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Quantifying Success: Measuring ROI in Test Automation



## Quantifying Success: Measuring ROI in Test Automation

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### Abstract

**Purpose:** The purpose of this paper to provide strategic decision to implement test automation with measurable ROI is a favoured approach for organizations seeking to improve the quality of their software, expedite delivery, and mitigate testing expenses.

**Methodology:** The present paper, titled "Quantifying Success: Measuring ROI in Test Automation," delves deeply into the fundamental aspects of ROI evaluation within the realm of test automation. It outlines the methodology behind ROI calculation, explores the cost factors and advantages associated with automation, and sheds light on the optimal strategies for achieving a favourable ROI.

**Findings:** By presenting real-world case studies and examples, this paper effectively demonstrates the practical application of ROI measurement in test automation. The formula for Return on Investment (ROI) typically falls under the category of being "basic". While costs are relatively simple to measure, assessing the worth of potential advantages proves to be considerably more challenging.

**Unique Contribution to Theory, Policy, and Practice:** Approaches to calculating ROI often oversimplify various aspects of test automation, subsequently resulting in inaccurate outcomes. These inaccuracies, in turn, foster impractical expectations among management in relation to test automation, ultimately culminating in failure at individual, team, and occasionally project levels, thereby offering valuable insights to organizations seeking to optimize the efficacy of their testing endeavours.

**Keywords:** *ROI, Test Automation, Automation, Investment*

## Introduction

Test automation has transformed into a fundamental aspect of contemporary software development. Its contributions surpass the mere assurance of software quality; it profoundly influences efficacy, swiftness, and competitiveness. The incessantly changing technological panorama necessitates the implementation of test automation to bestow high-caliber software that adheres to the most stringent criteria of dependability and user contentment. Some of significance such as:

The prompt and efficient execution of test cases through the use of automated testing expedites the software development process, which is of utmost significance in the Agile and DevOps environments, thereby enabling frequent and rapid releases. By ensuring the execution of a multitude of test cases across various configurations and environments, automation ensures comprehensive test coverage, thus ensuring a thorough examination of all critical functionalities [3]. The provision of consistent and precise results with each execution by automated tests eliminates the variability associated with manual testing, thereby ensuring reliable and reproducible results. Facilitating the early detection of defects, test automation allows teams to address issues in the initial stages of development when their resolution is less costly. Consequently, this reduces the overall cost of software maintenance. Automation optimizes the efficiency of regression testing by streamlining the process, thereby ensuring that new changes do not introduce unforeseen defects. As compared to manual regression testing, it saves both time and effort. Although the establishment of test automation may require an initial investment, it leads to efficiency in resource allocation by reducing the need for extensive manual testing. Consequently, teams can allocate resources to more creative and exploratory testing endeavors. Automation plays an integral role in CI/CD pipelines, enabling continuous integration, automated testing, and deployment. This, in turn, leads to a streamlined software delivery process and a reduction in the time-to-market. Automated tests have the capability to be easily scaled to meet evolving project requirements, whether it is the testing of large-scale applications, microservices, or complex systems. Automation provides teams and stakeholders with abundant data and comprehensive reports, thereby empowering them with insights into the quality and reliability of the software. Consequently, data-driven decisions optimize testing efforts and resource allocation. In a competitive landscape, the ability to swiftly release high-quality software is a significant advantage. Test automation ensures that organizations meet user expectations and compliance standards while maintaining a competitive edge.

The evaluation of return on investment (ROI) validates the initial investment made in test automation tools and resources, thereby guaranteeing that the advantages outweigh the expenses and that resources are allocated in a wise manner[2]. The analysis of ROI offers data-driven insights into the efficacy of automation efforts, empowering organizations to make well-informed decisions regarding the expansion, optimization, or adjustment of their test automation endeavors. The comprehension of ROI shapes decisions concerning the allocation of resources, thereby aiding

organizations in efficiently distributing budgets and personnel. It ensures that resources are directed towards areas that yield the greatest value. The assessment of ROI enables organizations to identify areas where automation can be further enhanced, thus fostering a culture of continuous improvement in automation strategies. In conclusion, the importance of test automation in contemporary software development is undeniable [1]. However, it is imperative to validate its effectiveness through ROI assessment to ensure that automation initiatives are aligned with the goals of the organization and contribute to efficiency, quality, and competitiveness.

