IMPACT FACTORS OF SOFTWARE TEST GOVERNANCE IN SRI LANKAN IT INDUSTRY

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DECLARATION

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ABSTRACT

In software development, software testing is one of the most important mechanisms for delivering high-quality products. It has been widely used in the software development industry over the last decade, as most software organizations have recognized the importance of testing. However, in most companies testing procedures are not standardized or aligned with their business strategies. Therefore, it is vital to properly govern the software testing processes as it affects the quality of product delivery and, as a result, customer satisfaction.

Software test governance is about establishing rules and processes that organizations should follow, which helps to execute testing activities easier and effectively. It aligns software testing with business goals and objectives and enables the decision-making of the management. Implementation of test governance provides an explicit way of managing the individuals, procedures, and technology involve in the software testing process.

This study aims to identify factors that influence software test governance. To achieve the objective of the study, a broad literature review and preliminary interviews with senior testing professionals were conducted and identified five different factors namely implementation of a clear test policy, defining explicit test strategies in organization-wide and specific program-wide, the establishment of a distinct testing unit, implementation of test training and mentoring programs, and, implementation of software test process auditing and reviews. A conceptual model was developed using identified variables and five hypotheses were built based on the conceptual model. An online survey was distributed among software test practitioners to gather sample data to test the formulated hypotheses which enable to prove whether there are associations between the identified variables and test governance. Statistical analysis was performed for the evaluation. The research findings reveal all these factors have strong relationships with software test governance. When considering the five identified influences, implementation of test process auditing and reviews has the comparatively highest influence, whereas creating a separate unit of test organization has the comparatively lowest influence.

Keywords: Test governance, test policy, test strategy

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LIST OF ABBREVIATIONS

IT	-	Information Technology
QA	-	Quality Assurance
ISTQB	-	International Software Testing and Quality Board
SDLC	-	Software Development Life Cycle
TMMi	-	Test Maturity Model Integration
CMMI	-	Capability Maturity Model Integration
ANOVA	-	Analysis of Variance
ICTA	-	Information and Communication Technology Agency

1. INTRODUCTION

1.1 Background

Software testing is widely regarded as one of the most important aspects of the software industry. Most organizations realize the need for improvements in the current software testing practices and align them with their strategic business goals. One of the major reasons for project failures can be identified as a lack of test management and control activities (Farooq & Dumke, 2008). Also, due to factors such as time, cost, and lack of resources, there is a risk of achieving software testing goals. Identify factors that can mitigate such risk is the key to achieving successful software testing (Whyte & Mulder, 2011).

Zhang, Onita, and Dhaliwal (2014) explain the importance of having distinct units for software testing and development for successful project delivery. In the current software industry, there is a gap between software testing and test management. To bridge the gap between these key factors for the success of IT projects, governance can be introduced into software testing. The importance of ensuring a high-level mechanism of monitoring activities related to the test management from the corporate level to the individual project level has the ability to maximizing the quality of software development. Software test governance leads to alignment with quality standards and influences effective software testing as well as the development in software organizations (Bertolino & Polini, 2009).

Different positive impacts can be identified by implementing a proper test governance process at the organizational level. While testers will be able to concentrate entirely on testing with less pressure, they will gain a better awareness of the organization's goals and objectives, as well as the software being tested. By establishing internal capacities, appropriate tools, and efficient processes, test governance will allow both testing and development to formulate and execute their strategies.

Several studies agree that governance of software testing is considered as a strategic alignment of testing with development which leads to maximized quality in software development. From this mechanism, the value of software development can be maximized by introducing and retaining successful control and accountability. In

terms of the characteristics of good governance, test governance delineates process and practices to meet the strategic testing goals and objectives while allocating the ownership of the software testing decision-making between the software engineering professionals and monitoring the strategic decisions regarding software testing (Zhang et al., 2014).

Recent studies outline that test governance has impacts on three different layers in the software industry namely organizational, group and individual. The organizational impact will make an effect on software quality, the value of testing as well as the testing and development alignment. On the other hand, concerning group impact, it will lead to strategy alignment, capability alignment and, etc. The individual perspective will increase the trust among project development team members and job satisfaction as well. All these discussions direct people into realizing the importance of test governance. Dolezel (2013) proposed a test governance framework that divides responsibilities and activities into three categories namely strategic, tactical and operational test management.

Although it is important to adhere to such standards in software organizations, there is a lack of research done regarding test governance and its relationship with the organization's software development strategy. This research study is focused to understand the elements of software testing which has an influence on test governance in the Sri Lankan context. The IT sector in Sri Lanka significantly contributes to the growth of its national economy. According to the National IT-BPM workforce survey in 2019, 17.25% of the ICT workforce possess the quality assurance job category. Therefore, understanding how the test governance works and provide suggestions to improve the process which will be valuable to Sri Lankan IT organizations to grow their positions in the IT market is an essential requirement.

1.2 Motivation

Software testing is widely used in the software development industry in this decade as most organizations realized the value of testing. But the structures and processes are not standardized and align with business strategy in most organizations. Governance is one of the most vital factors in successful software development and there exists

ample research literature, investigating different governance areas such as corporate governance, IT governance, and project governance. But only a few researchers studied governance on software testing. It is vital to properly govern the software testing processes as it affects the quality of product delivery hence customer satisfaction.

Understanding the importance of test governance and the factors in software testing that influence governance in testing will ensure increased transparency in decision making, increased control and accountability, risk mitigation, and proper resource utilization in testing and it will provide strategic direction to the business.

1.3 Research Scope

The study involves identifying elements that influence software test governance and find the use of these practices in Sri Lankan software organizations. The factors affecting software test governance were identified over the literature review as well as by conducting preliminary interviews with senior software test professionals such as test leads and test managers. Independent and dependent variables are identified and the relationship between those was examined. Required data for the study was collected through an online questionnaire and a sampling technique was used to understand the sample. Collected data were analyzed using the tool SPSS and analyzed the data to determine the reliability and to identify the correlation between variables.

1.4 Problem Statement

Although software testing is recognized as a more vital element of software development and has a positive relationship with software quality, there is a gap between software testing and software management and control. Several Studies show quality control problems are one of the main reasons for project failures. The question of how software testing should be coordinated at the strategic, tactical, and operational levels should be addressed by test governance that combines software testing with development. Implementing proper test governance in the organization will make sure all the testing activities are aligned with the organization's strategic direction to ensure the effective integration of development and testing.

This research study intends to identify components that influence successful software test governance in the Sri Lankan context and identify the usage of these components. The study will demonstrate the importance of having a test governance framework to ensure to reach high-level application quality.

1.5 Research Objectives

The study mainly focuses on achieving the below objectives.

1. Evaluate governance in software development and understand how it uses in software testing
2. Identify elements that influence software test governance
3. Understand the use of identified elements in the software industry
4. Provide recommendation to improve software test governance

1.6 Research Significance

This study is focused on identifying ways to improve software test governance which leads to quality product delivery as well as effective decision making in software development projects. Also, it will enable the administration and control of software testing activities throughout the organization.

At the end of the research, we will be able to understand how the test governance help to achieve organizational strategic objectives and identify factors that stimulus software test governance.

1.7 Conclusion

This chapter describes the background of the study, motivation for the research, problem trying to solve which lead to finding factors influence software test governance in software organizations, and objectives of the study.

2. LITERATURE REVIEW

2.1 Concept of Governance

Governance term is broadly used in many contexts; the business world as corporate governance, the IT industry is referred to as IT governance, in the project context as project governance, and so on. Existing literature used different terms to describe the 'Governance' concept. One of the major explanations says while governance structure directs executives to effective decision-making, also seeks to mitigate the risk of conflicts and inconsistencies between organizational processes and resources (Muller, 2009). Moreover, governance is about imposing, controlling, and administering a set of rules and regulations, policies, and responsibilities through a diverse network of relationships and interactions (Bertolino & Polini, 2009).

Related to an agile software project, Talby (2014) introduces governance as an iterative process of decision making in terms of project goals taken by different roles based on policies and metrics. There is a contradiction of defining governance structure as an incremental process since governance should be imposed across the organization not only at the project level.

Definition of roles and obligations, ensuring timely and accurate disclosure is made, risk management, control and monitoring, decision-making, achievement and efficacy, ethics, accountability, coordination mechanisms and strategy implementation are all characteristics of good governance (Kelly, 2010). Good governance enables better decision-making in an organization. It increases the transparency of decision-making, by establishing the organization's standards, policies, and goals to ensure secured work practices and improved quality of final products ("Sparx Systems", 2019). However, governance structure fails in some organizations, since personal objectives and plans can override the organizational objectives hence leads to project failures. Although there is a properly implemented governance framework, all the stakeholders should be informed and followed with the same mindset.

The importance of governance structure has been highlighted in several types of research such as high return on assets of organizations that have stronger governance (Bannerman, 2010), increased transparency in the decision-making process, enables

monitoring and controlling over the organization processes (Zhang, Onita & Dhaliwal, 2014).

The governance framework can be implemented through different stages ("Sparx Systems", 2019).

1. Establishing the principles
2. Process planning
3. Implementing governance
4. Monitoring the process

2.1.1 Types of governance in the software industry

The following section describes different governance areas which can be found in the corporate environment.

- **Corporate/enterprise governance**

Corporate governance involves the satisfaction and interest of the company's stakeholders such as shareholders, senior management executives, suppliers, customers, etc. It is about making structure to direct, administer and control corporations (Bannerman, 2010). It helps to ensure the organizational goals and objectives are achieved, risks are properly managed, and resources are used responsibly by providing a strategic direction to the business (Bertolino & Polini, 2009).

- **IT governance**

Corporate governance can be divided into subcategories and IT governance is one of such categories where IT and enterprise are strategically aligned through successful IT control and accountability, management of performance and risk. This will lead to the maximization of the business value (Webb, Pollard & Ridley, 2006). To aid this, responsibilities of IT governance, divide across different stakeholders from team leaders to their managers to executives to board of directors (Abbas, 2009).

IT governance scope is defined with the elements of alignment with the organization's business strategy, management of risk, performance and capability, IT-enabled business value delivery, control and accountability (Bannerman, 2010).

Weill and Ross (2004) explain three questions to ask when defining IT governance.

1. What decisions will be taken to ensure that IT is efficiently managed and utilized?
2. Who should be responsible for making those decisions?
3. What methods will be used to make and monitor these decisions?

Although this is defined to describe IT governance, it can be generally used to address governance in different aspects.

- **Project governance**

Another subcategory of corporate governance is project governance. According to Muller (2009), project governance is the process of determining project policies, roles, and procedures based on the interest of stakeholders which enables them to achieve organizational objectives by coordinating and controlling projects successfully.

2.2 Software Testing Approaches

Software testing plays a major role in terms of delivering quality products. There is no argument that it is one of the main factors of success in software development organizations. Various software testing practices are established in software organizations that align with their software development strategy. Maintaining and controlling testing processes have become a part of the responsibilities in software organizations. Software testing activities and approaches are different in many companies in terms of effectiveness and efficiency and most of them usually follow an ad hoc fashion. (Garousi, Felderer & Hacaloglu, 2017).

2.3 Test Governance

Although there are previous studies, related to software testing practices, tools, and techniques, methodologies, only a few studies discussed software testing governance. Bertolino and Polini (2009) suggest that test governance is about establishing rules and processes that organizations are capable of following, which facilitates the efficient and effective execution of testing activities. The importance of test governance is not only for testing activities but also for software development companies it highly influences the quality of the final product by aligning with the organization's quality standards. Using literature on IT governance as a foundation, Zhang et al. (2014) defined software testing governance as the presence of leadership and administration, integration of different organizational processes and procedures to enforce software

development strategy. In more detail, it is about dividing software testing decision-making ownership and responsibilities across the organization and building mechanisms and processes to monitor the strategic decisions of software testing.

Zhang et al. (2014) argue that there is a vital distinction between test governance and test management processes. While test management determines what relevant decisions on software testing are taken, test governance decides who makes decisions about software testing and how those are taken. On the other hand, IBM researchers, Cantor, Lundblad, Sinha, and Williams (2008) had presented a different idea that quality governance is the process of determining answers to five different questions which are who makes and informed decisions, what artefacts use for decision-making, when is the decisions should be made, how, and why of decision making on software testing. From there, another aspect of test governance can be disclosed, and this model helps software organizations to decide when testing is done, and quality is ensured before releasing the software product.

In summary, Software Testing Governance is a testing discipline for software product delivery. Further, it aligns with business goals and enables the decision-making of the management. Implementation of test governance provides an explicit way of managing the people, processes, and technology of the software development process.

2.4 Why is Test Governance needed?

The software test governance fills the gap between requirement management, technical issues, organization standards, and business risks. Cantor, Lundblad, Sinha, and Williams (2008) statistically proved how business risks can be mitigated using a test governance model. The software testing governance aims to define organization software testing standards that align with business strategy and provide the visibility of software product measurement and performance monitoring and evaluation to enable further improvements.

2.5 Test Governance Frameworks

From this section, our focus is to understand existing test governance frameworks introduced by various researchers and identify the associated roles and responsibilities. There are several existing research studies introducing the concept of governance into

software testing considering different aspects. Reviewing past literature, few studies recognize software testing governance frameworks.

Dolezel (2013) explains the testing governance framework for non-intensive software organisations' organizational, project-centric mechanism for controlling testing processes. Despite its domain, this framework design can be applied to organizations in the software industry by redefining their roles but responsibilities. Zhang et al. (2014) introduce the impacts of test governance activities on three different layers namely, organizational, group, and individual by considering integration of development with software testing. This emphasizes the alignment of test governance with software development strategy. Test governance roles and responsibilities are divided across the organization and these are categorized into three different levels. Table 1 shows the roles and responsibilities defined in test governance frameworks.

Table 1: Test governance framework roles and responsibilities

Test Governance Level	**Ownership**	**Responsibilities**
Strategic Level (Top layer)	Chief Information Officer	Test Goals and objectives
		Test policy
Tactical Level (Middle layer)	Chief Test Manager/Software Quality Officer	Test strategy
		Test life cycle and Integration
		Test organization
		Test training and mentoring
		QA audits and reviews
		Test process improvements
Operational Level (SDLC)	Project teams	Test planning
		Test designing and execution
		Test monitoring and control
		Test evaluation

These roles and responsibilities were defined from the fact of outsourcing testing activities in terms of non-software organizations. This helps to solve test management issues in the client organization. Despite that fact, roles should be redefined to apply to software organizations. As per International software testing standards, (International Software Testing Qualifications Board [ISTQB], 2012) ownership of test management activities can be defined as below. Table 2 represents the test governance ownership in different organizational levels.

Table 2: Test governance roles in different organization levels

Test Governance Level	Ownership
Strategic Level (Top org)	Senior test management staff Senior managers of testing stakeholder groups
Tactical Level (Middle org)	Test Manager
Operational Level (SDLC)	Test teams / Project Manager

Several organizational variables have a positive impact on the test governance process (Zhang et al., 2014). Table 3 depicts the impact of test governance in software organizations.

Table 3: Test governance impact

Organizational Level	Group Level	Individual Level
Software Quality	Strategy alignment	trust between developer and tester
Value of Testing	Capability alignment	the partnership between developer and tester
Development/Testing alignment	Social systems of knowing	job satisfaction

When developing a test governance framework in an organization, it is important to evaluate the maturity of the test process practices of the organization. TMMi Foundation (2009) explains the TMMi model that has five maturity levels organizations can achieve. Each level consists of a defined set of goals and objectives. It emphasizes going across the various maturity stages improves the potential of the test and alignment of software quality management with the overall organization's business goals. The test process strengthens as it progresses through the maturity model, from initial to managed, specified, measured, and optimized (Farooq & Dumke, 2008). TMMi model intends to evaluate the current testing processes of the organization against industry standards. One of the focus points of our analysis will be based on the maturity level, identifying the test governance activities currently being practised. Table 4 represents the TMMi maturity model below.

Table 4: TMMi maturity model

Level 1	Level 2	Level 3	Level 4	Level 5
No Defined Process Areas	Test Policy and Strategy	Test Organization	Test Measurement	Defect Prevention
	Test Planning	Test Training Program	Product Quality Evaluation	Test Process Optimization
	Test Monitoring and Control	Test Lifecycle and Integration	Advanced Reviews	Quality Control
	Test Design and Execution	Non-Functional Testing		
	Test Environment	Peer Reviews		

Bertolino and Polini, (2009) discussed establishing a test governance framework in the cross-organization level, in the context of service-oriented architecture, since these services are connected from different vendors, products, and technologies. In contrast, our study is focused on an intra-organization level analysis of test governance practices concerning the different software product domains.

2.6 Discussion

This section is focused on previous literature sources that discuss software testing activities, responsibilities, processes, practices, test management, and different testing criteria. Based on them, our research will find the factors influence software test governance in an organization and evaluate them in the context of the Sri Lankan software industry.

2.6.1 Existing software testing practices

Table 5 explains the findings of existing literature sources.

Table 5: Discussion of existing literature

Related work	Factors considered	Method Followed	Advantages	Disadvantages
Bertolino & Polini(2009) .	Service integration testing governance at the cross-organization level by enabling a multi-layer test process. Organizational test policy, test approach, project test management	Theoretical model	Introduced test layers that can be used in governance models.	Focused on cross-organization level defined policy rather than intra-organization.

	and test levels are defined as layers.			
Cantor, Lundblad, Sinha & Williams (2008)	The criteria for defining software testing is 'Done' based on the quality governance aspects. 1. **Roles** 2. **Decisions** 3. **Timing and Scheduling** 4. P**olicies** 5. **Artifacts**	Statistic based	Emphasize understanding of software delivery readiness for software testing. Business risks = Expected Cost Avoidance - Expected Value lost.	Consider statistics-based technical solutions for deciding on the cost of software testing.
Dolezel (2013)	Test Governance Framework management responsibilities divide between client and vendor organizations Responsibilities divide into three layers: Strategic, Tactical, Operational	Used TMMi maturity model as a base to define the test governance framework.	Introduced a software testing governance framework.	Focused on non-software intensive organizations to introduce software testing governance
Doležel & Buchalcevová (2015)	Proposed a system for controlling the test process of contracted software development projects that were organization-wide but project-focused.	Interviews	Test management process groups are the main focus.	Focused on contracted custom-built software development projects
Garousi & Zhi (2013).	Surveyed on software testing practices across the areas: organization type, test management, metrics, test types, techniques, test automation tools, training, the ratio rate between testers, developers, termination criteria	Questionnaire	Discussed some governance testing responsibilities such as test management, test training, and test metrics can be identified.	
Jahan, Riaz, Kashif, & Abbas (2019)	Software testing practices such as testing techniques, testing tools, test metrics, test process management, test training, and challenges were analysed.	A survey from the Pakistan IT industry	Practices that can incorporate governance processes such as test process management, test training, and decision making on termination of testing.	
Lee, Kang, & Lee (2012)	Surveyed on current practices and opportunities of software testing methods and tools Related areas of findings related to software testing methods and tools current practices low usage rate	Survey to collect organization -level practices Survey to collect software test experts' data	Able to identify focused areas when defining a survey.	

	difficulties and barriers Organizational categorization based on CMMI maturity level			
Zhang, Onita, & Dhaliwal, (2014).	Software testing governance enables integration of development with testing. 3 layers for governance Strategic level – Distinct Testing Unit Tactical level – Reporting structure of testing and development Operational level – Developers and testers are matched one-to-one.	Hypothesis testing considering two organizations that have different organizational structures.	The concept applies to software organizations as well.	The empirical study is limited only to two companies Literature is about governance mechanisms but not about test governance practices for the control and coordination of test processes.

2.6.2 Summary of software testing practices

Table 6 explains the main research findings applicable to the current study.

