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Magori Alphonce

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Challenges and Solutions in Software Testing Practices: A Systematic Review in Tanzanian Software Development Companies

Magori Alphonce
B.Sc. in Computer Science, Masters in Software Engineering, University of Dar es Salaam

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Abstract

Purpose: Software testing is an integral phase in the software development lifecycle, ensuring the delivery of high-quality software products. However, software development companies in Tanzania grapple with significant challenges in their software testing practices. This systematic review aims to identify, analyze, and propose potential solutions to these challenges. The primary objective of this study is to address the research question: "What are the challenges related to the existing software testing practices in software development companies?"

Methodology: The study conducted an extensive literature search and analyzed relevant studies published between 2010 and 2023.

Findings: Inadequate Testing Resources: Many companies contend with limited budgets, time constraints, and insufficient personnel dedicated to testing. Lack of Collaboration between Developers and Testers: Effective collaboration between developers and testers is paramount for successful software testing. Lack of Automated Testing Tools: Automation plays a pivotal role in enhancing testing efficiency and effectiveness. Unfortunately, many Tanzanian companies lack access to essential automated testing tools. Inadequate Test Coverage: Comprehensive test coverage, encompassing aspects like input validation, boundary conditions, and error handling, is often lacking.

Unique Contribution to Theory, Practice and Policy: Implementing Agile Methodologies. Agile methodologies foster collaboration, communication, and flexibility, creating an environment conducive to effective software testing. Using Cloud-Based Testing Tools. Cloud-based testing tools provide access to a diverse array of testing resources without necessitating extensive local infrastructure. Adopting Continuous Integration and Deployment Practices. Continuous integration and Deployment practices guarantee that software changes undergo thorough testing and swift deployment. Improving Test Case Design and Prioritization: Engaging stakeholders in the testing process and employing risk-based testing approaches. This systematic review sheds light on the challenges confronting software development companies in Tanzania concerning software testing practices and offers practical solutions to surmount these hurdles.

Keywords: *Software Testing, Software Development, Challenges, Systematic Review*

INTRODUCTION

Software testing plays a crucial role in ensuring the quality and reliability of software products. However, software development companies in Tanzania encounter various challenges in implementing effective software testing practices (Nadu & Nadu, 2019). These challenges can have significant consequences, including the delivery of poor quality software products, increased costs, and project delays. In order to address these challenges and improve software testing practices, it is necessary to identify and understand the specific issues faced by software development companies in Tanzania (Seuring et al., 2021).

The primary objective of this paper is to conduct a systematic review of the existing literature to identify the challenges related to software testing practices in software development companies in Tanzania. By examining the literature comprehensively, we aim to gain insights into the obstacles that hinder effective software testing and explore potential solutions to address these challenges (Bjarnason et al., 2014) (Bondarev et al., 2019). The findings of this study can serve as a valuable resource for both practitioners and researchers in the software development industry, facilitating the improvement of software testing practices and ultimately enhancing the quality of software products developed in Tanzania.

It is important to recognize that software testing challenges can vary based on the specific context of software development companies (Feldt et al., 2010) (Vasanthapriyan, 2018). Factors such as the size of the company and the nature of the software being developed can influence the challenges encountered in software testing (Upadhyay, 2012) (Garousi, Felderer, & Kuhrmann, 2020). Therefore, this study focuses specifically on challenges related to software testing practices in software development companies in Tanzania, with a scope limited to the period from 2010 to 2022. By narrowing down the scope, we can ensure a comprehensive and focused analysis of the challenges faced by Tanzanian software development companies in their software testing processes.

This introduction highlights the importance of software testing in ensuring the quality of software products and identifies the challenges faced by software development companies in Tanzania in implementing effective software testing practices. By conducting a systematic review of the literature, this study aims to identify these challenges and provide insights into potential solutions to address them (Tao et al., 2019) (Vukovic et al., 2020). The findings of this study can be valuable for practitioners and researchers in the software development industry in Tanzania, helping them improve their software testing practices and ultimately deliver high-quality software products.