## 2. Literature Review

**Test Automation:** Test automation entails the utilization of specialized tools and frameworks to execute tests on software applications, by comparing actual results to projected outcomes. In the realm of software development, testing plays a pivotal role in ensuring the quality, dependability, and performance of the software. Test automation replaces manual testing with automated scripts, which can be repeatedly executed with minimal human intervention.

**ROI of Test Automation:** Return on Investment (ROI) serves as a metric to gauge the profitability or cost-effectiveness of an investment. In the context of test automation, the ROI represents the value obtained from automating tests in relation to the cost of implementing and maintaining the automation process. Grasping the ROI of test automation is crucial for making well-informed decisions regarding whether to invest in automation and the extent of that investment.

### Key Components of ROI in Test Automation:

**Time Savings:** Automated tests can be executed at a significantly faster pace compared to manual tests. This time-saving aspect becomes particularly significant when running regression tests or tests that need to be repeated frequently.

**Reusability:** Automated test scripts can be reused across various phases of the development lifecycle, thereby reducing the effort required to create new tests for each release or iteration.

**Consistency:** Automated tests ensure consistent execution of the same set of tests, thereby diminishing the likelihood of human error and producing more dependable results.

**Early Bug Detection:** Automated tests can be integrated into the continuous integration/continuous deployment (CI/CD) pipeline, thus enabling the early detection of bugs in the development process and expediting bug fixes.

**Increased Test Coverage:** Automated tests have the capacity to cover a wide range of scenarios and data variations, thereby leading to greater test coverage in comparison to manual testing.

### Importance of Understanding ROI in Test Automation:

**Cost Justification:** Organizations must justify the costs associated with test automation. Comprehending the ROI aids in making a case for automation by showcasing the long-term benefits in terms of time and resource savings.



**Resource Allocation:** Having knowledge of the ROI enables organizations to allocate resources effectively. This includes determining the amount of time and effort to invest in creating and maintaining automated tests as opposed to manual testing.

**Strategic Decision Making:** Understanding the ROI aids in making strategic decisions regarding the areas to prioritize for automation. It enables organizations to focus on testing efforts in areas that yield the highest return.

**Continuous Improvement:** Regularly evaluating the ROI of test automation allows organizations to identify areas for improvement. This may involve optimizing test scripts, updating automation tools, or reevaluating testing strategies to enhance overall efficiency.

Based on our knowledge and extensive research, it has come to our attention that there is a scarcity of literature pertaining to the determination of return on investment (ROI) for test automation. Furthermore, existing papers on this topic lack detailed discussions. In an attempt to bridge this gap, the present study aims to address unanswered inquiries.

Table 1. Comparative Analysis of other studies

SrNo	Title	Key Contribution	Limitations
1	Investigating GUI test automation ROI : An industrial case study	<ul style="list-style-type: none"> <li>- Proof of concept for GUI test automation with Coded UI</li> <li>- Investigating ROI for continuing the automation work</li> </ul>	<ul style="list-style-type: none"> <li>- Limited time resulted in only 26 test cases being investigated and automated.</li> <li>- Issues with bad internet connection and long waiting times.</li> </ul>
2	Comparative study of test automation roi	<ul style="list-style-type: none"> <li>- Importance of test automation for achieving high ROI - ROI formula oversimplifies test automation leading to unrealistic expectations</li> </ul>	<ul style="list-style-type: none"> <li>- Oversimplification of ROI calculation in test automation - Unrealistic expectations leading to failure in test automation</li> </ul>
3	Understanding roi metrics for software test automation	<ul style="list-style-type: none"> <li>- Research on metrics for successful software test automation - Heavy initial investment, positive ROI takes time</li> </ul>	<ul style="list-style-type: none"> <li>- No discussed way to calculate ROI instead talks more on understanding metrics</li> </ul>
4	The Impacts of Test Automation on Software's Cost, Quality and Time to Market	<ul style="list-style-type: none"> <li>- Test automation positively impacts software's cost, quality, and time. - The paper discusses the effects of test automation on software development.</li> </ul>	<ul style="list-style-type: none"> <li>- No work done to calculate direct effects</li> <li>- Maintenance of automated test suite is a drawback</li> </ul>
5	Economic perspectives in test automation: balancing automated and manual testing with opportunity cost	<ul style="list-style-type: none"> <li>- Testing is a major cost factor in software development. - The paper discusses the trade-off between automated and manual testing.</li> </ul>	<ul style="list-style-type: none"> <li>- Overly simplistic cost models commonly used - Effort for maintaining and adapting automated tests</li> </ul>