Table 6: Main areas identified from existing literature

Related Work	Software testing roles / responsibilities / activities / practices	Layers of Software testing practices	Organization level of test maturity	Criteria of terminating testing phase	Software Quality Metrics
Bertolino & Polini (2009)	x				
Cantor, Lundblad, Sinha & Williams (2008)				x	
Dolezel (2013)	x	x			
Doležel & Buchalcevová (2015)	x				
Garousi & Zhi (2013)	x				
Grindal, Offut& Mellin (2006)	x		x		
Jahan, Riaz, Kashif, & Abbas (2019)	x			x	x
Lee, Kang, & Lee (2012)	x		x		
Surya &Tinnaluri (2016)	x				x
Tambotoh, Isa,Gaol, Soewito & Warnars (2017)					x
"TMMi model" (2009)			x		
Veenendaal (2009)	x				
Zhang, Onita, & Dhaliwal, (2014)	x	x			

2.6.3 Models of test governance structure

There are plenty of theoretical models used to describe testing practices. The summary of available theoretical models is as follows.

Table 7: Theoretical model

Theoretical Model	**Important of use**	**Existing case studies (name and ref)**
TMMi software testing maturity model	Understand organization testing process maturity	Veenendaal (2009)
Testing Governance Framework	Organization-wide test governance practices, roles, responsibilities, and decision making	Dolezel (2013)

2.6.4 Summary of elements in software test governance

When evaluating the use of a test governance model to enable the decision-making process key responsibilities, activities and roles are identified from existing literature. The study's main emphasis is to evaluate the use of these practices in the Software industry. Table 8 represents, the summary of the identified factors.

Table 8: Summary of factors

Reference	Elements in Test Governance										Governance Roles
							Test Management				
	Test Goals / Test Mission	Test Policy	Test Strategy / Test Methodology	Test Organization	Test Training / Test Mentoring	Testing practices Audit process / Advanced Reviews	Test Planning / Master Test Plan	Test Design and Execution	Test Monitoring and Control	Test Measurement	
Bertolino & Polini(2009)		x	x				x	x	x		
Cantor, Lundblad, Sinha & Williams (2008)		x					x				
Dolezel (2013)	x	x	x	x	x	x	x	x	x		x
Doležel & Buchalcevová (2015)		x	x				x	x	x		x
Garousi & Zhi (2013).			x		x		x	x	x	x	
Grindal, Offut & Mellin (2006)			x								
Jahan, Riaz, Kashif, & Abbas (2019)							x	x	x	x	
Lee, Kang, & Lee (2012)							x	x	x		
Quadri and Farooq (2010)	x										
Surya & Tinnaluri (2016)										x	
TMMi maturity model (2009)		x	x	x	x	x	x	x	x	x	x
Veenendaal (2009)	x	x	x	x	x		x	x	x		x
Zhang, Onita, & Dhaliwal, (2014).											x

2.7 Factors Influence Software Test Governance

The following are the factors identified by the analysis of previous literature sources.

2.7.1 Test goals / test mission

Software testing processes should be associated with specific goals and objectives. These defined goals should be achievable and measurable. It is crucial to maintain the standard of software test goals of the organization which guide software development processes. All the testing professionals must be aware of the organization's testing goals before engaging with the testing activities. One of the main goals is verification and validation of the product whether it fulfils the customer requirements and provides an acceptable quality. On the other hand, due to the impossibility of exhaustive testing, testing should focus on the priority coverage which enables us to find more defects from the most critical components. Software testing processes should maintain traceability to better decision-making. Tracking what was tested and how it was tested is part of the testing process. Additionally, software testers should have a better understanding of what is doing, what is the target, and what will be the possible outcome of the testing (Quadri & Farooq, 2010).

2.7.2 Test policy

The implementation of a test policy that applies to the entire business organization is another key component of test governance. The testing policy should be consistent with the quality policy of the organization (Dolezel, 2013). Test policy is a high-level document that outlines the company's overall goals and objectives, as well as the importance of testing to the organization, approaches of evaluating effectiveness and efficiency of the testing once objectives are achieved, describes the organization test process and ways to improve test processes (ISTQB Test Manager, 2012). Responsibility for defining test policy will go for the senior quality management staff and the group of test managers. Testing professionals should have a proper view regarding the testing policy to understand organization testing standards.

The following are high-level factors included in the test policy (Veenendaal, 2009).

- Testing definition unique to the organization
- Definition of testing objectives, testing value

- Quality standards of the organization
- Distinct test organization
- Roles and responsibilities of testing
- Definition of test process improvements
- Levels of testing
- Declaration of key performance indicators to measure the performance

To establish effective and efficient processes and document in the test policy, test management staff must be worked collaboratively with stakeholders and review. Based on the business goals, testing processes can be varied, and it is important to revisit the test policy and adjust as necessary (Veenendaal, 2009).

2.7.3 Test strategy/test methodology

"The test strategy describes the organization's general test methodology" (ISTQB, 2018). A generalized description of the test process, at the product or organizational level, is provided by the software test strategy. This should explain specific strategies that are relevant to the organization's needs and fit into project operations. Although one organization can have different strategies in different contexts such as different project requirements and different levels of risks, it should be consistent with the organization's test policy. Usually, it provides generic test entry and exit criteria for the organization (ISTQB Test Manager, 2012). Grindal, Offutt, and Mellin (2006) show the lack of usage in explicit test strategies in many software organizations while some do not use them, and some have implicit strategies that are embedded in their testing process.

Test strategy is one of the initial documents associated with test policy, which guides the decision-making process. Organizations that do not follow proper test strategies may have inconsistencies in product quality in different projects. Another drawback of lacking a test strategy is organizations may need to depend on key persons in those projects to achieve business goals. Hence adhering to test strategy in the testing process is crucial to achieving the success of the software development.

The following are some of the key areas that can be included in the test strategy (Veenendaal, 2009).

- List of risks and mitigation of risks
- Test levels
- Objectives and responsibilities
- Test case design techniques and testing types
- Entry and exit criteria
- Testing standards
- Level of independence of testing
- Test environment information
- Approach to perform different testing types

2.7.4 Test organization

People are one of the major factors for the success of the testing process. Test organization is about identifying and organizing a group of highly skilled people in different aspects to be responsible for testing. Highly skilled personnel are responsible for identifying the positive and negative effects of the ongoing testing process and enhance the quality of the process through multiple improvements. Having such a test group with an effective relationship between test professionals, test resources and project-specific operations, makes it easier to accomplish high-quality product tests. The presence of a separate corporate unit dedicated to software testing has a positive impact on product quality, testing value, and development/testing alignment. (Zhang et al., 2014).

The following can be identified as components in the test organization.

- Value of test group in organizational perspective
- Organizational type
- Unique reporting structure, the capability of independent decision making
- Roles and tasks, capabilities, responsibilities of the test organization
- Resources

There are different types of test specialists in test organizations including test managers, test team leaders, test designers, test engineers, test consultants, test environment engineers.

2.7.5 Test training/test mentoring

Focused areas of training

- Software Tester Onboarding Training Program
- Test Engineering
- Test Management
- Interpersonal skills
- Domain expertise

Identify the knowledge gaps of testing professionals and introduce training programs to develop knowledge and skills which enable them to perform testing activities more effectively and efficiently. Since testing tools and methodologies are always getting updated, and there are various skills needed, the establishment of test training programs has immense importance when making high-quality testing staff. Management needs to focus on launching a testing training program across the organization which enables continuous test process improvement. This training should guide testing professionals to execute the organization's test process standards.

The following steps can be taken when deploying organization-wide test training programs ((Veenendaal, 2009).

- Identify strategic test training needs
- Align the test training needs according to the organizational and project requirements
- Establish a plan for organizational test training and ensure that the capability is met.
- Execute the test training programs
- Evaluate effectiveness and the value of test training

2.7.6 Testing practices audit process / advanced reviews

The goal of auditing software quality engineering practices is to provide universal quality reviewing practices across the organization. This will ensure the effective and efficient high-quality delivery process of software products. This will give teams to adhere to a standard set of practices to optimize their quality engineering practices. Different organizations can work on different types of testing audits. Quality

engineering process audit, test automation practices audit, non-functional testing audit. When an organization has multiple software development teams, it is important to put them all to use the same set of well-defined practices across the organization. So, then every team will align with common practices and monitor and measure the performance can be done according to the well-defined quality criterion. Testing practices audit process is one of the most key components in governance frameworks.

2.7.7 Test management process

- Test Planning / Master Test Plan

The test planning process can be governed from a single project level or multiple project levels. The intention is to describe a test plan based on the predefined test strategy and the risk assessment to perform and manage the testing activities (Veenendaal, 2009). Development of a test plan is a process of risk assessment, establishing test approach, test estimations, defining testing resources – people and time, and reviewing the plan (Lee, Kang & Lee, 2012). The test manager is responsible for the development of the test plan with the collaboration of the team and delegates responsibilities and coordinates the planning process. Multiple reviews and revisions can be used to monitor and control the test planning process.

- Test Design and Execution

The test plan should be followed for the design and execution of tests. Activities involve preparing test design specifications, test design techniques, test execution, and test incident management (Lee et al., 2012). Standards of these practices should be defined in the organization test governance model and it will improve the transparency of tests which ensure the quality of the product developed. For example, maintenance of the traceability matrix can be considered as a best practice. Once test execution is carried out, test reporting should be conducted to the standard process. An organization should have a defined test policy for performing test design and execution (Veenendaal, 2009).

- Identify test design techniques to be performed in each level
- Test specifications templates and standards
- Documented test procedures
- Test automation requirement

- Test incidents management

- Test Monitoring and Control

Monitoring and controlling mechanisms are important to understand software development progress and product quality. If there is a deviation from the test plan, corrective actions should be taken.

2.7.8 Test measurement/test metrics

Proper use of software testing metrics is the best way of understanding where the testing is and which way it is heading within the project and organization. It is the responsibility of test management to define consistent test metrics that enable to measure the quality of the product developed. While defining test metrics, there are certain criteria to be considered. Test metrics should be defined based on the specific objectives for the process, project, and product. It is crucial to focus on the most relevant and limited set of useful metrics and avoid too many. While decision making, all the stakeholders should have the same understanding of when test metrics are interpreted and avoid confusion. Governing this process will increase the transparency of product quality status.

Test metrics are categorized into the following areas.

1. Project metrics
2. Product metrics
3. Process metrics
4. People metrics

2.8 Conclusion

Based on the analysis of previous literature sources, factors were identified that influence software test governance.

3. RESEARCH METHODOLOGY

3.1 Chapter Introduction

The research approach used in the study is explained in this chapter. In detail, it describes the information about the population, who were the targeted audience, how the sample is decided and what are the sampling techniques, the selected research design, the data collection procedure that were followed to conduct the study are included. Then, the implementation of the conceptual model by deriving independent variables and hypotheses going to test in the research is discussed. Furthermore, the chapter discusses the pilot survey which was conducted to validate the reliability of the study.

3.2 Research Approach

The focus of the research study is to identify the factors influence software test governance in IT organizations. In the initial stage, analysis of the literature review was helped to identify a set of testing activities that have the capability of test governance in the software development process. Preliminary interviews with software test experts from well-known IT firms in Sri Lanka were held to determine their viability in the Sri Lankan context. From the result of both literature review and interview findings, independent variables were derived and based on them, the conceptual model was developed.

The quantitative approach is used to perform a descriptive analysis of the research study. A quantitative approach is a numerical-based approach and objective in nature. Research is based on hypotheses development, data collection, interpretation and identify reliable inferences to approach the findings of the research. Figure 1 explains the research methodology of the study.

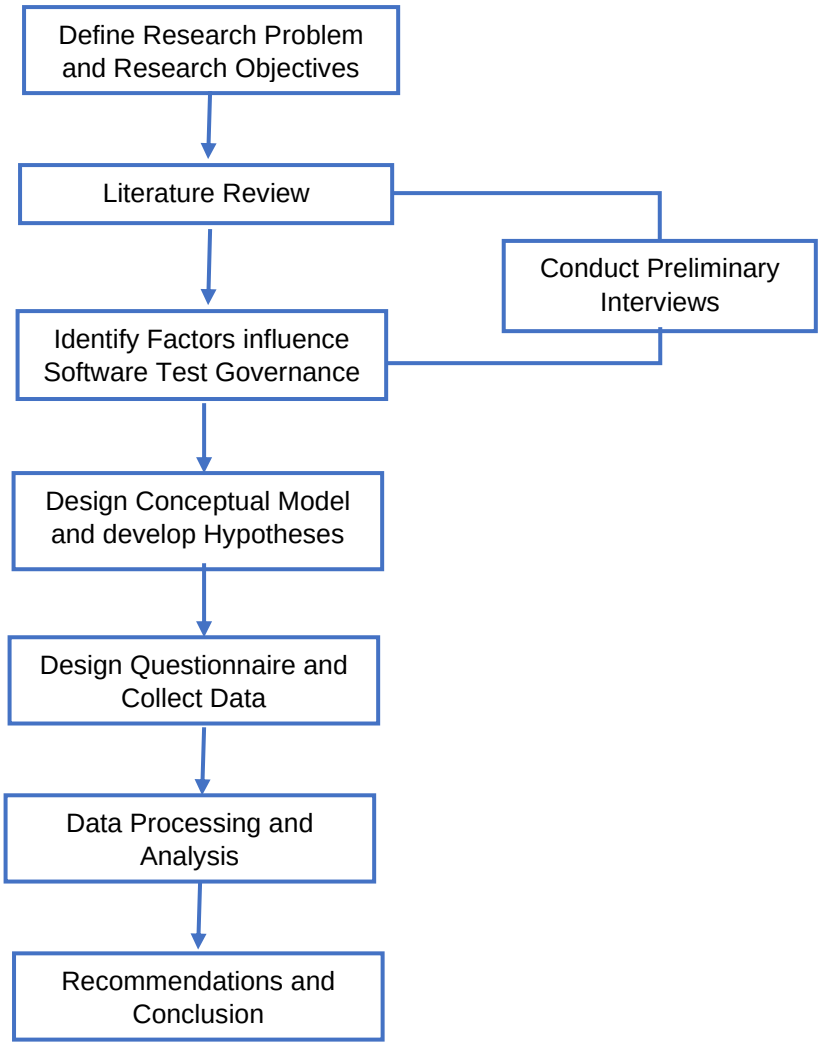


Figure 1: Research Methodology

3.3 Data Collection Methods

Data collection is a systematic process of gathering and analyzing specific information to understand a problem and evaluate the results. In the initial stage, it is essential to identify the objectives of the study, the type of data that needs to be collected, the target group of people, and the method or the tools of data collection before starting the process. For quantitative research study data collection is based on a survey questionnaire. The outcome of the research study is strictly based on the responses given through the questionnaire. The type of data obtained through the questionnaire is called primary data. To identify factors that need to conduct the research, many literature sources were referred to gain background knowledge and these data can be considered as secondary data.

3.4 Sample Design

This section explains the population of the study, the sample of the study, how the sample size is derived using a sampling technique, and research instruments.

3.4.1 Population

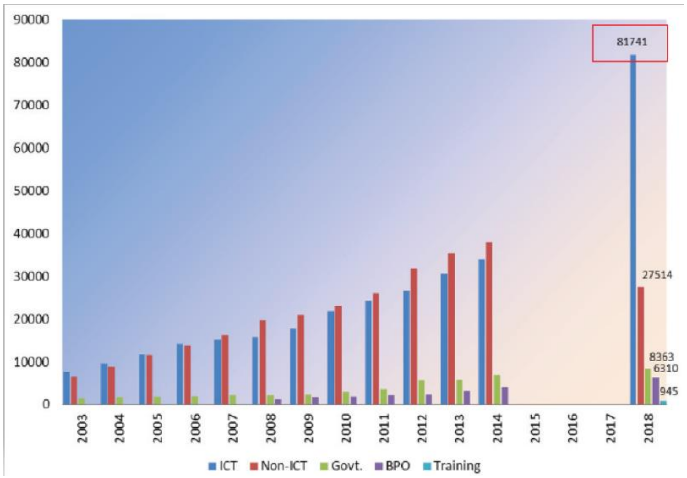


Figure 2: ICT Workforce (Source: *National IT-BPM Workforce Survey, 2019)*

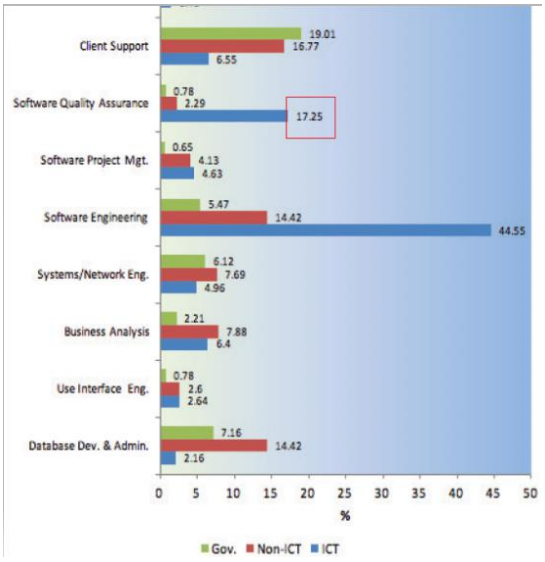


Figure 3: SQA Workforce (Source: *National IT-BPM Workforce Survey, 2019)*

Based on the survey conducted by ICTA in 2019, the ICT workforce is counted as 81741 (as shown in Figure 2) in ICT firms including software engineers, software quality assurance engineers, project management, Business analysts, etc. According to the report, out of this workforce, software quality assurance was secured 17.25% positions (as shown in Figure 3) in ICT firms which approximately 14,100 which is

software quality engineering professionals of ICT firms in Sri Lanka. Therefore, the population of the study is 14,100.

3.4.2 Sample size

The sample is the representation of the population which can be used to generalize the findings from the research. Determining the appropriate sample size is vital for more accurate research findings. The total number of subjects in the sample is referred to as sample size (Kumar, Talib & Ramayah, 2013). Cochran (1977) suggested when determining the sample size, it is better to consider the margin of error for items when conducting a survey. As a sample of our study, software test professionals in the Sri Lankan IT industry were selected.

As Danial (1999) explains, the formula represents in figure 4, can be used to calculate the sample size of a finite population.

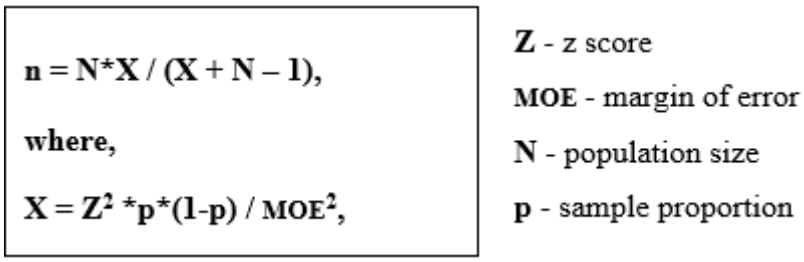


Figure 4: Calculation of sample size

The z value for the 95% confidence level is 1.96. With the values of the margin of error 0.05, confidence level 95%, and the sample proportion 50% and population 14100; the sample size is calculated as 374 using the above formula.

3.4.3 Research instruments

The primary research instrument was a survey questionnaire that was distributed among selected software testing practitioners in Sri Lanka. The questionnaire consists of 38 questions where the first 4 questions include the demographic characteristics of the respondent such as experience in testing, testing designation, organization information. The rest of the questionnaire assesses five variables in the research hypotheses. Closed-end questions with a Likert scale (Strongly Agree, Agree, Moderate, Disagree, Strongly Disagree) were used to get the responses from the subjects.

In the initial phase of the study, preliminary interviews were conducted with selected test professionals in well-known software organizations to identify test governance in the real software development environment.

3.5 Conceptual Diagram

The independent variables for the conceptual model were derived from the findings of the literature review and the preliminary research results, as outlined below.

3.5.1 Conducting a preliminary study

In the Sri Lankan software industry, a preliminary study was undertaken to identify test governance and the activities and processes that impact effective test governance. For this purpose, 10 senior quality engineering professionals from Sri Lankan IT companies were interviewed. Information was captured in three different perspectives namely basic understanding of the organizational structure, general view of test governance, and organization's test governance roles and activities. QA Leads/ Managers and Senior QA Engineers were interviewed from the following Organizations shown in table 9.

