Review of literature on Software Testing Practices and Quality Management approach in Software Industry

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ABSTRACT

The researcher has reviewed the literature to become familiar with existing published work **software testing practices and quality management approach in IT industry**. These efforts allowed the researcher to ensure that her research has depth and better understanding of the topic and identify gaps in the existing process and practices, and bring a integrated and a simple SOP to be implemented in the SME 's . This literature review will identify previous research that has been done on Software testing. And will bring out in-depth understanding of the previous research and findings. The literature survey brings our the gaps in quality implementation practices and the difficulties faced by SME.s for certifications on quality due to high cost and tedious implementation processes , no certification leads to loss in sales , loss of export orders and no trust b the customer . During the course of this research it has been established that there are a number of different metrics for software test planning and test design processes. There are many attributes in multiple categories for software test planning and test design processes for each of these attributes, different existing measurements that has been studied during the course of research suggests that there is a need for consolidation of these measurements. Therefore in this thesis the researcher will present the consolidation of measurements that is intended to provide an opportunity of Small and Medium Enterprises (SME's) to consider adoption of a single process to software testing. This thesis aims to bring out current software testing metrics and their benefits after a comparative analysis.

"Today the biggest challenge faced by the Small and Medium Enterprises (SME's) are how to adapt, use and implement the appropriate software and right metrics at affordable cost. Therefore to achieve benefit of software testing under limited resources, it becomes necessary to identify the best software testing practices and create a mapping between various existing software methods and tools. This can be achieved by analyzing current testing practices and identifying the improvement potential"

"According to an OECD Report 2014 titled 'Small and Medium-sized Enterprises: Local Strength, Global Reach' Small and Medium Enterprises (SMEs) account for over 95% of firms and in reality the Small and medium software companies comprise the majority of the software industry worldwide. In order for these small software companies to survive in a highly competitive marketplace, they must produce high quality software that will ensure a sustainable business model. Software units or an entire package are examined by running the programs on a computer. As new technologies and globalisation playing a vital role, the potential contribution of smaller firms is enhanced. [1]

Discussing about the significance of Testing Galin [2] explains in his book 'Software Quality Assurance - From theory to implementation', he explicitly explains that "

"Software testing is a formal process carried out by a specialized testing team in which a software unit, several integrated software units or an entire software package are examined by running the programs on a computer. All the associated tests are performed according to approved test procedures on approved test case. [3]. He further states that testing plays a

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central role in quality assurance activities of many organizations and finding one metric which is that is appropriate, useful and cost effective has been the greatest key challenge for SME's across the industry. It is observed that an efficient testing practice is vital to the quality of the developed product and to reduce the overall development expenses and emphasis that software quality has a direct relationship with software testing; hence testing is an important phase of the software development life cycle." [4]

Whereas Glenford J. Myers [5] says "Software Testing is a systematic activity but it also involves economics and human psychology. Economics of software testing is to determine and predict the faults of the system early by using foreseeab0le models and applying structured test strategies and test methodologies to discover those at early phases of the software development life cycle. Psychology of testing is to destructively test the application by identifying as many exceptional or out of the box scenarios or sometimes called as the third vision". [6]

"A set of good test case and real time scenarios helps in creating every possible permutations and combinations of a program during ideal conditions. In addition, Software Test Engineer needs the proper vision to successfully test a piece/whole application to comply with the Standards and the Quality. A standard operational procedure that is simplified will help them to real the goals of zeri rejection software is the only product that reaches the customers desk with bugs where in the customer also tolerates it to certain extent which is impossible in case of any other product since most of the customers are confused between a quality defect and technical snag ."

"According to Perry [7]brings to the fore the cost and budget factor while and opines that about 24% of the overall software budget and 32% of project management budget is allocated for testing.

"Software testing is an important and costly activity in the software development life cycle. Furthermore, inadequate software testing usually leads to major risks and consequences. For example, a 2002 report Tassey (2002) [8] by the "American National Institute of Standards and Technology (NIST) reported that the negative economic impacts of lack of software testing infrastructure in the United States alone amounts to \$62 billion USD per year. Needless to say, there are similar challenges in other countries. Tassey's view of implementing snd imbibing the quality practice clearl focuses on the cost of quality concept which is too expensive to afford by any organisation and hence suggestive in making testing mandatory in the life cycle process itself rather than an additional activity."

"Galin [9] brings to the fore the issues of costing and times pressure and states that SME's due to extra pressure to finish projects on time project managers are likely to reduce the testing activities. This can bring adverse effects on software quality, therefore to achieve benefit of software testing under limited resources, it becomes necessary to identify the best software testing practices and create a mapping between various existing software methods and tools. This can be achieved by analysing current testing practices and identifying the improvement potential."