### **3. Key Cost Factors**

Understanding the factors that contribute to costs and benefits is of utmost importance when determining the Return on Investment (ROI) of test automation. This analysis provides a financial basis for evaluating whether the benefits of implementing automation surpass the associated costs [5]. Additionally, it aids in the efficient allocation of resources, mitigates potential risks, and facilitates strategic decision-making. Familiarity with the elements that influence costs is invaluable for developing realistic budgets, serves as a crucial performance metric for assessing the success of the project, and empowers organizations to continually refine their automation processes. Having a clear understanding of the financial implications is vital for effective communication with stakeholders and garnering their support for test automation initiatives. This ensures that the efforts align with the overall objectives of the organization and yield successful outcomes.

Table 2. Understanding Key factors

SrNo	Cost Factor	Explanation	Value of Cost
1	Expenditure on Tool Licensing	The costs associated with procuring licenses for test automation tools	Augmented development and execution of test scripts. Enhanced test coverage and precision and Effective maintenance and administration of tests.
2	Costs of Infrastructure	Investment in hardware and software infrastructure to support the automation of tests	Accelerated execution of tests. Scalability to accommodate expanding test suites and Diminished need for manual intervention in test procedures.
3	Training and Skill Development	Expenses linked to training testers to become proficient in utilizing automation tools.	Proficient testers can efficiently create and maintain automation scripts. Decreased reliance on external resources and Enhanced expertise in best practices of test automation.
4	Costs of Maintenance	The ongoing expenses of maintaining and updating automated test scripts and tools.	Ensures the relevance and accuracy of test scripts. Swift adaptation to changes in the application and Prevention of regression defects.
5	Personnel Costs	Salaries and wages of automation engineers, testers, and support personnel.	Streamlined and efficient testing processes. Accelerated test execution and Improved coverage of tests.
6	Reporting & Documentation Costs	The cost factor entails the expenses incurred in generating, storing, and managing test reports and documentation. This includes the necessary resources and efforts to ensure that comprehensive and accurate reports are produced and maintained.	The benefits of investing in reporting and documentation include clear visibility into test results and quality metrics, which allows for informed decision-making and enhanced communication among stakeholders. Additionally, adherence to industry standards and regulations is achieved, ensuring compliance and reliability in testing processes.
7	Time and Resource Costs	The time and resources invested in planning, implementing, and maintaining automation constitute the cost factor. This encompasses the effort required to develop an efficient automation strategy, allocate resources effectively, and continuously update and improve automation processes.	The benefits of managing time and resource costs in automation are manifold. Test execution time is reduced significantly, leading to more efficient and productive testing. Additionally, the allocation of resources becomes more streamlined and optimized, resulting in improved productivity and cost-effectiveness. Furthermore, software release cycles are accelerated, allowing for faster delivery of high-quality products.
8	Integration and Compatibility Costs	The cost factor associated with integration and compatibility refers to the expenses incurred when integrating test automation with other software components. This includes the effort and resources required to ensure smooth interaction between testing and development tools, as well as streamlined bug tracking and reporting processes.	The benefits of managing integration and compatibility costs are significant. When test automation seamlessly integrates with other software components, it allows for efficient collaboration between teams and facilitates effective communication and coordination. Additionally, streamlined bug tracking and reporting processes enable faster identification and resolution of issues, enhancing the overall efficiency of the testing process.
9	Change Management Costs	The cost factor related to change management encompasses the expenses associated with managing changes in automation frameworks and processes. This includes the effort and resources required to adapt automation to evolving project requirements and ensure flexible and responsive test automation.	The benefits of effectively managing change management costs in automation are substantial. By adapting to evolving project requirements, organizations can ensure that their automation processes remain relevant and effective. This flexibility also allows for responsive test automation, which can quickly adapt to changes in the testing environment or requirements, enhancing the overall efficiency and reliability of the testing process.
10	Test Data Management Costs	The cost factor associated with test data management includes the expenses incurred in acquiring, organizing, and maintaining test data. This involves the effort and resources required to ensure that realistic and representative test data is available for testing purposes.	The benefits of managing test data management costs are crucial for effective testing. By ensuring the availability of realistic and representative test data, organizations can conduct thorough and accurate testing, mitigating potential data-related bottlenecks. This ensures the reliability and efficiency of the testing process.