Table 9: Software companies used for the preliminary study

#	**Company**
1	Sysco Labs (Pvt) Ltd.
2	Pearson Lanka (Pvt) Ltd.
3	Wiley (Pvt) Ltd.
4	Millennium IT (Pvt) Ltd.
5	Orange Software Technologies (Pvt) Ltd.
6	ISM APAC (Pvt) Ltd.
7	Intervest (Pvt) Ltd.

3.5.2 Conceptual model

Figure 5 illustrates the conceptual model developed using identified independent and dependent variables.

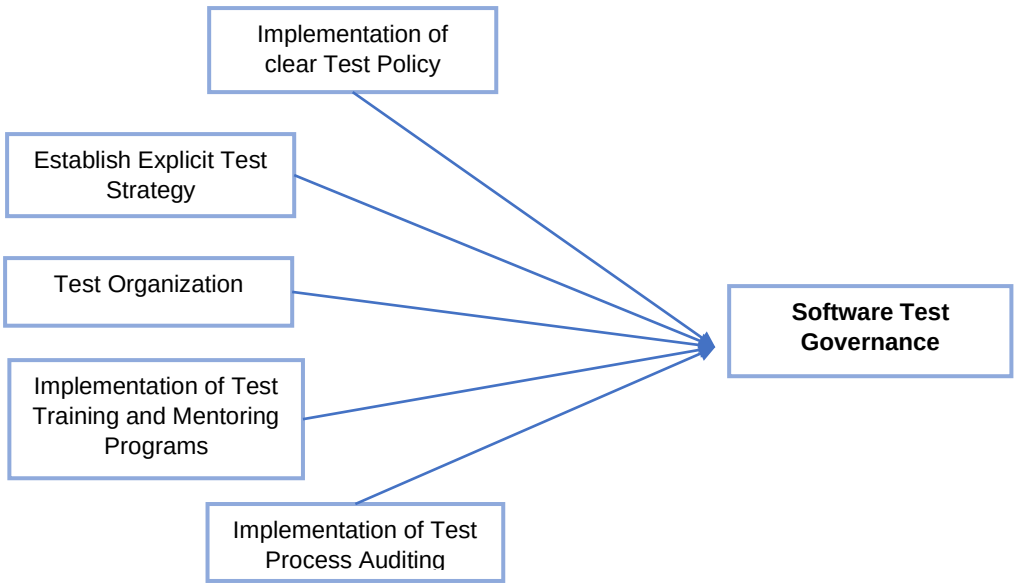


Figure 5: Conceptual Model

3.5.3 Selection of independent variables

- **Implementation of a clear test policy**

Test policy is one of the major documents which gives instructions on company software testing and it should align with organization quality policy (Dolezel, 2013). Test policy describes the systematic approach that should be applied in software testing including test objectives, benefits, indicators of quality and performance, test environment, and priority targets.

From the results of interviews conducted with test professionals, we identified that, even though most organizations have defined test policy, it is unsure whether all the testing professionals in the organization are aware of these guidelines. Test policy is the place where the value of testing is defined and highlighting the test process improvements. It is important to investigate how many companies have defined test policy and adhere to that to successful product delivery. To administer the organizational testing process, the test policy has a better position. Test policy is a document that defines rules and processes of software testing to execute testing activities easier and effectively. Therefore, it can use to cover one of the key characteristics of governance (Bertolino and Polini, 2009). Furthermore, the

implementation of a test policy in a software company mitigates the inconsistencies between processes and resources.

- **Establishment of explicit test strategy**

According to the ISTQB (2012), the test strategy describes the organization's general test methodology. This should explain specific strategies that are relevant to the organization's needs and fit into project operations. The test strategy should be consistent with the test policy. Most organizations have their test strategy which guides the testing process. This guides the decision-making process of software development. This can be considered as one of the test governance components. According to the view of software test professionals, test strategies are defined based on the organizational level as well as the program level. Defining explicit test strategies in the organization is critical because it allows for the definition of roles, obligations, accountability, risk management and mitigation as well as monitoring and control, all of which impact software test governance. (Veenendaal, 2009).

- **Distinct test organization**

Test organization is identified as one of the components which influence software test governance, based on the literature sources. Test organization is about identifying and organizing a group of highly skilled people in different aspects to be responsible for testing. Highly skilled personnel are responsible for evaluating the organization's ongoing testing process and enhance the quality of the process through multiple improvements (Veenendaal, 2009). Having such a test group with an effective relationship between test professionals, test resources and project-related operations, makes it easier to accomplish high-quality product tests. According to the view of senior test professionals interviewed in the preliminary study, a test group with independent management has effective test governance and allows effective decision-making in the software development process. Test organization increased the transparency in the decision-making process, hence enabled monitoring and controlling over the organizational testing processes (Zhang et al., 2014).

- **Implementation of test training and mentoring programs**

Identify the knowledge gaps of testing professionals and introduce training programs to develop knowledge and skills which enable them to perform testing activities more effectively and efficiently (Veenendaal, 2009). Since testing tools and methodologies are always getting updated, and there are various skills needed, the establishment of test training programs has immense importance when making high-quality testing staff. Management needs to focus on launching a testing training program across the organization which enables continuous test process improvement. These training programs should guide testing professionals to execute the organization's test process standards. This will help all the test professionals to have the same understanding of the testing process and help to control. In terms of the interviews conducted with different organizations, it is revealed that organizations with better training programs have a better influence on test governance. This will provide strategic alignment by conveying the organizational objectives and deliver business value through information technology (Bannerman, 2010).

- **Implementation of test process audit**

Audits and management reviews are activities, responsible by the quality assurance manager or test manager in an organization that contributes to the quality product delivery (ISTQB Test Manager, 2012), The purpose of auditing software quality engineering practices is to provide universal quality reviewing practices across the organization. This will ensure the effective and efficient high-quality delivery process of software products. This will give teams to adhere to a standard set of practices to optimize their quality engineering practices. Different organizations can work on different types of testing audits. Although most organizations did not implement a standardized test audit process as per the results from preliminary interviews, there are informal reviews that measure the process and the performance of testing teams against review metrics. Most of the interviewees agreed it is one of the major governance components which enables to have a universal set of test practices hence improve the test control in different teams. Different review metrics can be identified to the testing team, which enables monitoring and controlling the software testing process.

Performance measurements such as defect detection rate, defect leakage, and cost of defects has an immense influence on the decision-making process (Eriksson, 2012).

3.6 Hypotheses Development

A hypothesis is a statistical inference which forms using sample data to explain behaviour in the population. There are two types of hypotheses.

Null hypothesis **-** The null hypothesis indicates the two variables do not have any relationship. The null hypothesis is denoted by H_0.

The alternative hypothesis **-** The alternative hypothesis, denoted by H_1, builds contradictory to H_0 about the association of variables.

Based on the conceptual framework, the following hypotheses are derived. These will be validated based on the data gathered from the sample.

Hypothesis 1

The purpose of Hypothesis 1 is to evaluate whether there is a relationship between the implementation of a clear test policy and software test governance. $H1_0$ represents the null hypothesis and $H1_1$ represents the alternative hypothesis.

$H1_0$: There is no relationship between the implementation of a clear test policy and software test governance.

$H1_1$: There is a relationship between the implementation of a clear test policy and software test governance.

Hypothesis 2

The purpose of Hypothesis 2 is to evaluate whether there is a relationship between establishing an explicit test strategy and software test governance. $H2_0$ represents the null hypothesis and $H2_1$ represents the alternative.

$H2_0$: There is no relationship between establishing an explicit test strategy and software test governance.

$H2_1$: There is a relationship between establishing an explicit test strategy and software test governance.

Hypothesis 3

The purpose of Hypothesis 3 is to evaluate whether there is a relationship between the test organization and software test governance. $H3_0$ represents the null hypothesis and $H3_1$ represents the alternative.

$H3_0$: There is no relationship between the test organization and software test governance.

$H3_1$: There is a relationship between the test organization and software test governance.

Hypothesis 4

The purpose of Hypothesis 4 is to evaluate whether there is a relationship between the implementation of test training and mentoring programs and software test governance. $H4_0$ represents the null hypothesis and $H4_1$ represents the alternative.

$H4_0$: There is no relationship between the implementation of test training and mentoring programs and software test governance.

$H4_1$: There is a relationship between the implementation of test training and mentoring programs and software test governance.

Hypothesis 5

The purpose of Hypothesis 5 is to evaluate whether there is a relationship between the implementation of test process auditing and software test governance. $H5_0$ represents the null hypothesis and $H5_1$ represents the alternative.

$H5_0$: There is no relationship between the implementation of test process auditing and software test governance.

$H5_1$: There is a relationship between the implementation of test process auditing and software test governance.

3.7 Pilot Survey

A pilot survey has been distributed among 25 software test professionals to conduct the reliability analysis of the questionnaire.

3.7.1 Reliability analysis

Reliability refers to consistency. It measures how reliable are the responses of a questionnaire which will indicate the stability of the tools. Cronbach's alpha is used to

measure the consistency and stability of a questionnaire (Bujang, Omar, & Baharum, 2018). A questionnaire is considered valid and reliable if the alpha value is greater than 0.7, according to Cronbach's alpha reliability test requirements. (Taber, 2017).

3.8 Questionnaire

The questionnaire was designed by focusing on test practitioners in the Sri Lankan software industry. The questionnaire consists of 40 questions with a few open-ended questions and questions to be answered based on a Likert scale. Following are the scores for the responses. Table 10 shows the assigned scores for each Likert scale response.

Table 10: Scores for responses

Response	Score
Strongly Disagree	1
Disagree	2
Moderate	3
Agree	4
Strongly Agree	5

Following is the summary of the questionnaire which is published as a google form among 300+ respondents. Table 11 discusses the summary of the questionnaire.

Table 11: Summary of Questionnaire

No	Question	Test Policy Implementation	Deployment of Test Strategy	Test Organization	Test Training and Mentoring	Test Process Audit	Software Test Governance
1	There is a clearly defined test policy to improve the test process in my organization.	x					
2	The organization's test policy gives an understanding of the overall testing goals and objectives and strategic testing view.	x					
3	My organization has gained a lot of improvements in the test process by implementing a testing policy to enhance software quality.	x					
4	I believe our test policy is aligned with the organization's quality policy.	x					
5	Test policy guides the organization to follow standard practices across the organization hence avoid inconsistencies between organizational processes and resources.	x					

6	Test policy provides a mechanism for encouraging standardization across the projects and enabled controlling and monitoring.	x					
7	My organization has an organization-wide test strategy that is established and deployed to explain specific strategies that are relevant to the organization's needs and fit into project operations.		x				
8	Specific program-wide test strategies are defined in my organization which is fit into the program-related requirements.		x				
9	The test strategy is reviewed with stakeholders inside and outside testing.		x				
10	Test strategy is revisited and revised regularly as appropriate, Ex. yearly		x				
11	I believe organizations which do not follow explicit test strategy can have inconsistencies in product quality in different projects.		x				
12	My organization has a dedicated testing team that independently works according to the testing processes.			x			
13	Test Group reports to management independent of the development management.			x			
14	The existence of the independent test group has a positive influence on the organizational understanding of the importance of testing.			x			
15	I believe an independent test group allows management to identify and coordinate a group of highly qualified testing professionals who are responsible for delivering high-quality products.			x			
16	Strengths and weaknesses in the organization's existing process are identified by the organization's testing group, and enhancements to the test process and resources are implemented as a result.			x			
17	The organization's testing group is a representation of test professionals, testing assets and resources and project-related test activities which drives the standardized testing process.			x			
18	The organization's test group provides effective communication to business, development, and quality assurance which leads to better decision-making.			x			
19	My organization has a well-defined plan to execute training programs to develop knowledge and skills which enable them to perform testing activities more effectively and efficiently.				x		
20	Test Training programs involve assisting the organization's strategic business goals as well as fulfilling project-specific training requirements.				x		
21	Individual projects identify specific training needs, which are administered at the project level.				x		

22	The test training program aids the test organization by instructing test experts and other stakeholders on how to follow the organization's test process standards.				x		
23	The organization's test training program ensures testing professionals have a better understanding of organizational testing standards while improving their testing skills and domain knowledge and involve the capability alignment between developers and the test group.				x		
24	Deploying the training program helps the governing of the test process across the organization by delivering the right knowledge and competency among all people involved in testing.				x		
25	My organization has well-defined rules and a set of standard practices to optimize its quality engineering practices across the organization.					x	
26	Software test process audit in the organization is making sure effective and high-quality delivery of software and provide insights to the testing team about organization testing practices.					x	
27	Test Audit helps to monitor and measure project-level performance according to a well-defined adequate quality criterion.					x	
28	Categorization the test audit process into different areas such as process-related, automation-related, and performance-related will involve controlling and monitoring different process areas.					x	
29	Test Audit Process increases the ability of proper decision-making and ensures testing goals and objectives are achieved.					x	
30	I believe software test governance ensures the execution of test activities easy and effective.						x
31	I believe software test governance will mitigate the risk of conflicts and inconsistencies between organizational test processes and resources.						x
32	Test governance activities have a positive impact on software quality, testing value, alignment of development with testing, across the organization.						x
33	Implementation of test governance provides an explicit way of managing people, processes, and technology of the software development process with the enabled decision-making of the management.						x
34	I believe software test governance ensures test resources are used responsibly and provide strategic direction to the business.						x

3.9 Conclusion

The research technique used to approach the study's goals described in this chapter. For this purpose, a quantitative and descriptive survey design was used. Software QA/ Test professionals in Sri Lanka have been identified as the population of the study. The chapter described the research strategy, data collection methods, sample data, research process and the reliability and validity of the instruments used for the study.

4. DATA ANALYSIS

4.1 Chapter Introduction

The quantitative research data is outlined, analyzed, and interpreted in the chapter. As the initial step, the sample distribution was discussed using descriptive statistics. Then, a reliability analysis was conducted to validate the internal consistency of the questionnaire. Finally, statistical analysis was performed to identify correlations between variables and prove the developed hypotheses.

4.2 Data Collection

An online questionnaire was distributed among software test professionals to gather data for the study. Initially, the sample size was calculated as 374 for the population 14100 with a 95% confidence level. But due to practical problems of data gathering, only 310 responses were gathered from software test professionals who are working in multiple software companies in Sri Lanka. Data collection was started in the later December of 2020 and ended in February 2021. The questionnaire was created as a google form and distributed among QA groups, and social media users. Figure 6 shows the pattern of the data collection

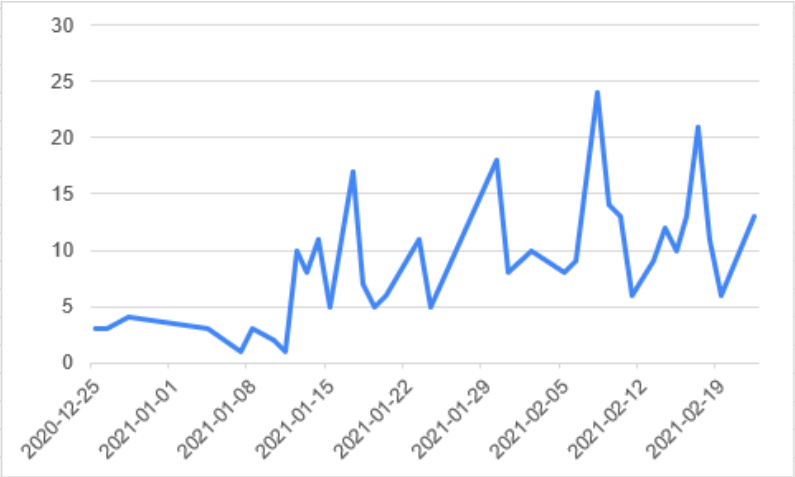


Figure 6: Illustration of the number of responses over time

The survey evaluated the use of five different elements in software testing to identify the association with test governance. Statements of the questionnaire were rated in the form of a five-point namely '*Strongly Disagree', 'Disagree', 'Moderate', 'Agree',* and

'Strongly Disagree'. As figure 8, a higher number of participants in the survey have more than three years of experience in software testing.

4.3 Descriptive Analysis

The descriptive analysis gives an understanding of the distribution of the sample data set. Descriptive analysis for the demographic information was performed to understand the composition of the sample data set.

4.3.1 Sample data categorization based on the job role in the software industry

This classification observed the sample data, based on different job categories of software test professionals who have responded to this survey. Job roles were identified as "Software Test/QA Engineer", "Senior Software Test/QA Engineer", "Software Test/QA Lead" and, "Software Test/QA Manager". All of them are from software development companies.

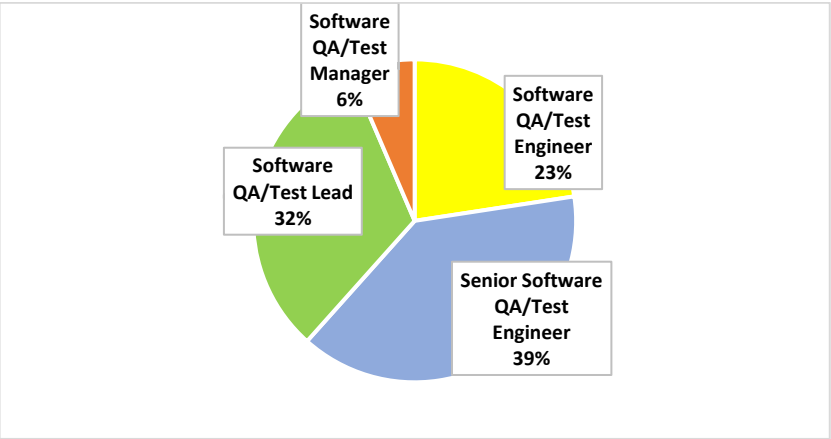


Figure 7: Sample data classification based on job role

As figure 7 illustrates, all the respondents are from the domain of software testing and a high number of respondents hold the position of senior QA engineer which is 39%. QA leads and managers percentage also considerable as 38% and this emphasizes the majority of respondents hold senior positions in software organizations.

4.3.2 Sample data categorization based on the years of experience in the software industry

The sample data set is classified based on the industry experience as a test professional. Figure 8 shows the data of respondents against the year of experience. The majority of

the participants have more than 3 years of experience in the industry and this will indicate more knowledgeable respondents.

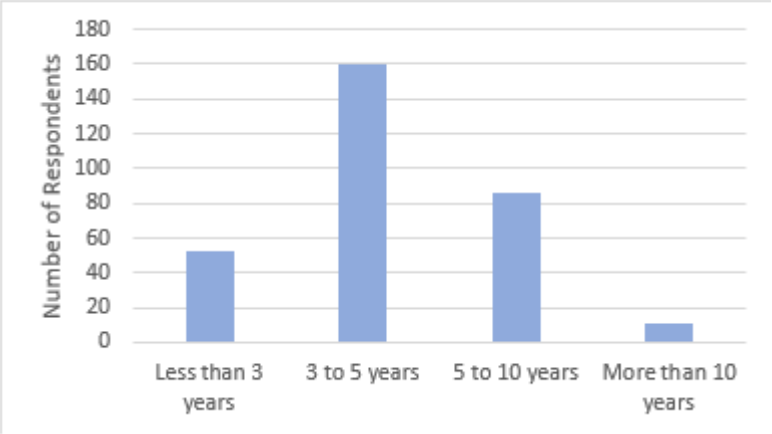


Figure 8: Sample data classification based on years of experience

Table 12: Distribution of sample data set – Years of Experience

Experience	**Number of respondents**	**Percentage**
Less than 3 years	53	17.1%
3 to 5 years	160	51.6%
5 to 10 years	86	27.7%
More than 10 years	11	3.6%

According to table 12, 82.9% of respondents have more than three years of software testing experience.

4.3.3 Sample data classification based on the organization category

Organization type is one of the most important data when analyzing software testing practices. Therefore, the sample data set is classified based on the organization category and the size of the organization. In this section, organization category data is presented. Table 13 shows the distribution of the organization category of survey respondents.

Table 13: Distribution of sample data set – Organization Category

Organization Type	**Number of Responses**	**Percentage**
Product-based	111	24.2%
Service-based	75	35.8%
Both	124	40%

Figure 9 shows the sample data classification based on the organization category.

