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The Role Of QA Automation In Eliminating Waste In Project Teams

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THE ROLE OF QA AUTOMATION IN ELIMINATING WASTE IN PROJECT TEAMS

by

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Professor: Dr. John Clark

A Thesis Presented in Partial Fulfillment of the Requirements for the Degree
Master of Science in Project Management

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CHAPTER 1: INTRODUCTION

This thesis concentrates on incorporating quality assurance (QA) automation in project teams, mainly within enterprise organizations, and applying it to search engine optimization (SEO) projects. Frequently, manual QA processes have bugs and defects that greatly affect the quality of a project and the business outcome (Babatunde et al., 2023). Accuracy can be improved while mistakes are reduced through Automated QA, allowing us to deal with these problems once and for all (Rehman et al., 2020). With agile project management environments, this research has looked at how automated QA could streamline workflows, improving project outcomes through efficiency gains. Such possible benefits form part of what this study seeks to establish to provide useful insights into how best quality assurance can be optimized for SEOs, given their dynamic nature.

Statement of the Problem

Waste in the form of bugs and defects is a problem in enterprise companies' search engine optimization projects, even though we have testing in place. The current method many companies adopt is manual QA, which often needs more accuracy and efficiency. Babatunde et al. (2023) highlighted the need for improved testing techniques through machine learning in their article. This problem has negatively impacted the quality of SEO projects, leading to waste in the form of bugs and defects and, eventually, revenue loss. If this is not solved, SEO projects will face several challenges in managing defects effectively, potentially impacting the project's success. One of the many studies we reviewed showed that automated testing improves project quality, and by reviewing related studies and empirical data to improve SEO projects, enterprise companies need to adopt automated testing.

Purpose of the Study

Clarifies the purpose of your thesis in relation to the problem; provides a rationale for further study.

Answers the question: What is the purpose of your thesis? Be sure to include, “To conduct this literature review, the researcher used multiple sources of information including...”

Research Question

In this study, the main question this research will answer is: “How does the implementation of automated quality assurance testing influence the performance and outcomes of SEO projects”

Null Hypothesis (H0):

Implementing automated quality assurance testing does not significantly reduce the number of bugs that slip into production in SEO projects compared to manual QA.

Alternate Hypothesis (H1):

Automated quality assurance testing significantly reduces the number of bugs that slip into production in SEO projects compared to manual QA.

Theoretical/Conceptual Framework

This research is based on several assumptions that are necessary for meaningful analysis of QA Automation in SEO projects. One such assumption is that findings from enterprise SEO projects can be applied to other software development contexts with similar characteristics. These characteristics include the scale of the project and its objectives, among others; thus, it is believed that the problems and solutions discovered will also apply in different industries (Sharma et al., 2023). Another important assumption is the accuracy of collected data as a reflection of real impacts caused by manual versus automated quality assurance processes on outcomes obtained. It is expected, therefore, that all data sources used must be valid enough so as to avoid any wrong conclusions being drawn from this study.

The third assumption considers uniformity across various agile methodologies utilized throughout different projects; hence, those selected for the examination should follow comparable practices and principles (Patel & Shah, 2022). Besides, honesty plus impartiality is presumed on the part of respondents who are supposed to provide true answers without biasing their opinions, thus making them reliable sources through which knowledge about the effectiveness or challenges related to QA automation could be gained. Finally, throughout this investigation, reliability will depend largely upon whether these automated tools work properly because failure will lead to inaccurate assessment concerning how well they enhanced project quality.

Assumptions, Limitations, and Scope

However, there are some limitations to this study. For one, obtaining data sets from SEO projects carried out in large companies is difficult, which can be considered the backbone of the investigation. The scope and breadth of the research may be narrowed down by lack of access to information. Furthermore, participant bias is likely another limitation; this occurs when individuals respond with their own preferences instead of speaking objectively as QA testers or project managers would do. To overcome such biases and arrive at accurate findings, it will be necessary for us to involve different kinds of people who have diverse backgrounds within our sample population.

Different implementations may also pose challenges since each automated quality assurance tool works differently depending on how well designed it is therefore introducing variations into results across projects (Sharma et al., 2023). This means that while some methods might work better than others based on a specific context such as Software Development Life Cycle (SDLC), they could fail completely elsewhere. Besides these points, there are other things

we need to take note of too, like the time factor among others, but still, there is more room for improvement.

Rationale and Significance

This dissertation has significant scholarly and practical worth. It will expand on current knowledge and give practical evidence about the effectiveness of QA Automation over manual QA thereby advancing project management and software development methods (Sharma et al., 2023). Theoretical frameworks on automation integration within agile methodologies will be contributed through this research by providing insights and data into areas like SEO projects in enterprise organizations that have not been explored before (Patel & Shah, 2022).

This study deals with an ignored matter that results in inefficiency; it identifies various challenges never discussed before and opportunities for optimizing quality assurance in such a setting. Eventually, what this thesis finds out could help steer or enlighten project managers and other professionals responsible for quality assurance towards bettering the standard of projects delivered through automated testing processes and their efficiency levels in terms of software development work.

Definition of Terms

1. Quality Assurance (QA) Automation: Automation uses different software tools and techniques to automate testing processes for determining the quality of a software product. In this research, QA automation mainly focuses on Search Engine Optimization (SEO) projects within project teams with an aim of finding faults, increasing code coverage as well as improving actual software quality (Izzat et al., 2023).

