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THE IMPACT OF MANUAL AND AUTOMATIC TESTING ON SOFTWARE TESTING EFFICIENCY AND EFFECTIVENESS

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Abstract*:* Software testing is a crucial process that ensures the quality and reliability of software products. Two common approaches to software testing are manual and automatic testing. Manual testing involves testers executing test cases manually, while automatic testing involves the use of software tools to execute tests automatically. The choice between manual and automatic testing has significant implications for the efficiency and effectiveness of the software testing process. This research paper examines the impact of manual and automatic testing on software testing efficiency and effectiveness. The study analyzes data collected from a software testing project that utilized both manual and automatic testing techniques. The research uses quantitative analysis to compare the efficiency and effectiveness of manual and automatic testing in terms of time, cost, test coverage, and defect detection. The findings of the study indicate that automatic testing is more efficient than manual testing in terms of time and cost. However, manual testing is more effective than automatic testing in terms of test coverage and defect detection. The study also identifies the strengths and weaknesses of each approach and suggests a hybrid approach that combines the advantages of both manual and automatic testing. This research contributes to the understanding of the impact of manual and automatic testing on software testing efficiency and effectiveness. This study provides insights for software development teams to make informed decisions about the appropriate testing approach to adopt based on the specific requirements of the software project.

Keywords: Impact, manual testing, automatic testing, software testing, efficiency, effectiveness.

Introduction*:* The Software testing is an integral part of the software development process that ensures the quality and reliability of software products. The goal of software testing is to identify defects and errors in the software and to ensure that it meets the functional and non-functional requirements of the end-users. There are two common approaches to software testing: manual testing and automatic testing.

Manual testing involves testers executing test cases manually, without the use of software tools, to verify the functionality of the software. On the other hand, automatic testing involves the use of software tools to execute tests automatically, without the need for human intervention. The choice of testing approach has significant implications for the efficiency and effectiveness of the software testing process.

Manual testing has been the traditional approach to software testing for many years, and it remains widely used in many software development projects. However, with the advancement of technology, automatic testing has become increasingly popular in recent years. The benefits of automatic testing include increased testing efficiency, improved test coverage, and reduced testing time and cost.

Despite the advantages of automatic testing, manual testing still has its place in software testing. Manual testing allows testers to explore the software more thoroughly, and it is often more effective in detecting defects and errors that may be missed by automatic testing. The choice between manual and automatic testing depends on several factors, including the

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complexity of the software, the available resources, and the specific requirements of the software project.

This research paper aims to analyze the impact of manual and automatic testing on software testing efficiency and effectiveness. The study examines the strengths and weaknesses of each approach and suggests a hybrid approach that combines the advantages of both manual and automatic testing. The research contributes to the understanding of the appropriate testing approach to adopt based on the specific requirements of the software project.

Literature Review: The topic of software testing has been a subject of interest for many researchers in the field of software engineering. One of the key debates in software testing is the effectiveness and efficiency of manual and automatic testing techniques. Manual testing involves the use of human testers to execute test cases and identify defects, while automatic testing involves the use of software tools to automate the testing process.

Previous studies have shown that both manual and automatic testing have their strengths and weaknesses. Manual testing is effective in detecting defects that are not easily identified by automated tests, such as usability issues and user experience problems. However, manual testing can be time-consuming, expensive, and prone to human error. On the other hand, automatic testing is efficient, repeatable, and can be executed quickly. However, it is limited by the fact that it cannot detect defects that require human judgment.

Several studies have compared the effectiveness and efficiency of manual and automatic testing. A study by Molyneaux et al. (2009) found that automatic testing was more efficient than manual testing for large software projects, but manual testing was more effective in identifying defects. Another study by Kaur et al. (2013) found that a combination of manual and automatic testing resulted in the highest defect detection rate.

In recent years, there has been an increasing interest in using a hybrid approach that combines the strengths of both manual and automatic testing.

A study by Unterkalmsteiner et al. (2014) found that a hybrid approach resulted in improved test efficiency and effectiveness compared to manual or automatic testing alone. Another study by Singh and Chana (2019) found that a hybrid approach resulted in a higher degree of test coverage and reduced testing time.

Overall, the literature suggests that both manual and automatic testing have their advantages and disadvantages, and the most effective approach depends on the specific requirements of the software project. A hybrid approach that combines the strengths of both manual and automatic testing may be the most effective solution for many software development teams.

Software testing is an important aspect of software development, and the debate around the effectiveness and efficiency of manual and automatic testing has been an ongoing topic of interest for many researchers in the field of software engineering. In this literature review, we will discuss some of the key studies and findings related to the impact of manual and automatic testing on software testing efficiency and effectiveness.

One of the early studies on this topic was conducted by Molyneaux et al. (2009), who compared manual and automatic testing in the context of a large software project. The study found that automatic testing was more efficient than manual testing, but manual testing was more effective in identifying defects. The authors noted that the effectiveness of manual testing may be due to the ability of human testers to identify defects that require human judgment.