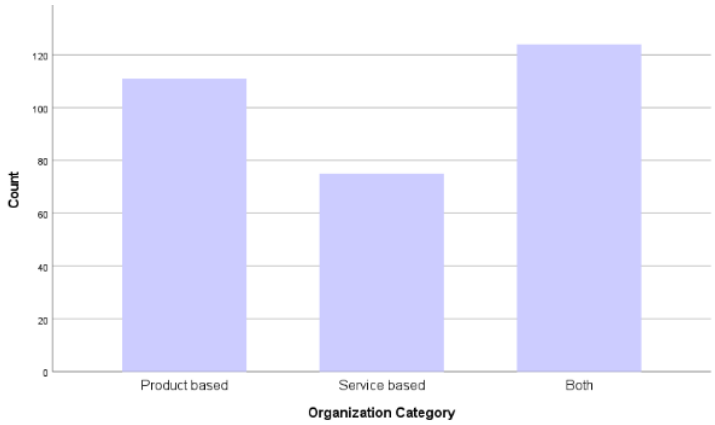


Figure 9: Sample data classification based on organization category

4.3.4 Sample data classification based on the organization size

Figure 10 shows the organization size of respondents of the online survey and table 14 shows the percentage of the respondents based on the organization size.

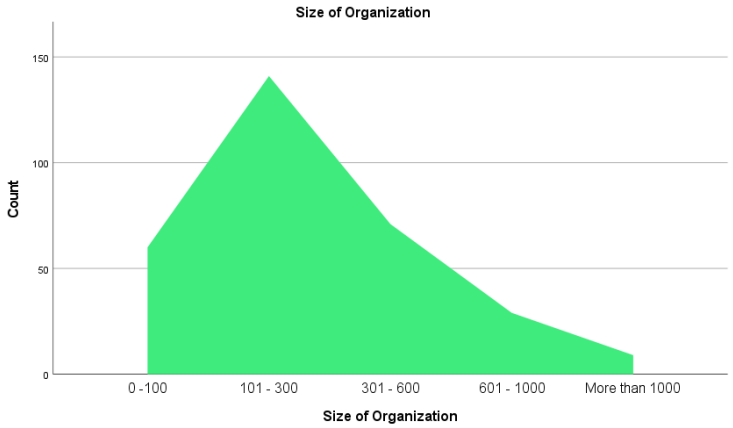


Figure 10: Sample data distribution based on the size of the organization

Table 14: Distribution of sample data set – Organization Size

Size of the Organization	Number of responses	Percentage
Less than 100	60	19.4%
101 - 300	141	45.5%
301 - 600	71	22.9%
601 - 1000	29	9.4%
More than 1000	9	2.9%

4.3.5 Frequency analysis of Likert-scale values of the online survey

Frequency analysis is a descriptive statistical method that shows the frequency of each response given by the respondents. The following analysis presents the use of test processes on which the study is focused on.

4.3.5.1 Use of explicit test policy in software companies

Figure 11 shows the distribution of Likert scale values of the responses about the software test policy usage in Sri Lankan IT companies. According to that most of the respondents selected 4 and 5 as there are defined test policies in their organization. 21.6% Percentage selected 1,2 and 3 as there is no defined test policy or they do not aware of the existence of a test policy in the company.

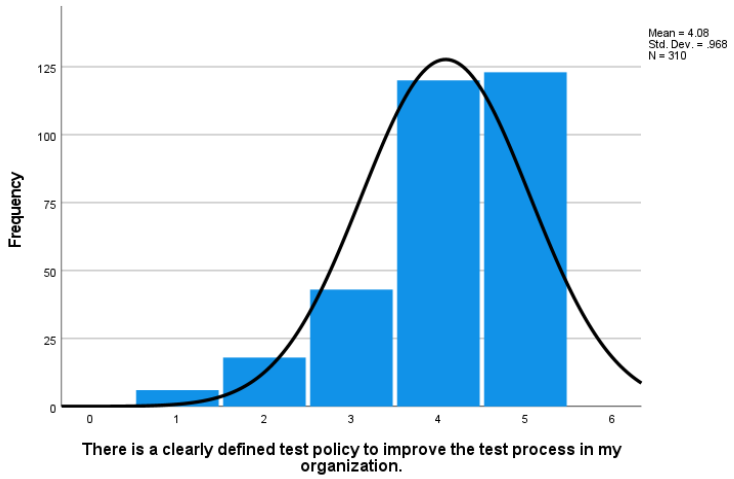


Figure 11: Use of test policy in software organizations

4.3.5.2 Use of explicit test strategy in software companies

Figure 12 shows the distribution of Likert scale values of the responses about the organization-wide explicit test strategy is defined in Sri Lankan IT companies. According to that most of the respondents selected 4 and 5 options. 15.5% of respondents selected 1,2 and 3 as there is no defined organization-wide test strategy or they do not aware of the existence of an organization-wide test strategy in the company.

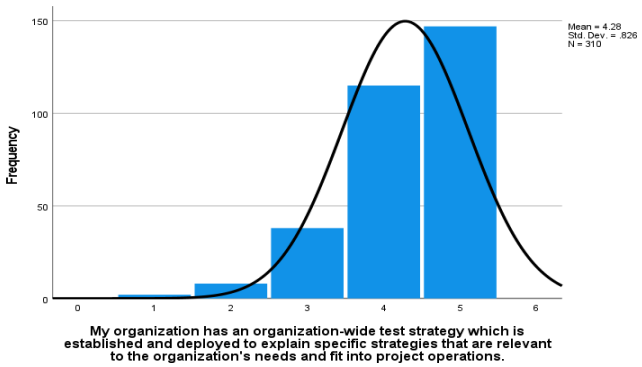


Figure 12: Use of organization-wide test strategy

Below figure 13 represents specific program-wide test strategy usage in software companies. 15.1% of respondents say there are no program-specific test strategies that were established, or they do not aware of that. These figures demonstrate some companies did not use explicit test strategies.

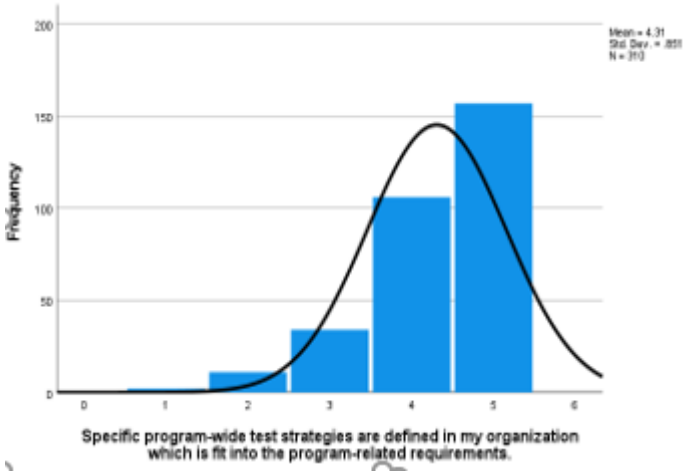


Figure 13: Use of program-wide test strategy

4.3.5.3 Existence of distinct unit of software testing.

Figure 14 shows the distribution of Likert scale values of the responses about the test organization in Sri Lankan IT companies. According to that majority of companies have distinct software testing units which 91.3% of given responses.

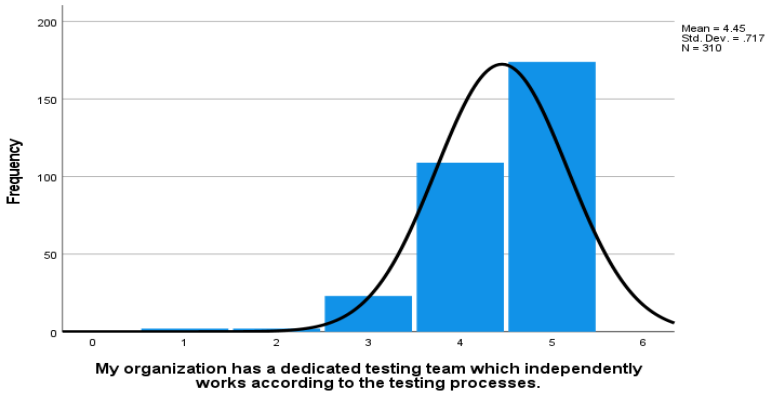


Figure 14: Existence of distinct test unit

4.3.5.4 Well-defined plan to conduct test training and mentoring.

Figure 15 shows the distribution of Likert scale values of the responses about test training and mentoring programs in Sri Lankan IT companies. While 75.2% of responses selected there are formal test training and mentoring programs in their organization 24.8% say they do not have or no understanding about that.

Figure 15: Existence of Test training programs based on the responses

4.3.5.5 Execution of test process auditing or reviews

Figure 16 shows the distribution of Likert scale values of the responses about the execution of test auditing or reviews in Sri Lankan IT companies. 19.3% of respondents selected they do not have any reviews or test process audits of that in their organization. The majority of respondents (80.7%) selected there are auditing or reviewing processes for software testing.

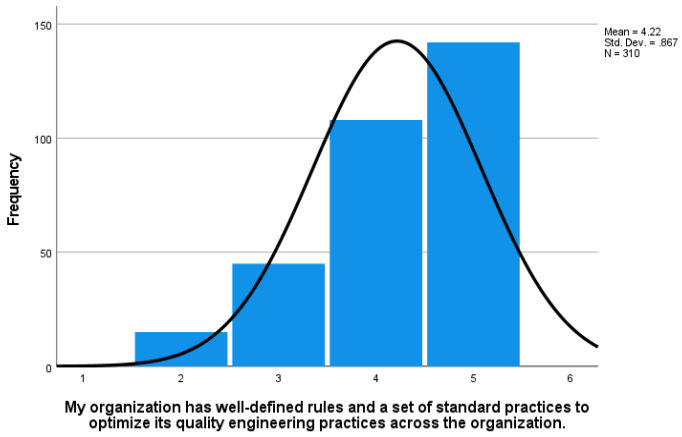


Figure 16: Existence of test audits

4.4 Reliability Analysis

To ensure the validity of the questionnaire used for data collection, a reliability analysis was performed. According to Cronbach's alpha reliability test standards, when the alpha value is 0.7 or higher, indicates an acceptable internal consistency of the questionnaire (Taber, 2017). The following are the result of the reliability of the questionnaire for each independent variable.

4.4.1 Cronbach's alpha value for independent variable – Implementation of a clear test policy

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.889	.856	6

Figure 17: Cronbach's alpha - test policy implementation

The independent variable 'Clear Test Policy Implementation' has 6 questions in the questionnaire of pilot survey. The reliability coefficient value is 0.889 as in figure 17 which is greater than 0.7 and the internal consistency of the questions is high.

4.4.2 Cronbach's alpha value for independent variable – Deployment of explicit test strategy

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.730	.682	5

Figure 18: Cronbach's alpha - deployment of an explicit test strategy

The independent variable ‘Deployment of Explicit Test Strategy’ has 5 questions in the questionnaire of the pilot survey. The reliability coefficient value is 0.730 as in figure 18 which is greater than 0.7 and the questions are reliable.

4.4.3 Cronbach’s alpha value for independent variable - Test organization

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.956	.961	7

Figure 19: Cronbach’s alpha value - establishing a distinct testing unit

The independent variable ‘Establishing distinct testing group/unit’ has 7 questions in the questionnaire of the pilot survey. The reliability coefficient value is 0.956 as in figure 19 and the internal consistency of the questions is highly reliable.

4.4.4 Cronbach’s alpha value for independent variable – Implementation of test training and mentoring program

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.870	.878	6

Figure 20: Cronbach’s alpha value - implementation of test training and mentoring program

The independent variable ‘Implementation of Test Training and Mentoring Program’ has 6 questions in the questionnaire of the pilot survey. The reliability coefficient value is 0.870 as figure 20 and internal consistency is high.

4.4.5 Cronbach’s alpha value for independent variable – Implementation of test process auditing

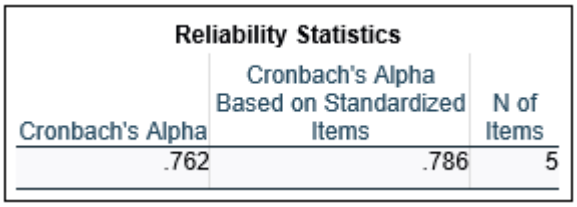
Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.757	.753	5

Figure 21: Cronbach’s alpha - implementation of test process auditing

The independent variable ‘Implementation of Test Process Auditing or reviews’ has 5 questions in the questionnaire of the pilot survey. The reliability coefficient value is 0.757 as figure 21 which is greater than 0.7 and the internal consistency is reliable.

4.4.6 Cronbach's alpha value for dependent variable – Software test governance



Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.762	.786	5

Figure 22: Cronbach's alpha value - software test governance

The dependent variable 'Software Test Governance' has 5 questions in the questionnaire of pilot survey. The reliability coefficient value is 0.762 as in figure 22 and which is greater than 0.7 and the internal consistency is reliable.

Table 15 shows, the summary of the reliability analysis.

Table 15: Summary of Reliability Analysis

Variable	**Cronbach's Alpha**
Test Policy Implementation	0.889
Deployment of explicit Test Strategy	0.730
Test Organization	0.956
Test Training and Monitoring	0.870
Test Process Audit	0.757
Software Test Governance	0.762

4.5 Inferential Statistics

Inferential statistics used to measure behaviour in samples when the population is large or inaccessible. Using multiple statistical techniques such as Pearson's Correlate Analysis, Regression Analysis, and ANOVA, the study describes the behaviour of the sample data set. These methods help to understand the relationship between variables, test the hypotheses and draw the conclusion.

4.5.1 Pearson's Correlation Analysis

Pearson's correlation coefficient is a statistical measurement of the relationship between two continuous variables ("Pearson's Correlation Coefficient", 2020). This reveals the magnitude of the correlation and, its direction. When analyzing Likert scale data, several items are grouped into a survey scale or variable and the mean score is calculated (Sullivan & Artino, 2013). It is said to be a perfect correlation when the correlation coefficient value is 1. It is called a strong correlation when the coefficient value is between 0.60 and 1. Variables have a medium correlation if the value is between 0.40 and 0.59. A poor correlation exists if the value is less than 0.39. When

the coefficient value is 0, there is no correlation between variables (Sedgwick, 2012). Table 16 describes the ranges of correlation with a clearer picture.

Table 16: Interpretation of Correlation Coefficient

Coefficient Interval	Correlation
0.80 – 1.00	Very Strong
0.60 – 0.799	Strong
0.40 – 0.599	Medium
0.20 – 0.399	Weak
0.00 – 0.199	Very Weak

Source: Evans, 1996, as cited in Ayunin, Mirizon & Rosmalina, 2018

Table 17 shows the correlation between test policy implementation, explicit test strategy, test organization, implementation of test training and mentoring programs, test process auditing, and software test governance. Pearson's Bivariate Correlation analysis was performed to identify the relationship. According to the table, all the independent and dependent variables have a positive relationship with each other.

Table 17: Correlation Analysis

		Test Policy Implementation	Deploy Explicit Test Strategy	Test Organization	Implementing Test Training and Mentoring Program	Implementing Test Process Auditing	Software Test Governance
Test Policy Implementation	Pearson Correlation	1	.802**	.652**	.747**	.787**	.686**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	310	310	310	310	310	310
Deploy Explicit Test Strategy	Pearson Correlation	.802**	1	.801**	.765**	.734**	.686**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	310	310	310	310	310	310
Test Organization	Pearson Correlation	.652**	.801**	1	.702**	.652**	.644**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	310	310	310	310	310	310
Implementing Test Training and Mentoring Program	Pearson Correlation	.747**	.765**	.702**	1	.802**	.694**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	310	310	310	310	310	310
Implementing Test Process Auditing	Pearson Correlation	.787**	.734**	.652**	.802**	1	.752**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	310	310	310	310	310	310
Software Test Governance	Pearson Correlation	.686**	.686**	.644**	.694**	.752**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	310	310	310	310	310	310

**. Correlation is significant at the 0.01 level (2-tailed).

4.5.2 Hypotheses testing

Significant tests are used to perform hypothesis testing to determine the likelihood of a statement to be proved as true, and at what possibility the statement is accepted as true (Massey & Miller, 2016). Hypothesis testing is used to accept or reject statistical hypotheses. In the research methodology, the study described five main hypotheses and this section will validate them by using correlation-based statistical analysis.

Significance Level – The significance level is described to define a statistical value, to reject the null hypothesis. The *p*-value defines to explain the significance level and

when the *p*-value is less than 0.05, it is explained as statistically significant. (McLeod, 2019).

Hypothesis 1

$H1_1$: There is a relationship between the implementation of a clear test policy and software test governance.

$H1_0$: There is no relationship between the implementation of a clear test policy and software test governance.

Correlations

		Test Policy Implementation	Software Test Governance
Test Policy Implementation	Pearson Correlation	1	.686**
	Sig. (2-tailed)		.000
	N	310	310
Software Test Governance	Pearson Correlation	.686**	1
	Sig. (2-tailed)	.000	
	N	310	310

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 23: Correlation Analysis– Explicit test policy implementation and software test governance

According to figure 23, the correlation between the implementation of a clear test policy and the software test governance is 0.686, which is a strong correlation. The significant level is 0, less than 0.05. The null hypothesis is therefore refuted, although the alternative hypothesis is accepted.

Hypothesis 2

$H2_1$: There is a relationship between the deployment of an explicit test strategy and software test governance.

$H2_0$: There is no relationship between the deployment of an explicit test strategy and software test governance.

According to Figure 24, the correlation between the explicit test strategy and software test governance is also + 0.686, which is strongly correlated. The significant level is 0, less than 0.05. As a result, the null hypothesis is refuted, while the alternative hypothesis is accepted.

Correlations

		Deploy Explicit Test Strategy	Software Test Governance
Deploy Explicit Test Strategy	Pearson Correlation	1	.686**
	Sig. (2-tailed)		.000
	N	310	310
Software Test Governance	Pearson Correlation	.686**	1
	Sig. (2-tailed)	.000	
	N	310	310

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 24: Correlation Analysis– Explicit test strategy implementation and software test governance

Hypothesis 3

$H3_1$: There is a relationship between the test organization and software test governance.

$H3_0$: There is no relationship between the test organization and software test governance.

Correlations

		Test Organization	Software Test Governance
Test Organization	Pearson Correlation	1	.644**
	Sig. (2-tailed)		.000
	N	310	310
Software Test Governance	Pearson Correlation	.644**	1
	Sig. (2-tailed)	.000	
	N	310	310

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 25: Correlation Analysis– Test organization and software test governance

According to Figure 25, the correlation between the test organization and the software test governance is + 0.644, which implies a strong correlation. The significant level is 0.00, less than 0.05. Therefore, the null hypothesis is rejected, and the alternative hypothesis is accepted.

Hypothesis 4

$H4_1$: There is a relationship between the implementation of test training and mentoring program and software test governance.

$H4_0$: There is no relationship between the implementation of test training and mentoring program and software test governance

Correlations

		Implementing Test Training and Mentoring Program	Software Test Governance
Implementing Test Training and Mentoring Program	Pearson Correlation	1	.694**
	Sig. (2-tailed)		.000
	N	310	310
Software Test Governance	Pearson Correlation	.694**	1
	Sig. (2-tailed)	.000	
	N	310	310

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 26: Correlation Analysis– Test training and mentoring program implementation and software test governance

According to Figure 26, the correlation between the implementation of test training and mentoring programs and the software test governance is + 0.694, which is a strong correlation. The significant level is 0.00, which is less than 0.05. Therefore, the null hypothesis is rejected, and the alternative hypothesis is accepted.

Hypothesis 5

$H5_1$: There is a relationship between the implementation of test process auditing and software test governance.

$H5_0$: There is no relationship between the implementation of test process auditing and software test governance.