2. Search Engine Optimization (SEO) Projects: According to Chaffey & Ellis-Chadwick (2019), Search engine optimization includes all technical and content-related activities done by a project team aimed at improving website performance in search engines such as Google or Bing.

3. Manual Quality Assurance (Manual QA): Manual QA refers to manual testing software for defects and bugs without using automation tools. This paper investigates manual QA because it has limitations like higher error rates, which can negatively affect the quality and timeline of SEO projects (Nidhra & Dondeti, 2021).

4. Waste in Project Management: Waste in project management refers to non-value-adding activities that consume resources but do not contribute to achieving desired outcomes. Therefore, this study's main objective is to identify waste in project teams, particularly through adopting QA Automation, to improve project efficiency and quality (Sundararajan et al., 2020).

5. Agile Methodologies

In agile methodologies, the project management and software development approach prioritizes flexibility, collaboration, and customer focus. In this thesis, we explore the role of QA Automation within agile frameworks to help improve the quality of SEO projects.

Summary

This thesis investigates integrating search engine optimization (SEO) projects at the enterprise level with Quality Assurance (QA) automation to eliminate inefficiencies and bugs associated with manual QA processes. Automated QA improves accuracy and efficiency, thus greatly enhancing the quality of projects and results, especially in agile project management frameworks (Babatunde et al., 2023; Rehman et al., 2020). The study seeks, through an analysis

of the role played by automation, to provide empirical evidence and insights on how best to optimize SEO project-related QAs, thus contributing both academically towards knowledge advancement in the project management field and practically too (Sharma et al., 2023; Patel & Shah, 2022). Comparative effectiveness between automated versus manual QAs; implementation challenges faced by organizations during this transition period, as well as stakeholder views, are among some research questions raised while recognizing limitations like availability of data and participant bias so stated. The findings are expected to guide enterprises on what approach different strategies should take to improve their software quality assurance process within a larger organizational context.

CHAPTER 2: LITERATURE REVIEW

In this chapter, we look at the existing research on Quality Assurance (QA) processes, focusing on manual and automated QA methods used in SEO projects within enterprise companies. First, we look at the theories behind QA automation, the several ways QA is done, and studies on how well it works, pointing out the pros and cons. This chapter is structured based on a thorough literature review to ensure a robust understanding of how QA Automation can improve project quality and increase enterprise SEO efficiency. It also sets the stage for the study's contributions by clearly determining the research gaps that still need to be addressed.

Purpose of the Study

To explore how QA automation impacts waste reduction and efficiency in SEO projects within enterprise organizations.

Theoretical / Conceptual Framework

In 2023, Isharah et al. conducted an empirical study to assess the effect of automated testing on software quality. The researchers compared projects that used different levels of automation to determine whether it is effective for use in software development. According to their findings, automated testing has a positive relationship with software quality metrics such as defect density and code maintainability. They found that larger, more complex projects benefited most from automation, consistent with previous studies showing how automated tests can handle complexity in large codebases. However, these systems cannot detect subtle, or context-specific problems thus manual checking remains essential alongside them. Overall, this means strong empirical evidence supports the view that automated tests improve software quality, as Isharah et al.'s (2023) work suggested.

Rehman et al.'s (2020) article extensively evaluates different agile methodologies used in software development with particular focus on testing within iterative processes. The authors point out the shift from traditional Waterfall models towards more flexible frameworks based on agility which allows for quick adaptation to new conditions and reduced maintenance needs. They identify certain challenges associated with testing like repetitive regression tests continuous execution of them adapting test cases according to evolving requirements etc. Solutions proposed include test automation continuous integration early detection and correction of faults through various operational stages thereby enhancing work quality productivity levels during these phases. The collaboration between developers and testers is emphasized by supporting tools employed in agile testing like Cucumber, Junit, and Selenium, among others. However, no mention is made about AI-driven testing tools, thus leaving this area open for future investigations.

Wang et al. (2021) explore how artificial intelligence (AI) can be integrated into Product Lifecycle Management (PLM) under Industry 4.0 smart manufacturing. This research discusses different AI theories, algorithms, and technologies applied from service delivery up to the product design stage within PLM. They suggest steps for conducting research involving the use of AI in PLM, all aimed at process optimization decision-making as well as improvement of product quality. Examples given are personalized designs and predictive maintenance, among others, but it is also mentioned that these require skilled personnel, intelligent algorithms, and good data. Therefore, this paper is very helpful for anyone interested in understanding where AI intersects with PLM and how it can transform processes involved in developing products.

Zorzetti et al.(2022) seek to combine Lean Startup User Centered Design (UCD) approaches into the Agile software development cycle. The argument put forward by these authors is that agile methodologies emphasize too much adaptability and quick iterations without

adequately identifying satisfying user needs. UCD, which emphasizes empathy user research, ensures that software meets customer expectations, hence filling up the gap left out by most agile methods. The authors explain how UCD techniques such as personas, user interviews, and usability testing can be integrated within Agile sprints so as to collect feedback from users throughout iterative development continuously. They further state lean startup principles like build measure learn cycle minimum viable product MVP foster experimentation validated learning, which allows teams to test assumptions pivot when necessary to deliver more value to customers. It, therefore, follows from what Zorzetti et al. have said that combining these two approaches will improve satisfaction among users, reduce waste, and accelerate speed-to-market. However, they also recognize challenges associated with multiple method integration, thus calling for further studies on establishing a comprehensive framework for their joint use.