Many of the previous research studies have focussed on good testing practices and brought to imbifore the very significant amount of knowledge on software testing and quality however they are mostly based on theoretical aspects. Also the literature studies tried to answer similar research questions with support of empirical data collected via an industrial case study.

Another recently published research study by "Sundmark *et al.* (2010) [10] presents results of an industrial survey on contemporary aspects of software testing using qualitative and quantitative methods":.

"Their study gives crucial information about discrepancies observed between the current practices and the perceptions of respondents which could prove beneficial in shaping future research on software testing, however the explanations for these observed discrepancies were provided based on researchers assumptions, or in some cases the explanations were not clear". In this case study the observed patterns in perception of respondents will be presented and an explanation for the observed anomalies or discrepancies will be explained by using qualitative data.

"The Performance based Management Handbook [11] A Six-Volume Compilation of Techniques and Tools for Implementing the Establishing an Integrated Performance Measurement System Process Management progression of resources developed to assist in the effective and efficient implementation of GPRA. In departmental strategic plan required under GPRA specifies and mentions that"

"Testing forms a critical tool that provides continuity throughout operations, forming the link between policy requirements, performance objectives, targets activities, Resources/Linkages , Methods/Tools ,Measurements ,Regulatory requirements applicable to the process, Risks associated with the process , Effectiveness and Efficiency , perhaps most importantly: customer requirements, both external and internal to ensure the quality and safety of their products, processes, and systems. The metrics should go beyond auditing and certification and help companies improve performance, gain efficiencies in testing and logistics, overcome market constraints, and reduce risk". [12]

"Glenford J. Myers [13] in his book "The Art of software Testing' explicitly mentions that Software Testing is a systematic activity but it also involves economics and human psychology. Economics of software testing is to determine and predict the defects early by using predictable models and implying strategies and different test methodologies to identify those at early stages."

Psychology of software testing is to destructively test the application by identifying as many exceptional or out of the box scenarios or sometimes called as the third vision.

"The Frits Philips Institute [14] identified three criteria for selecting the models that must be satisfied in order to compare a model usefully. The purpose of the model is to improve the whole test process.) The model must have a maturity structure There is sufficient information available about the model to compare it usefully The pre-investigation proved that it was hard to obtain TPI-model information. Sometimes, only a two-page description could be acquired. It is obvious that certain amounts of information are too little to compare the model usefully. Logically, only those models are described from which enough information could be acquired. Therefore, this means that the information about the purpose, elements and contents of the Key Process Areas are available.

This thesis aims at proposing an integrated framework for software testing that means compilation of various methods like TMMI, TPI, ISO & IEEE 928.

These methods will ensure single frame work with the best practices that will prove to be effective and efficient. It will also facilitate on quantity assessment and at a level at which each specific practices carried out at the metric against the standard metrics that will given them a clear understanding of the present status and the gaps"

1.   OVERVIEW OF CURRENT FRAME WORK

"CMMI stands for "Capability Maturity Model Integration". It's the integration of several other CMMs (Capability Maturity Models). By integrating these other CMMs, it also becomes an integration of the processes and practices within the model in ways that previous incarnations of the model(s) didn't achieve. CMMI framework is used in business process improvement , In other words, it is a model for building process improvement systems. In the same way that models are used to guide thinking and analysis on how to build other things (algorithms, buildings, molecules), CMMI is used to build process improvement systems. [15]"

"The International Software Testing Qualifications Board (ISTQB ®) "a not-for-profit association legally registered in Belgium. defines testing as "The process, consisting of all life cycle activities, both static and dynamic, concerned with planning, preparation, and evaluation of software products and related work products to determine that they satisfy specific requirements, to demonstrate that they are fit for purpose and to detect defects." [16]

With the literature studies it brings out that testing process is not just a manual proecedure that is followdwed ritually before coding but needs a clear scientific direction based on the cpre structrured approach which can be carried on as a standard operating process

The focus on testing has led to the development of test process improvement models that provide organizations with standard operating procedures . An approach of leading best practices of core activities that should form part of a test process based on next practices .based on the various test process improvement models have been developed to assist companies in establishing a mature test process. These include the" TMM, Map, TPI, and TIM." ®[17]

For this course of research the TMMi by the TMMi Foundation TPI, IEEE and ISO as model has been selected to compare the best practices to assess and improve the current test process in. The reason for selecting the TMMi model is that it is fast gaining recognition as an industry standard as was set out by its creators. It is relatively new and is also derived from the TMM and CMMI ®. "

