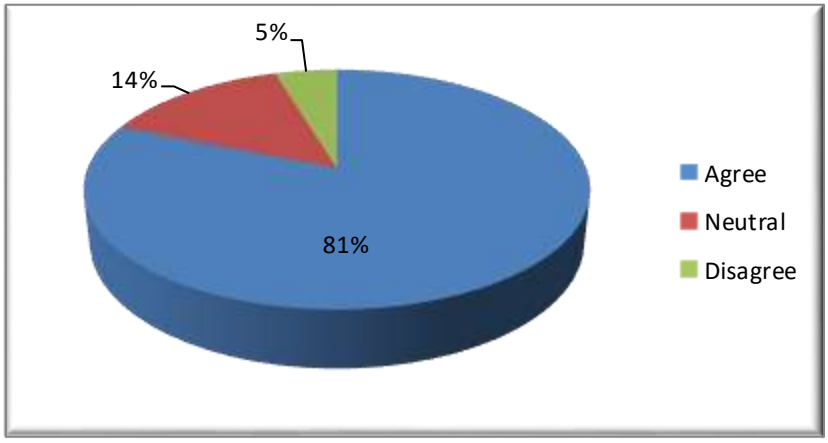

Figure 4.76: Extent to which participants agree "Lack of people management skills" in online survey 2015.

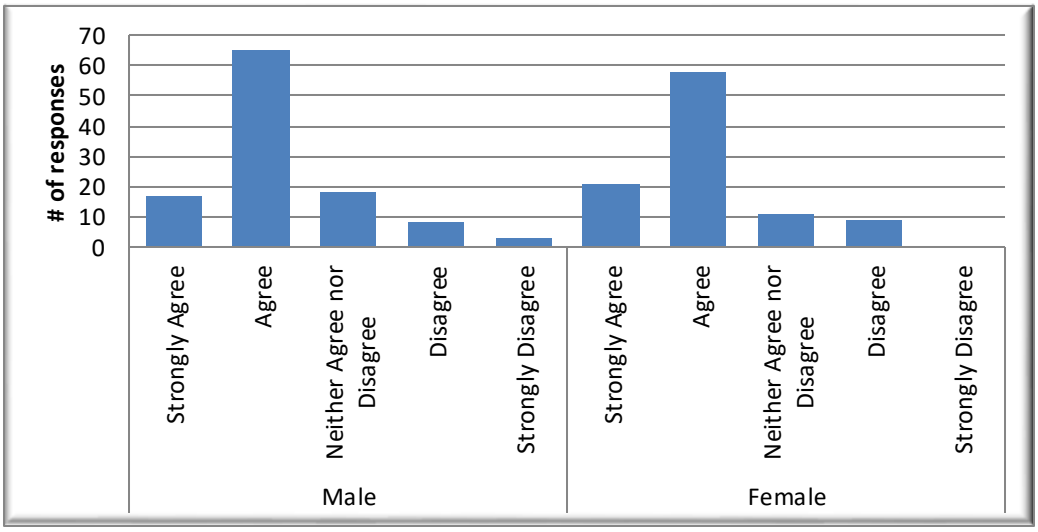

Figure 4.77: Gender wise analysis on distribution of "Lack of people management skills" in online survey 2014.

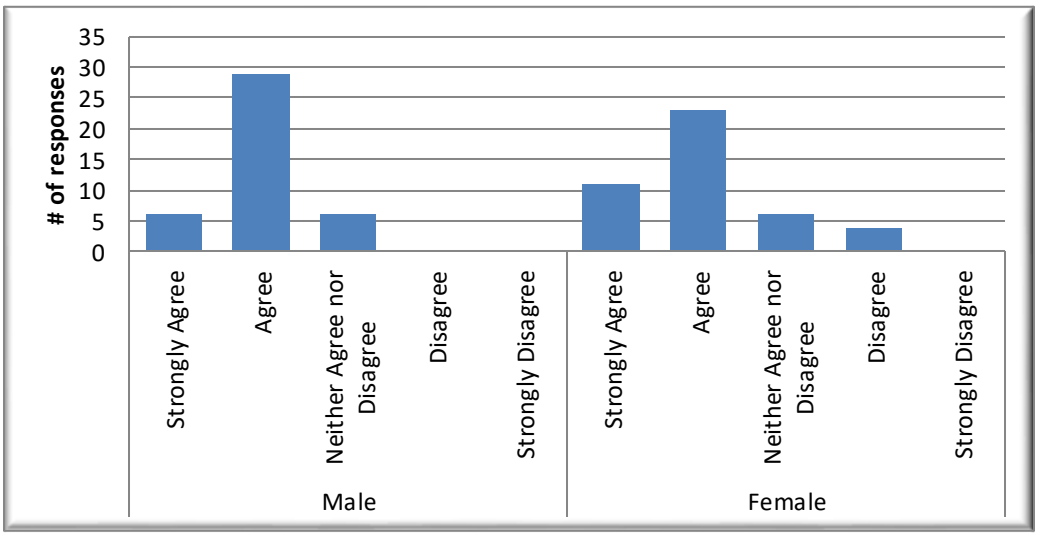

Figure 4.78: Gender wise analysis on distribution of "Lack of people management skills" in online survey 2015.

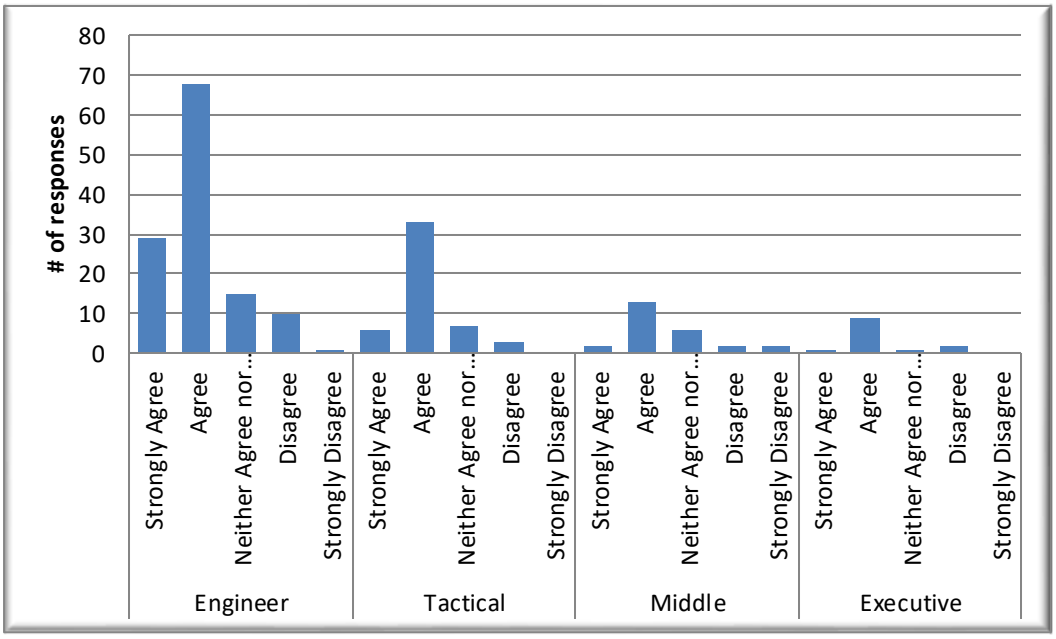

Figure 4.79: Organization level wise analysis on distribution of "Lack of people management skills" in online survey 2014.

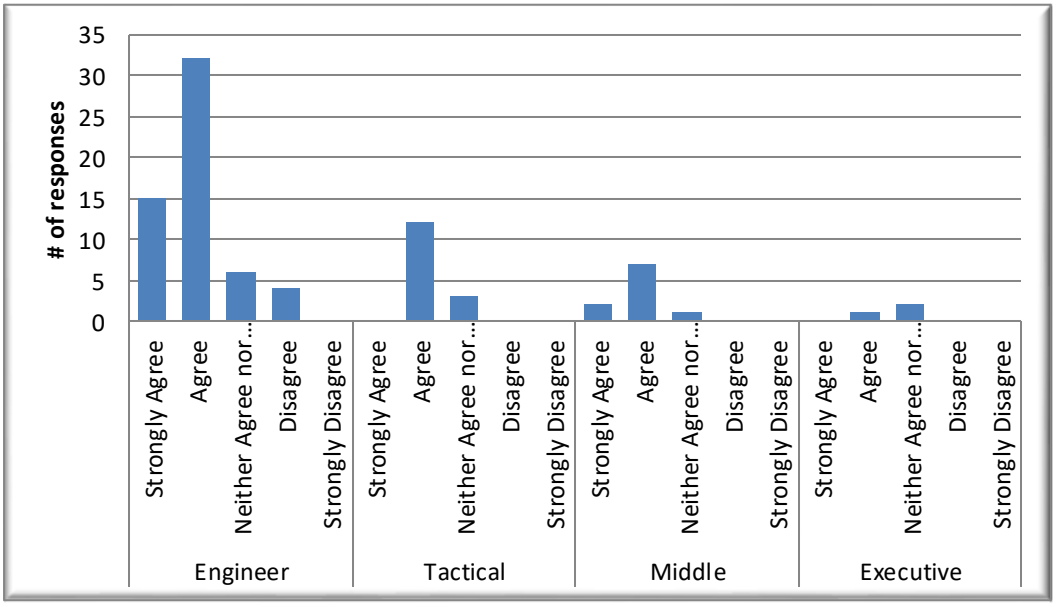

Figure 4.80: Organization level wise analysis on distribution of "Lack of people management skills" in online survey 2015.

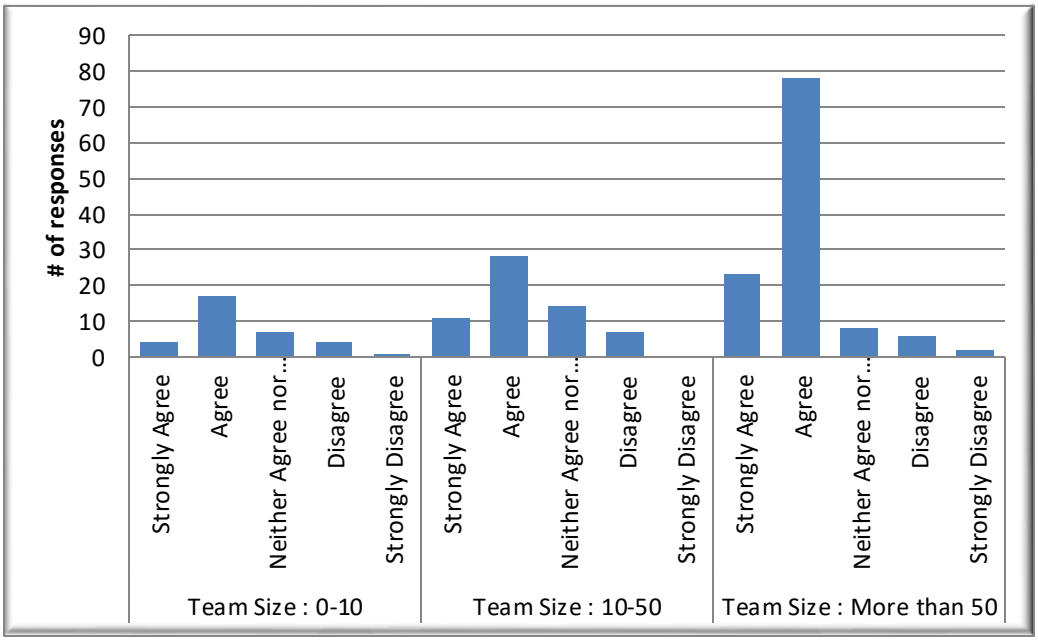

Figure 4.81: Size of the QA Dept wise analysis on distribution of "Lack of people management skills" in online survey 2014.

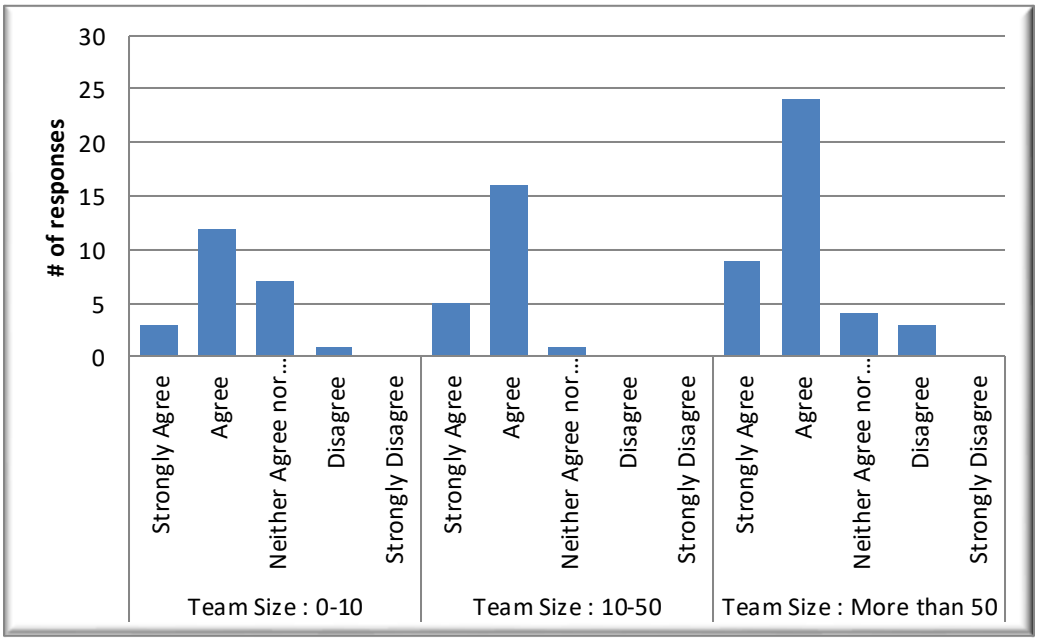

Figure 4.82: Size of the QA Dept wise analysis on distribution of "Lack of people management skills" in online survey 2015.

The suggestion made to overcome this challenge in online survey was 'Provide on the job trainings with the leadership on people management.' 95% of the respondents agreed to the suggestion made by the researcher in year 2014 and 2015. Table 4.38

shows the distribution of the agreeableness towards the researcher's suggestion to overcome the challenge.

Table 4.31: Distribution of suggestion made to overcome 'Lack of people management skills' challenge in online survey 2014 and 2015.

	Year 2014			Year 2015		
Solution Description	**Agree**	**Neutral**	**Disagree**	**Agree**	**Neutral**	**Disagree**
Provide on the job trainings with the leadership on people management.	95%	4%	1%	95%	5%	0%

Next challenge is *Higher Management Not Understanding the Benefit from QA*. As per respondent's comments, still there are managers who are not willing to accept QA is adding a great value to the organization. Most of them think QA as a bottleneck for the client deliverables. In 2015, it has ranked as second due to the criticality of this challenge. But in 2014, it was ranked as seventh. In 2015, 93% of respondents agreed this as a challenge while 77% agreed in 2014. Still, 9% in 2014 and 3% in 2015 respondents believe that, lack of understanding of the QA benefits from the higher management is not a challenge for SQA profession. Figure 4.83 and 4.84 show the distribution of the agreeableness towards 'lack of understanding of the QA benefits from the higher management' as a challenge in year 2014 and 2015.Figure 4.85 and 4.86 show the gender wise distribution of the agreeableness towards 'Lack of understanding of the QA benefits from the higher management' as a challenge in year 2014 and 2015. Figure 4.87 and 4.88 show the organization level wise distribution of the agreeableness towards 'Lack of understanding of the QA benefits from the higher management' as a challenge in year 2014 and 2015. Figure 4.89 and 4.90 show the size of the QA department wise distribution of the agreeableness towards 'Lack of understanding of the QA benefits from the higher management' as a challenge in year 2014 and 2015.

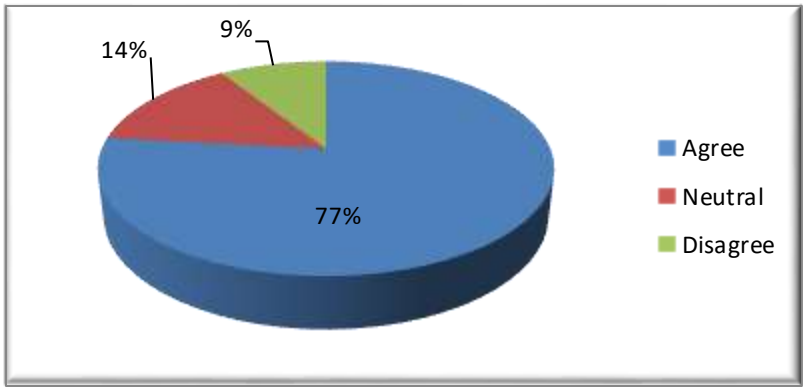

Figure 4.83: Extent to which participants agree "Lack of understanding of the QA benefits from the higher management" in online survey 2014.

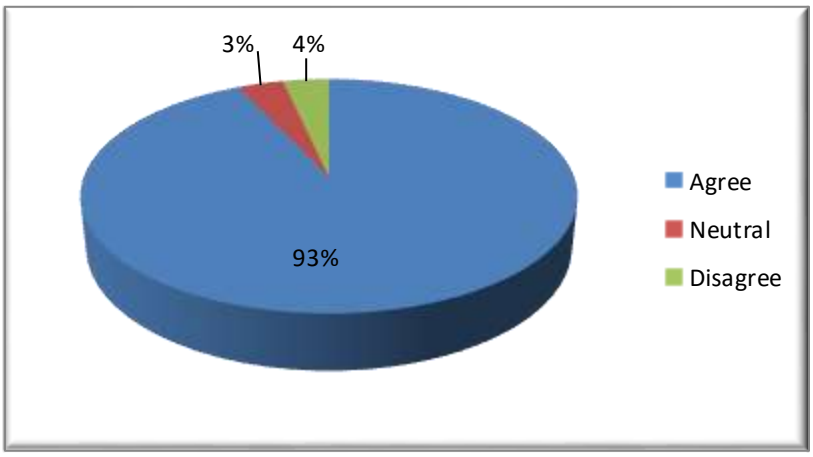

Figure 4.84: Extent to which participants agree "Lack of understanding of the QA benefits from the higher management" in online survey 2015.