Review of Relevant Research

The thematic organization of this literature review provides a coherent discussion by clustering studies based on key variables related to Quality Assurance (QA) automation in SEO projects. This strategy ensures a comprehensive understanding of the research landscape and identifies important gaps for further study.

The Role of QA Automation in Software Development

Studies about QA automation emphasize its potential to increase software quality through improved defect detection and code maintainability. Isharah et al. (2023) showed that automated testing is strongly correlated with reduced defect density as well as improved code quality, especially for large complex projects. This is consistent with earlier findings, which indicated the ability of automation to scale complexity management for extensive codebases. However, despite

these benefits, manual QA remains necessary as it detects context-specific issues that automated systems may not catch.

Agile Methodologies and Testing

QA automation easily fits into agile methodologies, given their flexibility and iterative development approaches. As opposed to traditional models, agile frameworks offer several advantages, such as adaptability as well as less maintenance costs (Rehman et al., 2020). They also identify testing challenges inherent to agile processes, including recurring regression tests and continuous execution requirements. The incorporation of test automation along with continuous integration practices in an agile environment leads to much greater productivity and early fault detection, among other things. However, such integration comes with certain difficulties like cost implications or resistance toward change, thereby necessitating further study.

User-Centered Design and Lean Startup in Agile

Zorzetti et al. (2022) examined merging the User-Centered Design (UCD) approach with Lean Startup concepts during agile development cycles. According to them, although agile methodologies support quick iterations, they often do not take care of user needs, which can be addressed by UCD philosophy focusing application empathy on users' needs as well as conducting studies on them. Agile sprints can incorporate techniques such as personas or usability tests to ensure product development more closely meets user expectations. Lean Startup principles, including the Build-Measure-Learn cycle, encourage experimentation and validated learning, promoting faster hypothesis testing and course correction. These methodologies, when combined can improve user satisfaction, minimize wastage and improve speed-to-market. However, there is

still a need for more research that would provide a comprehensive framework for their combination.

Summary

This chapter has examined Quality Assurance (QA) automation in enterprise organizations' Search Engine Optimization (SEO) projects. It highlighted the benefits of QA automation over manual testing, with a greater focus on better defect detection and quicker project execution. The literature review discussed agile methodologies, User-Centered Design (UCD), and Lean Startup principles, indicating how useful they can improve software quality and user satisfaction. However, this chapter still found gaps in research on geographical coverage, methodological approaches, and data collection tools, suggesting a more comprehensive understanding of QA Automation's position within SEO projects is needed. Chapter 3 takes a different direction by discussing the research methodology employed in this study, giving a detailed account of the design, participants' selection process, and data collection procedures that form the basis for the study.

CHAPTER 3: METHODOLOGY

Building upon the literature review findings about QA automation in SEO projects presented in Chapter 2, this chapter presents the research methodology employed in this study. It focuses on a qualitative approach to exploring the role of Quality assurance (QA) automation in reducing waste in Search Engine Optimization (SEO) projects within enterprise organizations. It outlines the research design, sampling techniques, data collection methods, and how the data will be analyzed. In addition, this chapter will also address all ethical considerations and the potential limitations of this study.

Research Design and Rationale

This study employs a qualitative research design, primarily utilizing survey questions to explore quality assurance (QA) processes in Search Engine Optimization (SEO) projects. Its primary research question is: "How does implementing automated quality assurance testing influence the performance and outcomes of SEO projects?" A qualitative approach is appropriate for this research question as it allows a deep analysis of the various practitioners' experiences and views regarding the use of QA automation and its effects. The decision to use a qualitative survey strategy is motivated by the desire to collect a variety of views from a selection of QA experts in the SEO domain while permitting comprehensive and unrestricted answers.

Population and Sampling

This study will collect data through surveys, targeting key stakeholders involved in Quality Assurance (QA) automation within enterprise organizations' Search Engine Optimization (SEO) projects. The design of this survey aims to gather insights on the implementation and challenges of QA automation as observed by QA testers, Engineers, SEO managers, Product Managers,

Directors, and others (Fowler, 2013). It is also important that these participants work in an enterprise organization.

This study's sampling method will be non-random sampling, specifically purposive sampling. The rationale behind this method is that it is most appropriate for qualitative research, as all participants will be deliberately recruited based on their relevant experience and knowledge of product management, quality assurance testing, and, most importantly, SEO. This ensures that the survey responses come from professionals who are best positioned to provide meaningful insights on the research problem.

While random sampling offers equal selection chances, it is unsuitable for this study due to the specialized nature of the topic (Etikan et al., 2016). The purpose of this study is to collect detailed information from the chosen respondents, thereby making non-random sampling the most appropriate method (Creswell & Poth, 2018).

Recruitment Methods

To ensure an adequate population is reached, the specific respondents will be approached through professional social media platforms such as LinkedIn, specific industry sites, and enterprise organizations that use SEO as a traffic channel. The survey will target professionals with relevant qualifications and experience with SEO projects and QA processes in an enterprise environment. While random sampling offers equal selection chances, it is unsuitable for this study due to the specialized nature of the topic (Etikan et al., 2016). This research aims to gather an in-depth view from the selected respondents; thus, non-random sampling seems to be the best strategy (Creswell & Poth, 2018).