Objectives

i. To identify the challenges related to software testing practices in software development companies.
ii. To analyze potential solutions to these challenges.
iii. To provide insights for practitioners and researchers to improve software testing practices

Research Question

What are the challenges related to the existing software testing practices in software development companies?

Statement of the Problem

The existing software testing practices in software development companies in Tanzania are facing several challenges. These challenges hinder the effective implementation of software testing, potentially leading to poor quality software products, increased costs, and delays in product delivery. To address these issues, it is crucial to identify and understand the specific challenges faced by Tanzanian software development companies regarding software testing practices. This study seeks to uncover these challenges through a systematic review of the literature.

Scope of the Study

This paper focuses specifically on the challenges related to software testing practices in software development companies in Tanzania. It excludes challenges associated with other aspects of software development, such as requirements gathering or project management. The study encompasses a systematic review of the literature published in English between 2010 and 2022

Significance of the Study

Software testing plays a crucial role in ensuring the quality and reliability of software products. However, software development companies in Tanzania, like many others worldwide, face various challenges in implementing effective software testing practices. This systematic review aims to identify these challenges and provide insights that can help improve software testing practices in Tanzanian software development companies. By understanding the challenges and potential solutions, this study contribute to enhancing the quality of software products, reducing costs, and ensuring timely product delivery.

LITERATURE REVIEW

Software testing is an essential activity in software development that aims to ensure the quality and reliability of software products (Hynninen et al., 2018) (Bäckström, 2022). However, despite the importance of software testing, many software development companies face challenges in implementing effective testing practices (Raulamo-Jurvanen et al., 2019) (Rahim et al., 2017) (Beyer, 2022a). In this section, we review the literature on the challenges related to software testing practices in software development companies.

Inadequate Testing Resources

One of the most common challenges related to software testing practices is inadequate testing resources. This includes insufficient budget, time, and personnel allocated for testing activities (Rajabli et al., 2021). Several studies have identified inadequate testing resources as a major challenge that can lead to incomplete testing, delays, and defects in software products (Braun et al., 2010; Hirsch et al., 2018). For example, Braun et al. (2010) found that companies with limited testing resources tend to focus on functional testing at the expense of non-functional testing, such as performance and security testing.

Lack of Collaboration between Developers and Testers

Another challenge related to software testing practices is the lack of collaboration between developers and testers (Al Neaimi, 2012) (Nadu & Nadu, 2019). This includes poor communication, insufficient knowledge sharing, and inadequate involvement of testers in the software development process. Several studies have identified the lack of collaboration as a major challenge that can lead to ineffective testing, rework, and delays in software development ((Beyer, 2022a); Raza et al., 2019). For example(Belay, 2020) found that developers and testers often have different priorities and perspectives on software quality, which can lead to misunderstandings and conflicts.

Lack of Automated Testing Tools

A third challenge related to software testing practices is the lack of automated testing tools (Raulamo-Jurvanen, 2020) (Rodriguez et al., 2019). This includes insufficient use of automated testing tools, such as unit testing frameworks, test management tools, and test automation frameworks. Several studies have identified the lack of automated testing tools as a major challenge that can lead to inefficient testing, high costs, and low test coverage (Rajabli et al., 2021)For example, (Garousi, Felderer, & Kuhrmann, 2020) found that companies with limited automated testing tools tend to rely on manual testing, which can be time-consuming and error-prone.

Inadequate Test Coverage

A fourth challenge related to software testing practices is inadequate test coverage(Rahim et al., 2017) . This includes insufficient testing of all aspects of software functionality, such as input validation, boundary conditions, and error handling. Several studies have identified inadequate test coverage as a major challenge that can lead to defects in software products and reduced customer satisfaction (Zhang et al., 2011; Xiao and Chen, 2019). For example, Zhang et al. (2011) (Vasanthapriyan, 2018) found that inadequate test coverage can lead to defects that are difficult to detect and can have serious consequences for users.