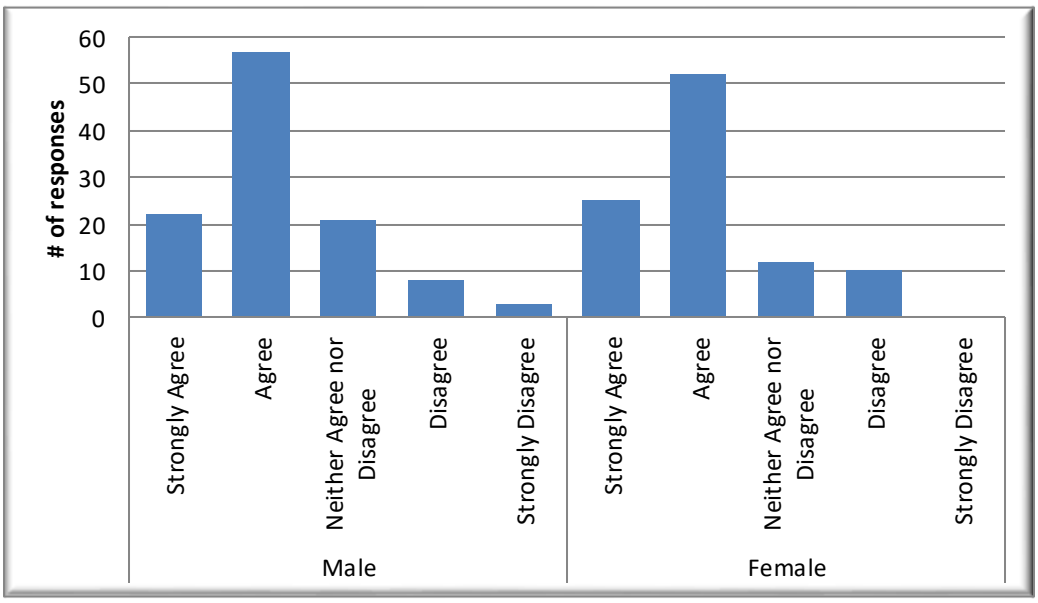

Figure 4.85: Gender wise analysis on distribution of "Lack of understanding of the QA benefits from the higher management" in online survey 2014.

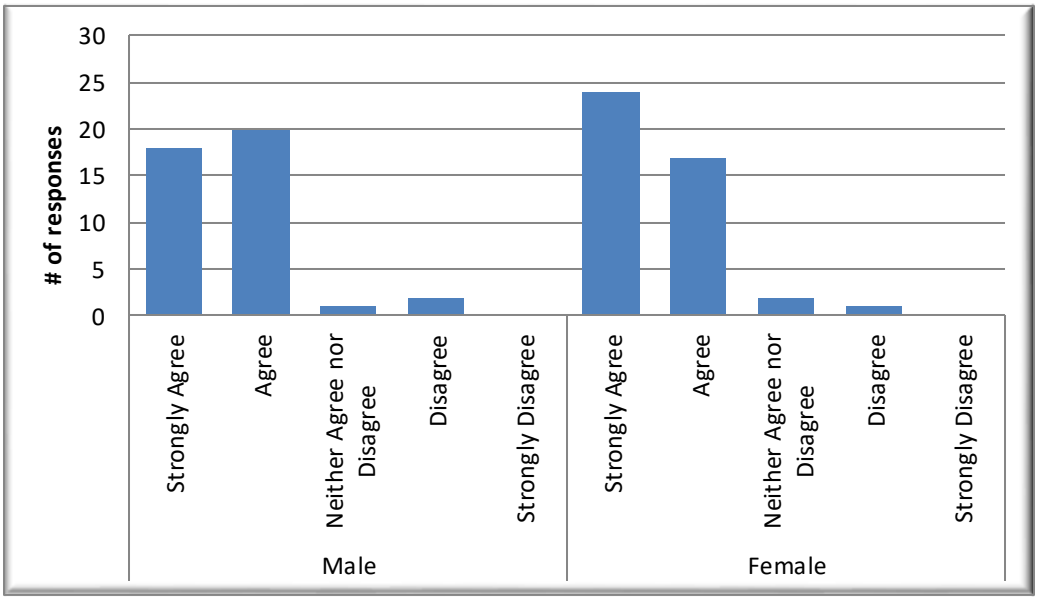

Figure 4.86: Gender wise analysis on distribution of "Lack of understanding of the QA benefits from the higher management" in online survey 2015.

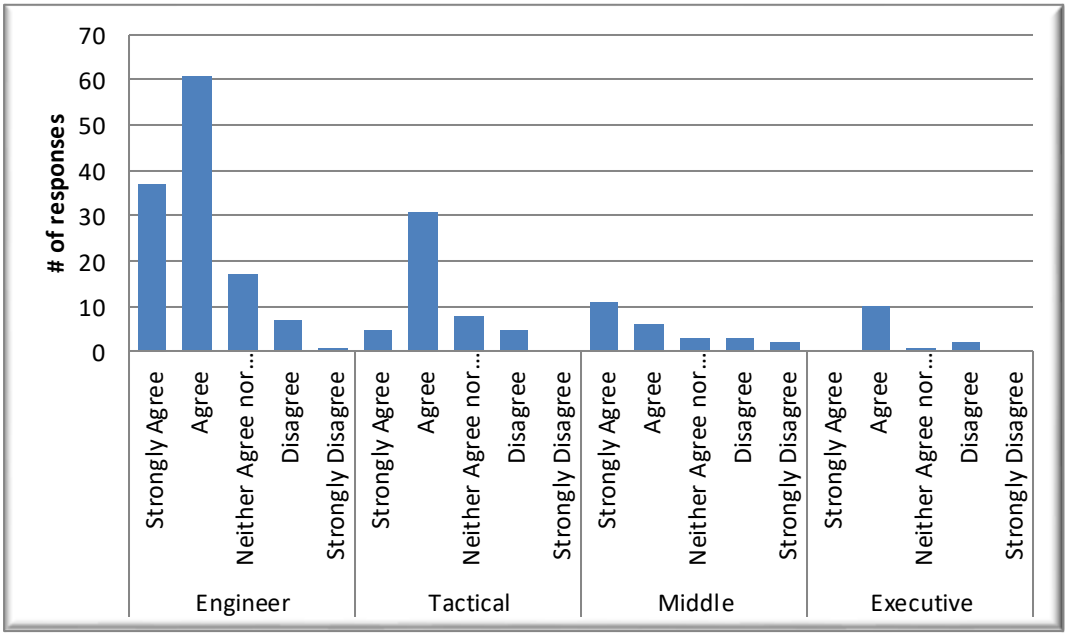

Figure 4.87: Organization level wise analysis on distribution of "Lack of understanding of the QA benefits from the higher management" in online survey 2014.

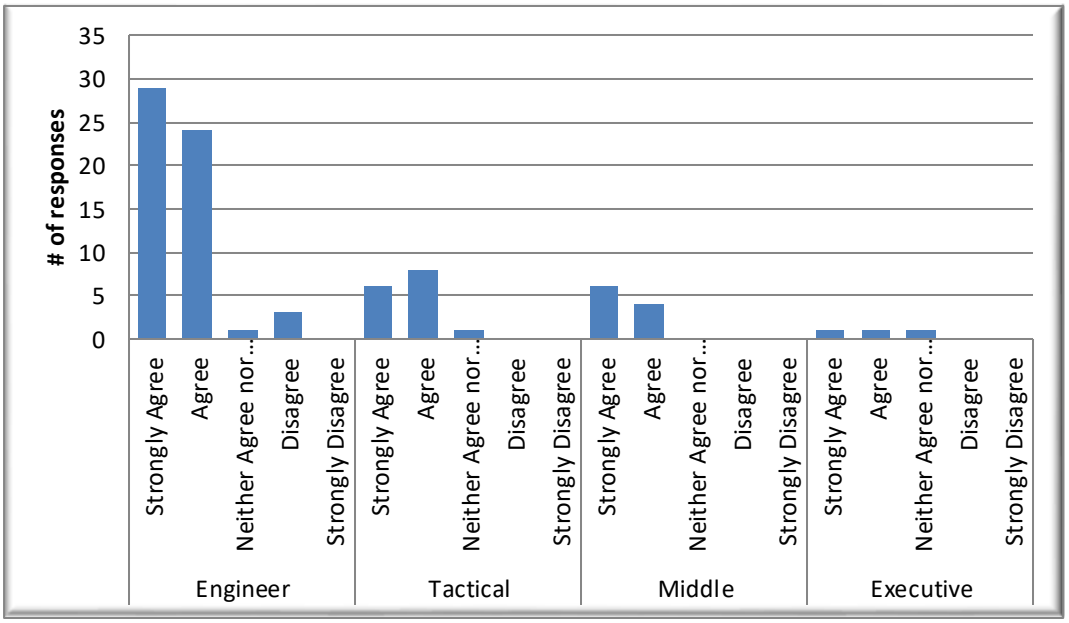

Figure 4.88: Organization level wise analysis on distribution of "Lack of understanding of the QA benefits from the higher management" in online survey 2015.

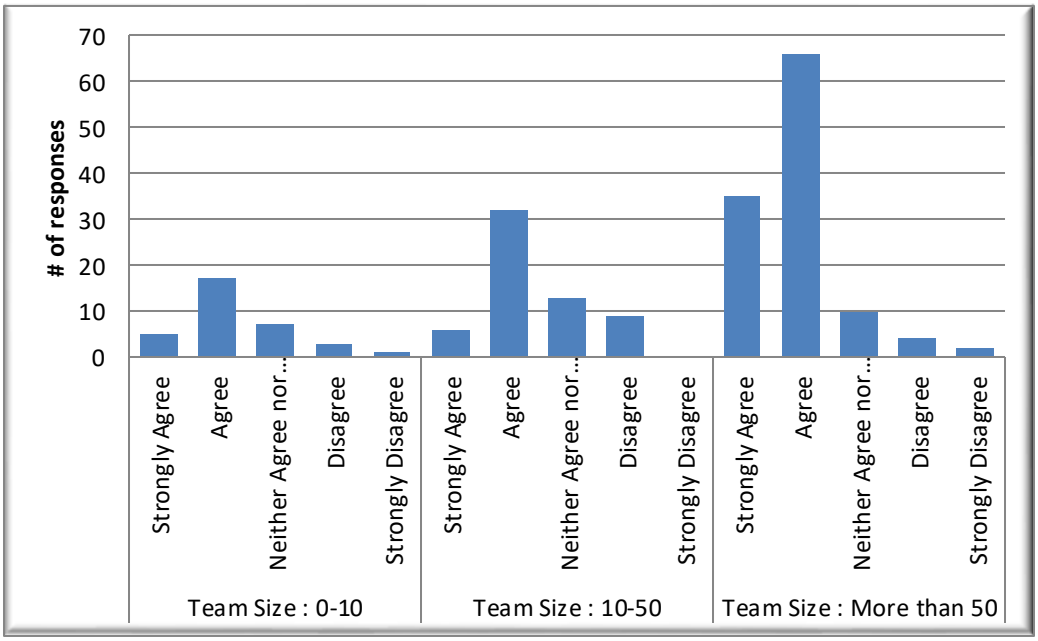

Figure 4.89: Size of the QA Dept wise analysis on distribution of "Lack of understanding of the QA benefits from the higher management" in online survey 2014.

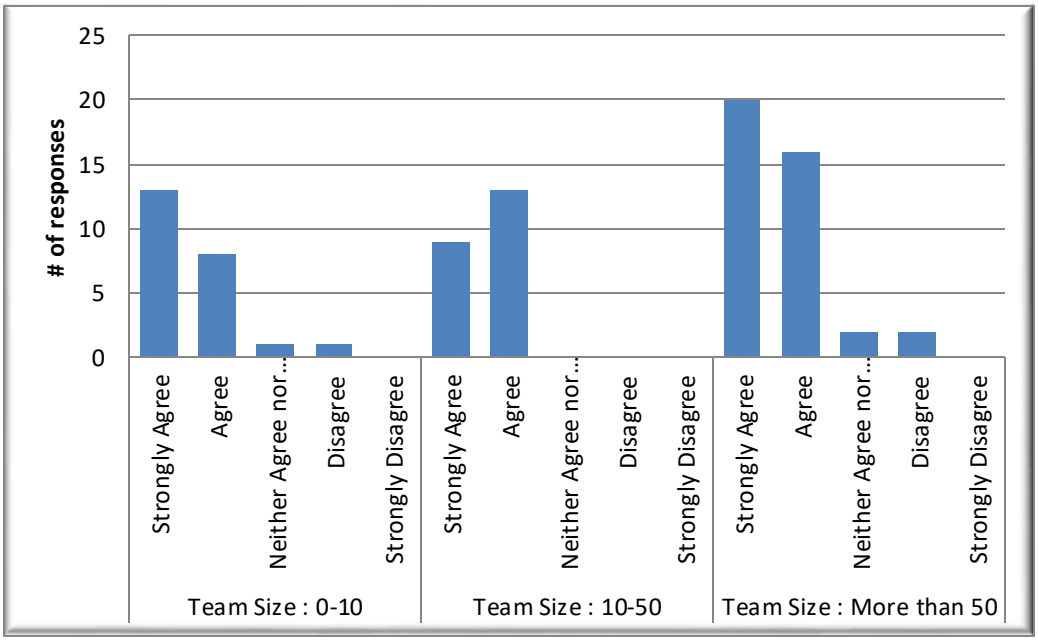

Figure 4.90: Size of the QA Dept wise analysis on distribution of "Lack of understanding of the QA benefits from the higher management" in online survey 2015.

The suggestion made to overcome this challenge in online survey was 'Keep the higher management informed by having weekly, monthly progress review or awareness meeting.' 91% of the respondents agreed to the suggestion made by the researcher in year 2014 and 2015. Table 4.39 shows the distribution of the agreeableness towards the researcher's suggestion to overcome the challenge.

Table 4.32: Distribution of suggestion made to overcome 'Lack of understanding of the QA benefits from the higher management' challenge in online survey 2014 and 2015.

	Year 2014			Year 2015		
Solution Description	**Agree**	**Neutral**	**Disagree**	**Agree**	**Neutral**	**Disagree**
Keep the higher management informed by having weekly, monthly progress review or awareness meeting.	91%	8%	1%	91%	9%	0%

Another challenge is *Less SQA Involvement in the Requirement Gathering Phase.* This is very critical and helps to destroy the concept 'prevention is better than cure.' Due to this matter, requirements get change at last minute and always double the

rework. In 2014 it has ranked in eighth and in 2015 it ranked in sixth. In 2014 and 2015, 86% of respondents agreed this as a challenge. And, 8% in 2014 and 2015 respondents consider that, less SQA involvement in the requirement gathering phase is not a challenge for SQA profession. Figure 4.91 and 4.92 show the distribution of the agreeableness towards 'lack of understanding of the QA benefits from the higher management' as a challenge in year 2014 and 2015.Figure 4.93 and 4.94 show the gender wise distribution of the agreeableness towards 'Less SQA involvement in the requirement gathering phase' as a challenge in year 2014 and 2015. Figure 4.95 and 4.96 show the organization level wise distribution of the agreeableness towards 'Less SQA involvement in the requirement gathering phase' as a challenge in year 2014 and 2015. Figure 4.97 and 4.98 show the size of the QA department wise distribution of the agreeableness towards 'Less SQA involvement in the requirement gathering phase' as a challenge in year 2014 and 2015.

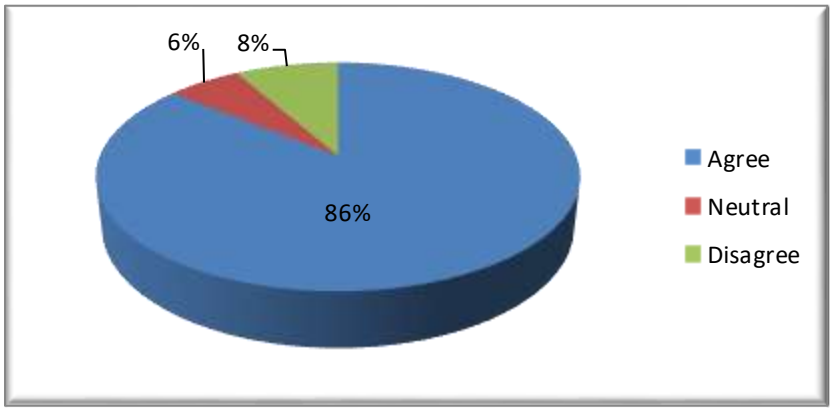

Figure 4.91: Extent to which participants agree "Less SQA involvement in the requirement gathering phase" in online survey 2014.

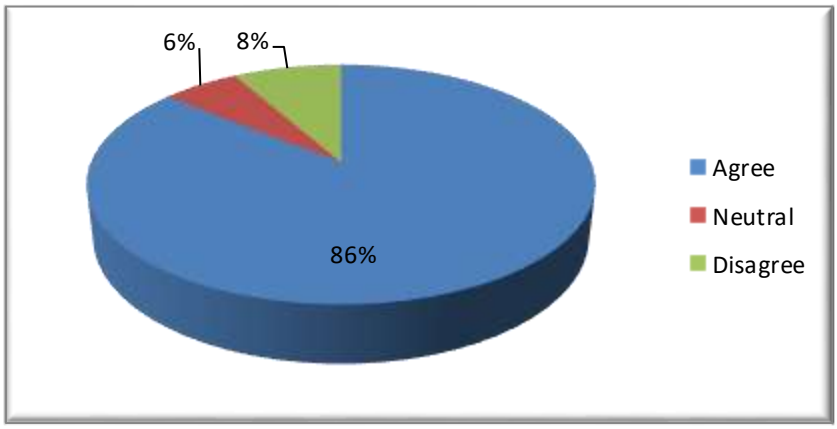

Figure 4.92: Extent to which participants agree "Less SQA involvement in the requirement gathering phase" in online survey 2015.