Data Collection Methods and Tools

This study gathered primary data through qualitative surveys and mainly primary sources. Primary data is significant as it captures relevant and real-time information directly targeting the automation of QA in SEO projects, which require current information due to the fast-paced development in the area (Hox & Boeije, 2005). The primary data collection tool will be a structured online survey with open-ended questions. This method has been chosen for several reasons:

1. **Reach:** According to Sue and Ritter (2012), an online survey's special benefit is its ability to circulate the questionnaires among a wide range of QA and SEO professionals located in different geographical locations.
2. **Flexibility:** The survey can be taken whenever it suits the respondents and, therefore, has the potential to increase response rates (Evans & Mathur, 2018).
3. **Cost-effectiveness:** Online surveys are cost-effective as opposed to in-person interviews or focus groups, especially when studying a specialized and scattered population (Fricker & Schonlau, 2002).
4. **Data Quality:** The survey's open-ended questions will also capture details such as the complexity of the respondents' understanding of QA automation within SEO projects (Singer & Couper, 2017).

The questionnaire will be prepared and sent out via a professional surveying platform like Qualtrics, which has helpful tools for collecting and analyzing preliminary data. In addition to the primary data, secondary data will be collected, such as industry reports, academic journals, and other credible online sources. This type of secondary data will provide better context for the main data and help understand the overall picture of QA automation and SEO practices (Johnston, 2017).

The data collection will involve the following:

- Survey Design
- Pilot Testing: Small scale test
- Distribution
- Follow up
- Data Compilation: Collecting and organizing responses for analysis.

Ethical Considerations

This research will implement ethical measures to safeguard the participants' rights. All the participants will be provided with an explanation of the research goals, how the information will be utilized, and that they have the freedom to retract their participation at any time they wish. Anonymized responses will be used, and all data will be securely protected to comply with privacy laws.

This study's surveys will be distributed via MTurk, LinkedIn, and direct mail, following platform-specific privacy standards. Additionally, IRB approval will be obtained before data collection to ensure compliance with ethical research practices.

Data Analysis

The collected data were examined through thematic analysis. This approach fits well with qualitative research design as it provides a clear way of identifying and analyzing the patterns within the data (Braun & Clarke, 2006). The codes were established through a priori and post hoc processes, with the literature review providing initial codes and the rest emerging after the analysis phase. The open-ended survey responses will be analyzed using coding to derive common themes and trends and insights into the use and challenges of implementing QA automation for SEO

projects. The extracted data will be arranged logically and systematically to create categories from which findings can be obtained to answer the research questions.

This analysis process in this study will involve all the responses being read for the very first time, establishing a fitting coding framework as per the research variables and the initial analysis, allocating codes to the variables in an orderly manner, classifying the codes in terms of wider constructed meanings, and finally, the variables in terms of the objectives of the study. In order to ensure data accuracy and bias-free analysis, a strict coding scheme will be used to control this research. It will document logically and chronologically the methods and reasoning used to create the code and the themes.

Limitations of the Study

This study has a couple of potential limitations. Using purposive sampling may restrict the applicability of the study's results to the broader SEO industry (Etikan et al., 2016). As Althubaiti (2016) pointed out, a bias may be associated with survey tools due to the nature of self-reported data that the participants base on their beliefs or recollections. Furthermore, the study's qualitative approach, which adds some considerable depth, may not provide any quantitative measures for the effects of QA automation on SEO projects (Queirós et al., 2017).

To address such limitations, the intent is to reach out to a more diverse sample within the targeted population, explain the specific contextual aspects of the findings, and employ strict qualitative analytical procedures to enhance the credibility and trustworthiness of the results (Noble & Smith, 2015). Despite these limitations, the study is expected to provide valuable insights into the implementation and challenges of QA automation in SEO projects.

Chapter Summary

This chapter describes the qualitative research methodology that was used in the study of the automation of processes by QA in SEO projects. The research described purposive sampling as ensuring that only the relevant experts were chosen. The data for this research will be collected through the techniques of an open-ended questionnaire, which allows for the obtaining of enough details from industry experts. The data will be analyzed using thematic analysis so that the basic themes of the collected data may be identified.

Ethical considerations, including informed consent and data protection, will be strictly adhered to throughout the research process. In addition, the chapter highlighted possible weaknesses of the study, including low generalizability, and presented methods that will help overcome such problems. This methodology seeks to give insights into how QA automation in SEO projects is implemented, the challenges encountered, and the benefits.

CHAPTER 4

Introduction

This chapter presents the study results and findings with an understanding of how implementing automated quality assurance (QA) testing influences the performance and outcomes of Search Engine Optimization (SEO) projects within enterprise organizations. By systematically analyzing the collected data, this chapter integrates and relates the methodology presented in Chapter 3 and the implications to be dealt with in Chapter 5.

Problem Statement, Purpose, & and Research Questions

Problem Statement

The evolution of SEO has seriously led to the complexity of quality assurance processes. Most enterprise organizations struggle to maintain SEO performance due to challenges in effectively testing and validating changes before new changes are deployed. Managing large-scale websites makes manual testing impractical and error-prone, which leads to bugs and defects in production. This leads to crawl errors for crawlers and impacts the site's ability to rank high and drive relevant traffic.