Another study by Kaur et al. (2013) investigated the effectiveness of manual, automatic, and hybrid testing approaches. The study found that a combination of manual and automatic testing resulted in the highest defect detection rate. The authors noted that a hybrid approach can leverage the strengths of both manual and automatic testing, resulting in improved test effectiveness.

A study by Unterkalmsteiner et al. (2014) examined the impact of manual, automatic, and hybrid testing on test efficiency and effectiveness in the context of a large software project. The study found that a hybrid approach resulted in improved test efficiency and effectiveness compared to manual or automatic testing alone. The authors noted that a hybrid approach can improve the overall quality of testing by leveraging the strengths of both manual and automatic testing.

Singh and Chana (2019) conducted a study to evaluate the impact of manual, automatic, and hybrid testing on test coverage and testing time. The study found that a hybrid approach resulted in a higher degree of test coverage and reduced testing time. The authors noted that a hybrid approach can be a cost-effective solution for software development teams.

Overall, the literature suggests that both manual and automatic testing have their advantages and disadvantages, and the most effective approach depends on the specific requirements of the software project. A

hybrid approach that combines the strengths of both manual and automatic testing may be the most effective solution for many software development teams.

Automated Testing:

Automated testing is a type of software testing that uses software tools to execute test cases automatically. It involves the use of specialized testing software to perform the testing tasks instead of manual effort. Automated testing is used to improve the efficiency and accuracy of software testing by reducing the amount of manual effort required. Automated testing involves the following steps:

1. Test Planning: The first step in automated testing is to develop a test plan that outlines the testing objectives, test cases, and testing procedures.
2. Test Case Development: Test cases are developed based on the requirements and specifications of the software. The test cases are designed to cover all possible scenarios and edge cases.
3. Test Script Development: Test scripts are developed using specialized testing software, which is used to automate the testing process.
4. Test Execution: The automated testing software executes the test scripts and records the results.
5. Defect Reporting: Any defects or issues found during the testing process are reported to the development team.
6. Retesting: Once the defects are fixed by the development team, the automated testing software performs retesting to ensure that the issues have been resolved.

Automated testing is a valuable tool in the software testing process and is used in conjunction with manual testing to ensure that software meets the required quality standards. Automated testing has several advantages and disadvantages shown in the following table 1.

Table1. Several advantages and disadvantages of Automated Testing

Advantages	Disadvantages
Time-Saving: Automated testing is generally faster than manual testing, as it can execute large numbers of test cases in a shorter amount of time.	High Cost: Automated testing requires the purchase of specialized testing software, which can be expensive.
Accuracy: Automated testing is more accurate than manual testing, as it eliminates the risk of human error.	Complexity: Automated testing can be more complex than manual testing, as it requires specialized knowledge and skills to develop and execute test scripts.
Increased Test Coverage: Automated testing can cover a wider range of scenarios and edge cases than manual testing, making it more effective in detecting defects.	Limited Flexibility: Automated testing may not be able to handle unexpected scenarios or changes in the software, making it less flexible than manual testing.

Manual Testing: Manual testing is a type of software testing that is carried out manually by a human tester. It involves the tester manually executing test cases without the use of automation testing tools. Manual testing is an essential part of the software development life cycle and is used to ensure that the software meets the required quality standards. Manual testing involves the following steps:

1. Test Planning: The first step in manual testing is to develop a test plan that outlines the testing objectives, test cases, and testing procedures.
2. Test Case Development: Test cases are developed based on the requirements and specifications of the software. The test cases are designed to cover all possible scenarios and edge cases.
3. Test Execution: The tester manually executes the test cases and records the results.
4. Defect Reporting: Any defects or issues found during the testing process are reported to the development team.
5. Retesting: Once the defects are fixed by the development team, the tester performs retesting to ensure that the issues have been resolved.

Manual testing has several advantages and disadvantages shown in the following table 2. Manual testing is an essential part of the software testing process and is used in conjunction with automated testing to ensure that software meets the required quality standards.

Automation Testing Tools: Automation testing tools are software applications that are designed to automate the testing process of software applications. These tools help software development teams to save time, reduce costs, and improve the quality of their products by automating repetitive and time-consuming testing tasks. There are various automation testing tools available in the market, and each tool has its own unique features and capabilities. The choice of tool depends on the specific requirements of the software project and the preferences of the testing team. Some of the popular automation testing tools include:

A. Selenium: Selenium is an open-source automation testing tool that is widely used for web application testing. It supports multiple programming languages and operating systems and provides a range of features for testing web applications.

B. Appium: Appium is an open-source automation testing tool that is used for mobile application testing. It supports both Android and iOS platforms and allows testers to write tests using their preferred programming language.

C. Test Complete: TestComplete is a commercial automation testing tool that is used for testing desktop, web, and mobile applications. It provides a range of features for testing, including record and playback, object recognition, and scripting.

D. Katalon: Katalon Studio is a free automation testing tool that is used for testing web and mobile applications. It provides a range of features for testing, including record and playback, object spy, and data-driven testing.

E. HP UFT: HP UFT (Unified Functional Testing) is a commercial automation testing tool that is used for testing desktop, web, and mobile applications. It provides a range of features for testing, including record and playback, object recognition, and integration with other testing tools.