The literature review of this study identified four common challenges related to software testing practices in software development companies: inadequate testing resources, lack of collaboration between developers and testers, lack of automated testing tools, and inadequate test coverage. These challenges can lead to incomplete testing, delays, defects, and reduced customer satisfaction. The next section of this paper address the research question of this study, which is to identify the challenges related to the existing software testing practices in software development companies.

Challenges in Software Testing: A Global Perspective

Software testing is a critical component of the software development process, aimed at ensuring the reliability and functionality of software applications. However, software testing practices face various challenges that are encountered by testing teams across different countries. This review examines the common challenges in software testing practices observed globally, shedding light on the issues that impact the industry universally.

Resource Constraints

Resource constraints are a pervasive challenge in software testing, particularly in developing countries (Garousi, Felderer, & Kuhrmann, 2020). Limited access to testing tools, a shortage of skilled testers, and inadequate testing infrastructure hinder the efficient execution of testing

processes. As a result, testing teams often struggle to meet project deadlines and maintain the desired level of testing quality.

Lack of Standardization

The absence of standardized testing practices is a significant issue in the field of software testing (Bäckström, 2022). Testing procedures and methodologies vary widely between organizations and even within different projects of the same organization. This lack of standardization can lead to inconsistencies in testing quality and processes, making it challenging to assess and compare testing outcomes effectively.

Cultural Differences

Cultural factors play a substantial role in software testing practices (Anwar & Kar, 2019) These cultural differences encompass communication styles, work ethics, and problem-solving approaches. In some cases, hierarchical communication norms may lead to misunderstandings between testing teams and developers, affecting the effectiveness of testing efforts.

Industry-Specific Challenges

The emphasis on software testing varies across different industries (Carlos & Ibrahim, 2021) Industries with critical safety requirements, such as healthcare, aviation, or finance, have more stringent testing standards than others. Consequently, testing professionals face unique challenges depending on the industry they work in, including regulatory compliance and specialized testing needs.

Gap between Academic and Industrial Focus

The disconnect between academic research and industrial practices in software testing is a common challenge (Scatalon et al., 2019). While academia focuses on theoretical advancements, innovative algorithms, and cutting-edge techniques, industry professionals prioritize practical considerations. Tight project deadlines, budget constraints, and specific business requirements often lead to a gap between the research-driven approaches advocated by academia and the real-world testing practices used in industry.

Tools and Automation Challenges

While the adoption of testing tools and automation has been on the rise, it also presents challenges (Bäckström, 2022). Selecting appropriate tools, integrating them into the development process, and ensuring their effective utilization can be complex tasks. Moreover, maintaining and updating these tools requires ongoing effort and expertise.

Software testing faces several common challenges worldwide, including resource constraints, the absence of standardized practices, cultural differences, industry-specific demands, and the gap between academic and industrial focus (Bäckström, 2022). These challenges impact the efficiency and effectiveness of testing processes, ultimately influencing the quality of software products. Addressing these challenges requires collaborative efforts from testing professionals, organizations, and the broader software development community. By recognizing these universal issues and working towards solutions, the software testing field can evolve and adapt to the ever-changing demands of the software industry, leading to improved testing practices and higher-quality software products on a global scale.

METHODOLOGY

To answer the research question, a systematic review of the literature was conducted. Four major databases, namely IEEE Xplore, ACM Digital Library, ScienceDirect, and SpringerLink, were searched using relevant keywords (Eungoo & Hwang, 2021). The search was limited to studies published in English from 2010 to 2022. After screening the titles and abstracts, 30 relevant studies were selected for full-text review. The selected studies were analyzed to identify the challenges related to software testing practices in Tanzanian software development companies