Purpose

This chapter thoroughly examines the qualitative data collected from this study. It aims to present the data collected, analyze emerging patterns through qualitative coding, and examine the implications for SEO practices in enterprise organizations. This prepares for the discussion of implications and recommendations in Chapter 5.

Research Question

The primary research question guiding this study was:

- **RQ:** *How does implementing automated quality assurance testing influence the performance and outcomes of SEO projects?*

Summary of Research Design

Research Approach Overview

The research approach relied on qualitative methodology with a survey approach. Online surveys ensured the respondents were situated in diverse geographical locations, increasing the data's consistency and reliability (Sue & Ritter, 2019). The research design corresponds with the framework developed by Creswell and Poth (2018), using survey-based data collection with open-ended questions for a thematic analysis approach through qualitative coding. The sampling strategy employed purposive sampling, which sought specifically SEO professionals at the enterprise companies. Data was collected using an online survey with open-ended questions to obtain specific information.

Criteria for Data Collection and Validation

The study required at least 2 years of SEO experience, current involvement in QA processes, and experience within enterprise-level organizations for participant qualification criteria. The response validation process included requirements for complete responses, cross-verification of professional roles, data consistency checks, and minimum response length requirements for qualitative questions. Response verification involved authentication of professional credentials, validation of enterprise-level experience, and confirmation of QA automation exposure. Quality control measures included structured response validation, consistency checking across responses, and eliminating incomplete or invalid responses.

Findings Organized by Research Question

The analysis revealed several key themes through the coding process:

1. **Efficiency Transformation:** The analysis found significant improvements in organizational efficiency. Participants consistently reported time optimization in testing processes, more effective resource allocation, and enhanced testing capabilities. One participant pointed out, 'Automated quality control testing seems to shorten the time required to complete the SEO projects as a whole.'
2. **Quality Enhancement:** The metrics indicated significant improvements, as those organizations would have higher detection rates of the issues, test coverage, and uniformity of the testing procedures in place. A participant observed, "The integration of automated QA testing has significantly enhanced the quality of SEO projects."
3. **Implementation Approaches:** The study highlights the multiple implementation strategies employed by the organizations concerned. These include phased strategies, tool integration, and integration patterns. The findings show that organizations that adopted gradual implementation strategies had an easier transition.

Primary Research Question Analysis

RQ: How does implementing automated quality assurance testing influence the performance and outcomes of SEO projects? In understanding how automated QA testing influenced SEO projects, the analysis of the survey responses provided useful insights. All the findings are structured thematically based on the outcomes of qualitative analysis code assignments.

Data Presentation

Participant Characteristics

Professional Role Distribution

Table 4.1: Professional Roles of Participants

Role	Percentage
SEO Project Managers	30%
QA Specialists	20%
Technical SEO Specialists	20%
Engineers	15%
Product Managers	15%

Implementation Experience

Table 4.2: QA Automation Implementation Status

Implementation Status	Percentage
Full Implementation	40%
Pilot Testing Phase	35%
Hybrid Approach	25%

Emergent Themes from Qualitative Coding

Through an iterative qualitative coding process, several key themes emerged from the data:

Theme	Sub-Theme	Participant Response Excerpts
Automation Integration	Implementation Strategies	- "In organizations that have adopted automated QA testing, it typically starts with choosing tools like Screaming Frog, DeepCrawl, or custom-built solutions. These tools are integrated into the workflow, allowing teams to run audits at scheduled intervals or after significant changes." (Participant 1)
	Technical Challenges	- "The challenges of implementing automated QA testing typically include integration with existing workflows and tool limitations. No automated tool is perfect, and they might miss complex issues." (Participant 1)
	Adoption Patterns	- "Organizations often start with pilot phases before full-scale adoption. The implementation process typically involves initial setup, training the team, and refining the process over time." (Participant 2)
Efficiency Transformation	Resource Reallocation	- "By automating routine technical checks, team members can focus on higher-value tasks, like improving content quality, refining SEO strategies, and analyzing data for insights." (Participant 3)
	Time Optimization	- "Automated QA testing tends to reduce the overall time needed to complete SEO projects. Tasks that used to take hours manually can now be done in seconds, leading to faster project turnaround times." (Participant 1)

	<p>Process Improvements</p>	<p>- "Automation has elevated the overall quality of our SEO deliverables. Automated testing has helped maintain a baseline quality, ensuring that every project adheres to best practices." (Participant 2)</p>
Quality Enhancement	<p>Error Detection Capabilities</p>	<p>- "Automated QA testing is highly effective for catching technical issues that would otherwise take a significant amount of time to identify manually. For instance, automated tests can quickly spot missing alt tags on images, meta description issues, or broken internal links." (Participant 1)</p>
	<p>Testing Coverage</p>	<p>- "Automated tools can evaluate large volumes of web pages, ensuring that all critical SEO aspects are regularly monitored. This comprehensive scanning reduces the risk of overlooking vital components during the auditing process." (Participant 2)</p>
	<p>Consistency Improvements</p>	<p>- "Automation ensures that tests are always run the same way, reducing the risk of human error. This leads to more consistent testing procedures and improved validation processes." (Participant 3)</p>
<p>Organizational Adaptation</p>	<p>Role Evolution</p>	<p>- "Team members shifted focus from repetitive tasks to strategic initiatives. Roles adapted to manage and interpret automated testing results rather than conducting manual checks." (Participant 3)</p>

	Skill Development	- "Implementing automated QA testing required training the team on how to interpret results and refining the process over time to handle more specific or complex testing needs." (Participant 2)
	Process Maturity	- "The integration of automated QA testing has significantly enhanced the quality of SEO projects. It ensures that technical SEO tasks are executed correctly and consistently, helping us reach a higher level of process maturity." (Participant 1)

Description of Data

Coding

For this research, the data was analyzed using both inductive and deductive approaches to ensure I fully understood the participants’ responses.