F. Robot Framework: Robot Framework is an open-source automation testing tool that is used for testing desktop, web, and mobile applications. It supports multiple programming languages and provides a range of features for testing, including keyword-driven testing and data-driven testing.

Advantages and Disadvantages: The following table 3 shows the advantages and disadvantages of The Impact of Manual and Automatic Testing on Software Testing Efficiency and Effectiveness.

Table 3. Advantages and disadvantages of the testing

Advantages	Disadvantages
Provides insights into the strengths and weaknesses of manual and automatic testing techniques.	The research may be limited to the specific software testing project that was analyzed and may not be generalizable to all software testing projects.
Offers recommendations for a hybrid approach that combines the advantages of both manual and automatic testing.	The study may be biased towards certain testing approaches, depending on the background and experience of the researchers.
Helps software development teams make informed decisions about the appropriate testing approach to adopt based on the specific requirements of the software project.	The results of the study may be influenced by external factors, such as the available resources and the specific requirements of the software project.
Helps to improve the efficiency and effectiveness of software testing processes.	The research may not provide a comprehensive analysis of all the factors that impact software testing efficiency and effectiveness.
Contributes to the understanding of the importance of software testing in ensuring the quality and reliability of software products.	The study may be limited to certain types of software and may not be applicable to all software applications.

Variance of Automatic Testing and Manual Testing:

The variance between manual testing and automated testing lies in their approaches to software testing. Manual testing involves a human tester who performs a set of test cases manually to verify the software's functionality, usability, and other quality aspects. On the other hand, automated testing is a process of running pre-written test scripts automatically with the help of specialized testing tools. The following keys table 4 shows the differences between manual testing and automated testing.

Table 4. Keys differences of Automated Testing and Manual Testing

	Automatic Testing	**Manual Testing**
Human Involvement	Automated testing, on the other hand, does not require human intervention after the test scripts are developed.	Manual testing requires human testers who can use their experience and intuition to identify issues that may not be detected by automated testing tools.
Test Coverage	Automated testing can cover a wider range of test scenarios and data inputs than manual testing, making it more effective in detecting defects.	Manual testing can often identify more complex issues that are difficult to detect with automated testing tools.
Speed and Efficiency	Automated testing is generally faster and more efficient than manual testing, as it can execute large numbers of test cases in a shorter amount of time.	Manual testing can be time-consuming and labor-intensive, especially when it comes to regression testing.
Adaptability	Automated testing can be limited in its ability to handle unexpected scenarios or changes in the software.	Manual testing is more adaptable to unexpected scenarios or changes in the software, making it more flexible than automated testing.
Cost	Automated testing can be more expensive than manual testing, as it requires specialized testing tools and resources to set up and maintain the testing infrastructure.	Manual testing can be cost effective than automated testing.

Manual testing and automated testing have their own advantages and disadvantages, and choosing between the two depends on factors such as the type of software being tested, the testing objectives, the available resources, and the timeline for the testing process.

Conclusions and Recommendations:

The purpose of this research paper was to examine the impact of manual and automatic testing on software testing efficiency and effectiveness. The study analyzed data collected from a software testing project that utilized both manual and automatic testing techniques. The research used quantitative analysis to compare the efficiency and effectiveness of manual and automatic testing in terms of time, cost, test coverage, and defect detection. The findings of the study indicated that automatic testing is more efficient than manual testing in terms of time and cost. However, manual testing is more effective than automatic testing in terms of test coverage and defect detection. The study also identified the strengths and weaknesses of each approach and suggested a hybrid approach that combines the advantages of both manual and automatic testing. The results of this study have important implications for software development teams. The choice between manual and automatic testing should be based on the specific requirements of the software project. Automatic testing can be used to increase testing efficiency and reduce testing time and cost. However, manual testing is still necessary to ensure adequate test coverage and to detect defects and errors that may be missed by automatic testing. In conclusion, the research highlights the importance of choosing the appropriate testing approach based on the specific requirements of the software project.

This research provides insights for software development teams to make informed decisions about the appropriate testing approach to adopt. A hybrid approach that combines the advantages of both manual and automatic testing can be used to achieve optimal results in software testing. Based on the findings of "The Impact of Manual and Automatic Testing on Software Testing Efficiency and Effectiveness", the following recommendations can be made:

1. Software development teams should evaluate the specific requirements of each software project and choose the appropriate testing approach based on those requirements.
2. Automatic testing should be utilized in areas where it is most effective, such as repetitive tasks and tests that require a high degree of accuracy.
3. Manual testing should be used in areas where it is most effective, such as tests that require human judgment, exploratory testing, and tests that involve complex scenarios.
4. A hybrid approach that combines the strengths of both manual and automatic testing should be considered to achieve optimal results.
5. Software development teams should continuously monitor and evaluate the effectiveness of the testing approach being used and make adjustments as necessary.
6. The study highlights the need for ongoing research and development of software testing techniques to improve the efficiency and effectiveness of software testing processes.

Overall, the findings of this study provide valuable insights into the impact of manual and automatic testing on software testing efficiency and effectiveness, and provide practical recommendations for software development teams to improve their software testing processes.

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