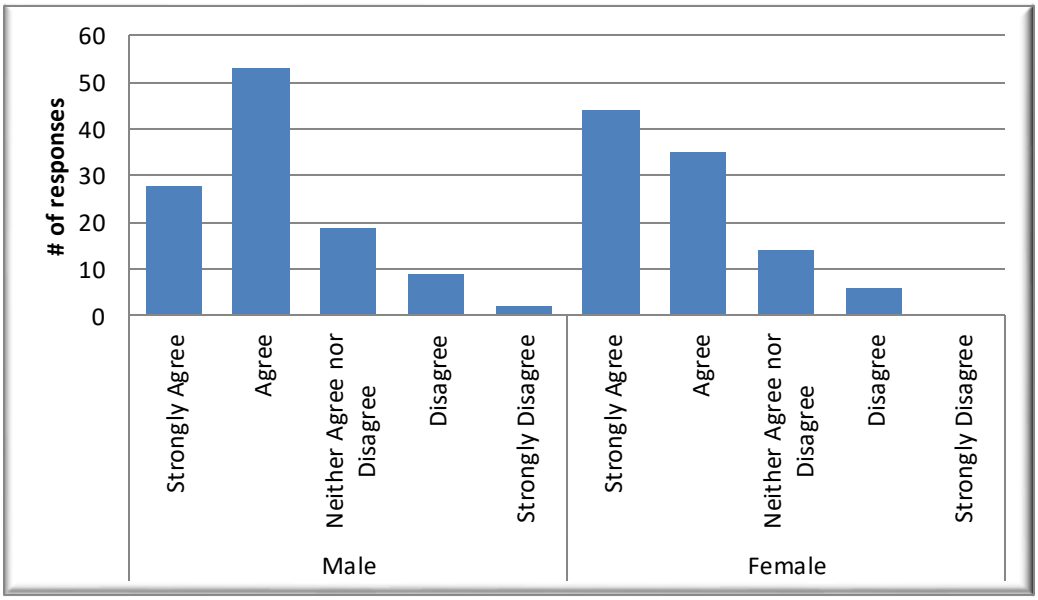

Figure 4.93: Gender wise analysis on distribution of "Less SQA involvement in the requirement gathering phase" in online survey 2014.

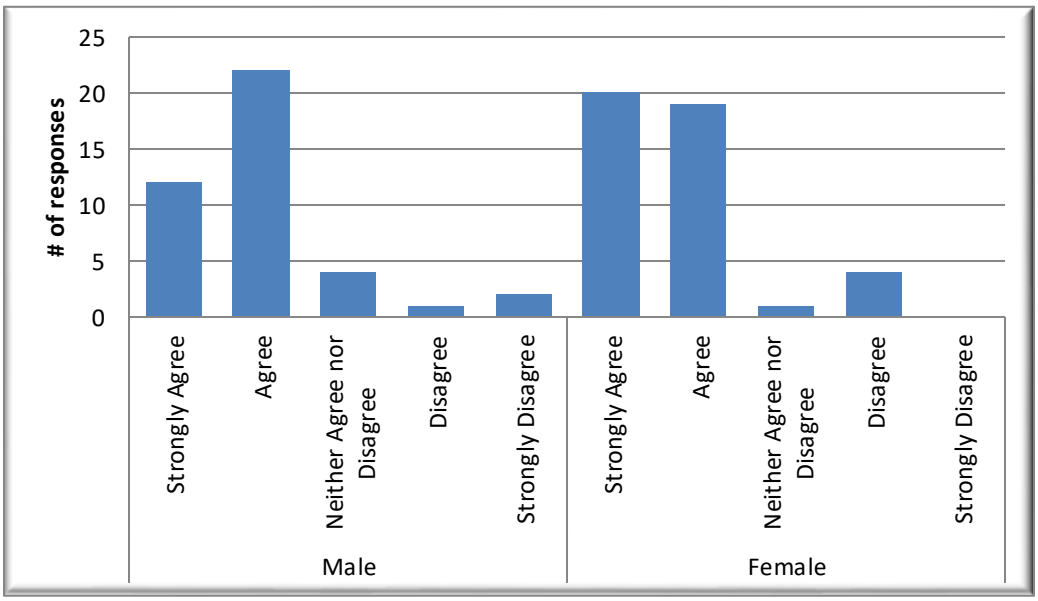

Figure 4.94: Gender wise analysis on distribution of "Less SQA involvement in the requirement gathering phase" in online survey 2015.

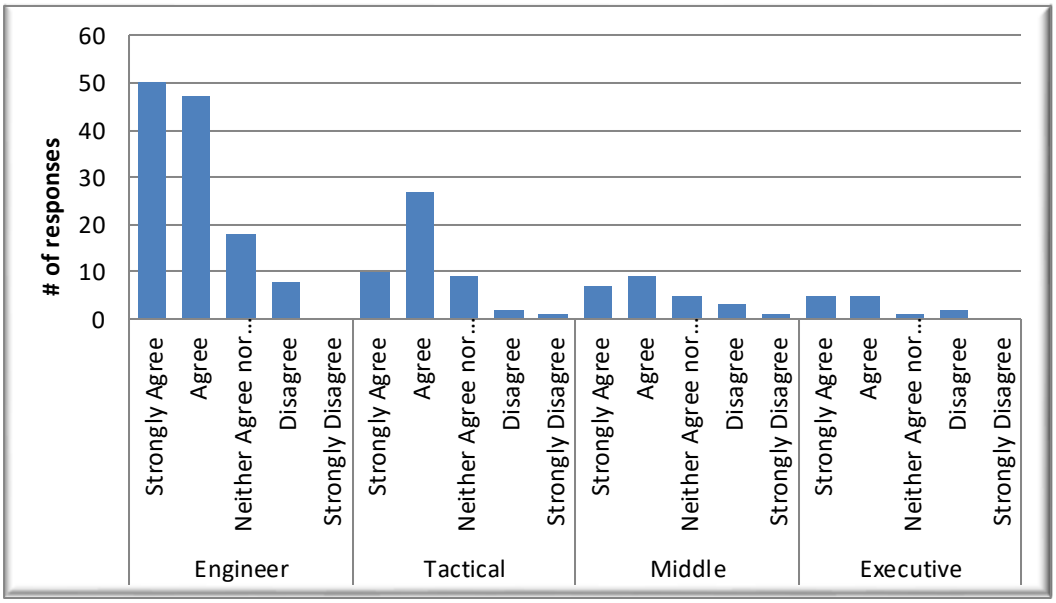

Figure 4.95: Organization level wise analysis on distribution of "Less SQA involvement in the requirement gathering phase" in online survey 2014.

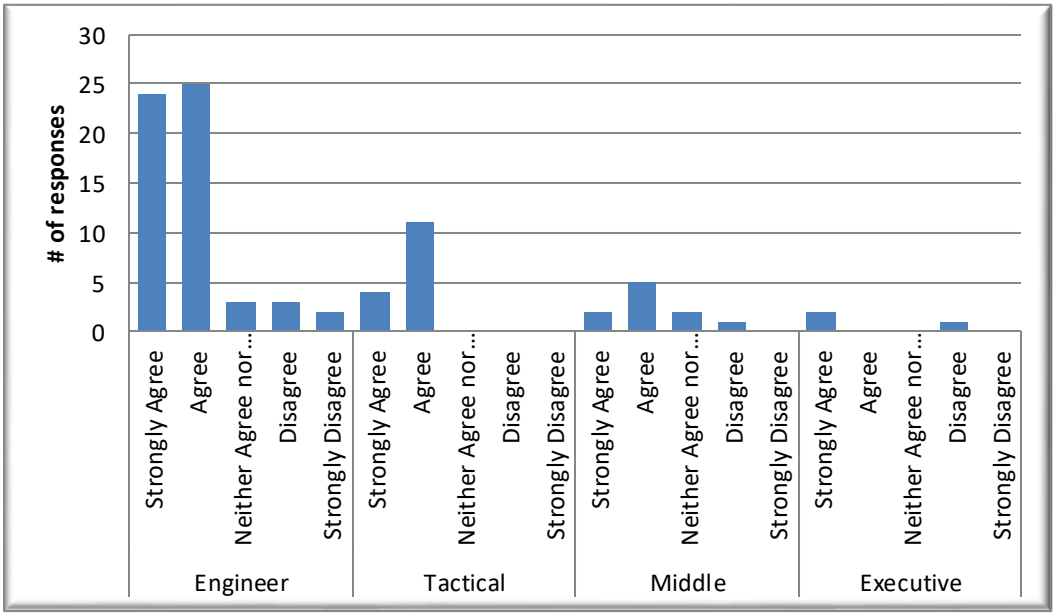

Figure 4.96: Organization level wise analysis on distribution of "Less SQA involvement in the requirement gathering phase" in online survey 2015.

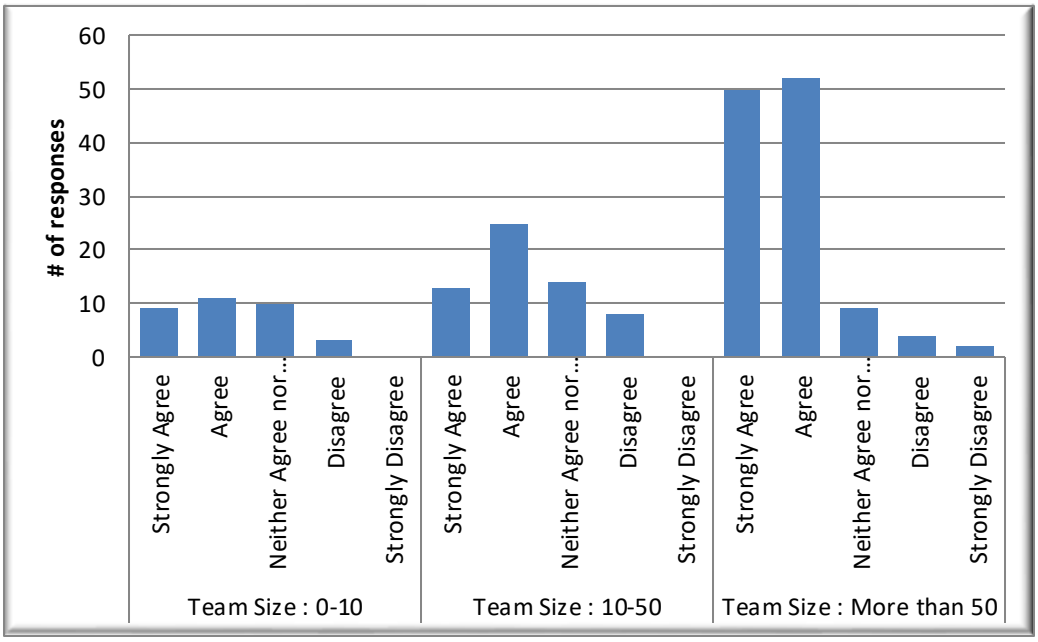

Figure 4.97: Size of the QA Department wise analysis on distribution of "Less SQA involvement in the requirement gathering phase" in online survey 2014.

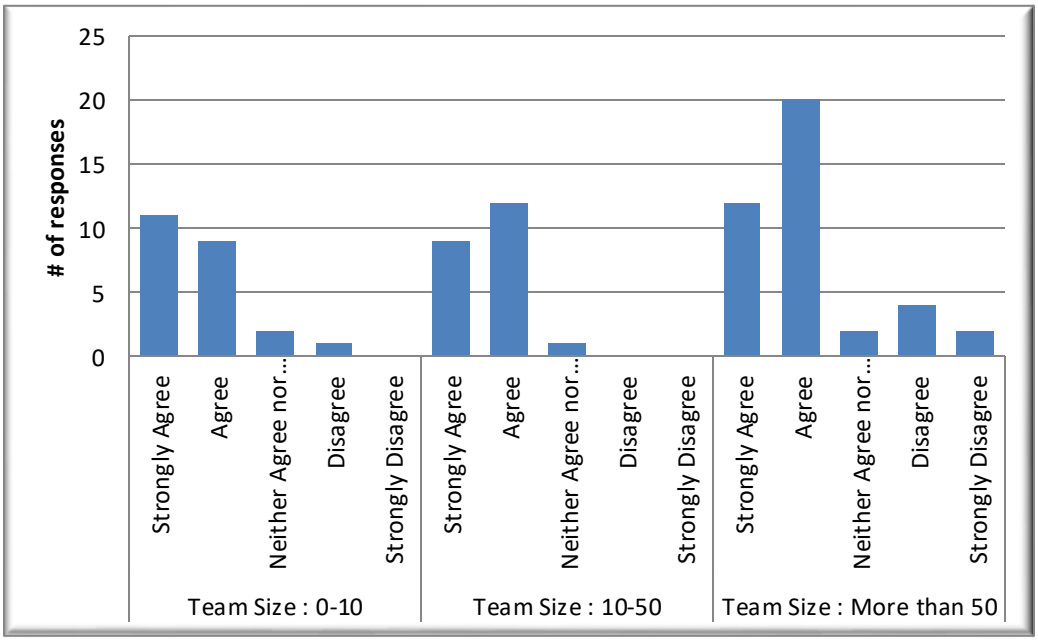

Figure 4.98: Size of the QA Department wise analysis on distribution of "Less SQA involvement in the requirement gathering phase" in online survey 2014.

The suggestion made to overcome this challenge in online survey was 'Facilitate SQA representation on requirement gathering phase.' 97% and 96% of the respondents agreed to the suggestion made by the researcher in year 2014 and 2015.

Table 4.40 shows the distribution of the agreeableness towards the researcher's suggestion to overcome the challenge.

Table 4.33: Distribution of suggestion made to overcome 'Less SQA involvement in the requirement gathering phase' challenge in online survey 2014 and 2015.

	Year 2014			Year 2015		
Solution Description	**Agree**	**Neutral**	**Disagree**	**Agree**	**Neutral**	**Disagree**
Facilitate SQA representation on requirement gathering phase.	97%	2%	1%	96%	4%	0%

High Turnover is another challenge to the company management as well as the next level leadership. As per the respondents, professional tend to change the job frequently because; they're motivated by higher pay, they're not engaged, they're bored or they're poorly managed. Due to this concern, 75% of respondents have selected 'Agreed' in 2014 and 83% in 2015. Still, 3% in 2014 and 5% in 2015 respondents believe that, high turnover due to the industry competition is not a challenge for SQA profession. Hence, it is ranked ninth in 2014 and seventh in 2015. Figure 4.99 and 4.100 show the distribution of the agreeableness towards *High Turnover due to the Industry Competition* as a challenge in year 2014 and 2015.Figure 4.101 and 4.102 show the gender wise distribution of the agreeableness towards 'High turnover due to the industry competition' as a challenge in year 2014 and 2015. Figure 4.103 and 4.104 show the organization level wise distribution of the agreeableness towards 'High turnover due to the industry competition' as a challenge in year 2014 and 2015. Figure 4.105 and 4.106 show the size of the QA department wise distribution of the agreeableness towards 'High turnover due to the industry competition' as a challenge in year 2014 and 2015.

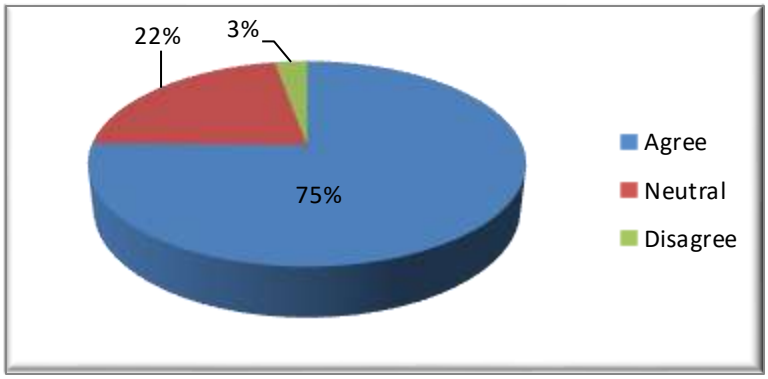

Figure 4.99: Extent to which participants agree "High turnover due to the industry competition" in online survey 2014.

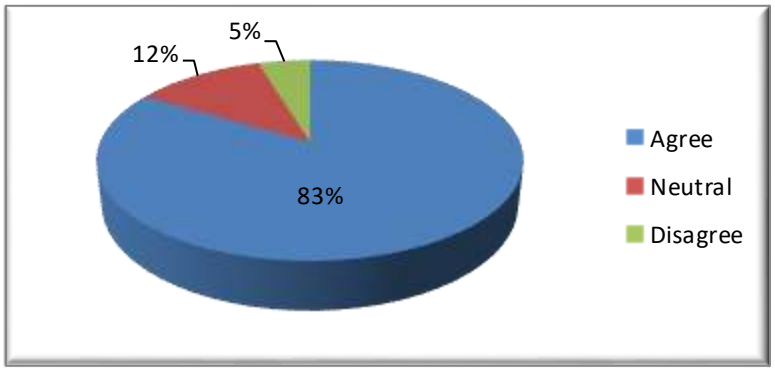

Figure 4.100: Extent to which participants agree "High turnover due to the industry competition" in online survey 2015.

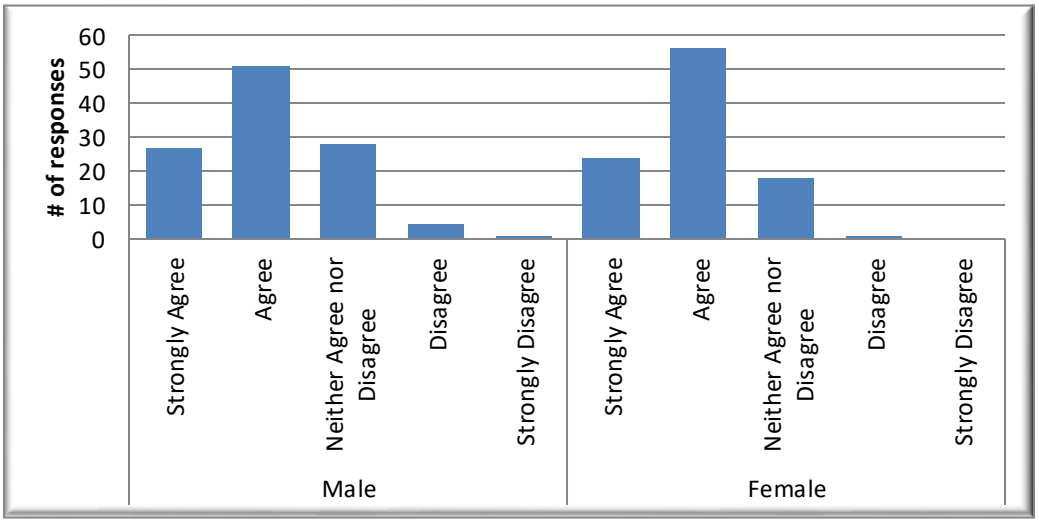

Figure 4.101: Gender wise analysis on distribution of "High turnover due to the industry competition" in online survey 2014.