Each of these cost factors presents its associated benefits, contributing to the overall efficiency, reliability, and cost-effectiveness of test automation. By effectively managing these factors,

organizations can optimize their testing processes and achieve a high return on their automation investment.

#### 4. ROI Calculation

The analysis of costs and benefits is necessary to accurately estimate the return on investment of test automation. However, quantifying the benefits of test automation poses a significant challenge, leading many estimates in industrial projects to focus solely on cost considerations[6]. The costs examined in these cases typically encompass the expenses related to the testing tool or framework, the labor costs associated with automating the tests, and the labor costs associated with maintaining the automated tests. These costs can be categorized as fixed or variable. Fixed costs refer to the initial expenses incurred in test automation, while variable costs increase in proportion to the number of automated test executions.

The frequency at which the automated tests will be performed should be taken into account when computing the advantages, which are frequently evaluated based on the resources saved through the utilization of automation[4]. This can manifest in the form of cost and time savings, heightened efficacy, enhanced product quality, and diminished risks. The calculation of the time savings of ROI and determination of the break-even point will employ the subsequent three equations.

$$ROI_{automated} = Va + n * Da$$

V = Expenditure for test specification and implementation

D = Expenditure for single test execution

whereby Va is the expenditure for specifying and automating the test case, Da is the expenditure for executing the test case one time, and n is the number of automated test executions.

$$ROI_{manual} = Vm + n * Dm$$

whereby Vm represents the expenditure associated with the specification of the test case, Dm denotes the expenditure associated with the execution of the test case, and n represents the total number of manual test executions.

The point at which the cost of test automation becomes equal to the cost of manual testing, also known as the break-even point, can be determined by comparing the cost of automated testing with the cost of manual testing.