RESULTS

The analysis of the selected studies identified several challenges related to the existing software testing practices in Tanzania software development companies. These challenges include:

i. Inadequate testing resources: Many companies in Tanzania face challenges related to testing resources, such as insufficient budget, time, and personnel.
ii. Lack of collaboration between developers and testers: Collaboration between developers and testers is essential for effective software testing. However, many companies face challenges related to communication, coordination, and integration between developers and testers.
iii. Lack of automated testing tools: Automation is necessary to increase the efficiency and effectiveness of software testing. However, many companies face challenges related to the lack of automated testing tools and the difficulty of developing and maintaining automated tests.
iv. Inadequate test coverage: Test coverage is an essential aspect of software testing, which ensures that all aspects of the software product are tested. However, many companies face challenges related to inadequate test coverage, such as difficulty in identifying test cases and prioritizing testing activities.

Discussion

The challenges related to software testing practices identified in this study have significant implications for software development companies. These challenges can lead to poor quality software products, increased costs, and delays in product delivery (Garousi, Felderer, Kuhrmann, et al., 2020). To address these challenges, software development companies can adopt several solutions, such as:

i. Implementing agile methodologies: Agile methodologies promote collaboration, communication, and flexibility
ii. Using cloud-based testing tools: Cloud-based testing tools can provide access to a wide range of testing resources, such as virtual machines, without the need for local infrastructure.
iii. Adopting continuous integration and deployment practices: Continuous integration and deployment practices can ensure that software changes are tested and deployed quickly, reducing the risk of defects and improving the software development process.
iv. Improving test case design and prioritization: Companies can improve their test case design and prioritization by involving stakeholders, such as customers and end-users, in the testing process and using risk-based testing approaches.

In addition, the challenges related to software testing practices may differ depending on the specific context of the software development company. For example, small companies may

face different challenges compared to large companies, and companies developing safety-critical systems may face different challenges compared to companies developing non-critical systems. Therefore, it is important for software development companies to identify their specific challenges related to software testing practices and develop tailored solutions.

Limitations

This study has several limitations. The search was limited to specific databases and studies published in English, potentially missing relevant studies in other languages or non-indexed databases. The selected studies varied in terms of research design, context, and focus, which may limit the generalizability of the identified challenges. The quality of the selected studies was not assessed, affecting the reliability of the findings.

Future Research

Future research can address the limitations of this study. Broader searches across databases and languages can enhance the comprehensiveness of the review. Standardized approaches for evaluating the quality of selected studies can improve the reliability of Software

Implications for Practice

The findings of this study have several implications for software development companies.

Firstly, software development companies should prioritize testing resources and ensure that they have sufficient budget, time, and personnel for testing activities.

Secondly, companies should promote collaboration and communication between developers and testers to ensure that testing activities are integrated with the software development process.

Thirdly, companies should invest in automated testing tools and continuous integration and deployment practices to increase the efficiency and effectiveness of testing activities. Finally, companies should improve their test case design and prioritization by involving stakeholders and using risk-based testing approaches.

Conclusion

This paper conducted a systematic review (Snyder, 2019) to identify the challenges related to the existing software testing practices in software development companies. The identified challenges include inadequate testing resources, lack of collaboration between developers and testers, lack of automated testing tools, and inadequate test coverage (Bäckström, 2022) (Beyer, 2022a). These challenges can have significant implications for software development companies, leading to poor quality software products, increased costs, and delays in product delivery (Latif & Rana, 2020) (Vukovic et al., 2020).

To address these challenges, software development companies can consider implementing agile methodologies, using cloud-based testing tools, adopting continuous integration and deployment practices, and improving test case design and prioritization (Peddireddy & Nidamanuri, 2021) (Beyer, 2022b) (M. et al., 2018). It is important for companies to identify their specific challenges and develop tailored solutions based on their context.

The findings of this study provide insights for practitioners and researchers to improve software testing practices and ensure the quality of software products. However, it is important to acknowledge the limitations of this study, such as the limited scope of the search and the

variation in the selected studies. Future research could address these limitations and explore challenges related to software testing practices in specific contexts.

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