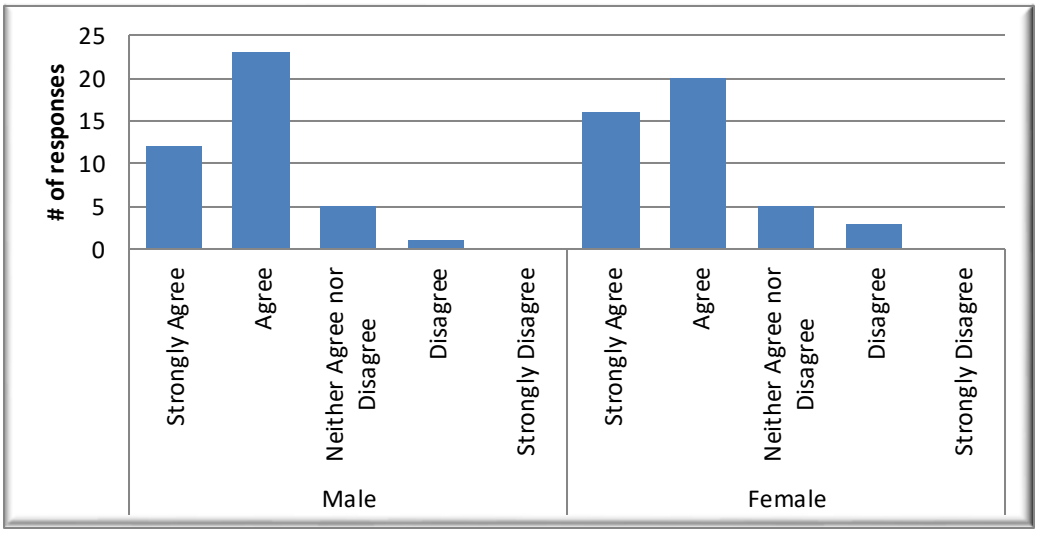

Figure 4.102: Gender wise analysis on distribution of "High turnover due to the industry competition" in online survey 2015.

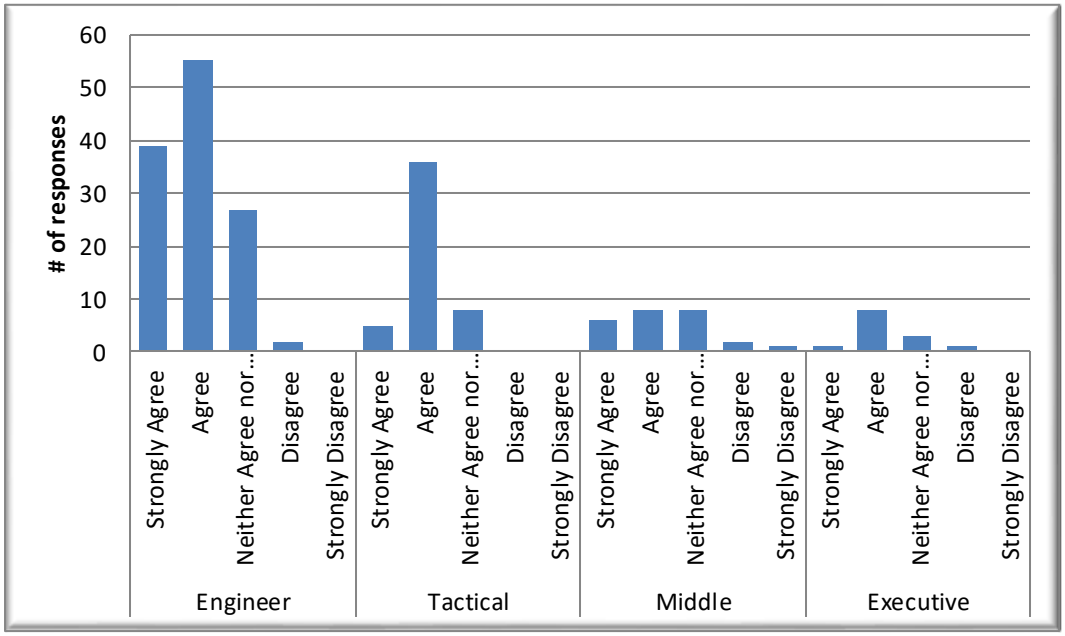

Figure 4.103: Organization level wise analysis on distribution of "High turnover due to the industry competition" in online survey 2014.

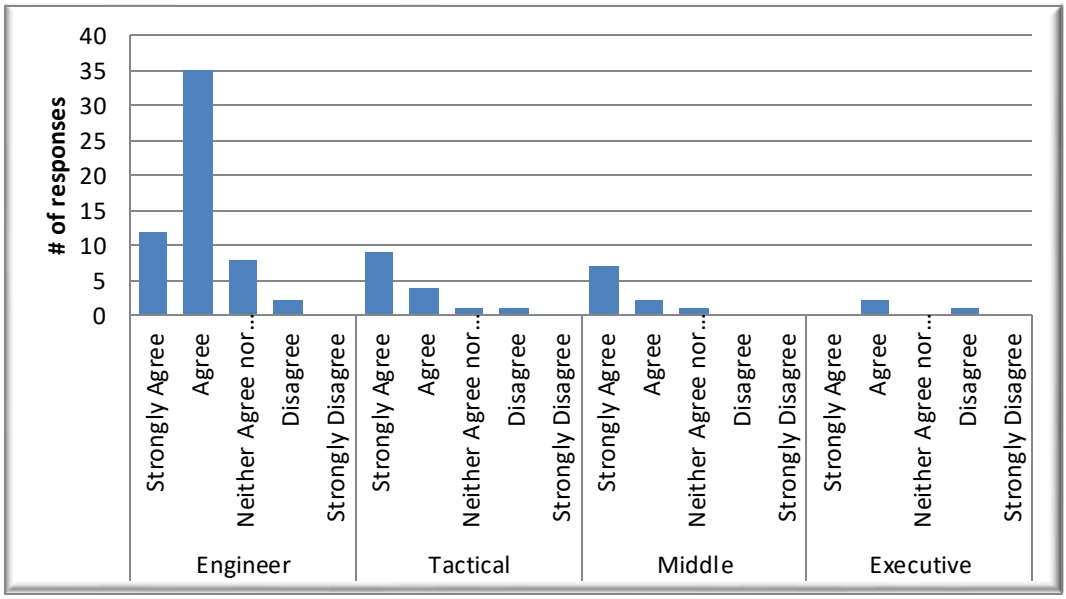

Figure 4.104: Organization level wise analysis on distribution of "High turnover due to the industry competition" in online survey 2015.

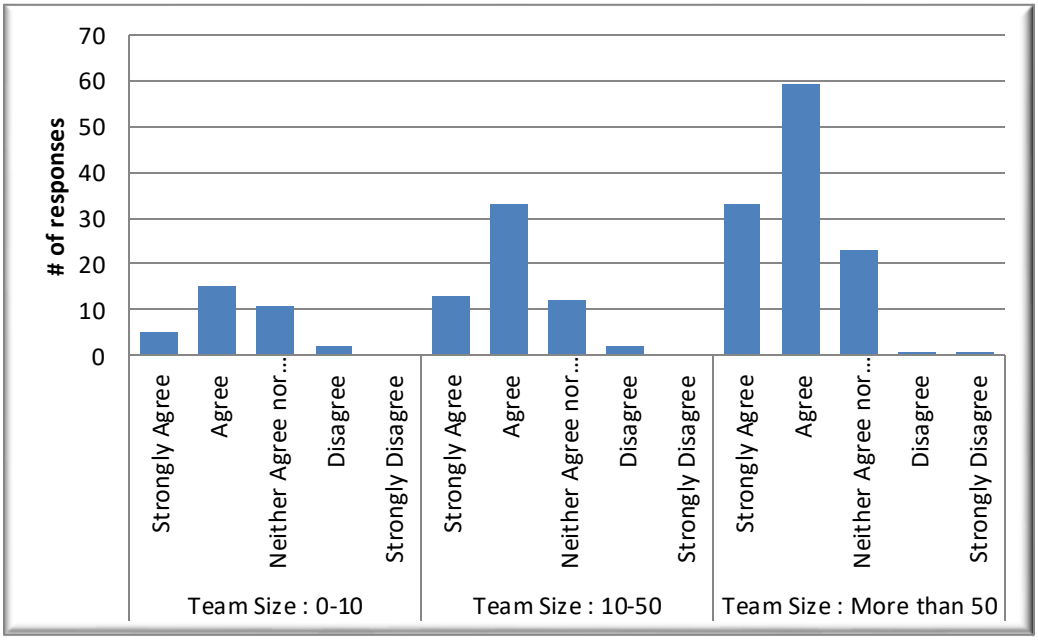

Figure 4.105: Size of the QA Dept wise analysis on distribution of "High turnover due to the industry competition" in online survey 2014.

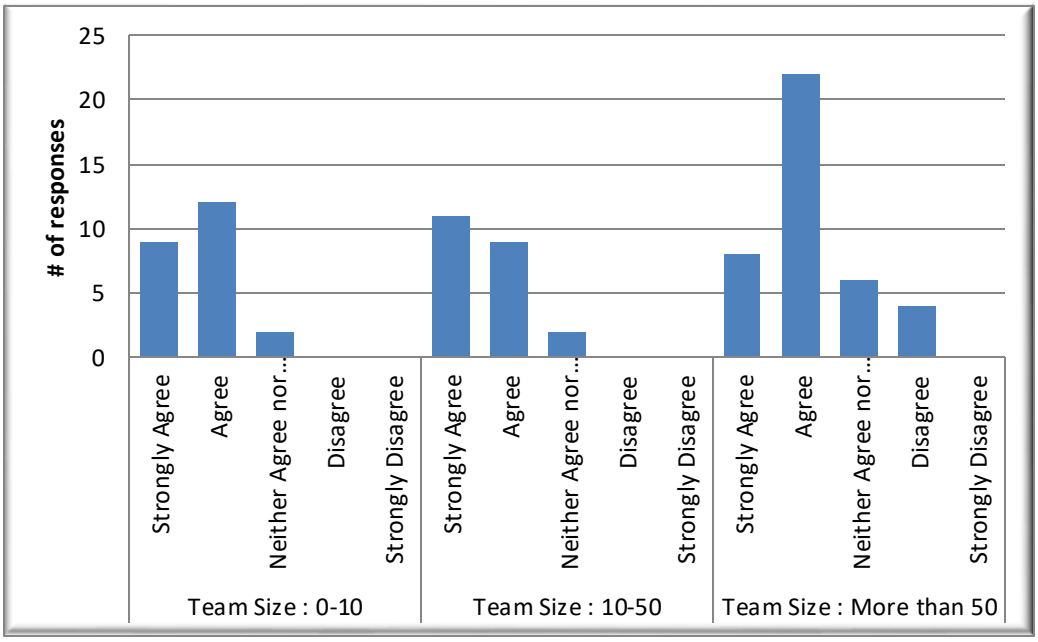

Figure 4.106: Size of the QA Dept wise analysis on distribution of "High turnover due to the industry competition" in online survey 2015.

The suggestion made to overcome this challenge in online survey was 'Provide relevant reword, recognition and compensation to reduce turnover.' 90% and 96% of the respondents agreed to the suggestion made by the researcher in year 2014 and 2015. Table 4.41 shows the distribution of the agreeableness towards the researcher's suggestion to overcome the challenge.

Table 4.34: Distribution of suggestion made to overcome 'High turnover due to the industry competition' challenge in online survey 2014 and 2015.

	Year 2014			Year 2015		
Solution Description	**Agree**	**Neutral**	**Disagree**	**Agree**	**Neutral**	**Disagree**
Provide relevant reword, recognition and compensation to reduce turnover.	90%	9%	1%	96%	4%	0%

Final identified challenge is *Lack of Understanding about the QA Benefits for Projects or Organization from the QA individuals*. Sometimes, due to the mistakes of the SQA professional they have to pay the penalty. As per the respondents, there are so many SQA individuals who don't have a clear awareness about the SQA benefits for projects and organization. They just working on the given tasks and trying to

complete it within the given time period, but without thinking the criticality of their tasks. 72% of respondents have selected 'Agreed' in 2014 and 77% in 2015. Still,10% in 2014 and 8% in 2015 respondents believe that, lack of understanding about SQA oriented benefits for projects and organization is not a challenge for SQA profession. Hence, it is ranked ninth in 2014 and seventh in 2015. Figure 4.107 and 4.108 show the distribution of the agreeableness towards 'Lack of understanding about SQA oriented benefits for projects and organization from the professional' as a challenge in year 2014 and 2015.Figure 4.109 and 4.110 show the gender wise distribution of the agreeableness towards 'Lack of understanding about SQA oriented benefits for projects and organization from the professional' as a challenge in year 2014 and 2015. Figure 4.111 and 4.112 show the organization level wise distribution of the agreeableness towards 'Lack of understanding about SQA oriented benefits for projects and organization from the professional' as a challenge in year 2014 and 2015. Figure 4.113 and 4.114 show the size of the QA department wise distribution of the agreeableness towards '*Lack of understanding about SQA oriented benefits for projects and organization from the professional*' as a challenge in year 2014 and 2015.

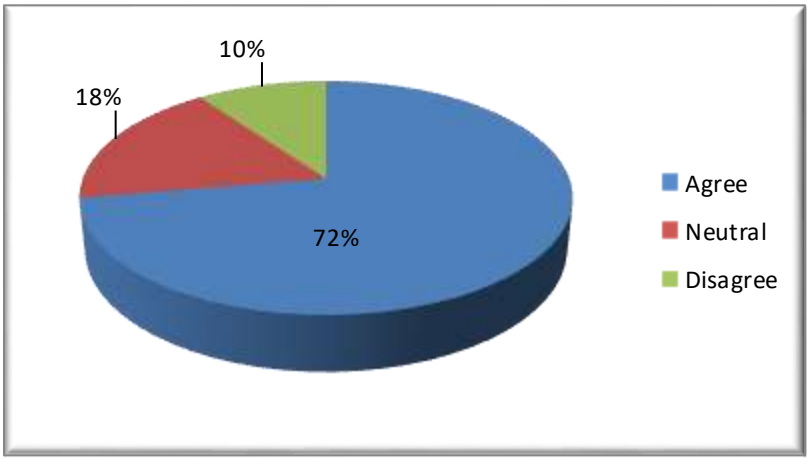

Figure 4.107: Extent to which participants agree "Lack of understanding about SQA oriented benefits for projects and organization from the professional" in online survey 2014.

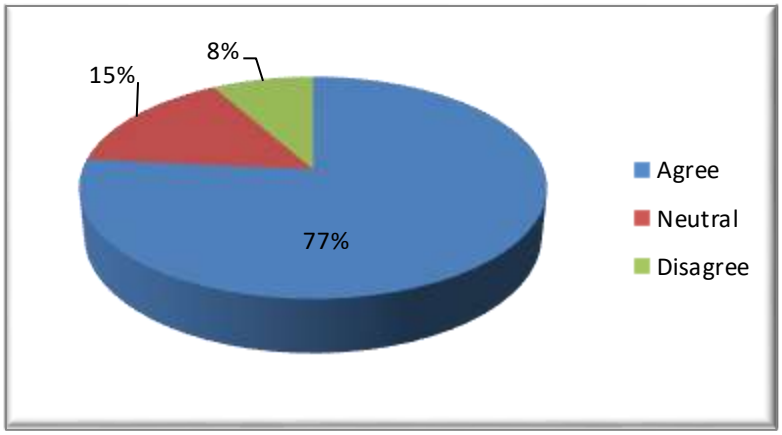

Figure 4.108: Extent to which participants agree "Lack of understanding about SQA oriented benefits for projects and organization from the professional" in online survey 2015.

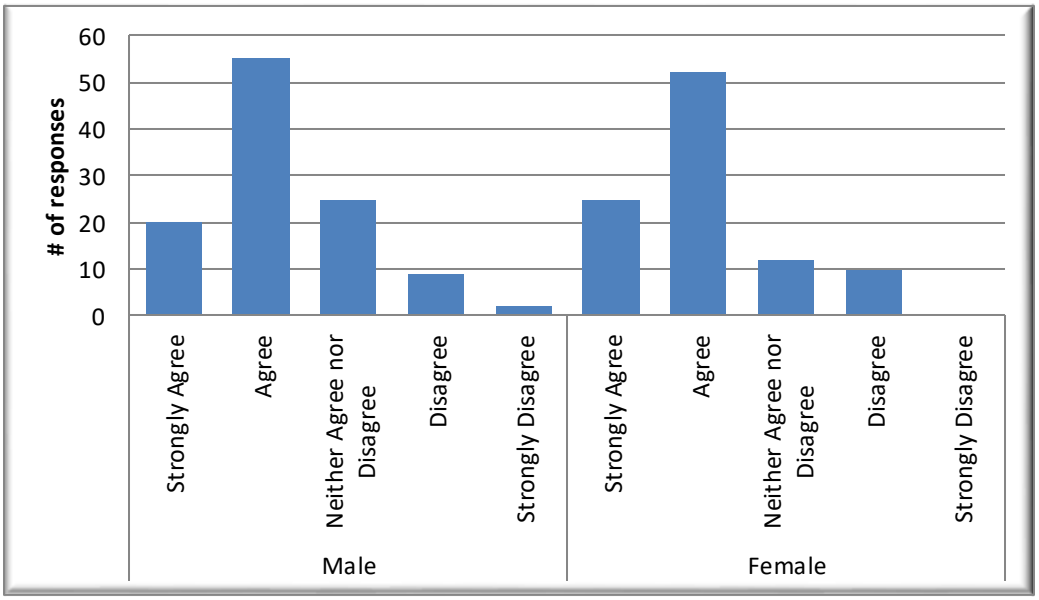

Figure 4.109: Gender wise analysis on distribution of "Lack of understanding about SQA oriented benefits for projects and organization from the professional" in online survey 2014.

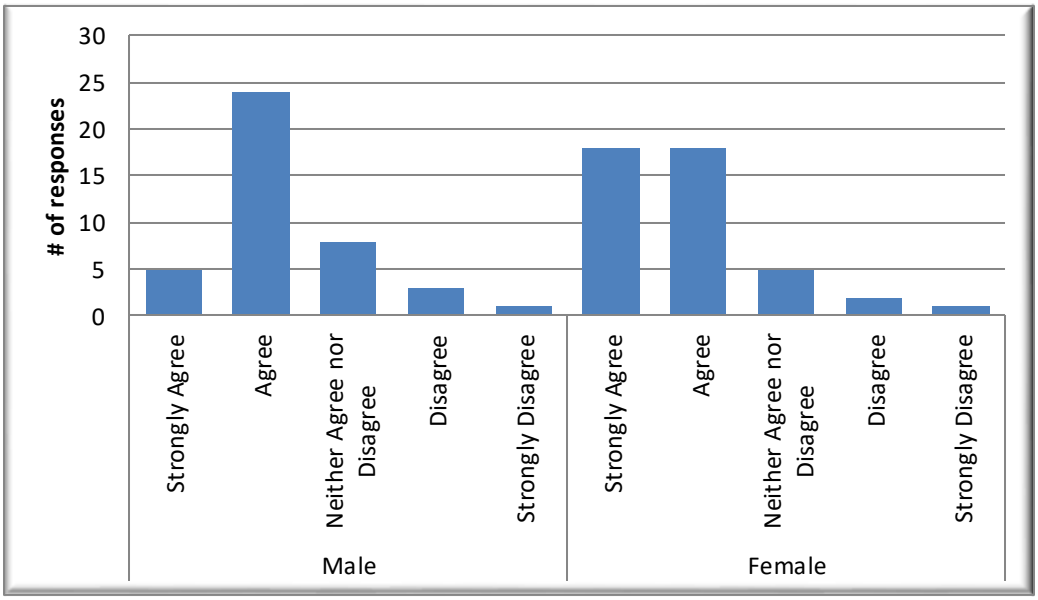

Figure 4.110: Gender wise analysis on distribution of "Lack of understanding about SQA oriented benefits for projects and organization from the professional" in online survey 2015.