Correlations

		Implementing Test Process Auditing	Software Test Governance
Implementing Test Process Auditing	Pearson Correlation	1	.752**
	Sig. (2-tailed)		.000
	N	310	310
Software Test Governance	Pearson Correlation	.752**	1
	Sig. (2-tailed)	.000	
	N	310	310

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 27: Correlation Analysis– Test process audit implementation and software test governance

According to Figure 27, the correlation between the implementation of test process auditing and reviews and the software test governance is also + 0.752, which is a strong correlation. The significant level is 0.00, which is less than 0.05. Therefore, the null

hypothesis is rejected, and the alternative hypothesis is accepted. Table 18 shows, the summary of the correlation between independent and dependent variables.

Table 18: Summary of the correlations between dependent and independent variables

Statement	Correlation Coefficient	Null Hypothesis	Alternative Hypothesis	Strength of Correlation
There is a relationship between clear test policy implementation and software test governance.	0.686	Rejected	Accepted	Strong
There is a relationship between the deployment of an explicit test strategy and software test governance.	0.686	Rejected	Accepted	Strong
There is a relationship between the test organization and software test governance.	0.644	Rejected	Accepted	Strong
There is a relationship between the implementation of test training and mentoring program and software test governance.	0.694	Rejected	Accepted	Strong
There is a relationship between the implementation of test process auditing and software test governance.	0.752	Rejected	Accepted	Strong

4.6 Regression Analysis

When conducting research studies, linear regression analysis is one of the most commonly used statistical methods for data analysis. It is used to figure out how the dependent variable and the independent variables are related. Regression analysis is capable of indicating significant relationships between independent and dependent variables, indicating the relative strengths of the relationships, and make predictions (Sarstedt & Mooi, 2014).

4.6.1 Regression analysis – Implementation of a clear test policy and successful software test governance

Figure 28 represents the influence on software test governance by implementing a test policy in a software organization. In this diagram test policy implementation is positively related to software test governance. The study has done a linear regression analysis for the dependent and independent variables.

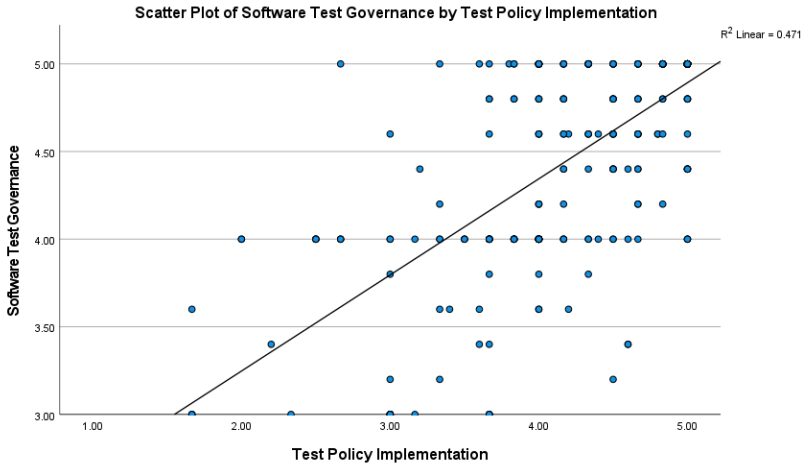


Figure 28: Scatter plot – Clear test policy implementation and test governance

In figure 29, the 'R' value represents the correlation of two variables. The correlation between test policy implementation and successful software test governance is 0.686 which is positively correlated. R square gives the coefficient of determination. This measurement describes how differences in one variable can be described by the difference in another related variable (Bloomenthal, 2020). The value 0.471 indicates the variance of success of software test governance can be explained by implementing a strong software test policy.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			
					R Square Change	F Change	df1	df2	Sig. F Change
1	.686[a]	.471	.469	.43647	.471	274.162	1	308	.000

a. Predictors: (Constant), Test Policy Implementation

Figure 29: Regression model summary – Test policy implementation

ANOVA

ANOVA test is known as Analysis of Variance is used to understand the association between the dependent and independent variables. Figure 30 shows that the correlation between the predictor variable and the dependent variable is statistically significant which is 0.000 hence the p-value is less than 0.05 and it is an indication that the null hypothesis is denied and the alternative hypothesis is accepted which is there is a positive relationship between test policy implementation and successful software test governance.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	52.230	1	52.230	274.162	.000[b]
	Residual	58.677	308	.191		
	Total	110.907	309			

a. Dependent Variable: Software Test Governance
b. Predictors: (Constant), Test Policy Implementation

Figure 30: ANOVA - Test policy implementation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.150	.143		14.992	.000
	Test Policy Implementation	.548	.033	.686	16.558	.000

a. Dependent Variable: Software Test Governance

Figure 31: Coefficients – Test policy implementation

According to the statistics in figure 31, the significant value is 0 for test policy implementation. Therefore, the independent variable has an impact on software test governance.

4.6.2 Regression analysis – Defining explicit test strategy and successful software test governance

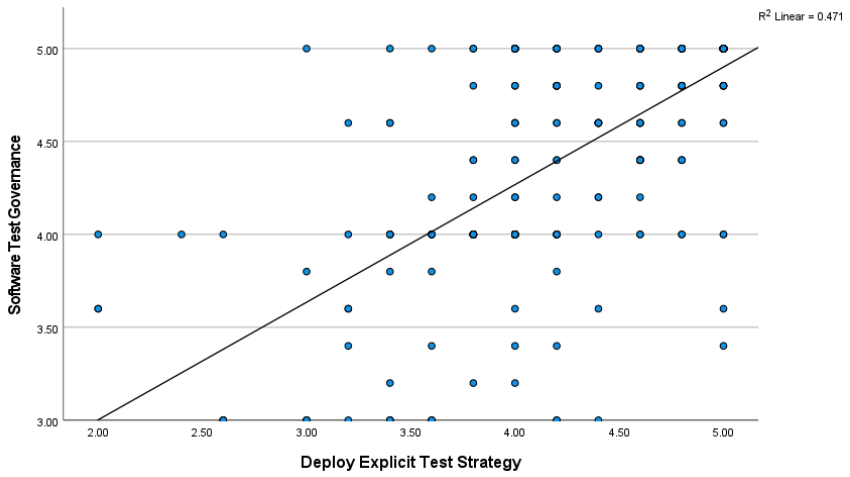


Figure 32: Scatter plot – Explicit test strategy deployment

Figure 32 represents the influence on successful software test governance by deploying explicit test strategies in software organizations. This diagram shows deploying explicit test strategy is positively related to software test governance. The study has done a linear regression analysis for the dependent and independent variable

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.686[a]	.471	.470	.43633	.471	274.534	1	308	.000

a. Predictors: (Constant), Deploy Explicit Test Strategy

Figure 33: Regression model summary – Explicit test strategy implementation

As per figure 33, the strength of the relationship between explicit test strategy deployment and successful software test governance is 0.686 which is positively correlated. The coefficient of determination of 0.471 indicates the variance of success of software test governance can be explained by implementing an explicit test strategy.

Figure 34 shows that the correlation between the predictor variable and the outcome variable is statistically significant which is 0.0 which the p-value is less than 0.05 and it is an indication of rejecting the null hypothesis and accept the alternative hypothesis. Therefore, the study accepts there is a positive relationship between explicit test strategy deployment and successful software test governance.

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	52.268	1	52.268	274.534	.000[b]
	Residual	58.639	308	.190		
	Total	110.907	309			

a. Dependent Variable: Software Test Governance
b. Predictors: (Constant), Deploy Explicit Test Strategy

Figure 34: ANOVA –Explicit test strategy implementation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.736	.168		10.334	.000
	Deploy Explicit Test Strategy	.633	.038	.686	16.569	.000

a. Dependent Variable: Software Test Governance

Figure 35: Coefficients – Explicit test strategy implementation

According to the statistics in figure 35, the significant value is 0 for explicit test strategy deployment. Therefore, the independent variable has an impact on software test governance.

4.6.3 Regression analysis – Test organization and successful software test governance

Figure 36 represents the influence on successful software test governance by establishing a distinct test group in a software organization.

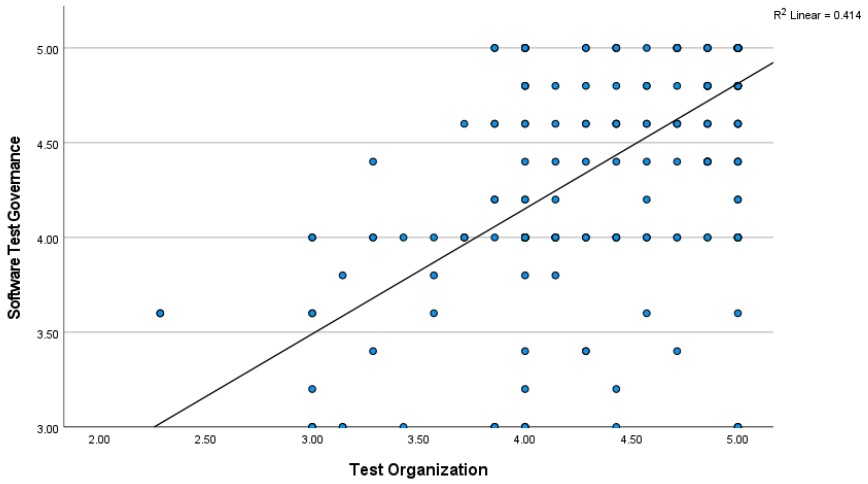


Figure 36: Scatter plot - Test Organization

This diagram shows test organization is positively related to software test governance.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			
					R Square Change	F Change	df1	df2	Sig. F Change
1	.644[a]	.414	.412	.45930	.414	217.732	1	308	.000

a. Predictors: (Constant), Test Organization

Figure 37: Regression model summary – Test organization

As per figure 37, the correlation between the distinct test organization and successful software test governance is 0.644 which is positively correlated. The coefficient of determination of 0.414 indicates the variance of success of software test governance can be explained by establishing a distinct test organization.

Figure 38 shows that the correlation between the predictor variable and the dependent variable is statistically significant which is 0.000 which the p-value is less than 0.05 ($p < 0.05$). It is an indication of rejecting the null hypothesis and accept the alternative hypothesis. Therefore, the study accepts there is a positive relationship between the establishment of the distinct testing unit and successful software test governance

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	45.932	1	45.932	217.732	.000[b]
	Residual	64.975	308	.211		
	Total	110.907	309			

a. Dependent Variable: Software Test Governance

Figure 38: ANOVA – Test organization

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.507	.204		7.397	.000
	Test Organization	.661	.045	.644	14.756	.000

a. Dependent Variable: Software Test Governance

Figure 39: Coefficients – Test organization

According to the statistics in figure 39, the significant value is 0 for the test organization. Therefore, the independent variable has an impact on software test governance.

4.6.4 Regression analysis – Implementation of test training and mentoring program and successful software test governance

Figure 40 represents the influence on successful software test governance when test training programs are deployed in the organization. This diagram shows test training and mentoring program is positively related to software test governance. A linear regression analysis has been conducted to analyze the relationship.

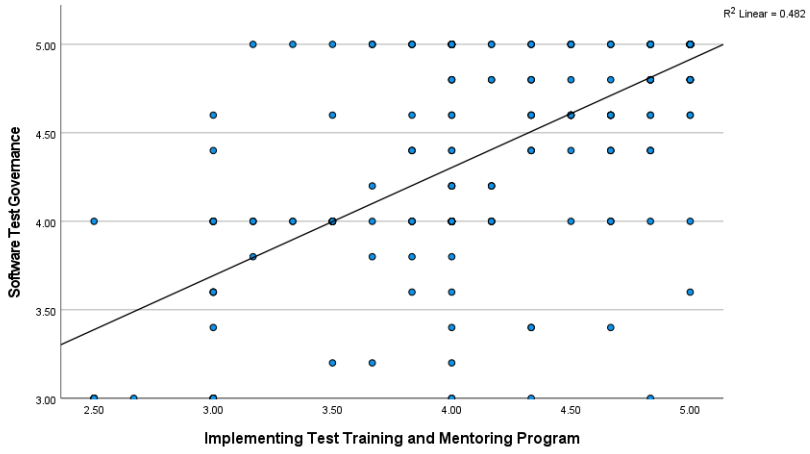


Figure 40: Scatter plot – Test training and mentoring program implementation

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			
					R Square Change	F Change	df1	df2	Sig. F Change
1	.694[a]	.482	.481	.43180	.482	286.820	1	308	.000

a. Predictors: (Constant), Implementing Test Training and Mentoring Program

Figure 41: Regression model summary – Test training and mentoring program implementation

As per figure 41, the correlation between the implementation of test training and mentoring program and successful software test governance is 0.694 which is positively correlated. The coefficient of determination of 0.482 indicates the variance of success of software test governance can be explained by implementing test training programs.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	53.479	1	53.479	286.820	.000[b]
	Residual	57.428	308	.186		
	Total	110.907	309			

a. Dependent Variable: Software Test Governance
b. Predictors: (Constant), Implementing Test Training and Mentoring Program

Figure 42: ANOVA – Test training and mentoring program implementation

Figure 42 shows that the correlation between the predictor variable and the dependent variable is statistically significant which is 0.0. (*p*-value is less than 0.05). This will reject the null hypothesis and accept the alternative hypothesis. Therefore, the study accepts there is a positive relationship between the implementation of test training programs. and successful software test governance.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.861	.157		11.845	.000
	Implementing Test Training and Mentoring Program	.611	.036	.694	16.936	.000

a. Dependent Variable: Software Test Governance

Figure 43: Coefficients – Test training and mentoring programs implementation

According to the statistics in figure 43, the significant value is 0 for test training and mentoring program implementation. Therefore, the independent variable has an impact on software test governance.

4.6.5 Regression analysis – Implementation of test process auditing and successful software test governance

Figure 44 represents the influence on successful software test governance by implementing test process auditing standards in software organizations.

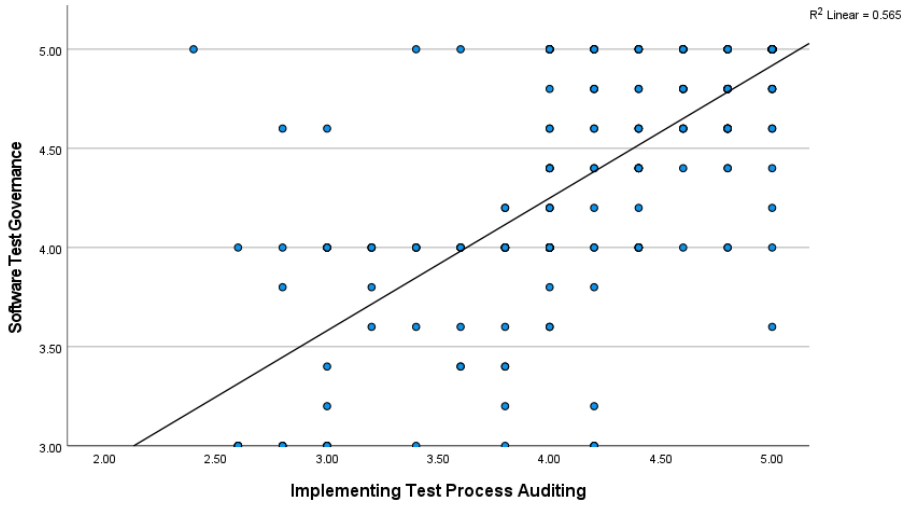


Figure 44: Scatter plot – Test audit implementation

This diagram shows the implementation of the test auditing process is positively related to software test governance. A linear regression analysis was conducted to understand the relationship between the two variables.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics F Change	df1	df2	Sig. F Change
1	.752[a]	.565	.564	.39564	.565	400.520	1	308	.000

a. Predictors: (Constant), Implementing Test Process Auditing

Figure 45: Regression model summary – Test process audit implementation

As per figure 45, the correlation between the implementation of test process auditing and successful software test governance is 0.752 which is positively correlated. The coefficient of determination of 0.565 indicates the variance of success of software test governance can be explained by the implementation of test process auditing

Figure 46 shows that the correlation between the predictor variable and the dependent variable is statistically significant which is 0.000 ($p < 0.05$). This will reject the null hypothesis and accept the alternative hypothesis. Therefore, the study accepts there is a positive relationship between the implementation of test process auditing and successful software test governance.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	62.695	1	62.695	400.520	.000[b]
	Residual	48.212	308	.157		
	Total	110.907	309			

a. Dependent Variable: Software Test Governance
b. Predictors: (Constant), Implementing Test Process Auditing

Figure 46: ANOVA – Test process audit implementation

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1.575	.147		10.688	.000
	Implementing Test Process Auditing	.669	.033	.752	20.013	.000

a. Dependent Variable: Software Test Governance

Figure 47: Coefficients – Test process audit implementation

According to the statistics in figure 47, the significant value is 0.0 for the test process auditing implementation. Therefore, the independent variable has an impact on software test governance.

4.7 Summary

This chapter describes the data analysis procedure of the study. Initially, reliability analysis was performed to validate the internal consistency and reliability of the questionnaire. Then descriptive analysis was performed to understand the distribution of the sample data set.

Inferential data analysis was performed to understand the behaviour of the sample which used Pearson's correlation analysis and regression analysis was performed to test the hypotheses and identify the association between independent and dependent variables. Finally, the study concludes its findings as there is a strong correlation of each independent variable on software test governance.

5. CONCLUSION AND RECOMMENDATION

5.1 Chapter Introduction

The chapter concludes the key research findings by describing the main findings of the research and emphasizes how software test governance improves the software development process by adhering to governance practices. The objective of the study is to identify elements of testing which has an association with software test governance. For this, a conceptual model was developed to identify independent variables and dependent variable and the relationship between those. From the literature review and the preliminary interviews with software test professionals, five independent variables were identified, and five hypotheses were developed. Reliability analysis, descriptive analysis, correlation analysis, and regression analysis were performed using collected sample data. SPSS tool was used to perform the statistical analysis.

Data collected from 310 respondents and as table 12, 82.9% have more than 3 years of experience and it confirms the majority of the respondents have a clear idea about the survey questions.

5.2 Data Interpretation

The following sections are described how the data was interpreted and presented which helps to achieve research objectives.

5.2.1 Reliability of data

Cronbach's alpha test was performed to validate the internal consistency of the questions used to test each variable. Reliability analysis was performed for the set of independent and dependent variables. Each of these variables was measured using multiple questions in the questionnaire. The study used Likert scale questions scaled from 1 to 5. Cronbach's alpha value for all the variables was above 0.7 and the questionnaire was validated as reliable to proceed with the study.

5.2.2 Demographic analysis of sample data

The demographic analysis was performed to understand the behaviour of the sample data set. All the respondents are from the domain of software testing and the majority of respondents hold senior positions and have more than three years of experience in

the industry. Based on the analysis of the organization type, respondents of the survey belong to product-based, service-based, and both types of organizations.