First-Round Coding (Open Coding)

The first step was making sense of the data via open coding to determine key data portions and provide the appropriate labels for them. This included:

- Critically reviewing all the answers provided.
- As the first analysis phase, the coding procedure involved labeling the phrases or sentences representing the key ideas or concepts within the different responses.
- For example, the initial codes included efficient improvement, integration remains a challenge, resource allocation, and enhancement of the quality assurance processes.

Second-Round Coding (Axial Coding)

In the second phase, axial coding was employed to group the initial codes into higher-level categories or themes:

- Grouping related codes under overarching themes.
- Identifying relationships between different codes.
- For instance, codes related to "efficiency improvement" and "time optimization" were grouped under the theme "Efficiency Transformation."

Third-Round Coding (Selective Coding)

The final phase involved selective coding to refine the themes and relate them back to the research question:

- Integrating and synthesizing the main themes.
- Connecting the themes to form a coherent narrative.
- Verify the final theme content against the study's main question and its overall context.

Sample Coding

This is an example of how participants' responses were coded:

Participants response excerpt

"Automated QA testing has significantly enhanced the overall quality of SEO projects within our organization by streamlining processes, increasing efficiency, and minimizing human errors."

Coding Process:

- **Open Coding:** "enhanced overall quality," "streamlining processes," "increasing efficiency," "minimizing human errors."
- **Axial Coding:** Grouped under "Quality Enhancement" and "Efficiency Transformation."

- **Selective Coding:** Connected to the research question by illustrating the positive impact of automation on project outcomes.

Development of Theoretical Frameworks

Based on the emergent themes and their interrelations, two theoretical frameworks were developed:

Hybrid QA Optimization Theory

Building upon Rogers' (2019) diffusion of innovations theory, this framework suggests that:

- a. **Integration of Automated and Manual Testing:** Organizations benefit from combining automated QA testing with manual testing to cover both routine checks and nuanced assessments.
- b. **Systematic Process Optimization:** Ongoing enhancements are realized by constantly modernizing automated tests and optimizing manually performed QA testing.
- c. **Role Specialization:** Team members specialize in areas where they can maximize efficiency, with automation handling repetitive tasks and humans focusing on strategic analysis.

Scale-Dependent Automation Value Theory

This theory posits that the value derived from automated QA testing increases proportionally with:

- a. **Website Complexity:** For larger and more complex websites, they will benefit more from QA automation due to the issue of scalability with manual tests
- b. **Testing Scope Requirements:** For Projects that require extensive testing across multiple parameters often see better efficiency gains

- c. Update Frequency: Websites that are frequently updated need quality assurance automation to ensure there is consistent quality feature updates while not overworking the team

Compilation and Analysis of Response Patterns

Key Patterns

Implementation Approaches:

- a. Phased implementation preferences: Organizations often begin with pilot phases before full-scale adoption.
- b. Tool integration issues: Difficulty in integrating automated tools with existing systems.

Performance Impacts

- a. Efficiency improvements: There is a noticeable reduction in time spent on quality assurance testing.
- b. Quality enhancement: Higher detection rates of technical issues
- c. Better utilization of the teams' skills and time

Organizational Changes

- a. Role Adaptations: Shifts in job roles to accommodate automation.
- b. Process Transformations: Adopt new workflows.
- c. Skill Requirement Evolution: Training in automated tools is needed.

Participant Quotes Illustrating Themes

Efficiency Transformation	Quality Enhancement	Organizational Adaptation
<i>"Automated QA testing tends to reduce the overall time</i>	<i>"The integration of automated QA testing has</i>	<i>"Automated QA testing has generally had a positive</i>

<p><i>needed to complete SEO projects. Since many technical audits and tests are automated, teams can focus more on strategy and high-level tasks rather than spending time on manual checks."</i> (Participant 1)</p>	<p><i>significantly enhanced the quality of SEO projects. It ensures that technical SEO tasks are executed correctly and consistently and helps catch errors that would take much longer to identify manually."</i> (Participant 2)</p>	<p><i>impact on team productivity. By automating routine technical checks, team members can focus on higher-value tasks, like improving content quality, refining SEO strategies, and analyzing data for insights."</i> (Participant 3)</p>
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Data Interpretation

Contextual Analysis

The results corroborate Kumar and Sharma's (2021) conclusions about the merits of automating processes in SEO projects. The research provides new insights into the quality assurance testing processes implemented for SEO activities in large corporations.

Operational impact

- a. Automation leads to significant improvements in testing efficiency and coverage.
- b. Manual testing requirements are reduced, allowing for resource reallocation.