$$E(n) = ROI_{automated} / ROI_{manual} = Va+n*Da / Vm+n*Dm$$



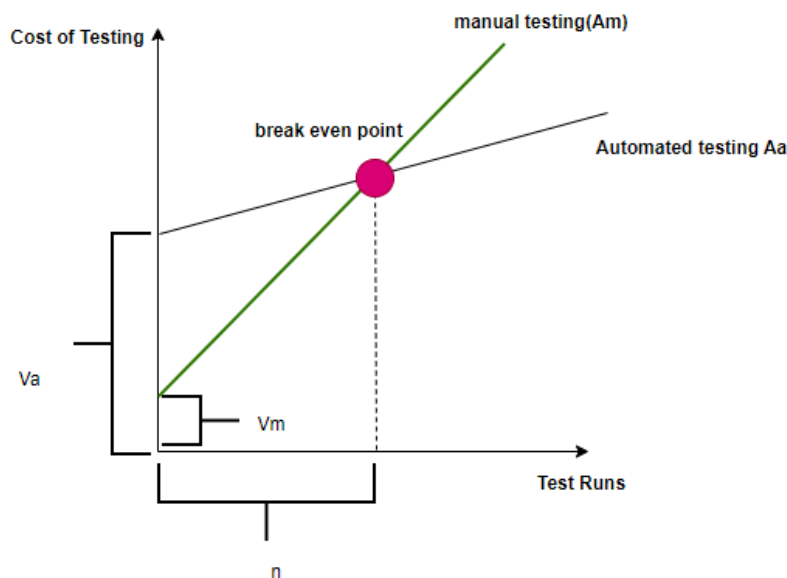


Figure 1: Break-even point for automated testing

The number of test runs is displayed on the x-axis, whereas the cost incurred in testing is depicted on the y-axis. The two curves portray the manner in which the costs escalate with each test run. While the curve representing the expenses of manual testing exhibits a steep incline, the costs of automated test execution increase at a more moderate rate. Nevertheless, the implementation of automated testing necessitates a significantly higher initial investment compared to the execution of manual testing. The point at which test automation becomes financially viable is determined by the intersection of the two curves.

### Scenario Study to understand formula-

#### Example - Cost break even

Let us consider an illustrative instance of computing the point at which the costs of manual testing and automated testing for a software development venture become equivalent. In this particular scenario, we will make a comparison between the expenses incurred in manual testing and automated testing and ascertain the point at which the investment in automation becomes financially viable.

#### Assumptions:

- Initial Investment in Test Automation: \$40,000 (inclusive of costs for automation tools, training, and setup).
- Annual Labor Costs for Manual Testing: \$60,000 (for a team consisting of three manual testers).

- Annual Labor Costs for Automated Testing: \$20,000 (for a smaller team comprising a single tester responsible for maintaining and executing automated tests).
- Annual Savings Attributable to Automation: \$40,000 (the disparity between labor costs in manual and automated testing).
- Predicted Annual Cost of Automation Maintenance: \$5,000 (encompassing software updates and tool maintenance).
- Discount Rate: 10% (the rate employed to account for the time value of money).

**Calculations:**

**Calculation of Annual Savings:**

Annual Savings - Annual Labor Costs for Manual Testing - Annual Labor Costs for Automated Testing Annual Savings = \$60,000 - \$20,000 = \$40,000

**Calculation of the Break-Even Point:**

To discern the break-even point, it is necessary to ascertain the year when the cumulative savings from automation equal the initial investment.

Years	Formula	Numbers	Savings
Year-1	Annual Savings - Annual Cost of Automation Maintenance Cumulative Savings	\$40000-\$5000	\$35000
Year-2	Previous Cumulative Savings + Annual Savings - Annual Cost of Automation Maintenance Cumulative Savings	\$35,000 + \$40,000 - \$5,000	\$70,000
Year-3	Previous Cumulative Savings + Annual Savings - Annual Cost of Automation Maintenance Cumulative Savings	\$70,000 + \$40,000 - \$5,000	\$105,000

The break-even point transpires during Year 2 since, by the culmination of that year, the cumulative savings amounting to \$70,000 surpasses the initial automation investment of \$40,000.

In this illustrative example, it necessitates two years for the automation investment to become financially viable. Subsequent to the break-even point, the organization will continue to realize cost savings as long as the automation tool remains in usage and the expenses related to maintenance and labor remain relatively stable. This elucidates the financial superiority of test automation over manual testing in the long run.

**Example-Time break even**

It is assumed that the amount of time required to manually run a test is 0.25 hours on average. In order to simplify the analysis, we assume that there are no initial costs associated with specifying and preparing the test. On the other hand, automating a test is estimated to take 1 hour on average, which includes the necessary expenses for adapting and maintaining the automated tests in case of any changes. Thus, in our particular example, once a test has been automated, it can be run without any additional effort. According to the model presented in the previous section, the break-even point for a single test is achieved after the test case has been executed four times.