5.2.3 Research outcome

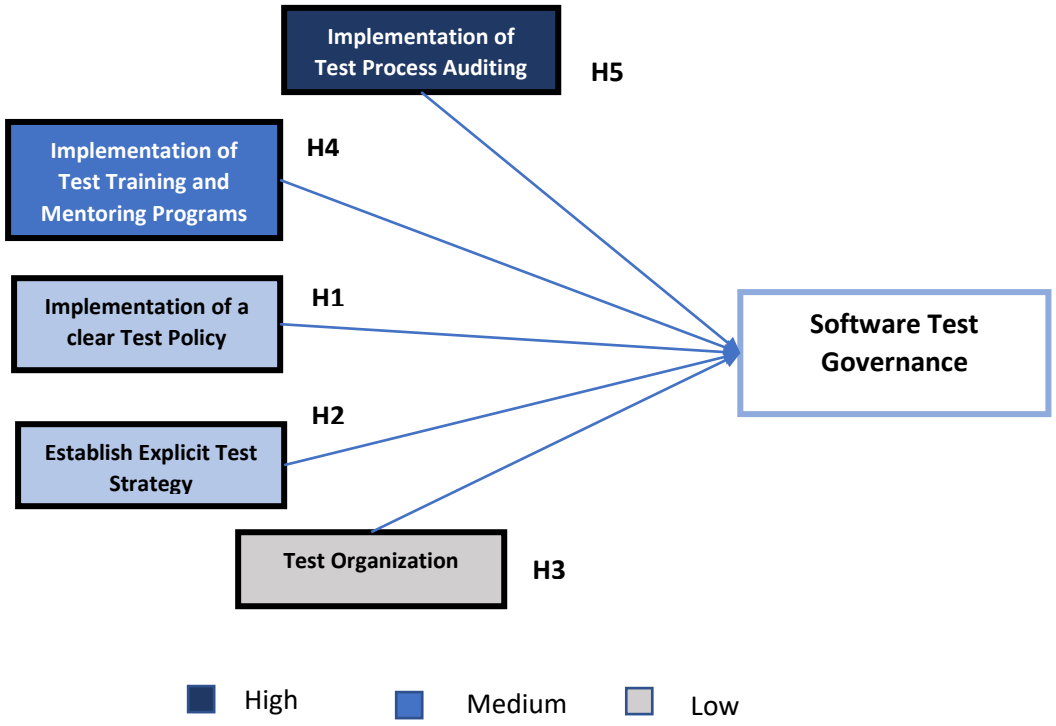


Figure 48: Levels of Correlations of Hypotheses

As the discussion in chapter 4, each independent variable has a positive correlation with software test governance. Based on the analysis, all the independent variables have a strong relationship with test governance. Figure 48 illustrates the sequence of factors when it is ordered from highest to lowest influence and as figure 48 shows, out of these factors, the factor of implementation of test process auditing and reviews has the highest influence on test governance. Factors of implementation of a clear test policy and establishment of an explicit test strategy have the same association with software test governance which both have a correlation value of 0.686. The lowest influence shows from the test organization factor. In summary, the study shows practising software test process audit and reviews and implementation of test training and mentoring programs have the highest influence on test governance. As the diagram demonstrates, the test auditing and review process has a comparatively high influence on test governance when compared with the test organization. The test audit process

defines the quality standards and processes each software development project should adhere and it directly helps to achieve test governance. This enables monitoring and measuring project-level performance. Although software development companies do not have a separate unit for performing their testing activities, monitoring testing activities against a well-defined quality criterion will guide the organization to properly manage its testing activities towards quality product delivery. The colours indicate the order of highest to lowest influence, where dark blue indicates the highest impact and light grey indicates the lowest impact on test governance.

5.2.4 Correlation between independent variables and dependent variable

Pearson's Bivariate Correlation analysis was performed using identified five independent variables and the dependent variable to understand whether there are associations between them with software test governance or not.

5.2.4.1 Hypothesis testing – Implementation of explicit software test policy

According to the two-tailed test shown in table 17, the alternative hypothesis was accepted such that, there is a relationship between a clear test policy implementation and software test governance which has a strong correlation with the value of 0.686 and the 0 significance that is a positive relationship. The main target of the testing policy is to ensure the right direction and the effectiveness of software testing. Having an effective test policy in a software organization, will guide software testing towards the alignment with business strategy and also provide the visibility of testing processes hence it is very important for successful software test governance. Compliance with the testing policy rules will reduce the risk of failure.

5.2.4.2 Hypothesis testing – Implementation of explicit software test strategy in organization-wide and specific program-wide

According to the two-tailed test shown in table 17, the alternative hypothesis was accepted such that, there is a relationship between explicit test strategy implementation and software test governance which has a strong correlation with the value of 0.686. With the 0 significance, it demonstrates that the two variables have a positive relationship. Having an explicit test policy in a software organization that guides the

software development process, will improve the management and control over the software testing and it has a better association with software test governance.

5.2.4.3 Hypothesis testing – Test Organization

According to the two-tailed test shown in table 17, the alternative hypothesis was accepted such that, there is a relationship between a distinct testing unit in software organization and test governance which has a strong correlation with the value of 0.644 where 0 significance that is, two factors have a positive relationship. Having a distinct software testing unit in a software organization is one of the most important factors for software test governance. This will improve the dedication of roles and responsibilities among the unit with improved accountability. And also has a high influence on capability alignment among the testing professionals with software development in the organization.

5.2.4.4 Hypothesis testing – Establish test training and mentoring programs

According to the two-tailed test shown in table 17, the alternative hypothesis was accepted such that, there is a relationship between the development of test training and mentoring programs and software test governance which has a strong correlation with the value of 0.694 where the significant value is 0 which means there is a positive relationship between two variables. Test training programs will guide professionals to work towards organizational objectives and deliver the business value by standardizing the test process across the organization hence it is a crucial factor when implementing software test governance in software organizations.

5.2.4.5 Hypothesis testing – Implementation of test process auditing

According to the two-tailed test shown in table 17, the alternative hypothesis was accepted such that, there is a relationship between implementation of test process auditing and software test governance which has a strong correlation with the value of 0.752 and the 0 significance that is a positive relationship. The implementation of the test process auditing enables monitoring and controlling the software test process. Review measurements use in audits have an immense effect on the decision-making process. This is the most important factor of software test governance according to the analysis.

5.3 Recommendations

By analyzing the collected data from the survey, the researcher identified five elements that need to be deployed within any software organization to achieve better software test governance. Practising proper test governance in software organizations has a high impact on quality product delivery. Also, defining organization-wide as well as program-wide standard test processes will lead to transparency, management of risks, performance, better decision making, and improved efficacy and effectiveness.

The main goal of developing a clear testing policy is to ensure the software testing process is heading and test execution is successful. Defining the test objectives and standardizing the test process helps the effective decision-making process. The majority of respondents agreed that the test policy should give an understanding of the overall testing goals and strategic testing view. This will help to govern overall software testing in the organization. Following standardized test practices across the organization will avoid inconsistencies between processes and resources and enable controlling and monitoring. Therefore, this has a better influence on test governance.

Defining explicit test strategies organization-wide as well as specific program-wide will helps to better control the test processes. The majority of respondents agreed that they believe organizations with no explicit strategies can have inconsistencies in product quality in different projects. Test strategy is defined based on the priority of the organization, testing objectives, and testing goals. This guides the test process in the right direction and supports to achieves organizational objectives.

The existence of a distinct software testing unit has a positive impact on the quality of the software produced, the organization's knowledge of the value of testing, and also the capability alignment between test and development professionals. 94.5% of respondents agreed that independent test groups allow management to identify and organize a group of capable individuals who are responsible for quality product delivery. Establishing a distinct test group that has a management which independent from development is very crucial and these test groups provide effective communication to business, development, and quality assurance which leads to better decision-making.

From the analyzed data, the researcher found some of the organizations do not have a proper plan to execute test training and mentoring programs. Test training programs guide test professionals across the organization to support the strategic business goals and objectives and ensure by improving the knowledge will involve the capability alignment between the developers and testers. The appropriate knowledge helps to achieve effective governance across the organization. Therefore, the implementation of specific training and mentoring programs which handle organization-wide, program-wide, as well as project-wide, will help to implement successful software test governance.

Software test process audit is identified as one of the major components of software test governance. The majority of respondents agreed that test process audit making sure effective decision-making by providing insights to the testing team about organization testing practices. Test process audit should be implemented within the organization according to a well-defined quality criterion and involve controlling and monitoring different process areas. The test audit process increases the ability to proper decision-making and ensures testing goals and objectives are achieved. Therefore, to achieve successful test governance, audit process and reviews should be implemented.

Based on the above discussion, the following actions are recommended when implementing test governance in software organizations.

1. Implement a clear test policy in the organization by describing the overall value of testing and management of test activities. This should describe the objective of software testing in the organization. Testing goals and objectives are unique from organization to organization and it should be defined organizational objectives, the process of evaluating the effectiveness and efficiency when meeting the defined objectives, describe organizational testing processes which standardize to follow the same process when it comes to different projects. Also, define the standards of software testing which provide better controlling and monitoring in organization-wide processes. When defining testing policy, include the elements namely, test goals, objectives, test roles and responsibilities, required skills, test techniques, test

process improvement criteria and align them with the organization's quality standards.

2. Define organization-wide and program-wide software test strategies. The organization needs to define the exact process of testing which needs to be followed when doing software testing. Maintain the organizations' standards and processes explicitly by defining test strategies and practice them among test professionals. It should guide test management to get the clear state of the project at any point. By properly addressing the test strategy will avoid the chances of missing testing activities.
3. Establish a unique software testing unit in the organization. Make sure software organizations have test organization units with independent management by enabling improved communication, decision-making within the testing unit. Introduce processes of improving the internal capabilities of the testing unit which can strategically align with software development.
4. Implement a well-defined plan to execute test training and mentoring programs in the organization. Identify test training requirements from organization-wide as well as specific project-wide and establish a plan to execute. Introduce training that provides an understanding of organizational testing standards and processes and guide every testing professional to follow them with the goal of quality product delivery.
5. Implement software process audits and reviews regularly in the organization. Software organizations need to establish well-defined rules and a set of practices, quality criteria that optimize quality engineering practices across the organization. Categorize test process audits into different areas such as testing processes, performance engineering, etc to enhance better controlling and monitoring. Also, focus on defining specific review metrics such as deployability, defect detention effectiveness, defect ageing, etc. which enables better decision-making of the software testing.

5.4 Limitations

For the data collection process, 17.1% percentage of respondents have less than three years of experience, therefore it is better if data can be collected from people with

management experience in software testing. And this research only collected data from software test professionals, but this can be extended to other software professionals as well since software test governance is more important to the complete software development process. Data is collected focusing on the Sri Lankan context only but when considering the global population result can be varied.

5.5 Future Research Directions

The study is focused on the organization-wide factors which influence software test governance. Agile governance is one of the current trends in modern software development which focuses on agile projects monitoring and controlling in software organizations. Our study can be extended by incorporating agile governance with test governance.

Future researches also can investigate whether there are different test governance factors identify based on the organization types, the structure of the organization, etc. They can also undertake more concentrated qualitative investigations to add another level of validation to determine the significance of test governance.

And, future work can focus on studying how the software test governance influences alignment of development and testing strategies.

Furthermore, in terms of risk management in software development projects, the role of software test governance can be explored.

5.6 Conclusion

As per the research findings, test governance has a high impact on quality product delivery as well as effective decision-making in software development projects. Also, it will allow better control and administration of testing activities throughout the organization. Therefore, software test governance is one of the most important factors in software organizations. It is shown by implementing the testing elements described in the study, organizations can achieve better software test governance.

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APPENDIX A – PRELIMINARY INTERVIEW QUESTIONS

Question category	Questions
Basic Questions	1. What is your designation in the software organization?
	2. What is the organization category?
	3. What is the type of product?
	5. Organization size - Number of employees
	6. Type of Software development methodologies being used
	7. Have ever done a test maturity assessment in your company? What maturity model does your company use? What is the maturity level of the organization?
General View of Test Governance	1. Is there a separate Test/QA department in your organization?
	2. How do you define software testing as 'done' before releasing the product? What is the software testing termination criterion?
	3. Who decides software testing is done? Who is informed about the decisions?
	4. What artefacts from the testing process can be used for decision-making?
	5. As you think, what activities, practices can control and administer software testing organization-wide?
Test Governance Activities and Roles	1. Do you know organizational testing goals? Are testing goals aligned with business objectives?
	2. Is an organization-wide test policy available? All the test professionals are aware of the test policy?
	3. Is there a well-documented test strategy is available? Is the test strategy is implicit or explicitly defined? What kind of information is included in the test strategy?
	4. How does it help to control overall test process practices in different projects?

	5. How much testing training is conducted both internally and externally in companies? Is training guided to execute the organization's test process standards? How test training programs are defined in the organization? What are the barriers to the implementation of test training programs?
	6. Are there predefined test process audit guidelines in the organization? Is there a dedicated team to execute the audit process?
	7. What are the procedures for managing test teams and processes? Who responsible for defining the master test plan? What are the activities in the master test plan? Who reviews the project test plan?
	8. Standard test design and execution process defined organization-wide? a. eg. Regression suite runtime/nightly/daily execution, test pass rate, test reporting
	Any other Ideas

APPENDIX B – FINAL SURVEY

Impact Factors of Software Test Governance in Sri Lankan IT Industry.

I am a postgraduate student of the Department of Computer Science and Engineering, University of Moratuwa. As partial fulfilment of the Master of Business Administration (MBA) in IT program, currently, I am engaged in a research study on;

"Impact Factors of Software Test Governance in Sri Lankan IT Industry."

It would be appreciated if you could spare about 10 minutes of your precious time to complete and submit the below questionnaire. Your complete response will be very important and helpful for me to conduct my research study.

All the information you provide will remain completely anonymous and confidential and will be used solely for academic purposes only.

Thanks in advance for taking the time to assist me in my educational endeavours. I recognize the value of your time and gratefully appreciate your commitment to completing this questionnaire. Please do not hesitate to contact me if you have any concerns regarding this.

Thank You,

M.T.C.Jayasiri | thivanka.18@cse.mrt.ac.lk

MBA in IT (2018)

Department of Computer Science & Engineering

University of Moratuwa

Sri Lanka

Demographic Information

1. Years of experience you have in software testing*

- Less than 3 years
- 3 to 5 years
- 5 to 10 years
- More than 10 years

2. Select your Job Category*
   - Software QA/Test Engineer
   - Senior Software QA/Test Engineer
   - Software QA/Test Lead
   - Software QA/Test Manager
   - Software QA Director
3. Which category does your organization belong to *
   - Product-based
   - Service-based
   - Both
4. What is the size of your organization? *
   - 0 -100
   - 101 - 300
   - 301 - 600
   - 601 - 1000
   - More than 1000

Test Policy Implementation

5. There is a clearly defined test policy to improve the test process in my organization. *
   - Strongly Disagree
   - Disagree
   - Moderate
   - Agree
   - Strongly Agree
6. The organization's test policy gives an understanding of the overall testing goals and objectives and strategic testing view.*

- Strongly Disagree
- Disagree
- Moderate
- Agree
- Strongly Agree

7. My organization has gained a lot of improvements in the test process by implementing a testing policy to enhance software quality. *
   - Strongly Disagree
   - Disagree
   - Moderate
   - Agree
   - Strongly Agree

8. I believe our test policy is aligned with the organization's quality policy. *
   - Strongly Disagree
   - Disagree
   - Moderate
   - Agree
   - Strongly Agree

9. Test policy guides the organization to follow standard practices across the organization hence avoid inconsistencies between organizational processes and resources. *
   - Strongly Disagree
   - Disagree
   - Moderate
   - Agree
   - Strongly Agree

10. Test policy provides a mechanism for encouraging standardization across the projects and enabled controlling and monitoring. *

- Strongly Disagree
- Disagree
- Moderate
- Agree
- Strongly Agree

Explicit Test Strategy Implementation

11.My organization has an organization-wide test strategy that is established and deployed to explain specific strategies that are relevant to the organization's needs and fit into project operations. *

- Strongly Disagree
- Disagree
- Moderate
- Agree
- Strongly Agree

12. Specific program-wide test strategies are defined in my organization which is fit into the program-related requirements. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

13. The test strategy is reviewed with stakeholders inside and outside testing. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

14. Test strategy is revisited and revised regularly as appropriate, Ex. yearly *

- Strongly Disagree
- Disagree
- Moderate
- Agree
- Strongly Agree

15. I believe organizations which do not follow explicit test strategy can have inconsistencies in product quality in different projects. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

Test Organization

16. My organization has a dedicated testing team that independently works according to the testing processes. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree
17. Test Group reports to management independent of the development management. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree
18. The existence of the independent test group has a positive influence on the organizational understanding of the importance of testing. *

- Strongly Disagree
- Disagree
- Moderate
- Agree
- Strongly Agree

19. I believe an independent test group allows management to identify and coordinate a group of highly qualified testing professionals who are responsible for delivering high-quality products. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

20. Strengths and weaknesses in the organization's existing process are identified by the organization’s testing group, and enhancements to the test process and resources are implemented as a result. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

21. The organization's testing group is a representation of test professionals, testing assets and resources and project-related test activities which drives the standardized testing process. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

22. The organization’s test group provides effective communication to business, development, and quality assurance which leads to better decision-making. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

Test Training and Mentoring

23. My organization has a well-defined plan to execute training programs to develop knowledge and skills which enable them to perform testing activities more effectively and efficiently. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

24. Test Training programs involve assisting the organization’s strategic business goals as well as fulfilling project-specific training requirements. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

25. Individual projects identify specific training needs, which are administered at the project level.*
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

26. The test training program aids the test organization by instructing test experts and other stakeholders on how to follow the organization's test process standards. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

27. The organization's test training program ensures testing professionals have a better understanding of organizational testing standards while improving their testing skills and domain knowledge and involve the capability alignment between developers and the test group. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

28. Deploying the training program helps the governing of the test process across the organization by delivering the right knowledge and competency among all people involved in testing. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

Test Audit and Reviews Implementation

29. My organization has well-defined rules and a set of standard practices to optimize its quality engineering practices across the organization. *

- Strongly Disagree
- Disagree
- Moderate
- Agree
- Strongly Agree

30. Software test process audit in the organization is making sure effective and high-quality delivery of software and provide insights to the testing team about organization testing practices. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

31. Test Audit helps to monitor and measure project-level performance according to a well-defined adequate quality criterion. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

32. Categorization the test audit process into different areas such as process-related, automation-related, and performance-related will involve controlling and monitoring different process areas. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

33. Test Audit Process increases the ability of proper decision-making and ensures testing goals and objectives are achieved. *

- Strongly Disagree
- Disagree
- Moderate
- Agree
- Strongly Agree

Overall Test Governance Practices

34. I believe software test governance ensures the execution of test activities easy and effective. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree
35. I believe software test governance will mitigate the risk of conflicts and inconsistencies between organizational test processes and resources. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree
36. Test governance activities have a positive impact on software quality, testing value, alignment of development with testing, across the organization. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree
37. Implementation of test governance provides an explicit way of managing people, processes, and technology of the software development process with the enabled decision-making of the management. *

- Strongly Disagree
- Disagree
- Moderate
- Agree
- Strongly Agree

38. I believe software test governance ensures test resources are used responsibly and provide strategic direction to the business. *
    - Strongly Disagree
    - Disagree
    - Moderate
    - Agree
    - Strongly Agree

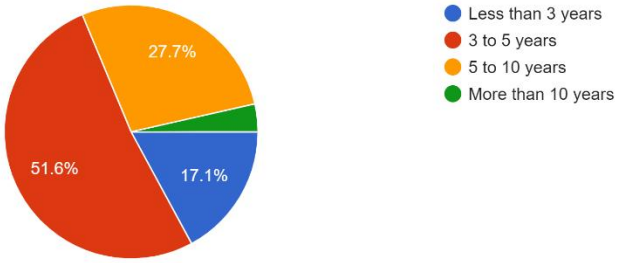
General Feedback

39. What are the test governance practices being practised in your organization other than addressing in this questionnaire?
40. Any Comment

APPENDIX C – FINAL SURVEY RESULT SUMMARY

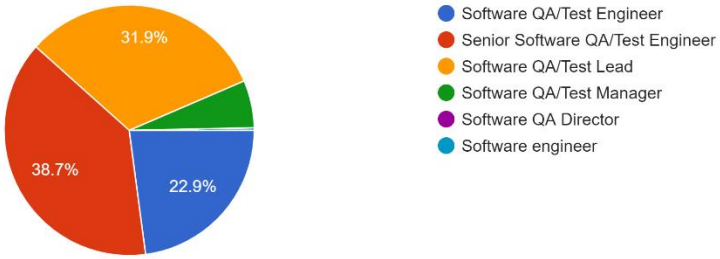
1. Years of experience you have in software testing

310 responses



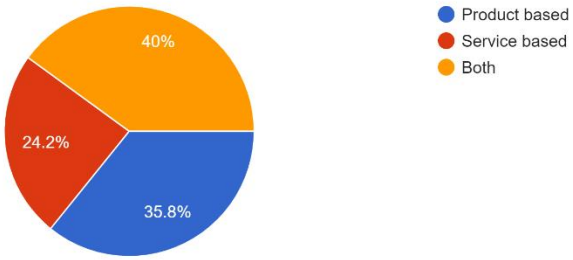
2. Select your Job Category

310 responses



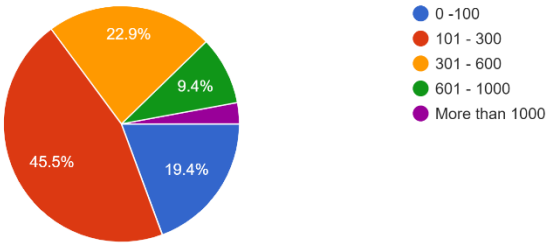
3. Which category does your organization belong to

310 responses



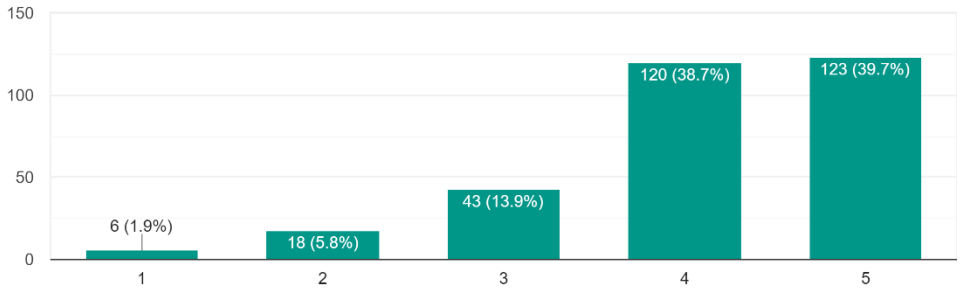
4. What is the size of your organization?