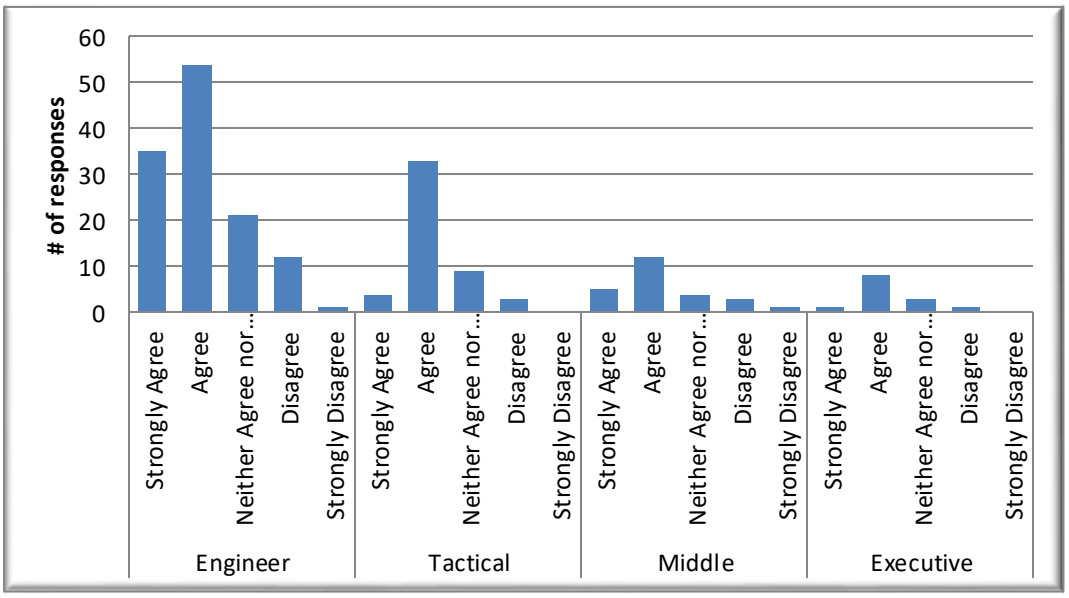

Figure 4.111: Organization level wise analysis on distribution of "Lack of understanding about SQA oriented benefits for projects and organization from the professional" in online survey 2014.

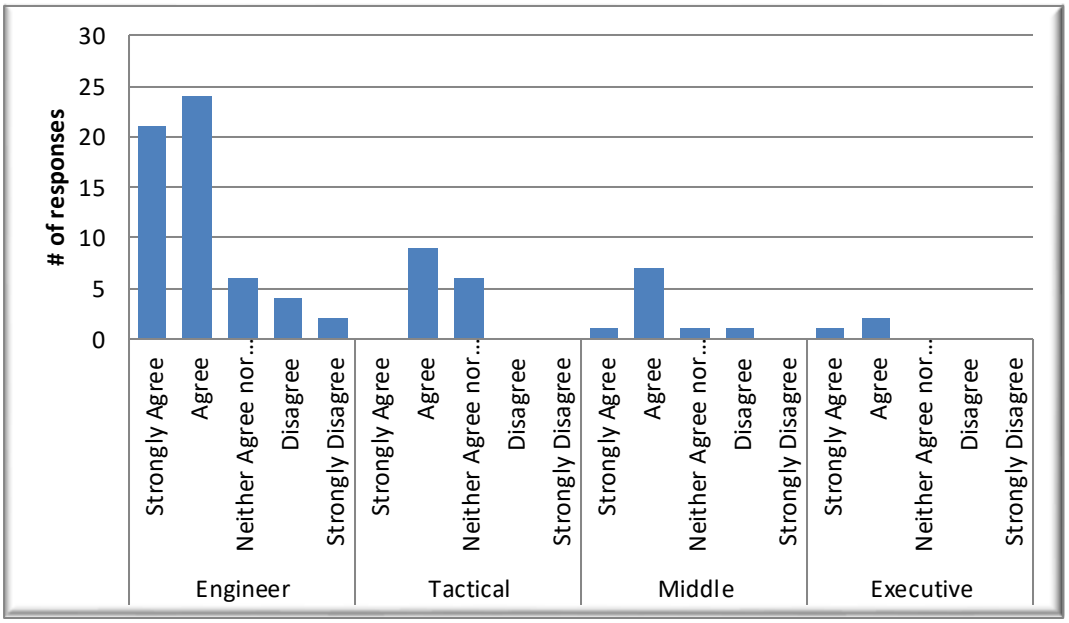

Figure 4.112: Organization level wise analysis on distribution of "Lack of understanding about SQA oriented benefits for projects and organization from the professional" in online survey 2015.

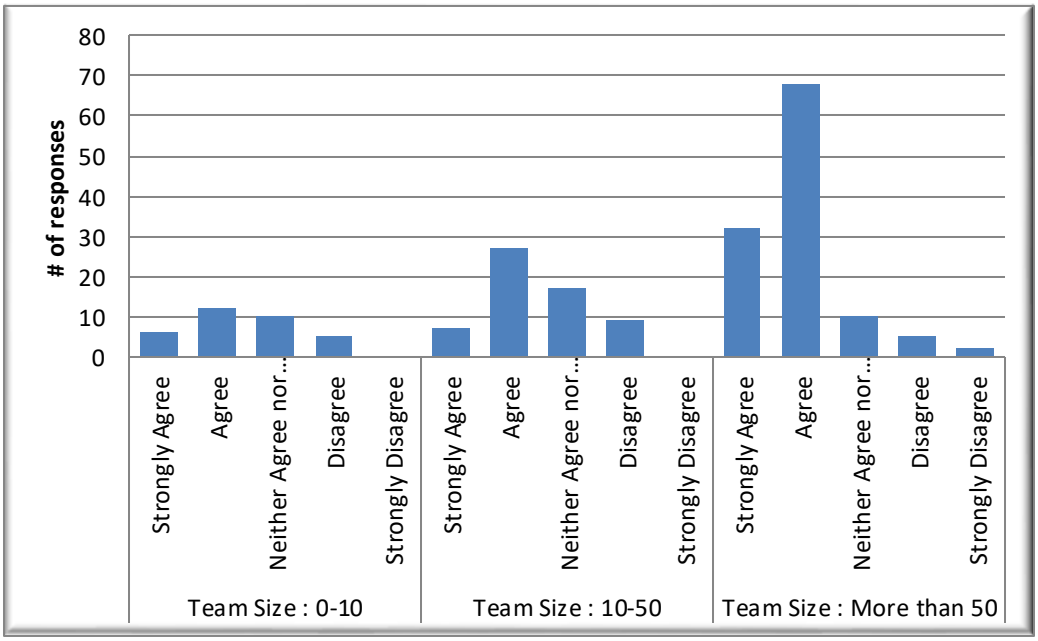

Figure 4.113: Size of the QA Dept wise analysis on distribution of "Lack of understanding about SQA oriented benefits for projects and organization from the professional" in online survey 2014.

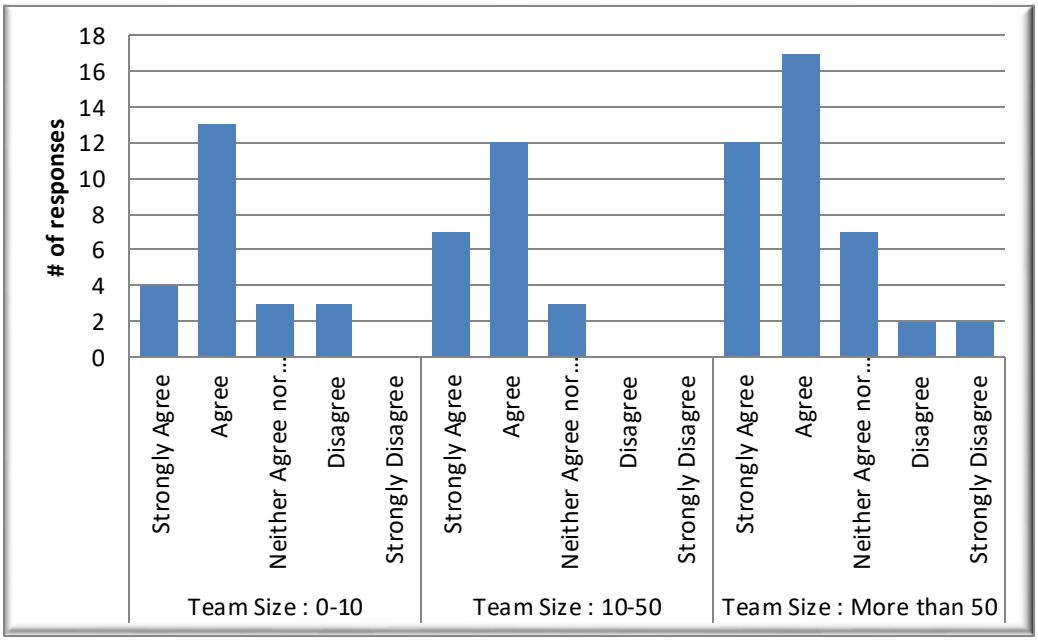

Figure 4.114: Size of the QA Dept wise analysis on distribution of "Lack of understanding about SQA oriented benefits for projects and organization from the professional" in online survey 2015.

The suggestion made to overcome this challenge in online survey was 'Reduce SQA individual's lack of understanding of quality oriented by providing awareness.' 90% and 95% of the respondents agreed to the suggestion made by the researcher in year 2014 and 2015. Table 4.42 shows the distribution of the agreeableness towards the researcher's suggestion to overcome the challenge.

Table 4.35: Distribution of suggestion made to overcome 'Lack of understanding about SQA oriented benefits for projects and organization from the professional' challenge in online survey 2014 and 2015.

	Year 2014			Year 2015		
Solution Description	**Agree**	**Neutral**	**Disagree**	**Agree**	**Neutral**	**Disagree**
Reduce SQA individual's lack of understanding of quality oriented by providing awareness.	90%	9%	1%	95%	5%	0%

4.1.3 Interview Results

With the intention of finding the suggestions to overcome the challenges identified, a set of interviews were conducted with the SQA higher management/experts. It was

essential to find out how the management see the identified challenges, because the 59% in 2014 and 67% in 2015 respondents were from the Engineer level. Also, their suggestions are important, because this study is related to management level and only they can implement those suggestions in an organization. Followings sections describes the agreeableness of the management towards the top ten challenges and their suggestions to overcome them.

4.1.3.1 Time

All SQA experts faced for the interview agreed that, 'Time' is a key challenge to SQA professionals in the Sri Lankan IT industry. Following are the practical suggestions they mentioned to overcome the challenge: (Please refer 'APPENDIX 4' for more details.)

- ✓ Identify number of test cases/ test scenarios for each major test areas/ objects. Based on the test execution time, place them into several blocks. (e.g., test cases that are take 5 minutes to execute in block A, test cases that are take 10 minutes to execute in block B, etc.) Based on the blocks, come up with an effort to execute all the identified test cases/ scenarios. With the available time line, test team can priorities the execution of blocks with the use of risk based testing methodology. Test teams can have series of Q&A session to get clarify the requirements. If not can made the necessary assumptions for unclear points while estimating the execution times.
- ✓ Mandated to do two-level of estimations. First is to do the high level estimation, when get the initial requirement. Once the requirement document is finalized by the BA, need to do another detailed level estimation. Need to decide the exact delivery date for all the delivering features after the second level estimation. Within the estimation process, have to include the complete WBS to avoid missing certain requirements.
- ✓ Introducing 'Acceptance Test Driven Development' methodology. Similar to what test team does when practicing Test Driven Development by using Acceptance Test Driven Development, test team writes the tests before the code. Instead of writing a specification as a static document, test team create an executable specification that will run the code to be written and that can be refactored and refined.

- ✓ When proposing the estimates, it is important to highlight all the identified risk factors to all project stakeholders. Deliverables, commitment that are given to client need to be justified. Predict the number of defects and test cycles based on the competency level of the development team at the early stage. Also, can add a multiplier for the effort based on the team capability level. (10%-15%)
- ✓ When requesting additional testing time from the client/ higher management, always show them the value and expected quality level after allocating additional time. Follow practices, processes and historical data.
- ✓ When the development team took more time to develop and acquired time from the QA testing time, get together and come with collaborative plan. While developing can start testing, invest on automation activities, add some additional resources achieve deadline. Also, use proper QA methods that give rise to better development quality.
- ✓ When approved get the number hours to QA, check the available resources, get clear about the quality expectation from the client and scope the QA (services can do and align resources).
- ✓ Like in agile, QA activities should happen parallel to the development and rest of the other activities. As well as the final test point. Make the QA activities more crashing to the early part of the development life cycle. Highly recommend DevOps methodology.
- ✓ When have a deadline/ end date, test teams have to work and plan the things backwards. Need to come up with strategies to deliver the product within the timeframe.
- ✓ In early testing phases use breath first approach/ methodology. Skim through the important functionalities/ basic flow (smoke test) with the objective of finding high critical/ important issues early as possible.
- ✓ Sharing the test knowledge with the developers at early stages to get a quality releases early by empowering them. Issues will be fixed before you get the release. Prevention is always better than cure.

Also, the experts agreed to the below suggestion made by the researcher in the online survey;

- Accept only feasible project deadlines and defer non-feasible deadlines.

4.1.3.2 Budget

Most of the SQA experts faced for the interview agreed that, 'Budget' is a key challenge to SQA professionals in the SL IT industry. Following are the practical suggestions they mentioned to overcome the challenge; (Please refer 'APPENDIX 4' for more details.)

- ✓ Proper assessment of these resources needs to be happened at the planning stages of the project. This is about better project planning that includes QA/QC planning. This will avoid expensive mistakes.
- ✓ When proposing the estimates, it is important to highlight all the identified risk factors to all project stakeholders. Deliverables, commitment that are given to client need to be justified. It is important for the QA manager to provide multiple options available and their pros and cons to senior management and let them pick the most feasible option.
- ✓ Introducing 'Acceptance Test Driven Development' methodology. Similar to what test team does when practicing Test Driven Development by using Acceptance Test Driven Development, test team writes the tests before the code. Instead of writing a specification as a static document, test team create an executable specification that will run the code to be written and that can be refactored and refined.
- ✓ Use test automation, where lot of regression testing effort can be reduced by this. Automated testing tools require a significant investment in product selection, staff training, implementation, and maintenance. Only after repeated use will the management begin to see an ROI for testing tools. At the early stages of projects, determine if the project is a candidate for test automation. The key is to understand the true purpose and value of test automation.
- ✓ There is a way to do good job and there are always ways to do a better job. Doing a better job (in this case, increased effectiveness and efficiency in QA) requires various resources, such as human resources, tools, environments, etc. Which means, more cost to the project or company. Management need to be convinced that QA is a vital component to the project and important of finding defects. Convince client to reduce the resources with the time by applying innovative and creative approaches.

- ✓ Make sure developer value the QA involvement for the project. Also, they need to demand quality. This is about productivity (how fast you can send to the market.)

Also, the experts agreed to the below suggestion made by the researcher in the online survey;

- ➢ Provide proper SQA resources regardless of profit margin, e.g., people, tools, environments, etc.

4.1.3.3 Lower salary scale compared to other IT professions

SQA experts faced for the interview had mixed feelings about this challenge. Some were neutral and some were disagreeing with this. Following are the practical suggestions they mentioned to overcome the challenge; (Please refer 'APPENDIX 4' for more details.)

- ✓ Hiring more technical oriented professional for testing activities. Interview can consist with more technical related questions. This will avoid the entering of button pushers to the QA industry. Also, this will make the professional that who capable of doing more than developers.
- ✓ Introduce mapping to different designations (engineer, lead, manager) with 3 levels apprentice (associate), practitioner and master level. All the tracks (DEV/QA/BA/PM) will be mapped to these levels (intention of creating more uniform levels).Within these uniform levels, average salaries are very similar. When recruiting the people, need to standardize for same level people with common competencies (communication/ leadership/ domain knowledge) and same scales will be used to evaluate.
- ✓ Give the exposure to the QA member for all the disciplines they get a chance to climb the organization ladder soon as a successful individual. Also, educate them to perform more effective testing/ QA with the proper skills.
- ✓ Provide good foundation level training for lower level professional. Because of this, they become good QA professionals in the market.
- ✓ Increase the value in front of the management compared to the developers. More in technical aspect. This will increase the individual's confident level to perform a key role in the project team.

- ✓ Encourage and empower the professional to be specialized in a niche area like automation, performance, mobility and security testing.
- ✓ Encourage and empower the professional to be a domain specialist for QA (telecommunication, healthcare, banking, HR, etc.) and professional will be allocated to domains. Because management expected more from the end user perspective testing in future.
- ✓ It is important for QA professionals to educate and understand how their salary is determined in their company (e.g., in an IT consulting firm, it'll be based on the respective billing rate). Therefore, it is up to each individual, to take necessary efforts to increase their billing rate.
- ✓ Human resource department should involve the strategic planning and management of employees to create a productive and motivated workforce.

Also, the experts agreed to the below suggestion made by the researcher in the online survey;

- ➢ Recruit SQA people who have the necessary level of expertise.

4.1.3.4 Lack of specialized SQA people

Again most of the SQA experts faced for the interview agreed it is a key challenge to SQA professionals in the SL IT industry. Following are the practical suggestions they mentioned to overcome the challenge; (Please refer 'APPENDIX 4' for more details.)