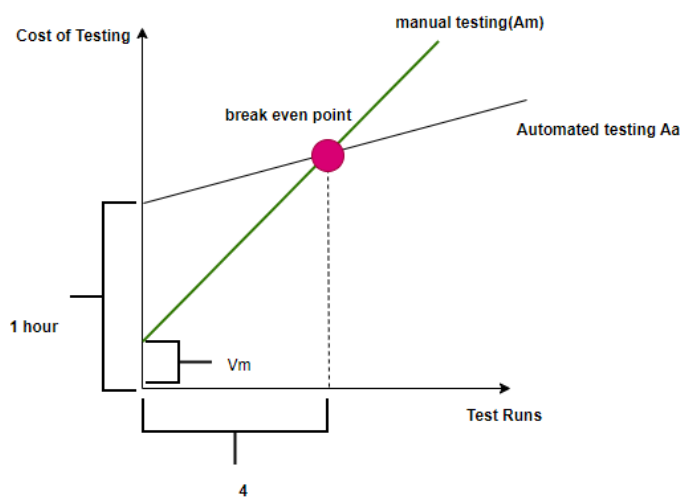


Figure 2: Break-even point for a single test case

**5. Ways to Improve ROI**

There exists a multitude of prevailing elements that exert influence on every individual return on investment (ROI) computation. Hence, modifications or reductions made to any of these elements will undoubtedly enhance the ROI, irrespective of the method employed for its calculation. The following elements encompass the aforementioned factors:

- Average time required for Test Development/Debugging per test
- Time taken for Test Execution
- Time spent on Test Analysis
- Time allocated for Test Maintenance.

**Average time required for Test Development/Debugging per test**

The duration required for the development and debugging of each test has a significant impact on the Return on Investment (ROI) of test automation. Prolonged periods of development and

debugging lead to increased initial expenses, which delays the point at which automation becomes financially viable. The costs of maintenance increase as intricate and time-consuming scripts necessitate updates and fixes, thereby diminishing the overall ROI. Sluggish test development can have implications for resource allocation, as it restricts the availability of the team for other tasks[7]. The ability of automation to cover a wide range of test scenarios is hindered by slow development times, thereby affecting scalability. There is a risk of script obsolescence when the maintenance of outdated scripts becomes burdensome, resulting in higher costs. Subpar script quality arises when rushed development leads to inefficient and error-prone code. The efficiency of the testing process, especially in Agile and continuous integration settings, is impacted by slower test execution. To expedite ROI and enhance the cost-effectiveness of automation, it is essential to decrease the duration of test development and debugging through efficient practices, training, and tool selection.

### **Time taken for Test Execution**

The duration of test execution per test is an influential element that affects the Return on Investment (ROI) of test automation. Prolonged test execution times can have the following implications on ROI. Firstly, longer execution durations may result in delayed feedback on the quality of the application, which in turn, can extend the time needed to identify and rectify defects. This delay can lead to higher costs associated with defect resolution and impede faster time-to-market.

Secondly, slower test execution can restrict the frequency at which tests can be conducted, especially in continuous integration environments. This delay can cause a delay in the detection of bugs, potentially resulting in the accumulation of more issues and further escalating the cost of defect resolution.

To optimize ROI, it is crucial to optimize test execution durations. By employing efficient and parallel test execution, careful test selection, and the utilization of suitable hardware and infrastructure, substantial reductions in test execution times can be achieved. Quicker test execution not only enhances ROI by enabling prompt defect detection but also enhances the efficiency and effectiveness of the testing process.

### **Time spent on Test Analysis**

The duration allocated to the examination of tests per individual examination has a direct effect on the Return on Investment (ROI) of test automation. Elaborate examination stages amplify the initial investment costs and postpone the point at which automation becomes cost-effective. Prolonged examination periods also decelerate the testing procedure, leading to delayed identification of defects and augmented costs of rectifying those defects. To optimize ROI, it is crucial to streamline the examination phase of tests through efficient planning and the employment of practices that are accommodating to automation. By reducing the duration allocated to the

examination of tests, not only does the acceleration of ROI occur through the expeditious creation of test cases, but the effectiveness of the testing procedure is also enhanced by the earlier detection of issues within the development cycle, thus reducing costs.

### **Time allocated for Test Maintenance**

The amount of time allotted for the maintenance of each test has a significant impact on the Return on Investment (ROI) of test automation. Prolonged periods of maintenance result in higher ongoing expenses, thus delaying the achievement of ROI. Additionally, it can impede the efficiency of the testing procedure by diverting resources away from the creation of new test cases. An emphasis on efficient script design, regular updates, and the utilization of automation-friendly tools is of utmost importance. By reducing the time spent on test maintenance, the acceleration of ROI is achieved through the reduction of ongoing costs, the enhancement of script quality, and the preservation of the effectiveness of the testing process. This, in turn, enables the identification of defects at a quicker pace, the reduction of defect-fixing expenses, and an overall more cost-effective approach to automation.