310 responses



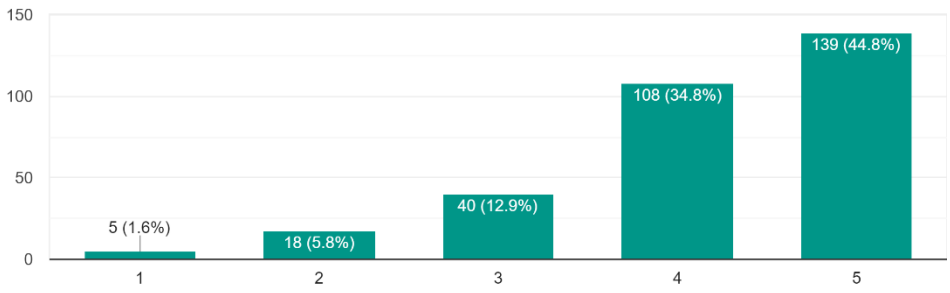
5. There is a clearly defined test policy to improve the test process in my organization.

310 responses



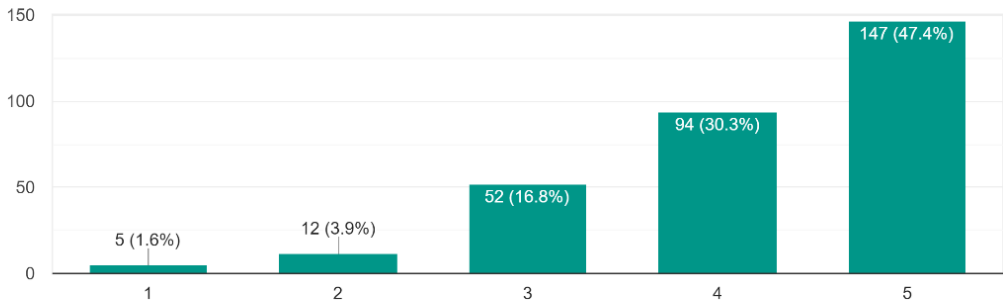
6. Organization's test policy gives us an understanding of the overall Organization's test objectives, goals and strategic views regarding testing.

310 responses



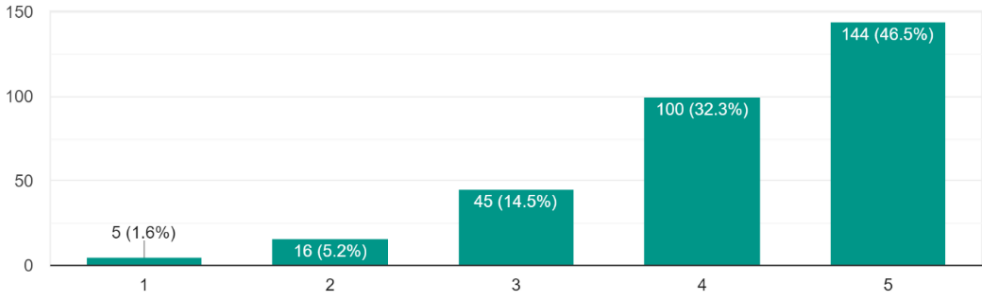
7. My organization has gained a lot of improvements in the test process by implementing a testing policy to enhance software quality.

310 responses



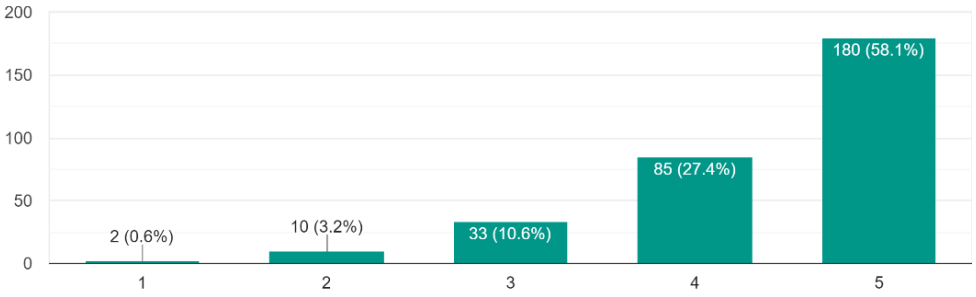
8. I believe our test policy is aligned with the overall business (quality) policy of the organization

310 responses



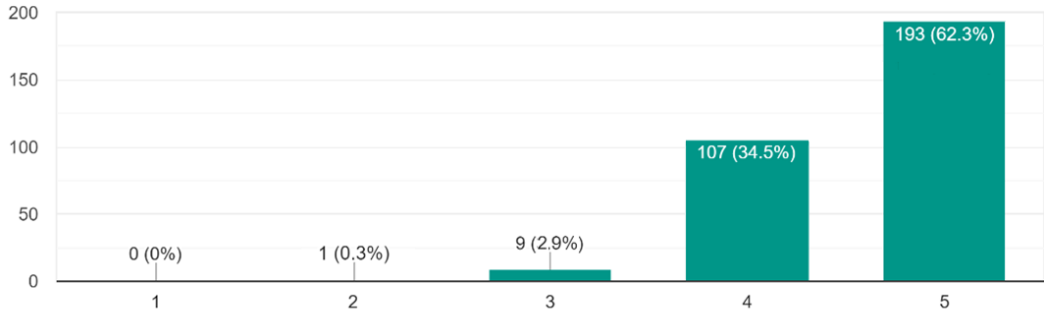
9. Test policy guides the organization to follow standard practices across the organization hence avoid inconsistencies between organizational processes and resources.

310 responses



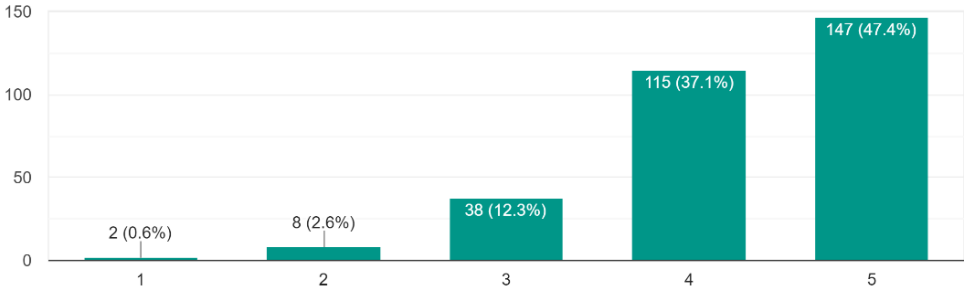
10. Test policy provides a mechanism for encouraging standardization across the projects and enabled controlling and monitoring.

310 responses



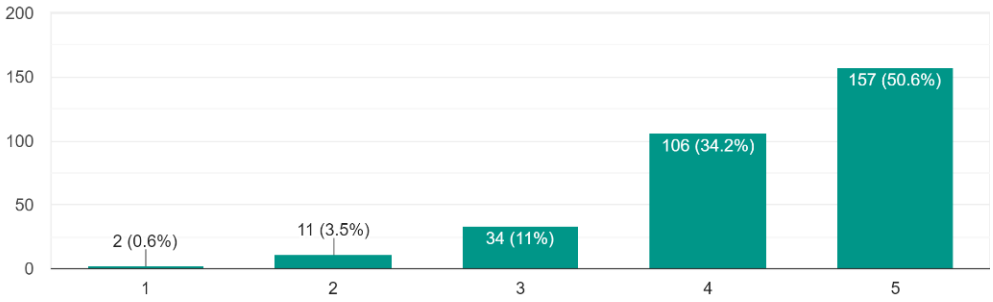
11. My organization has an organization-wide test strategy which is established and deployed to explain specific strategies that are relevant to the organization's needs and fit into project operations.

310 responses



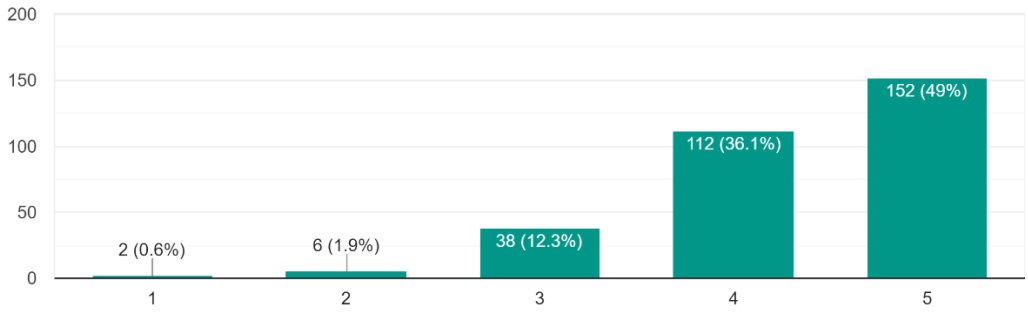
12. Specific program-wide test strategies are defined in my organization which is fit into the program-related requirements.

310 responses



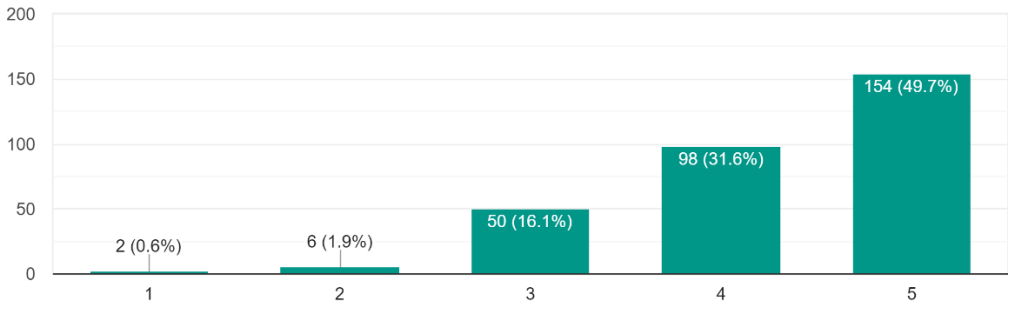
13. The test strategy is presented to and discussed with stakeholders inside and outside testing.

310 responses



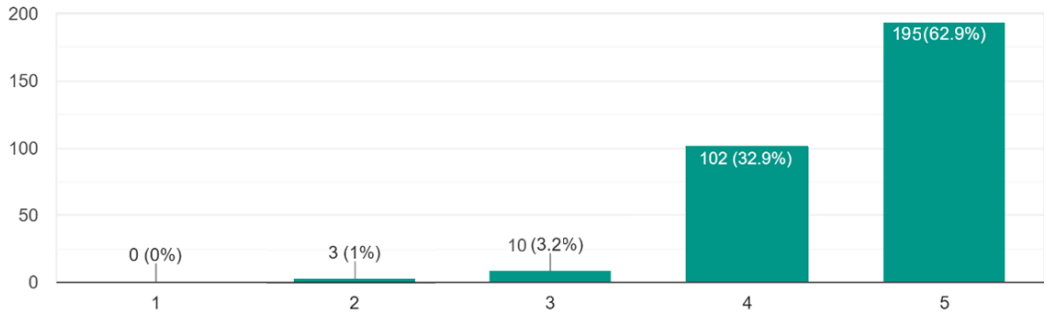
14. Test strategy is revisited and revised regularly as appropriate, Ex. on a yearly basis

310 responses



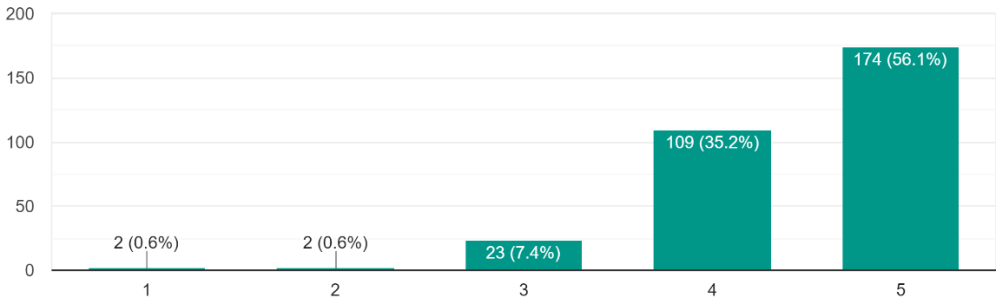
15. I believe organizations which do not follow explicit test strategy can have inconsistencies in product quality in different projects.

310 responses



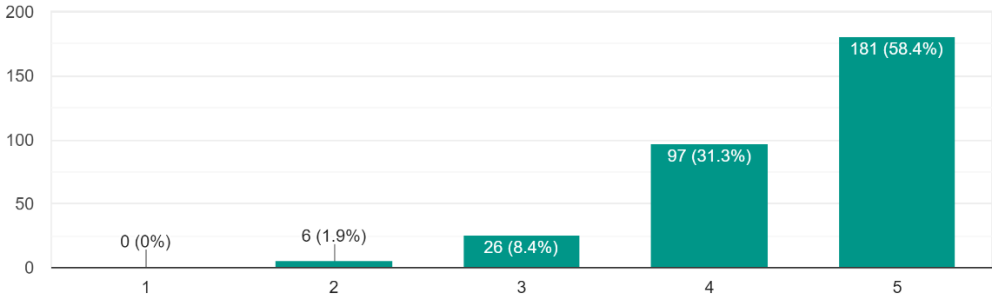
16. My organization has a dedicated testing team which independently works according to the testing processes.

310 responses



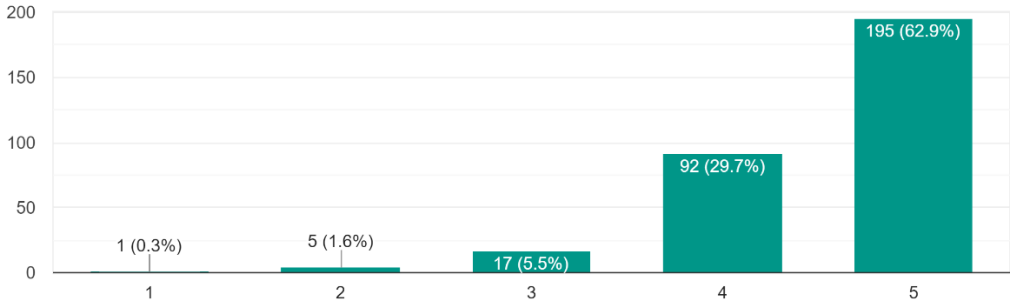
17. Test Group reports to management independent of the development management.

310 responses



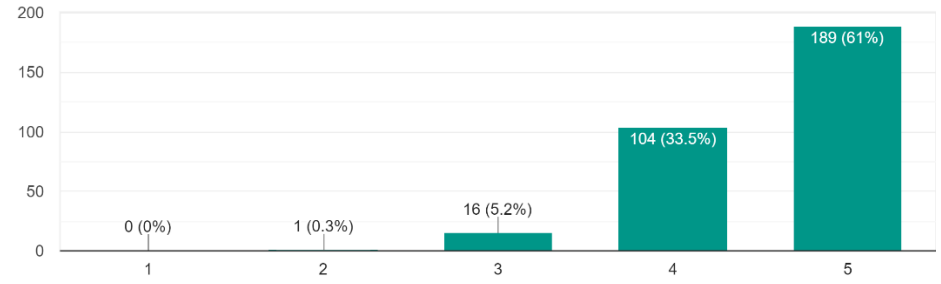
18. The existence of the independent test group has a positive influence on the organizational understanding of the value of testing.

310 responses



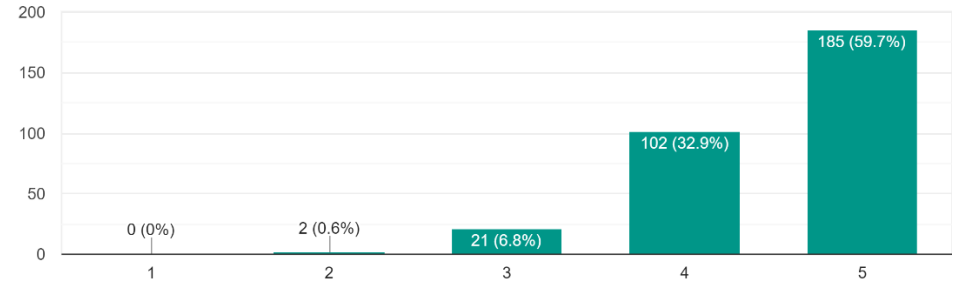
19. I believe independent test group allows management to identify and organize a group of highly skilled people that is responsible for quality product delivery.

310 responses



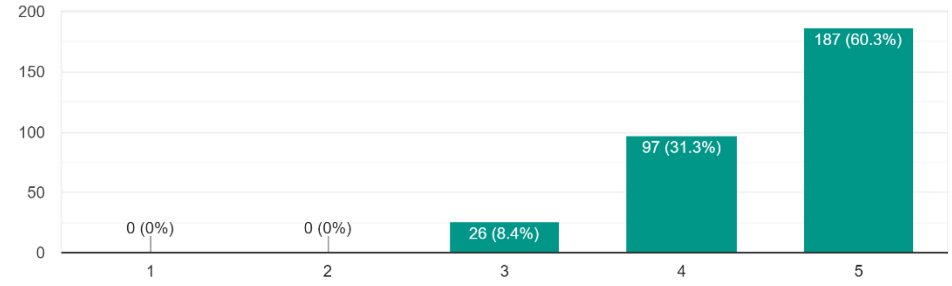
20. My organization's test group helps to manage improvements to the organization's test process and test process assets based on a thorough under...n's current test process and test process assets.

310 responses



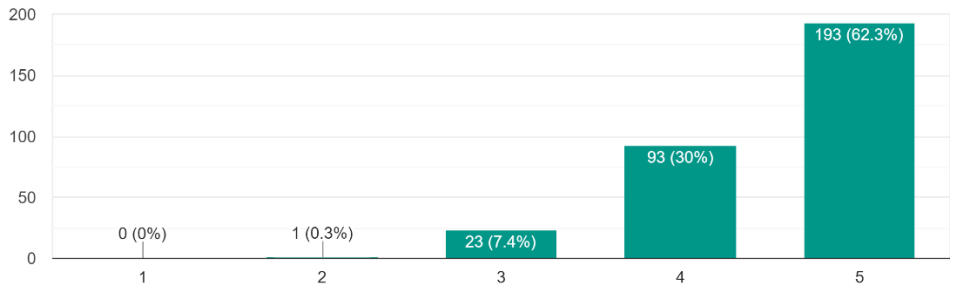
21. The organization's testing group represents effective relationships between test specialists, test facilities, and project-related test activities to achieve a high standard in structured testing.