- ✓ Develop specialized SQA professionals by providing necessary on the job trainings and they are need to be done for both technical and domain aspects.
- ✓ Get the intern or people who have less than 2-3 years of experience. And train them about the SQA technologies as specialized testers. And hire only the right people into QA industry during the interviews.
- ✓ This is all about how management builds the competency within the organization. Identify areas for a year, (automation, performance, security, mobility and cloud testing) and organized internal trainings and get the external trainers to do trainings. Make sure the competency build within the company.
- ✓ Professional also needs to invest some time to achieve this. Because forcing them to become specialized QA will not going to work. This is more

successful when put a collaborative effort with the support of developers and implementation engineers.

- ✓ Introducing more QA related modules at degree level. And giving them the awareness about the QA. Hence undergrad curriculum in universities should be modified to cater this. Also, these courses should include more practical aspects and hands on sessions compared to the theory portion. Students should be given assignments to develop automation suites or performance test scripts, etc. When these fresh grads join a company, this practical knowledge will enable them to start working directly in a automation project or performance project (initially with the help of senior resources). This will reduce the burden on companies having to spend more time and money on training the fresh grads from ground up.

Also, the experts agreed to the below suggestion made by the researcher in the online survey;

- ➢ Develop specialized SQA professionals by providing necessary technical training.

4.1.3.5 Migration of experienced SQA people

SQA experts faced for the interview had mixed feelings about this challenge. Some were agreed and some were neutral with this. Following are the practical suggestions they mentioned to overcome the challenge; (Please refer 'APPENDIX 4' for more details.)

- ✓ Promote succession planning within the teams and organization.
- ✓ This is happen because of lack of opportunities within the organization or country. Hence, empower professional to persuade new opportunities by encouraging doing more innovative.
- ✓ Most of the migrant workers have travelled from Asia with dreams of earning a better living. But many find themselves housed in squalid conditions, exploited by corrupt people. Awareness sessions need to be provided for experience QA professional. Provide the quality of the life by changing the thinking patter of the experienced people.
- ✓ Provide onsite working opportunities. This will help to individual to get aware the real picture of the outside IT world.

- ✓ Promote more IT entrepreneurship programs in country. And educate the professional about the real picture of the future.
- ✓ Facilitate cross track transfers (QA to PM), where applicable. If the organization have onsite client, branches at the migrating country then professional can refer to them.
- ✓ We have a large talent pool in the local industry, which can learn the required skills. However, due to reasons mentioned above, appreciation of their contribution has led to this situation. Higher management should always encourage and appreciate the experience professional to perform with a work-life balance.
- ✓ Use migrated people as remote consultant to the organization to use their specialized knowledge.
- ✓ Need to minimize the human factor and introduce more test automation tools for regular tasks and maintain a good knowledge base within the organization.

Also, the experts agreed to the below suggestion made by the researcher in the online survey;

- ➢ Increased standard of living for the skilled SQA resources.

4.1.3.6 Lack of people management skills

All SQA experts faced for the interview highly agreed it is a key challenge to SQA professionals in the SL IT industry. Following are the practical suggestions they mentioned to overcome the challenge; (Please refer 'APPENDIX 4' for more details.)

- ✓ Everyone wants to get the technical skills improved, and very few want to improve the managerial skills. Recommend suitable and competent people to get the MBA/ PMP and sponsored by the company. And give more exposure to the management side.
- ✓ Provide in house training programs on leadership, client management, team management. And give more exposure to the management side. Also, improve the soft skills of the professional by introducing communication and presentation trainings.
- ✓ Encourage more extra activities other than QA activates within the organization or industry to get the management skills.

- ✓ Given the opportunity to potential professional to handle the team and clients, encourage other professional. Fundamentals of project management should be taught to them. They should be trained on how to be assertive – saying 'yes' to everything a client asks is not always a good approach.
- ✓ It is vital to identify the resources with right skill sets and attitude to be groomed to the next level. These resources should be closely mentored (pairing/ shadowing with a senior resource is a good approach). Introducing buddy program, where senior individual will work with junior member who have the potential.

Also, the experts agreed to the below suggestion made by the researcher in the online survey;

- ✓ Provide on the job trainings with the leadership on people management.

4.1.3.7 Lack of understanding of the QA benefits from the higher management

SQA experts faced for the interview had mixed feelings about this challenge. Some were disagreed and some were neutral with this. Following are the practical suggestions they mentioned to overcome the challenge; (Please refer 'APPENDIX 4' for more details.)

- ✓ Educate and showcase the higher management about the risks benefits cost benefit based on the past figures, statistics, case studies related to other companies, how they leverage the QA and convince the management. Unfortunately, if there is no QA representation at that level (e.g., Manager/ Director QA, etc.). It will be a daunting task for a relatively junior resource to educate the senior management.
- ✓ Requesting management to pass down the quality expectations to the other Dev/ marketing/ sales/ accounts/ HR/ department as well. And, have quality goals when setting organization goals in corporate level. Have integrated quality goals.
- ✓ QA manager has to be a sales person to selling the QA. Should not expect a formal set up (with lot of infrastructure to support QA). Should aim to achieve this in a long run. Need to find out the simplest way to communicate to the management. Use real world and practical examples to educate about the QA value.

- ✓ QA manager should involve in process and deliverables related discussions. And need to input for process optimization areas. Try to become a part of decision making (should be able to enforce for risk mitigation actions).
- ✓ Implement dashboards for the management (risk and effort related to the activities). Giving the innovative numbers related to QA to the management in a way that they understanding. Especially in term of defects.

Also, the experts agreed to the below suggestion made by the researcher in the online survey;

- ✓ Keep the higher management informed by having weekly, monthly progress review or awareness meeting.

4.1.3.8 Less SQA involvement in the requirement gathering phase

SQA experts faced for the interview had mixed feelings about this challenge. Some were disagreed and some were neutral with this. Following are the practical suggestions they mentioned to overcome the challenge; (Please refer 'APPENDIX 4' for more details.)

- ✓ Use tools like Smart Office, where you can come up with a SRS template. When the SRS is done, it is automatically providing the user stories in the back and uploaded to TFS.
- ✓ Have QA and BA in a same department. QA do BA work and BA do QA work. Ask BA to share or do sessions at or near to completion of requirement gathering. Encourage Q&A session needs to be happening. By doing this, increase the QA and BA collaboration. At least get a recorded audio from the requirement gathering phase.
- ✓ Introducing 'Acceptance Test Driven Development' methodology. Similar to what test team does when practicing Test Driven Development by using Acceptance Test Driven Development, test team writes the tests before the code. Instead of writing a specification as a static document, test team create an executable specification that will run the code to be written and that can be refactored and refined.
- ✓ Company higher management has to be made aware, about where the QA need to be start. Companies' SDLC/ QMS should be revised in order to

mandate the QA team (at least the QA lead) to be involved, right from the beginning of the project.

- ✓ QA should read about the domain to improve it, during the client calls/ meetings need an actively participation to show the value.
- ✓ Select few implementation project and work hard on them and show the benefits to the management. (without working/ selecting all the projects) When the project requested for another implementation, replicate the same model.
- ✓ Use varies metrics to understand the requirement clarity level. Process need to be tuned to highlight the requirement gaps if exists. Instruct to log defects for requirements. This will encourage professional to log defects from the requirement phase by this.
- ✓ When the test design is done, there should be a review meeting with BA and DEV teams. It'll help to identify the requirement gaps.
- ✓ At least on a rotational basis, QA professional need to position onsite/ client site. Need to improve the communication channel between QA, support engineer and product owners.

Also, the experts agreed to the below suggestion made by the researcher in the online survey;

- ✓ Facilitate SQA representation on requirement gathering phase.

4.1.3.9 High turnover due to the industry competition

SQA experts faced for the interview had mixed feelings about this challenge. Some were agreed and some were neutral with this. Following are the practical suggestions they mentioned to overcome the challenge; (Please refer 'APPENDIX 4' for more details.)

- ✓ This is because of there is no mechanism to generate enough number of QA people to the industry. Make sure the professional not get the same opportunities they get internally from the same role have in external organization.
- ✓ Have work life balance and HR partner should concerns about this factor. Based on the contribution you get the benefit portion. This should not base on

the role or any other factors. Need to have proper control and management on the benefit providing.

- ✓ As a management always believe 'if we look after the people well, they will look after the business'. Creating the company work environment, where people like to live. Attract people through HR related activities. Encourage family type of culture within the team and organization.
- ✓ Facilitate tuition/ certification reimbursement, regular team outings, holiday allowances, if you utilize your annual leave, hotel bills will be paid by the company under conditions.
- ✓ Initiate collaborative and organized training sessions across the industry. And authority should give to try out new things and to grow.
- ✓ Identify top talent people by based on different criteria's and keep them as the core team. When the core team is there, can train another set of new people easily.
- ✓ Rotate the professional on the job, to reduce the dependency. And have one to one mapping for professional wherever possible.
- ✓ Drive people with new technologies and methodologies. And make more capable to mitigate the challenge. People should feel their importance within the team and organization.
- ✓ QA manager should be a good mentor with a god direction. (What to do/ How to do) need to have good standards. Professional should learn something new from their management (not only coding and manual testing) but how they manage a situation.
- ✓ Recruit people who can sustain for at least 2 years' time. If the number is low, management needs to fix as an organization. As companies will have to be innovative in order to attract the experienced and talented resources.
- ✓ Give professional new challenges, new technology experiences, and latest trend in the IT industry. By doing this, keep the professional busy with new activities.

Also, the experts agreed to the below suggestion made by the researcher in the online survey;

- ✓ Provide relevant reword, recognition and compensation to reduce turnover.

4.1.3.10 Lack of understanding about SQA oriented benefits for projects and organization from the professional

All SQA experts faced for the interview agreed it is a key challenge to SQA professionals in the SL IT industry. Following are the practical suggestions they mentioned to overcome the challenge; (Please refer 'APPENDIX 4' for more details.)

- ✓ Do proper goal settings for professional early as possible in project life cycle. Have a performance goal/ expectation agreement and get signed off by the individual. Have parameters to check individual's competency like time to log a defect, UAT to live environment defect ration, number of complaints, etc.). And individual make aware what they are getting tracked.
- ✓ For each and every project rolling out, there should be a checklist. PM and Manager are accountable to communicate project expectations to all the team members. (Quality expectations/ timelines need to communicate at the beginning.)
- ✓ Make organization goals align with the department goals, department goals are align with the project level goals, all of those goals are align with individual level goals. That level of transparency, tracking should be there. Make sure individual aware what the value the organization dealing with the client/ end users.
- ✓ Create a descriptive job description for each individual. And educate the professional about the value they adding to the project or an organization.
- ✓ Improve the professional' attitude about the future demanding areas. Because demanding will be very less for manual tester in future.
- ✓ Advice newly joins professional to the industry to do continuous learning within first 5 years. And tolerate the problems with the thinking of the good future yet to come in next year's.
- ✓ Professional should be rewarded based on the number of defects that they eliminated from the system, not the removed from the system.
- ✓ Empower professional to earn the reputation through adding more value to the company. As an example QA individual can help developers to check their development by giving them the regression test automation suite to run easily.

Also, the experts agreed to the below suggestion made by the researcher in the online survey;

- ✓ Reduce SQA individual's lack of understanding of quality oriented by providing awareness.

4.2 Summary of results

Results of preliminary and online survey were beneficial to identify the top ten challenges faced by the SQA profession in Sri Lanka. A summary of the online surveys ranks and distributions related to challenges are showing in table 4.18 for both year 2014 and 2015. Even though the order of identified top ten challenges are not same for the year 2014 and 2015, they received more than 70% agreeableness from the respondents for both years.

Table 4.36: Summary of online survey challenges for 2014 and 2015.

Challenge Description	Year - 2014				Year - 2015			
	Rank	Distribution			Rank	Distribution		
		Agree	Neutral	Disagree		Agree	Neutral	Disagree
Time	1	89%	5%	6%	1	95%	5%	0%
Budget	2	80%	13%	7%	3	89%	5%	6%
Lower salary scale compared to other IT professions	3	79%	14%	7%	5	88%	8%	4%
Lack of specialized SQA people	4	79%	14%	7%	4	88%	7%	5%
Migration of experienced SQA people	5	77%	19%	4%	9	79%	18%	3%
Lack of people management skills	6	77%	14%	9%	8	81%	14%	5%
Lack of understanding of the QA benefits from the higher management	7	77%	14%	9%	2	93%	4%	4%
Less SQA involvement in the requirement gathering phase	8	76%	16%	8%	6	86%	6%	8%
High turnover due to the industry competition	9	75%	22%	3%	7	84%	12%	5%
Lack of understanding about SQA oriented benefits for projects and organization from the professional	10	72%	18%	10%	10	76%	15%	8%

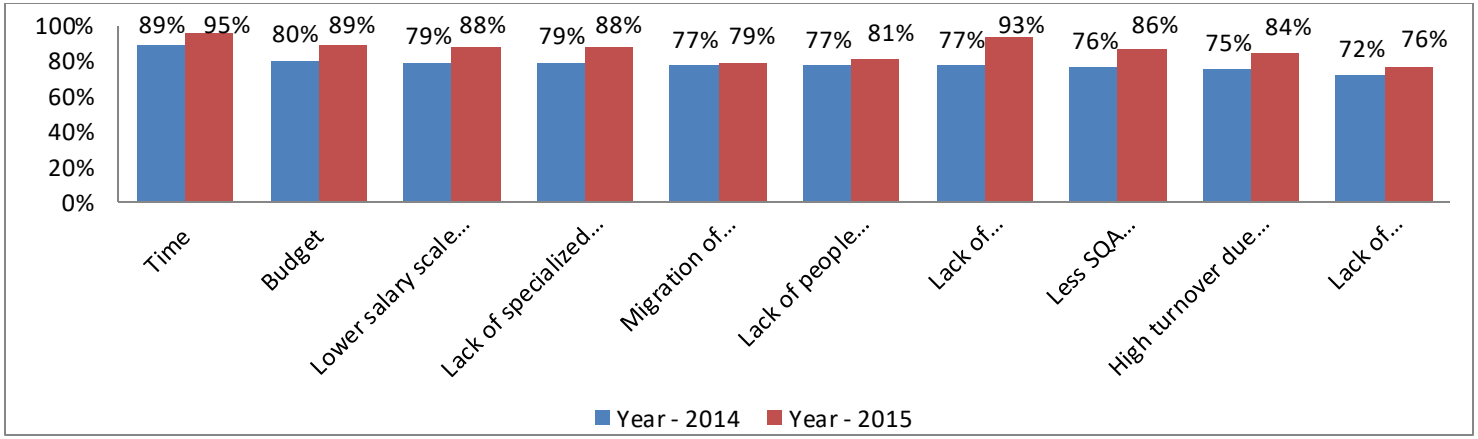

Figure 4.115: Analysis on agreeableness towards the challenges in 2014 and 2015.

A summary of the online surveys distributions related to suggestions to overcome above top ten challenges are showing in table 4.19 for both year 2014 and 2015.

Table 4.37: Summary of suggestions based on online survey for 2014 and 2015.

Challenge Description	Suggestion Description	Year - 2014			Year – 2015		
		Distribution			Distribution		
		Agree	Neutral	Disagree	Agree	Neutral	Disagree
Time	Accept only feasible project deadlines and defer non-feasible deadlines.	80%	15%	5%	88%	10%	2%
Budget	Provide proper SQA resources regardless of profit margin, e.g., people, tools, environments, etc.	80%	15%	5%	92%	6%	2%
Lower salary scale compared to other IT professions	Recruit SQA people who have the necessary level of expertise.	84%	11%	5%	88%	12%	0%
Lack of specialized SQA people	Develop specialized SQA professionals by providing necessary technical	98%	2%	0%	99%	1%	0%

	training.						
Migration of experienced SQA people	Increased standard of living for the skilled SQA resources.	91%	7%	2%	95%	4%	1%
Lack of people management skills	Provide on the job trainings with the leadership on people management.	95%	4%	1%	95%	5%	0%
Lack of understanding of the QA benefits from the higher management	Keep the higher management informed by having weekly, monthly progress review or awareness meeting.	91%	8%	1%	91%	9%	0%
Less SQA involvement in the requirement gathering phase	Facilitate SQA representation on requirement gathering phase.	97%	2%	1%	96%	4%	0%
High turnover due to the industry competition	Provide relevant reword, recognition and compensation to reduce turnover.	90%	9%	1%	96%	4%	0%
Lack of understanding about SQA oriented benefits for projects and organization from the professional	Reduce SQA individual's lack of understanding of quality oriented by providing awareness.	90%	9%	1%	95%	5%	0%

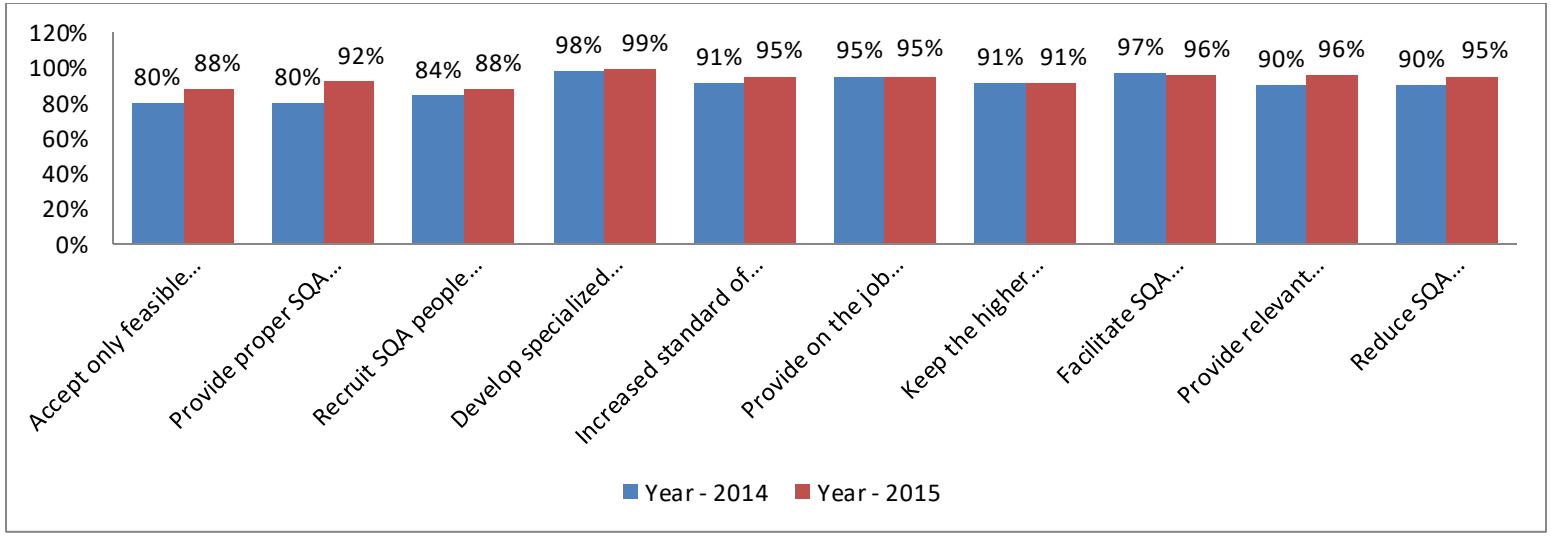

Figure 4.116: Analysis on agreeableness towards the suggestions in 2014 and 2015.