### **6. Future Trends**

Artificial Intelligence (AI) and Machine Learning (ML) are profoundly transforming the test automation landscape, exerting a significant influence on the Return on Investment (ROI) for organizations. These technologies are redefining the testing process, and their impact on ROI can be succinctly summarized as follows:

AI and ML empower automation to be more intelligent, efficient, and agile. Through the intelligent selection of test cases, predictive identification of defects, and self-healing capabilities, the testing process becomes expeditious and cost-effective. By curtailing testing timelines, organizations realize cost savings and can expeditiously release software products to the market, thus positively influencing ROI.

The capability of AI to prioritize test cases based on risk factors, historical data, and code changes optimizes resource allocation and reduces testing effort. By concentrating on high-impact areas, organizations utilize testing resources efficiently, thereby minimizing costs and ensuring that critical issues are promptly addressed.

Furthermore, AI and ML aid in the maintenance of automated scripts by endowing them with adaptability to changes in the application. The self-adjusting nature of scripts diminishes the need for manual intervention, thereby decreasing maintenance costs and ensuring that automation remains cost-effective as applications evolve.

AI's ability to identify areas that necessitate comprehensive testing contributes to enhanced test coverage and quality. Improved test coverage leads to the early detection of defects, thus diminishing post-release defect-fixing costs and augmenting the quality of software products.



Lastly, employing ML algorithms to discern between false positives and genuine issues in test results streamlines the test analysis process, reducing the requirement for manual intervention and facilitating expeditious, accurate decision-making.

In synopsis, AI and ML propel increased ROI in test automation by enhancing efficiency, reducing costs, augmenting adaptability, increasing test coverage and quality, and expediting time-to-market. Organizations that embrace these technologies in their test automation strategies can achieve a faster and more substantial return on their automation investments.

## **7. Conclusion**

In conclusion, the measurement of Return on Investment (ROI) in test automation is of utmost importance. It acts as a guiding principle for organizations that aim to strike a balance between the costs and benefits of automation. By quantifying the savings in terms of reduced effort in manual testing and costs associated with fixing defects, ROI analysis validates the justification for implementing automation. Moreover, it also encompasses the qualitative aspects of early detection of defects and improved software quality. A flexible approach that adjusts to the changing dynamics of projects and leverages emerging technologies, such as Artificial Intelligence (AI) and Machine Learning (ML), is indispensable. The success of automation lies in finding the right equilibrium between manual and automated testing, ensuring that each investment in automation contributes to overall efficiency and effectiveness.

## **8. Contribution to Theory, Policy, and Practice**

Contributions to the theory, policy, and practice of test automation are integral to advancing the measurement of success, specifically in terms of Return on Investment (ROI). Theoretical advancements involve the establishment of standardized metrics and dynamic models that capture the multifaceted nature of ROI in test automation. Furthermore, the comprehension and quantification of risks associated with automation contribute to the enrichment of these theoretical foundations.

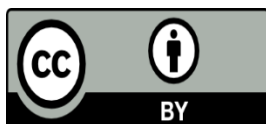
From a policy standpoint, advocating for the adoption of industry-wide best practices and the incorporation of ROI measurement standards into regulatory frameworks ensures a cohesive approach to evaluating automation initiatives. The provision of guidelines for resource allocation, tool selection, and workforce training, based on projected ROI, contributes to the effective development of policies within organizations.

On a practical level, contributions are demonstrated through the provision of guidance on tool selection, the seamless integration of automation into development lifecycles, and the establishment of frameworks for continuous improvement. Skill development programs equip teams with the necessary expertise to effectively navigate the complexities of test automation. These practical contributions facilitate a unified and strategic approach, ensuring that organizations not only measure ROI but also enhance it through informed decision-making, skillful

implementation, and alignment with evolving industry standards. In essence, the synergy between theory, policy, and practice establishes a robust framework for quantifying success in test automation.

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