310 responses



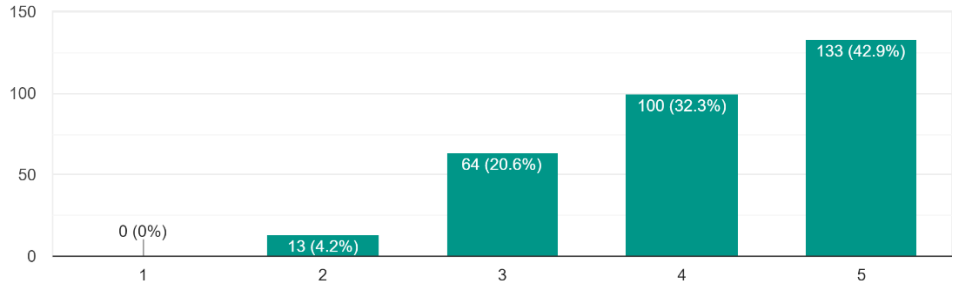
22. The organization's test group provides effective communication to business, development, and quality assurance which leads to better decision-making.

310 responses



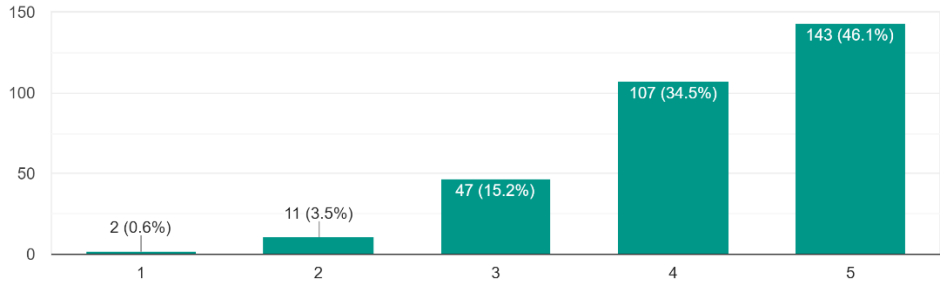
23. My organization has a well-defined plan to execute training programs to develop knowledge and skills which enable them to perform testing activities more effectively and efficiently.

310 responses

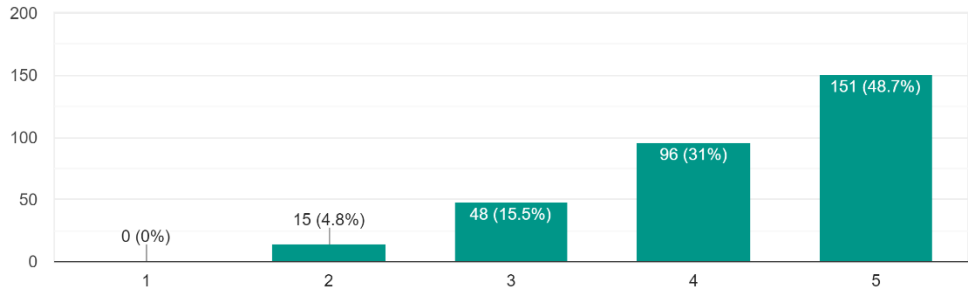


24. Test Training Program includes training to support the organization's strategic business objectives and to meet the training needs that are common across projects.

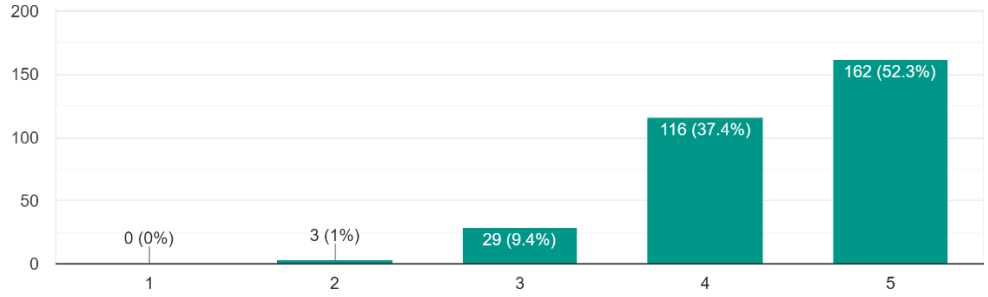
310 responses



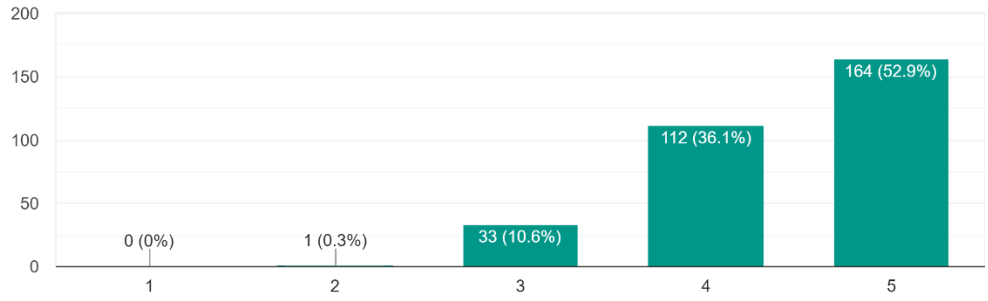
25. Specific training needs are identified by individual projects are handled at the project level.
310 responses



26. Test training program supports the test organization by training the test specialists and other stakeholders involved and guide them to execute the organization's test process standards.
310 responses

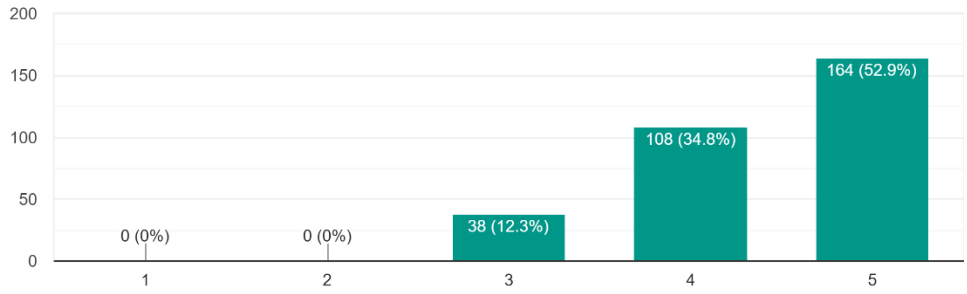


27. The organization's test training program ensures that those involved in testing continue to improve their testing skills and update their dom... alignment between developers and the test group.
310 responses



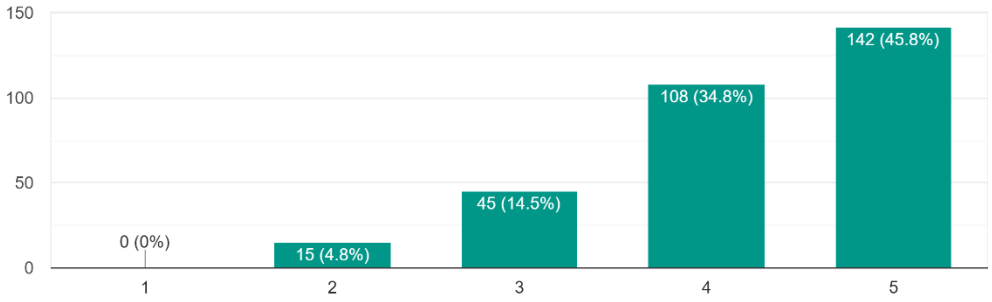
28. Deploying the training program which guarantees the appropriate knowledge and skill level for all people involved in testing, helps the governing of test process across the organization.

310 responses



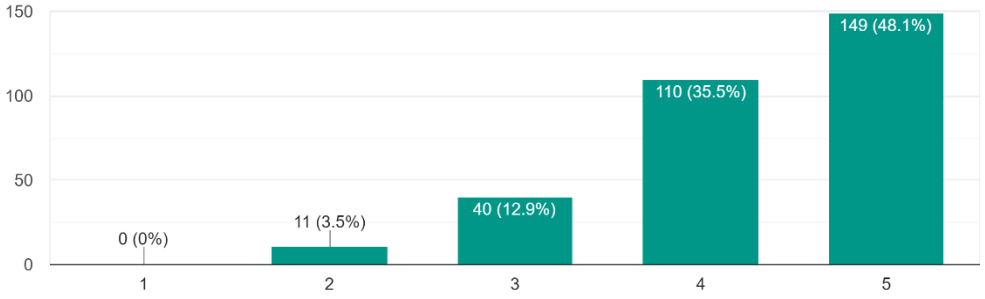
29. My organization has well-defined rules and a set of standard practices to optimize its quality engineering practices across the organization.

310 responses



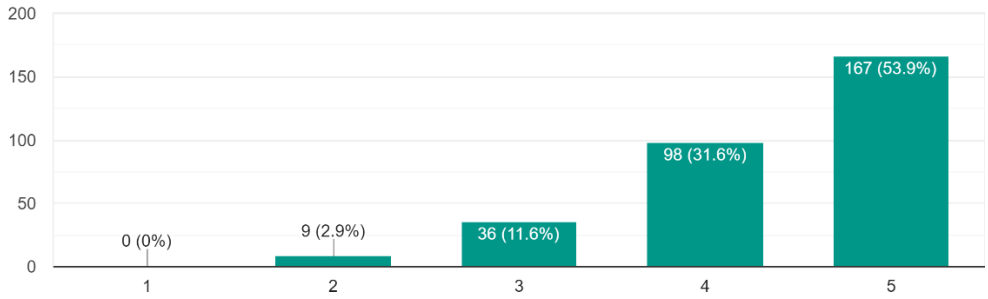
30. Software test process audit in the organization is making sure effective and high-quality delivery of software and provide insights to the testing team about organization testing practices.

310 responses



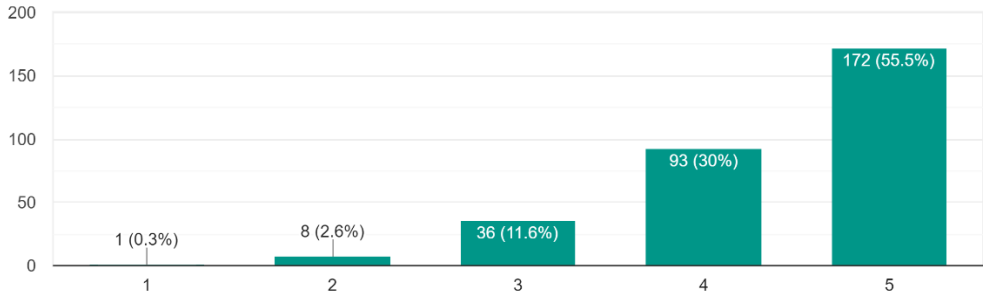
31. Test Audit helps to monitor and measure project-level performance according to a well-defined adequate quality criterion.

310 responses



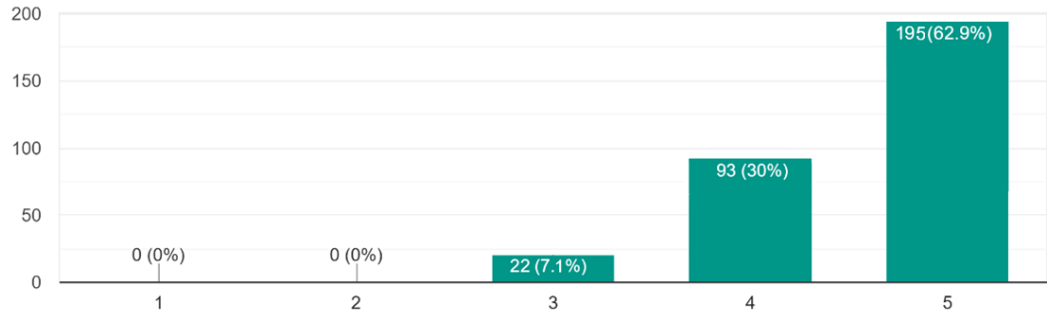
32. Categorization the test audit process into different areas such as process related, automation related, and performance related will involve controlling and monitoring different process areas.

310 responses



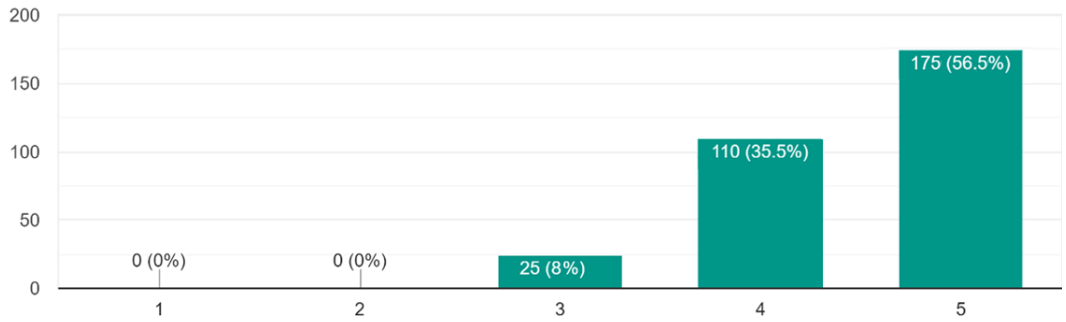
33. Test Audit Process increases the ability of proper decision-making and ensures testing goals and objectives are achieved.

310 responses



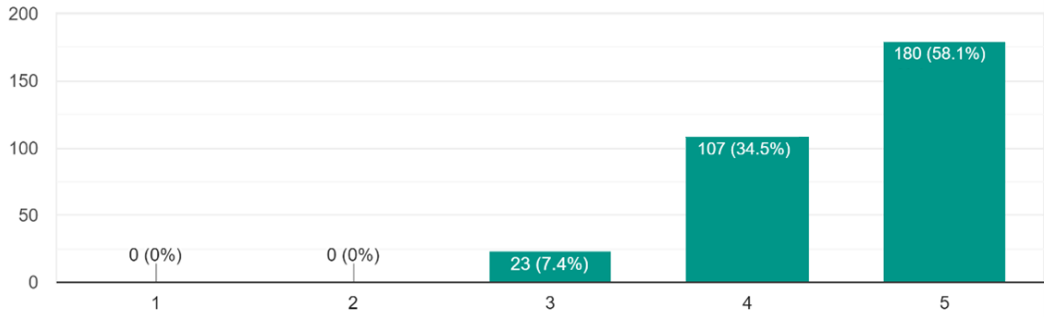
34. I believe software test governance ensures the execution of test activities easy and effective.

310 responses



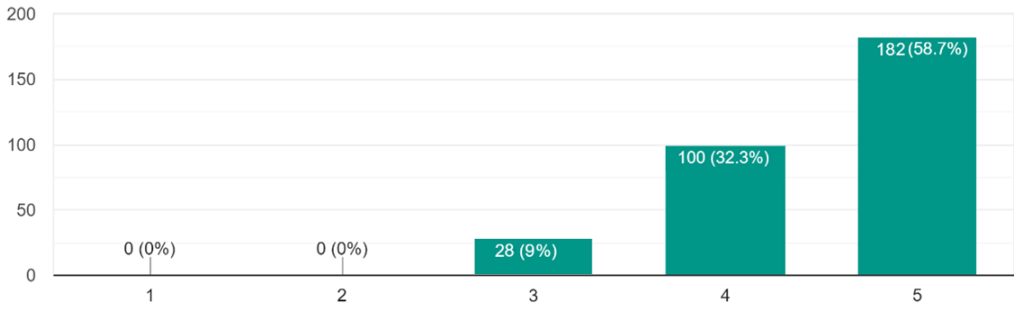
35. I believe software test governance will mitigate the risk of conflicts and inconsistencies between organizational test processes and resources.

310 responses



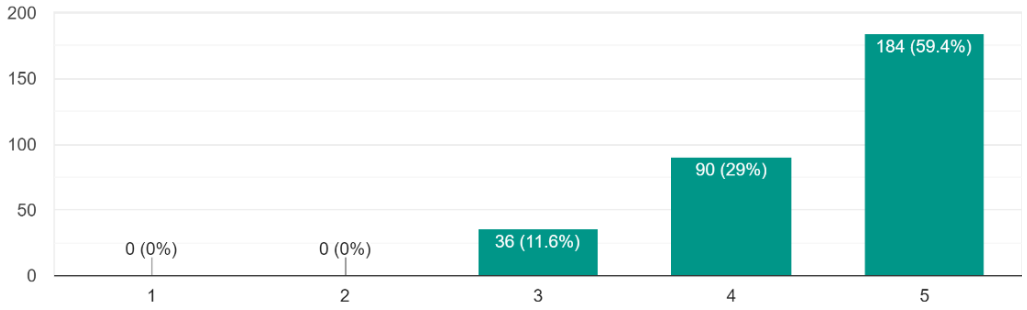
36. Test governance activities have a positive impact on software quality, the value of testing, software development, and testing alignment across the organization.

310 responses



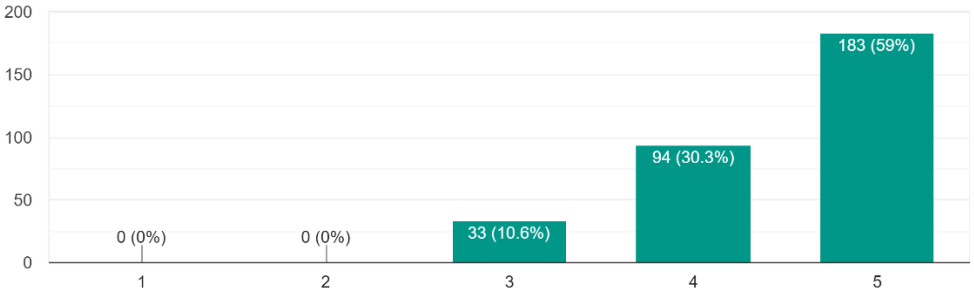
37. Implementation of test governance provides an explicit way of managing people, processes, and technology of the software development proc...the enabled decision making of the management.

310 responses



38. I believe software test governance ensures test resources are used responsibly and provide strategic direction to the business.

310 responses



APPENDIX D – COMPANY LIST

#	**Company**
1	Sysco Labs (Pvt) Ltd.
2	Pearson Lanka (Pvt) Ltd.
3	Orange Software Technologies (Pvt) Ltd.
4	Virtusa (Pvt) Ltd.
5	Millenium Information Technologies (Pvt) Ltd.
6	99X Technologies (Pvt) Ltd.
7	WSO2 (Pvt) Ltd.
8	Digiratina Technology Solutions (Pvt) Ltd.
9	Creative Software (Pvt) Ltd.
10	Villvay (Pvt) Ltd.
11	Axiata Digital Labs (Pvt) Ltd.
12	1 Billion Tech (Pvt) Ltd.
13	Nable Solutions (Pvt) Ltd.
14	Mobitel (Pvt) Ltd.
15	Epic Lanka (Pvt) Ltd.
16	Mutants International (Pvt) Ltd.
17	Auxenta Digital Labs (Pvt) Ltd.
18	Cambio Software Engineering (Pvt) Ltd.
19	Wiley (Pvt) Ltd.
20	GeoEdge (Pvt) Ltd.
21	Circles.Life (Pvt) Ltd.
22	MyBudget (Pvt) Ltd.
23	DirectFN (Pvt) Ltd.
24	Simcentric Technologies (Pvt) Ltd.
25	Codegen International (Pvt) Ltd.
26	Datavail (Pvt) Ltd.
27	Evonsys (Pvt) Ltd.
28	Holoteq (Pvt) Ltd.
29	Exilesoft (Pvt) Ltd.
30	Vitalhub Innovations (Pvt) Ltd.
31	Omobio (Pvt) Ltd.
32	ISM APAC (Pvt) Ltd.
33	Swivel Group (Pvt) Ltd.
34	BlackSwan Technologies (Pvt) Ltd.
35	Cloud Solutions (Pvt) Ltd.
36	Synergen Health (Pvt) Ltd.
37	Mitra Innovations (Pvt) Ltd.
38	Geveo Australasia (Pvt) Ltd.
39	Intervest (Pvt) Ltd.