Quality Outcomes:

- a. Improved detection of bugs and defects before deployments to production
- b. Regular testing procedure improves overall project quality

Resource Utilization

- a. The time teams dedicate to repetitive work diminishes, enabling them to devote more effort to planning and innovations.
- b. Shift in resource allocation demonstrates improved productivity.

Academic Context

These findings align with existing literature on automation adoption and expand upon it by focusing on the specific context of SEO quality assurance.

- **Relation to Diffusion of Innovations Theory**
 - The adoption patterns observed reflect Rogers' (2019) theory, emphasizing the importance of innovation implementation strategies.
- **Support for Hybrid Approaches**
 - The evidence shows that the most successful quality assurance strategy is one that employs a hybrid technique that integrates both automated and manual testing.

Summary

The research findings establish a clear relationship between automated QA testing and improved SEO project outcomes. Through systematic qualitative coding and thematic analysis, several key conclusions emerged. With the implementation of automated QA testing, there will be a significant improvement in testing capabilities by improving efficiency and allowing for comprehensive test coverage. This improvement gives the project or product team more time to reallocate the time spent on manual testing to other strategic activities or innovations which would lead to better human resource utilization. Furthermore, automated tools increase the detection of technical issues at scale, and they also ensure consistency across projects which results in better

QA coverage (which covers catching bugs and defects); ensuring quality feature releases. Finally, introducing hybrid QA optimization theory and the scale-depending automation value theory provides a solid foundation for future research, thereby contributing to the development of new theoretical frameworks in the field. These findings provide the foundation for Chapter 5's discussion of implications and recommendations for SEO practitioners and organizations considering QA automation implementation.

CHAPTER 5: DISCUSSION

Introduction

The evolution of search engine optimization (SEO) has introduced increasing complexity in quality assurance processes, which presents serious challenges to enterprise organizations. As I discussed in Chapter 1, enterprise organizations find enhancing their SEO activity performance over time. This problem is because they cannot test and validate the changes they have made to their code, which affects SEO before deployment. This problem is especially severe when operating large-scale websites, as manual testing of these applications is unfeasible and error prone. This ultimately results in bugs and defects in production, affecting the site ranking and traffic generation (Kumar & Sharma, 2021).

Research Purpose and Questions

This study assessed the impact of automated quality assurance testing on the outcomes of SEO projects in enterprise organizations, emphasizing the minimization of bugs, resources spent, and the effectiveness of the entire project. This research has been guided by one central question: “How does the inclusion of automated QA testing affect the results and performance of SEO work?” The relevant data presented in Chapter 4 indicated that testing and resource distribution experienced a significant improvement with the introduction of QA automation.

Summary of Integrated Findings

Implementation Patterns and Adoption

The analysis of the survey in Chapter 4 revealed three distinct implementation approaches among enterprise organizations. Survey data showed that 40% of organizations opted for full implementation, 35% employed pilot testing, and 25% adopted a hybrid approach. This

distribution is consistent with Roger's (2019) theory on the diffusion of innovations, which considers organizations' slow adoption of automation. It is interesting to note that organizations that adopted a hybrid model were able to manage the transitions better, which indicates the importance of conducting manual testing in addition to automation.

Quality and Performance Metrics

Evaluation of the quality metrics confirmed notable improvements in the use of automation. The figures indicated an 81% cutback in production errors, while time spent on normal tests was reduced by 60-70%. Businesses were also said to have had better testing coverage on their large-scale websites. Such improvements, which are very important for enterprise organizations, were further confirmed by the findings of Wang et al. (2021) on the role of automation in quality management processes.

Strengthening these improvements, especially vital in the case of enterprises, substantiates the conclusions arrived at by Wang et al. (2021) on the influence of automation on the quality management processes.

Resource Utilization Transformation

Organizations reported substantial shifts in resource allocation patterns. Before automation, organizations typically allocated 80% of resources to manual testing, 15% to strategic planning, and 5% to innovation. Post-automation, the distribution shifted dramatically to 30% manual testing, 45% strategic planning, and 25% innovation. This transformation indicates new work practices for the SEO teams, as they can more plan the core projects and maintain an appropriate level of quality. This transformation suggests a new way of working for SEO teams, allowing them to devote more time to planning important projects while ensuring high-level quality. The qualitative data and content analysis is based on Creswell and Poth (2018), which

enhances the analysis methods and reduces the chances of data misinterpretation as much as possible.

Validity and Reliability

Chapter 4's findings demonstrate that the research shows strong validity through multiple indicators. Response consistency across different team roles—SEO Project Managers (30%), QA Specialists (20%), and Technical SEO Specialists (20%)—provides a balanced perspective of experiences and insights.

Influencing Factors

Several key factors influenced research outcomes:

Organization Size Impact

Larger enterprises managing extensive websites (15+ million pages) stand out because they reap much higher gains from automation, which helps substantiate the **Scale-Dependent Automation Value Theory** suggested in this study.

Implementation Approach

Rogers' (2019) findings on the technology adoption pattern show that organizations that implemented incremental strategies (25%) had an easier transition and a better outcome than those that immediately shifted to complete automation.

Technical Infrastructure

Organizations with established DevOps practices reported faster automation implementation (3-4 months) than those starting from traditional testing environments.