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

This chapter discuss the conclusion and recommendations based on the research findings. Section 5.1 describes the Evaluation of the research objectives. Section 5.2 gives a summary of the research findings and analysis. Sections 5.3 to 5.4 describe the limitations, recommendations and future directions respectively.

5.1 Evaluating the Objectives

This section describes how the researcher used the preliminary survey, online survey and interviews to achieve the research objectives.

5.1.1 Objective 1: To identify the top ten challenges faced by the software quality assurance professionals in Sri Lankan IT industry

To achieve this objective online survey was used to filter out the top ten challenges faced by the SQA professionals. From the literature review phase and preliminary survey findings 16 key challenges were identified. Online survey was used to evaluate the identified challenges using percentage and weighted scale approaches. To evaluate the objective, survey responses were analysed in different approaches and viewpoints. Most of the challenges identified during the survey were due to the lack of understanding about the value addition from the SQA to an organization. Due to the pressure made by the client/customer, management most of the time compromise the quality and try to go for a win-win situation. But in the long run, this is damaging the image of the organization and may lead to losing valuable customers. Another reason is that the management does not foreseen the risk related the product/project. Client/customer always plays the major role and only a very little negotiation can be done by the organization end. Brain drain is another biggest challenge, not just in Sri Lanka, but any growing economy is facing. Mostly, this will be out of control for any organization. Due to these challenges, country is not having sufficient number of skilled/specialized QA resources to cater the incoming project opportunities. The research findings are listed in Section 4.2 and Table 4.43.

5.1.2 Objective 02: To identify and present recommendation and suggestion to overcome the identified top ten challenges

To achieve this objective online survey and interview sessions was used to filter out the key suggestions identified through the literature review phase and preliminary survey findings. Interviews were conducted with the SQA experts who are having vast experience in implementing strategies in IT industry. The major limitation identified is due to various reasons most of the organizations are not looking at the SQA related problems from the individual's end. Even though some of the suggestions are pretty straight forward, management is not willing to implement them due to losing their benefits. Most of the challenges related to professionals can be solved if the salary, compensation and appreciation issues are addressed. The research findings are listed in Section 4.2.3 and in Table 4.43.

5.2 Summary of Contributions

SQA profession is an emerging job category, where a large number of new opportunities foreseen in the future IT industry. The programming/software engineering category still has the highest share among job categories but it has reduced to 21% in 2013 from 26% in 2009. However, its share remains as high as 36.7% in ICT companies followed by SQA (16%), jointly occupying more than half of the workforce in ICT companies. SQA is a vital department for any IT organization, because it has an on-going process within the SDLC that routinely checks the developed software to ensure it meets desired quality measures.

According to the research finding SQA professionals in the Sri Lankan IT industry face various challenges. Hence, it is necessary to implement the required management strategies to avoid/overcome those challenges. Organization's management should always focus on the benefits that can be derived from the SQA in the long run of the business. Businesses are established to make money as quickly as possible and at the highest possible margins. If they compromise the quality for the short term advantages, soon they are going to lose the market share and customer credibility in the long run.

SQA experts highlighted that project managers or respective managers do not consider the QA effort that is required due to either not understanding the role of QA or lack of information from QA department/team. Hence, the SQA management or the leadership should always showcase the value of the SQA interaction towards the project/organizations to the management. This will solve most of the challenges faced by the SQA profession. Also, the management should provide appropriate benefits to the potential professionals to increase their standard of living. This will encourage the rest of the professional to achieve the required competency level.

There are similarities and differentiation between the results of the Pakistan study conducted by AshfaqQazi et al. (2012) and the author's study in Sri Lanka. In both the studies time, budget, lack of specialists, and team formation for requirement gathering were identified as challenges. Less use of quality standards, project durations, and compromise on quality to less profit, developer's attitude and politics were unique to Pakistan context. Lower salary scale, migration of experienced SQA people, lack of people management skills, lack of understanding of the QA benefits from the higher management, high turnover and lack of understanding about SQA oriented benefits for projects and organization challenges were unique to Sri Lankan context. Table 5.1 lists the challenges identified in Pakistan and Sri Lanka separately. Even the both countries belong to Asian IT market, there is a significant different between the identified challenges faced by the SQA community which could be due to the different levels of industrial maturity.

Table 5.1: Challenges identified in Pakistan and Sri Lankan contexts.

Sri Lankan Context	**Pakistan Context**
Time (e.g., presence of unrealistic project deadlines	Time
Budget (e.g., less allocation of SQA people, tools, environments, etc.)	Budget
Lower salary scale compared to other IT professions	Less use of quality standards

Lack of specialized SQA people (e.g., performance, automation, security testers)	Lack of specialists
Migration of experienced SQA people	Project durations
Lack of people management skills (e.g., team, client management)	Compromise on quality due to less profit
Lack of understanding of the QA benefits from the higher management	Developer's attitude
Less SQA involvement in the requirement gathering phase	Team formation for requirements gathering
High turnover due to the industry competition	Politics
Lack of understanding about SQA oriented benefits for projects and organization	

5.3 Limitations

The major limitation of this study was due to the time limitation to gather sufficient data. Due to this matter there could be several limitations in the study. The representativeness of the sample is a limitation of this study as not all organizations were included in the sample. The honesty of the respondents will have a major effect on the findings of the study. That will limit the observing 100% accurate results.

5.4 Recommendations

As stated in research objective, it is essential to present the identified recommendations and suggestions to the potential SQA management. By using content analysis, following key recommendations were identified (detailed recommendations are listed in Section 4.2.3):

- Perform risk-based effort estimation for QA tasks during the project planning.
- Management should apply innovative and creative ideas for projects with the limited resources.
- Use specialized testing activities like test automation.
- Improve the value addition to the project/organization.
- Management should build the competency within the organization using on the job trainings.

- Introduce SQA to undergraduate level as a subject where the courses should include more practical aspects and hands on sessions compared to the theory portion.
- Promote more entrepreneurship and cross track transfers.
- Identify the people who have the potential to become leaders and promote leadership building programs.
- Educate and showcase the higher management about the risks, costs, and benefit based on the past figures, statistics, and case studies.
- Company process need to be tuned to highlight the requirement gaps if exists and metrics related clarity of the requirements.
- Provide salary, compensation, and appreciation for potential/competent candidates.
- Improve the transparency about the organization quality objectives to the whole organization.

5.5 Future Work

Challenges faced by the SQA professionals in SL IT industry is a broad area. It is an interesting and worthwhile to study on SQA profession as it is a growing profession in Sri Lanka. The following aspects are some suggestions for future research which are related to SQA profession.

- Conduct focus group interviews to discuss factors in an open forum. (This is helpful to identify more effective suggestions as an industry.)

- Compare challenges among different countries related to different regions. (This approach will helpful to identify whether challenges are different from region to region and the reasons for those changes. The overcoming methods may also differ from region to region; therefore regions can use new methods for future work.)

- Evaluate how the challenges affect to the individual's productivity. (This will help employers to improve the employee's productivity by implementing the

appropriate/ necessary suggestions for the optimal/ selected challenges. Further, this will bring lot of benefits the employer to improve the organization as a whole)

- Consider other professional categories like Software Engineer, Business Analysis, Project Managers, Support Engineers, DB Administrators, Network Administrators, etc. (It's important to identify the challenges and suggestions to overcome those challenges for other professional categories in the IT industry. By improving the other professions, SQA profession can obtain more benefits. Hence those suggestions can be taken as indirect overcoming methods for SQA challenges.)

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APPENDIX 1 – PRELIMINARY SURVEY QUESTIONNAIRE

This is a pilot survey for my MBA research on 'Analysis to Improve Software Quality Assurance Profession in Sri Lankan IT Industry'. Please fill out this survey as honestly and in as much details as possible. It will really help me to design the expected guideline to improve the Software Quality Assurance (SQA) profession. Thanks and Appreciate your valuable inputs.

-Section A-

Level in the organization?*Required

- Executive Management
- Middle Management
- Tactical Management
- Engineer / Executive

Type of your company?*Required

- Product Development
- IT Services
- Both

Target Market?*Required

- Local Market
- Overseas Market
- Both

Size of the QA Department?*Required

- Less than 5
- 5-10
- 10-20
- 20-50

50-100

More than 100

-Section B-

- **How you have defined SQA in your organization?**

- **How important SQA for/in your organization?**

- **What are your main challenges in current role? (High Important)*Required**

- **As per your experience what are the challenges faced by SQA professionals in industry? (High Important)*Required**

- **What are your suggestions to overcome those challenges? (High Important)*Required**

- **Do you have any experiences in implementing those suggestions, if so please briefly explain?**

- **What are the improvements you can suggest for Sri Lankan SQA industry, when compared to other companies in Asia?*Required**

- **What would you expect future to be like for SQA professionals? (High Important)*Required**

- **Do you think Sri Lankan SQA professionals are in a position to face the future? Why?**

- **Anything else you like to share?**

It is a great help if you can provide further feedback by participating for a follow up survey. Pleas provide you email address if you wish to participate in follow up survey.

APPENDIX2 – ONLINE SURVEY QUESTIONNAIRE

Dear Friends,

We are conducting a research study to analyse the challenges faced by the Software Quality Assurance (SQA) profession in Sri Lanka. As a member of the Sri Lankan SQA community, we are inviting you to participate in this study by completing the following questionnaire. It will take about ~15 minutes to complete the survey.

This survey is stipulated confidential and anonymous. Your responses will not be identified with you personally and all findings will appear in aggregated form. You and your organization will not be linked in any manner.

Survey Link: https://docs.google.com/forms/d/1qpZeCDepVY0f4ZQig01EXj-DFPGQ9ev1M3eEUQzDqpA/viewform

Your participation in the research would be greatly appreciated. If you have any queries or wish to know more please feel free to contact us using the details provided below.

Thank you very much for your time and help in making this study possible.

Sincerely,

Kumindu Dias and Dilum Bandara

kumindu777@gmail.com & dilumb@cse.mrt.ac.lk

+94 772269581

Dept. of Computer Science and Engineering,

University of Moratuwa

1. To what extent do you agree with the following challenges related to software quality assurance profession? *

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Time (e.g., presence of unrealistic project deadlines)					
Budget (e.g., less allocation of SQA people, tools, environments, etc.)					
Lack of specialized SQA people (e.g., performance, automation, security testers)					
Less emphasis on quality standards (e.g., no CMMI, ISO, and other maturity models)					
Compromise quality for certain customers (e.g., lower SQA resource allocation for local projects)					
Developers' negative perception on SQA contribution					
Less SQA involvement in the requirement gathering phase					
Presence of internal politics					
Migration of experienced					

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
SQA people					
Lack of people management skills (e.g., team, client management)					
Difficulty in simultaneously serving multiple projects					
High turnover due to the industry competition					
Lack of understanding about SQA oriented benefits for projects and organization					
Lack of desired level of expertise (e.g., IT degree, certification, etc.)					
Lower salary scale compared to other IT professions					
Lack of understanding of the QA benefits from the higher management					

2. Any other challenges that you may have experienced/observed? *

3. To what extent do you agree with the following suggestions to overcome the challenges faced by SQA profession? *

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Accept only feasible project deadlines and defer non-feasible deadlines					
Provide proper SQA resources regardless of profit margin, e.g., people, tools, environments, etc.					
Deploy process models like CMMI, ISO, etc.					
Develop specialized SQA professionals by providing necessary technical training					
Provide equal SQA priorities for all local and foreign projects without compromising on quality					
Improve developer attitude by the organizing training sessions and workshops held by the					

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
management					
Facilitate SQA representation on requirement gathering phase					
Politics should not affect the quality of a software					
Increased standard of living for the skilled SQA resources					
Provide on the job trainings with the leadership on people management					
Provide cross-domain trainings to serve multiple projects					
Have a SQA pool of people to serve multiple projects					
Have different SQA structures to serve multiple projects					
Provide relevant reword, recognition and compensation to reduce turnover					
Reduce SQA individual's					

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
lack of understanding of quality oriented by providing awareness					
Recruit SQA people who have the necessary level of expertise					
Introduce more SQA related training and exams					
Keep the higher management informed by having weekly, monthly progress review or awareness meeting					
Demonstrate quality improvements by using SQA metrics					
Decrease dependencies in SQA (e.g., encourage developer testing prior to release to SQA)					

4. Any other suggestions for addressing the issues faced by the SQA profession. Please also mention the challenge(s) that can be overcome by applying your suggestions. *

5. Do you have any experiences in implementing the above any suggestion(s), if so please briefly explain. *

6. Level in the organization? *

- (•) Executive Management
- ( ) Middle Management
- ( ) Tactical Management
- ( ) Engineer / Executive

7. Gender? *

- (•) Male
- ( ) Female

8. Type of your company? *

- ( ) Product Development
- ( ) IT Services
- ( ) Both

9. Target Market? *

- ( ) Local Market
- ( ) Overseas Market
- ( ) Both

10. Size of the QA Department? *

- ( ) Less than 5
- ( ) 5-10
- ( ) 10-20
- ( ) 20-50
- ( ) 50-100
- ( ) More than 100

It is a great help if you can provide further feedback by participating for a follow up interview. Pleas provide you email address if you wish to participate in follow up interview.

APPENDIX 3 – INTERVIEW QUESTIONNAIRE

Dear Sir/ Madam,

I'm Kumindu Dias - A student at University of Moratuwa, MBA in IT 2012 batch. And I'm currently heading the QA department at hSenid Business Solutions (PVT) LTD.

I have conducted a survey for my MBA research on "**Analysis to Improve Software Quality Assurance Profession in Sri Lankan IT Industry**". Through the survey, I have identified the main 10 challenges faced by the SL SQA community and I'm in progress of identifying the solutions to overcome those challenges.

Appreciate if you can provide me your valuable inputs to complete this study by providing an appointment to have an interview with you. Further, I'm planning to record the interview for my reference and the details will be kept as confidential.

Please let me know the possibility.

Many thanks in advance.

Kumindu Dias

+94772269581/ +94722304078

1. Details of the contacted person

Name:
Designation:
Company Name:
Email Address:
Contact Number:

2. Details of the company

Type: (Product Development/ IT Services/ Both) Target Market Segment: (Local Only/ Overseas Only/ Both) Size of the QA Department:

3. What is your agreeableness (agree/ neutral/disagree) and suggestion(s) to overcome following challenges faced by the SL SQA profession?

   a. Time (e.g., presence of unrealistic project deadlines)

   b. Budget (e.g., less allocation of SQA people, tools, environments, etc.)

   c. Lower salary scale compared to other IT professions

   d. Lack of specialized SQA people (e.g., performance, automation, security testers)

e. Migration of experienced SQA people

f. Lack of people management skills (e.g., team, client management)

g. Lack of understanding of the QA benefits from the higher management

h. Less SQA involvement in the requirement gathering phase

i. High turnover due to the industry competition

j. Lack of understanding about SQA oriented benefits for projects and organization

4. Any other suggestions to improve this study?

APPENDIX 4 – INTERVIEW RESULTS

Challenge	Interviewer Profile	Suggestions/ Recommendations
Time	Expert 01	- When proposing the estimates, identified and highlighted all the risk factors, and quantified them, and clearly communicated to the client. (For a particular module, this many number of hours we have to spend, will be identifying this many number of changes, for that we will required this much of time. Per change we have identified the time. If it exceeds, contact the client and tell the additional time we required. Posting the CRs and get the time and budget approved. - Identifying number of test cases for each module. Put them into 3 buckets. (3-4 mins, 7-8 mins, 12 mins) based on the time came up with the effort. Have series of Q&A sessions, and made assumptions for the points are not clear. Projected the number of defects based on the competency level of the development team. - For additional hours have meeting with clients and get the budget approved for the things beyond our control. - Showing the expected quality level after allocating this much of time and budget. - When the developers take QA time, we get together and come with collaborative plan. While developing we doing QA, invest on automation, add some additional resources to overcome. - Sometime we have to compromise the quality and go for win-win situation. - Follow practices, processes and historical data. - When we get the number hours to QA, check the available resources/ get quality expectation from the client/ scope the QA (service can do, align resources,) also show the client if you give me this much additional time, these are the things I can include, these are the risk I can mitigate, this is the quality level I can achieve.
	Expert 02	- We can make the QA activities more crashing to the early part of the development life cycle. - Like in agile QA activities should happen parallel to the development and rest of the other activities. As well as the final test point. - Highly recommend DevOps methodology. Testing activities divided by the other team members like developers and BA. - Use risk based methodology and executes the most critical test scenarios when you have a limited time.

	Expert 03	- The issue of not allocating enough time in the project plan is with the PMs, who do not consider the QA effort that is required due to either not understanding the role of QA or lack of information from QA team. Usually the problem with the deadline comes as a result of additional testing cycles required due to poor development quality. The solution is in proper QA (not QC) methods that give rise to better development quality.
	Expert 04	- Very little negotiation can do with the client in IT. - Always have to figure out creative ways to overcome this. - When you have a deadline/ end date, you have to work and plan the things backwards. Need to come up with strategies to deliver the product within the timeframe. - Every deliverables, commitment you give to client need to be justified. Risks need to be highlighted upfront. - QA individuals should educate how to safe guard them self and team from this challenge. - Identify challenges and dependencies upfront.
	Expert 05	- Most of the time end date set by the customer is not negotiable. - Can negotiate only on features we are going to release. - Customer doesn't understand what they really need and the dependencies having with the existing system. - Use test automation where applicable. (specially for regression testing) - Mandated to do 2 levels of estimations. 1st is to do the high level estimation, when get the initial requirement. Once the requirement document is finalized by the BA, need to do another detailed level estimation. Need to decide the exact delivery date for all the delivering features after the 2nd level estimation. - Within the estimation process, have included complete WBS to avoid missing certain requirements. - When doing estimation, can add a multiplier for the effort based on the team capability level. (10%-15%) - When estimating need to have a proper mechanism to track the timings. This help management to prove the effort to the higher management as well as client. - Introduce internal set of tools to cut down the process related activities. By doing this can automate test design, test case design, test case creation.