Test Process Areas of TMMI TPI and ISO

Process Areas	TMMI	TPI	IEEE 829
Improvewhole process	Yes	Yes	
MaturityStructure	YES	Yes	
Sufficientinformation	Yes	No	
Rating Process Areas	Yes	NO	NO
Key Processs Areas (Goals)	Yes	Yes	NO
Maturity Model	Yes	NO	
Assessment Model	YEs	NO	No
Assesment Levels	1-5	A-D	
Test Maturity Matrix	1-5	1-56-1011-13	
Methods to improve current processes	Yes	NO	NO
Completeness leading to good analysis between current situation and desired situation	Yes	NO	No
Expertise and knowledge of people	High	High	Does not emphasise
Implementation levels in industry	Level 2, 3 (Partial implementation)	Partial	Partial
Completeness	Yes	Partial	Partial
Compatibility with CMMI	Fully	Partial	No

1.2. Theoretical Framework to Study Software Testing

The definition of testing as given in 1979 by Myers [18] distinctly characterized the destruction-oriented period. According to him the emphasis was placed on finding faults. The reasoning behind this was that if a program was tested with the aim of finding faults, then the tests would have a higher probability of finding the faults. This in turn would lead to improved testing.

 ➢ The review done in 1983 on the testing and verification. Validation and testing the Institute for Computer Sciences and Technology of the National Bureau of Standards brought out the facts that testing should be a part of the life cycle of the development "According to the document earmarked the evaluation-oriented period by placing an emphasis on activities to be performed during the software life cycle. These activities included integrated review, analysis and test of the software product at each phase of the software life cycle." [19]

➢ The phase where emphasis was on avoiding the importance of intital test planning and design , now focuses on the fact that t we imbibe testing at the start itself and not as a rejection approach at the end . Testing also looked into the aspects of risk management and brought down the risk of product reject and cost of performance ailure of the software " According to [20]the prevention model is represented at level 5 of both the CMMI and TMMI."

"According to Craig and Jaskiel [21] exit criteria is the "metrics specifying the conditions that must be met in order to promote a software product to the next stage or level". An example of such a metric is code coverage. Code coverage indicates the percentage of code that is covered by a test case.

Standards that must be adhered to such as the IEEE829 [31] and coding conventions."

"ISO :

International Standards Organization

ISO stands for International Standards Organization (recently changed to International Organization for Standardization) and is made up of members representing, for their country, the national body most representative of standardization "According to Larry Whittington[22]. A joint announcement by the ISO (International Organization for Standardization) and the IAF (International Accreditation Forum), the two organizations have agreed to an implementation plan for a smooth migration to ISO 9001:2008."

"This international body has promoted a number of standards useful for software testers, such as:ISO 9126:1998, that is now split into the following standard and technical reports (TR):"

IIEEE Standard

"IEEE is the Institute of Electrical and Electronics Engineer, a professional organization based in the USA. National representatives are available in more than one hundred countries. "

Improvement Models of testing have broungt out to bring in a metric of comparing between cross organisations to quantify and benchmark the standards across organisations to bring in the quality focus and revolution across IT industry too .

"There are many improvement models available in industry today. In addition to those covered in this section, Test Organization Maturity (TOM), Test Improvement Model (TIM) and Software Quality Rank (SQR) should also be considered. There are also a large number of regional models that are in use today. TPI is primarily a process reference model."

Scope for Future Research

The Software Quality implementation and management faces the implemation challenge of a single standard to implement and bring about the quality approach and can be applied to ring about a great product without any bugs to the customers desk. Reviews do focus on the ample number of processes available in the areas to test but the challenge is which one is the best for the companies and how they can use it for their quality approach. This reseatch wants to bring out the single standard frame work intergerated and simplified in processes which will help the company to reach maturity levels and proceed into to the nest level in each process areas from planning to delivery of the software. The proposed modelof an intregrated new frame work will focus on the efforts reduction and cost and more focussed approach with economics of time, moneyand productivity.". To deliver a successful software product to the client.

We have mainly focussed was to compare and bring out the best processes of each test model at all levels from planning to deleivery carry out the test process. The purpose of this research is to describe and

compare the most important Test Process Improvement models available and to give useful input for the development of the a comprehensive test process frame work. Several models are studied on goals, structure, key process areas and its assessment procedure. A unifying metric for quality is defined to be the ratio of the cost expended at a given point in time to that which will be required to satisfy all requirements placed on quality attributes, such as correctness, reliability, etc. Unit quality then corresponds to a system that fulfills all of its quality attribute requirements. The paper indicates the need for developing cost-versus-attribute relationships for all quality factors of concern.

The production of high-quality software focussing on schelduled delivery every time and within budget, and satisfying all of its requirements. This objective is a significant technical challenge for researchers, managers, and practitioners.

CONCLUSION

The research gap in this survey gives scope for looking into integration of all the best practices into a single point Standard operating practice and also a metric to mark the levels and stages that an organisation has reached in its quality implementation practices a scale similar to Likerts scale could be framed and the company can be certificated based on the ratings which is also the aim of the researcher.

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