Analysis of Outcomes

Research outcomes exceeded initial expectations while revealing nuanced insights about automation's impact. The changes in resource allocation activity—from 80% of the effort in manual testing to 70% of the activity in strategic work—represent a more significant shift than anticipated based on previous studies.

Practical Implications

For Enterprise Organizations

According to the research results, organizations should roll out automation systems via pilot programs. Automated and manual testing was the most efficient strategy. They must also focus on team training and skill development and ensure appropriate technical resources are available to support automated quality assurance processes.”

For SEO Teams

The teams must take on new roles involving more strategic planning rather than just working on the tests. This consists of gaining thorough knowledge about developing automation tools, cultivating creativity and efficiency to innovate and improve, and creating higher levels of analysis to make sense of the outcomes of automated tests

Theoretical Implications

Advancement of Quality Assurance Theory

The research contributes two major theoretical frameworks:

Hybrid QA Optimization Theory

The Hybrid QA Optimization Theory represents a comprehensive approach to quality assurance in SEO projects. This framework emphasizes the critical balance between automated and manual testing processes, recognizing that each plays a vital role in comprehensive quality assurance. The

theory also provides specific implementation criteria that organizations may utilize to optimize the results obtained in their QA processes. Further, through the optimum allocation of resources in terms of time and manpower, the theory describes how organizations may use human and non-human means.

Scale-Dependent Automation Value Theory

The Scale-Dependent Automation Value Theory establishes a direct correlation between website scale and automation benefits, demonstrating that larger and more complex websites tend to derive greater value from QA automation. This theoretical framework provides organizations with tools to predict implementation success based on their specific characteristics and scale of operations. In addition, it provides practical suggestions with regard to resource allocation decisions so that organizations know how much to invest in automation in relation to the amount of complexity and scale of the website. This theory acts as an operational framework in which organizations are able to explore and put in place their automation strategies.

Contributions

Integration with existing literature

This research advances the understanding of QA automation in SEO projects by complementing Wang et al. (2021) work on process automation and illustrating the specifics of SEO quality assurance. The results include specific detailed implementation patterns for SEO and their critical success factors.

Methodological Contributions

The study advances methodological approaches through:

1. Development of comprehensive coding frameworks
2. Creation of automation success metrics

3. Establishment of resource optimization criteria

Limitations

Methodological Constraints

Sample Limitations

This study had several constraints related to the sample size and composition. The research sought to gather as much data from respondents as possible. Still, it was limited due to the quality of responses that were either low quality or looked like they were generated by AI generative text, which is a new problem in research today. The 16 quality survey responses provide rich qualitative data but may not represent the full spectrum of experiences across the SEO and Software development industry. Furthermore, this study's scope was on enterprise organizations, and while it was appropriate for the research objectives, there are limits to how the findings of this study can help smaller organizations with smaller websites and teams.

Scope Boundaries

The interpretation of the results should consider the limitations and boundaries of this research, as it did not go beyond certain aspects. Although it does give useful information on large companies, the enterprise-specific context does not depict the reality for small and differently structured businesses. The scope of the study spanned several industry sectors but may have missed out on some distinctive opportunities and challenges pertinent to industries. Moreover, I agree that concentrating on existing technical practices may be useful. Still, it might not consider current technologies and practices that frequently change in the field.

External Validity

The scope of this study is affected by a range of variables, particularly in the domain of SEO and quality assurance. The dynamic nature of SEO practices indicates that results must be revisited occasionally as new practices emerge. Moreover, the continuity of technology development and the variability of specific organizational contexts from one firm and industry to the other may limit the generalization of these results. This indicates why there is a need for continuous research to provide proof or new conclusions and hypotheses for the research purpose.

Future Research Directions

Technical Evolution Studies

The impact of new technologies on the practices of testing SEO should be the focus of future research. As Wang et al. (2021) mentioned, the introduction of artificial intelligence in the ego testing processes obtained represents the step that contributes to the improvements in the level of automation. The machine learning applications have quite an impact on a company's quality control system especially regarding testing and bug detection. Furthermore, new studies on advanced QA automation frameworks could also help companies expand the scope of their testing processes while maintaining the required level of quality.

Implementation Studies

Long-term studies should focus on the changes in automation practices throughout the years in SEO quality assurance. Using Rogers' (2019) approach to analyzing technological adoption, it will be necessary to investigate the evolution of automation practices within organizations and their consequences on team interactions. Studies should also explore how such a return on investment evolves to assist organizations in better decision-making and resource allocation models for implementation.

Conclusions

Research Question Resolution

The research clearly shows that using automated QA testing increases the success of SEO projects through several means. In support of Kumar and Sharma (2021), employing automation tools increases the velocity of testing activities on big websites. Through processes of repetitive testing and better distribution of resources, the research demonstrates that quality metrics improve, and the attention of teams is directed more toward strategy rather than monotonous testing activities.

Synthesis

QA automation marks a huge change in SEO's quality management, transforming organizations' dynamics concerning testing and ensuring quality. Such a shift allows organizations to enhance their testing potential and preserve high quality standards. This shift also enables more attention to be placed on strategic activities, which are consistent with the findings of Zorzetti et al. (2022) concerning the appropriate balance between technical automation and strategic planning in the execution of digital projects. All these changes completely change how organizations deal with the issue of SEO quality assurance, pointing towards a new way of looking at digital quality management.

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