	Expert 06	- Grooming individuals to give proper estimations for project planning. - While giving estimations, use resprospective. This is helping you to assess yourself and identify the true velocity and efficiency rate. Also can identify the same criteria's for the team. - perform expert judgment for estimations. - Test automation can help for regression testing effort. - Prioritization test scenarios. - Use breath first approach/ methodology. Can skim through the important functionalities/ basic flow (smoke test) with the objective of finding high critical/ important issues early as possible. - sharing the test knowledge with the developers at early stages to get a quality releases early by empowering them. Issues will be fixed before you get the release. Prevention is always better than cure. - Have planning poker approach.
	Expert 07	- Understandably there is always a critical path to everything, a path that you just can't skip ahead. This is true for SW projects as well. Therefore, if pressured by the senior management or project manager, it is very important for the respective QA Manager/ Lead to explain how Brooks' law applies in this context and not agree to any unreasonable timelines.

Budget	Expert 01	- When proposing the estimates, identified and highlighted all the risk factors, and quantified them, and clearly communicated to the client. (for a particular module, this many number of hours we have to spend, will be identifying this many number of changes, for that we will required this much of time. Per change we have identified the time. If it exceeds, contact the client and tell the additional time we required. Posting the CRs and get the time and budget approved. - Identifying number of test cases for each module. Put them into 3 buckets. (3-4 mins, 7-8 mins, 12 mins) based on the time came up with the effort. Have series of Q&A sessions, and made assumptions for the points are not clear. Projected the number of defects based on the competency level of the development team. - For additional hours have meeting with clients and get the budget approved for the things beyond our control. - Showing the expected quality level after allocating this much of time and budget. - When the developers take QA time, we get together and come with collaborative plan. While developing we doing QA, invest on automation, add some additional resources to overcome. - Sometime we have to compromise the quality and go for win-win situation. - Follow practices, processes and historical data. - When we get the number hours to QA, check the available resources/ get quality expectation from the client/ scope the QA (service can do, align resources,) also show the client if you give me this much additional time, these are the things i can include, these are the risk i can mitigate, this is the quality level i can achieve.
	Expert 02	- Use test automation a lot, where lot of regression testing effort can be reduced by this. (test automation decision should accurate from the business perspective should be give correct ROI and test automation scenarios has to be technically feasible) - Get the developers to do the most of the testing. Trying get the more quality code out of the developers. (test driven development) - People don't understand the value of the QA. So better to justify the ROI. Have discussion with the people who are allocating budget with more dollar terms. Justify the resource requirement into more ROI equation. (driving ROI of QA)

	Expert 03	- Again the issue is with lack of understanding of 'what is required' with respect to QA/QC. My experience is that no proper assessment of these resources happens at the planning stages of the project. At times the QA team is to be blamed as they fail to come up with tangible plans to convince the PMs on the risks of not following proper QA/QC as relevant to the specific project. The solution is to have better project planning that includes QA/QC planning.
	Expert 04	- Management need to be convinced that QA is a vital component to the project and important of finding defects. - Convince client to reduce the resources with the time by applying innovative and creative approaches. Like adding tools related automation. - Management should apply innovative and creative harnesses with the limited resources. This will help to cut down the resource but the amount of work is same.
	Expert 05	- Convince the management by showing the value of QA.
	Expert 06	- Convince the management by showing the value of QA. - Make sure developer value the QA involvement for the project. Also they need to demand quality. This is about productivity (how fast you can send to the market.) - Need to have a proper recognition from the rest of the organization.
	Expert 07	- There is a way to do good job and there are always ways to do a better job. Doing a better job (in this case, increased effectiveness and efficiency in QA) requires various resources, such as human resources, tools, environments, etc. Which means, more cost to the project or company. Therefore, it is vital to educate the senior management to understand this. On the other hand, QA team can't afford to sit idle until all the desired tools and resources are available, to start their work. It is important for the QA manager to provide multiple options available and their pros and cons to senior management and let them pick the most feasible option.
Lower salary scale compared to other IT professions	Expert 01	- Hiring developers (Interview consist with more technical questions)(4 sections technical/ 2 sections manual test) - Have BA/ DEV/ PM members within the QA team. - Give the exposure to the QA member for all the disciplines they get a chance to climb the latter soon. - Convince the value addition/ proposition to the PM/ higher management.
	Expert 02	- Right comparison need to do be done in technical rules(Avg dev. and Avg qa capabilities carries) - It's a value discussion. People who add comparable value always paid comparable value. - Increase the value in front of the management compared to the developers. More in technical aspect. - Always make the individuals that who capable of doing more than developers.

	Expert 03	- This is due to lack of understanding of the value that QA teams bring to projects, by the PMs. However, the poor quality of the QA professionals is also a reason, since a lot of them lack the proper skills to conduct effective testing/QA. In most projects, QA team appears to be playing the 'second fiddle' to developers. This is not necessarily due to lack of skills, but mostly due to lack of confidence and assertiveness to play a key role in the project team.
	Expert 04	- Focus more on senior resources. - Provide good foundation level training for lover level individuals. Because of this, they become good QA professionals in the market. - Need to recognize the people who stay with the company for 4-6 years, other than the people who left the company and coming back. - top tiers salary need to be competitive with the market value. - need to demand a higher salary from the individuals. need to know the new trends and tools for this demand. - need to be specialized in an niche area like automation, performance, mobility and security. - need to upgrade yourself constantly on new technologies. - need to be a domain specialist for QA (Telco, healthcare, banking, etc.) and individuals will be allocated to domains. Because management expected more from the end user perspective.
	Expert 05	- Individuals also need to responsible for their salary scales. People who don't have calibre to do development and expected level of the QA get low salary at the beginner level and later complain to the management. - Need to improve the technical and domain knowledge. - Need to improve the value addition to the project or organization. - Introduce mapping to deferent levels (engineer, lead, manager) and 3 levels apprentice (associate), practitioner and master level. all the tracks will be mapped to these levels. (intention of creating more uniform levels) within this uniform levels, average salaries are very similar. - When recruiting the people, need to standardize for same level people with common competencies. (communication/ leadership/ domain knowledge) Same scale will be used.
	Expert 06	- Need to come up with new strategies to make QA life easier. - Try to signify yourself by going beyond traditional manual testing and performing grey box testing techniques. - Empower the individuals to meet the required competency level. - Show it by example as a manager to prove that they have done the things better.

	Expert 07	- Professionals in SL QA community can be categorized in to various groups based on skill levels experience levels, performance levels, etc. Therefore, QA salary cannot be and should not be generalized. Different specializations should be identified (e.g.; Test Automation, Performance Testing, etc.) and remuneration should be decided accordingly. - There should be a sufficient salary band (lower and upper band), within each level/ designation. This will allow the management to provide required salary increments for high performers. - On the other hand, it is important for QA professionals to understand how their salary is determined in their company (e.g.; in an IT consulting firm, it'll be based on the respective billing rate). Therefore, it is up to each individual, to take necessary efforts to increase their billing rate.
Lack of specialized SQA people	Expert 01	- Need to have basic concepts of IT and include SQA modules in to degree. Or specialized on SQA in 4th year. - Have in-house trainings. - Get the intern or people who have less than 2-3 years of experience. And train them about the SQA technologies.
	Expert 02	- Those who are coming to the QA, because you hate development. - Always make the individuals that who capable of doing more than developers. - Hire only the right people into QA during the interviews.
	Expert 03	- This is a fundamental problem. It is not just 'having the skill' (which can be learnt quickly) but knowing how to apply it properly to the relevant situation (e.g. application of these techniques in waterfall is different from agile)
	Expert 04	- All about how management build the competency within the organization. - lot of initiatives need to be done related to these areas. - Identify areas for a year, (automation, performance, security, mobility and cloud testing) and organized internal trainings and get the external trainers to do trainings. Make sure the competency build within the company. - should not force individuals to become specialized QAs. Individuals also need to invest some time to achieve this.
	Expert 05	- Internally on the job trainings need to be done. Both technical and domain. - Put collaborative effort with the support of developers and implementation engineers.

	Expert 06	- Individuals should see the current threat of industry right now. They should know their competency level to face the demand. - Training programs will not help to build people. It's all about the learning they get on the job within the organization. - Training people to do POC for some extent and allow them to do real time activities. - Introducing more QA related modules at degree level. And giving them the awareness about the QA.
	Expert 07	- Lack of skilled/ specialized QA resources is a genuine challenge, countries like SL face. It would be a bigger challenge if it has to be tackled at company level. Rather it should be tackled at the industry level. There should be initiatives to identify the 3 or 4 main specialized skills. Undergrad curriculum in universities should be modified to cater this. These courses should include more practical aspects and hands on sessions compared to the theory portion. Students should be given assignments to develop automation suites or performance test scripts, etc. - When these fresh grads join a company, this practical knowledge will enable them to start working directly in a automation project or performance project (initially with the help of senior resources). This will reduce the burden on companies having to spend more time and money on training the fresh grads from ground up.
Migration of experienced SQA people	Expert 01	- Not going to stop migration. - Happen because of lack of opportunities.
	Expert 02	- Happen because of lack of opportunities. - Provide the quality of the life. - Change the thinking patter of the experienced people. - Encouraging to doing the more innovative. - Promote more entrepreneurs. - Cross track transfers. (QA to PM)
	Expert 03	- We have a large talent pool in the local industry, which can learn the required skills. However, due to reasons mentioned above, appreciation of their contribution has led to this situation.
	Expert 04	- Educate the individuals about the real picture of the future. - Provide more opportunities within the organization.
	Expert 05	- If the organization have onsite client, branches at the migrating country then individuals can refer to them. - Use migrated people as remote consultant to the organization to use their specialized knowledge. - reduce the impulse to get migrate by reducing the interaction. - Succession planning.
	Expert 06	- Need to minimize the human factor and introduce more test automation tools for regular tasks.

	Expert 07	- Brain drain is one of the biggest challenges, not just SL, but any growing economy is facing. Mostly, this will be out of control for any company. If this needs to be reduced, there needs to be large scale initiatives and funding taken by SL government.
Lack of people management skills	Expert 01	- Everyone wants to get the technical skills improved, very few want to improve the managerial skills. - recommend few people to get the MBA and sponsored by the company. - In house training programs on leadership and management. - Sending abroad to get certain trainings. - facilitate to participating conferences.
	Expert 02	- Giving more/ maximum exposure to the management side. - Encourage more extra activities other than QA activates to get the management skills.
	Expert 03	- As mentioned before, the lack of soft skills is a primary reason for the poor showing of QA teams in the local industry.
	Expert 04	- Individuals should market themselves. Not only technical achievement. - Educate and get some trainings to the individuals on how they can deal with the team and client. - by giving the opportunity to potential individuals to handle the team and clients, encourage other individuals. - Get external trainers for training and mentoring on communicational and presentation skills. - introducing buddy program. Senior will work with junior members who have the potential. - Leadership building program. Identify the people who have the potential to the leadership. Buddy them with the senior people.
	Expert 05	- Start internal trainings. - Introduce specific trainings for QA people on leadership, client management, team management. - Trainings need to be categorized and customized depending on the generation.
	Expert 06	- Sending people for PMP trainings and workshops. - Empowering and giving freedom next level leaders to deal with matter without the involvement of managers. And use them as the method of communication stream to the team. And ask them to collaborate with the team. - introducing communication and presentation trainings.
	Expert 07	- Any leadership role requires team/ client management skills. It is vital to identify the resources with right skill sets and attitude to be groomed to the next level. These resources should be closely mentored (pairing/ shadowing with a senior resource is a good approach). Fundamentals of project management should be taught to them. They should be trained on how to be assertive – saying 'yes' to everything a client asks is not always a good approach.

Lack of understanding of the QA benefits from the higher management	Expert 01	- Educate and showcase the higher management about the risks benefits cost benefit based on the past figures, statistics, case studies related to other companies, how they leverage the QA and convince the management. - From the objective itself convincing the management should happened at the beginning. - Requesting management to pass down the quality expectations to the other Dev/ marketing/ sales/ accounts/ HR/ department as well. - Having quality goals when setting organization goals in corporate level. Have integrated quality goals.
	Expert 02	- QA manager has to be a sales person. Selling the QA. - Should not expect a formal set up (with lot of infrastructure to support QA). Should aim to achieve this in a long run.
	Expert 03	- This is also due to the reasons mentioned above and the solution is better organization and management of QA teams.
	Expert 04	- Educate the management. - Management should focus on the Quality and its' importance. - Need to find out the simplest way to communicate to the management. Use real world examples to educate about the value.
	Expert 05	- Get more practical examples for the management to convince and explain the difference. - Manager should involve in process and deliverables related discussions. And need to input for process optimization areas. - implement dashboards for the management. (risk and effort related to the activities). - trying to become a part of decision making. (should be able to enforce for risk mitigation actions)
	Expert 06	- Need to give the quality visibility to the higher management and other rest of the organization. - Giving the innovative numbers related to QA to the management in a way that they understanding. Specially in term of defects.
	Expert 07	- Educating the senior management is the only option. Unfortunately, if there is no QA representation at that level (e.g.; Director QA, etc.). It will be a daunting task for a relatively junior resource to educate the senior management.
Less SQA involvement in the requirement gathering phase	Expert 01	- Have QA and BA in a same department. QA do BA work and BA do QA work. - Tools like smartoffice, where you can come up with SRS templates. When the SRS is done, it's automatically provides the user stories in the back and uploaded to TFS.

	Expert 02	- Company senior management has to be made aware, about where the QA need to be start. - QA should read about the domain to improve it, client need and like a BA actively participate for discussion. - Select few implementation project and work hard on them and show the benefits to the management. (without working/ selecting all the projects) When the project requested for another implementation, replicate the same model.
	Expert 03	- Again, this relates to issues already mentioned, i.e. lack of understanding of the QA role by PMs, lack of confidence and skills of QA folks etc.
	Expert 04	- Use varies metrics to understand the requirement clarity level. - Process need to be tuned to highlight the requirement gaps if exists. - Instruct to log defects for requirements. Encourage people to log defects from the requirement phase by this.
	Expert 05	- Ask BA to share or do sessions at or near to completion of requirement gathering. And Q&A sessions need to be happened. (need to be mandated) - Need to increase the QA and BA collaboration. - When the test design is done, there should be a review meeting with BA and Dev teams. It'll help to identify the requirement gaps.
	Expert 06	- Ask individual to use their leisure time to educate more on the application, domain, integration points. - Ask individuals to get feedback on the clarifications and enhancement on the system. - Use quality time at the early stages of the project life cycle. - At least on a rotational basis, QA individuals need to position onsite/ client site. - Need to improve the communication channel between QA and product owners. - Need to improve the communication channel between QA and support engineers. - Get a recorded call from the requirement gathering phase.
	Expert 07	- Companies' SDLC/ QMS should be revised in order to mandate the QA team (at least the QA lead) to be involved, right from the beginning of the project.

High turnover due to the industry competition	Expert 01	- Treat people well, give lot of freedom, pay well, give required opportunities. - make sure the individuals not get the same opportunities they get internally from the same role have in external organization. - have work life balance. HR concerns about this factor. - believe 'if we look after the people well, they will look after the business' as a management. - give lot of benefits, hence they get profit share. based on the contribution you get the bonus portion. not based on the role or any other thing. - Holiday allowance, if you utilize your annual leave, hotel bills will be paid by the company under conditions. - Tuition/ certification reimbursement. - Regular team outing. - Foreign trips for annual trips. - Need to have proper control and management on the benefit providing.
	Expert 02	- This is because of there is no mechanism to generate enough number of QA people to the industry. - Control the outflow. - Increase the inflow. - Having collaborative and organized training sessions across the industry.
	Expert 03	- If the salary/compensation/appreciation issue is addressed, this can be resolved
	Expert 04	- Identify top talent people by based on different criteria's and keep them as the core team. When the core team is there, can train another set. - Rotate the individuals on the job, to reduce the dependency. - Have 1 to 1 mapping for individuals wherever possible.
	Expert 05	- Driving people with new technologies and methodologies. And making more capable to mitigate the challenge. People should feel their importance. - Authority should be given to try out new things and to grow. - QA manager should be a good mentor with a god direction. (what to do/ how to do) need to good standards. - Individuals should learn something new from their management. (not only coding and manual testing) How you manage a situation.
	Expert 06	- Creating the company work environment, where people like to live. - Attract people through HR related activities. - Recruit people who can sustain for at least 2 years times. If the number is low, management need to fix as an organization. - Encourage family type of culture. - Give them challenges, new technology experiences, latest trend in the industry. - Keep the individuals busy with new activities.

	Expert 07	- Industry competition will be good for the QA profession; as companies will have to be innovative in order to attract the experienced and talented resources.
Lack of understanding about SQA oriented benefits for projects and organization from the individuals	Expert 01	- Have a performance agreement and get signed off by the individual. - There are parameters to check. (# of time to log a defect, UAT to Live defect ration, # of complaints). Individual aware what they are getting tracked. - For each and every project rolling out, there is a checklist with 21 items. PM and Lead is accountable to communicate project expectations to all the team members. (quality expectations/ timelines need to communicate at the beginning.) - (7 geeks)organization goals align with the department goals, department goals are align with the project level goals, all of those goals are align with individual level goals. that level of transparency, tracking should be there. Recognition also there. - Individuals get gifts at monthly company meetings.
	Expert 02	- This is because of narrowly defined scope for the QA individuals. If the management can ask to own the entire responsibility of the qualify to the individual. - Creating a descriptive job description. - Experience QA professionals should not attempt give them a wrong model.
	Expert 03	- If the salary/compensation/appreciation issue is addressed, this can be resolved
	Expert 04	- Educate the individuals about the value they adding to the project or an organization. - Demanding will be very less for manual tester in future. - Improve the individuals' attitude about the future demanding areas. - Do proper goal settings for individuals early as possible. - Advice new people to do continuous learning within first 5 years. And tolerate the problems with the thinking of the good future yet to come in next years.
	Expert 05	- Need to improve the transparency to the whole team. - Make sure what the value the organization dealing with the client/ end users. - defect finding and fixing effort need to be educate to the individuals.

	Expert 06	- Empower them to have their own quality standards. - Individuals should be rewarded based on the number of defects that they eliminated from the system, not the removed from the system. - Introduce a contest like 'like a bug', where the individual get rewarded at the end of each month. This show the clarity of the defects. - Empower individuals to earn the reputation through adding more value to the company. - help developers to check their development by giving them the regression test automation suite to run easily.
	Expert 07	- Educating the senior management is the only option. Unfortunately, if there is no QA representation at that level (e.g.; Director QA, etc.). It will be a daunting task for a relatively junior resource to educate the senior management.