

# Contemporary Software Testing Techniques: A Review

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## ABSTRACT

In past decades lots of emerging technologies have been used in the development and testing of software. Every software industry works on a process with the objective of producing high-quality and effective software that meets all the stated objectives of the customer by consuming the possible least cost within time. Due to the competition and market pressure, every company wants to develop and deliver software with the priority of cost optimization. So, companies are adopting the latest and most efficient testing practices to test the software by consuming less testing time and cost. These software testing practices include the best practices of Agile, DevOps, Machine learning, blockchain shift left testing, etc. In this paper, a survey of the various latest trends in software testing has been presented.

## General Terms

Software Testing, Software Engineering, Agile.

## Keywords

Software testing, trends in software testing, strategies of testing, agile.

## 1. INTRODUCTION

Software testing plays an important role in the development of the software. Software developed using systematics and effective processes may not meet the customer's requirement if effective testing is not performed on the software. Testing is not a single phase in the software development life cycle whereas testing shows its presence during the whole software development life cycle i.e. from requirement gathering to post maintenance phase. The testing of software is performed to ensure that the developed software is defect-free and meets all the expected functional and non-functional requirements of the customers. The product's effective testing of the software certifies the dependability, security, and high performance of the product. As per the report given by Cambridge [1] University cost spending on the testing of the software has exceeded \$300 billion. The software industries are spending nearly 25 to 30% of the total allocated budget on the activity related to testing. An effective testing strategy helps to reduce the testing cost and time by discovering the maximum bugs as early as possible. Fixing a bug at a later stage will be expensive as compared to fixing the same bug at an earlier stage.

There are various [2] strategies that are used to reduce the testing cost. These strategies include early detection of bugs, minimizing manual testing, prioritization of test cases, and hand-coding testing of the user interface. By performing manual testing various human errors are undiscoverable as the size of the software grows. So, software needs to be tested by

using automated testing which helps in reducing the cost and delivering quality software.

The prioritization of the test cases also reduces the cost and time. The test case prioritization techniques used various factors to prioritize the test cases. The test case prioritization produces the execution order in such a way the maximum faults are discovered [3] earlier. The testing of the User interface also consumes a heavy cost. The user interface has included features from hundreds to thousands due to various states of the components of the user interface. For effective testing of the software, all the UI features need to be tested. So, hand coding to test all the UI features is costly and takes time.

Presently every software industry is incorporating the latest technology and testing strategy to reduce the testing cost, and time and enhance the quality of the software. The traditional testing techniques are not effective on the software developed using the latest trending technology like the blockchain, computer vision, and Artificial intelligence-based applications. It is a very challenging task to effectively test the software developed using trending technology. Due to the advancement of technology and to automate the task with the objective of enhancing the business, almost in every area software has been deployed. It is not possible to deal with the quality of the software that has been used for health care purposes as well as for defence purposes. So, software that has been used in healthcare and defence needs to be tested effectively. There should be a need for effective testing techniques by using trending technology like Machine learning etc. Researchers are currently working in this direction and proposed various testing techniques to test state-of-the-art software with the objective of delivering quality software within the assigned budget and time. In the paper, a survey has been performed to analyse and investigate the various approaches proposed by the researchers to test the software equipped with trending technology. The performed survey also highlights the latest trends to test the software. The outcomes of the survey presented that the latest trends in testing include the use of agile, DevOps, and machine learning.

## 2. LITERATURE REVIEW

In this section, a rewritten overview of the various techniques published by the researchers with the objective of delivering quality software has been presented.

In recent years every company has been using information technology to automate their routine business work. They are making the decision by using the tools based on the statistical and mathematical models. The effective use of information technology helps the company to increase business and productivity. Almost every area of business is using the application of information technology. This area includes

healthcare, defence, education, and commerce. Every person is dependent on information technology for daily routine work like ordering the grocery, making transactions, and watching flicks by using mobile applications through websites. These types of websites and apps have been regularly updated by introducing new features and fixing bugs. Due availability [4] of advanced tools and technology and Agile methodology make it possible to regularly update the software. The strategies and testing techniques are continuously evolving to perform effective testing of the product developed using advanced technology. The tester is still facing various issues in software testing. This issue includes lack of communication [5], missing documents, diversity in testing environments, and inadequate testing.

Across the globe [6] now companies work on an objective to get their applications faster to the market and by spending the minimum cost as possible. Testing plays a significant role in meeting the objective of the company. Effective testing of software is required to certify the quality, reliability, and scalability of the system.

V. Akila et al. presented [7] a study about the suitability of usage of linear regression, decision trees, and random forests for the generation of test cases. They compared the performances of the considered algorithm based on accuracy, mean absolute error, and root mean square error. The obtained results of the comparison show the effectiveness of the random forest algorithm over the other accounted algorithms. They found that the usage of machine learning (ML) in software testing also enhances the reliability of the software being tested.

Y. Wang et al. presented [8] a report on test automation process improvement (TAPI) in the DevOps team. They considered experience notes, team reflection reports, and telemetry result reports for performing the review process. They found that for continuous development, test automation maturity is defined by the increasing speed to release, refining the productivity of the team, and high test efficacy. They also found that the incremental approach, the whole team effort, test tool choice and architecture, and telemetry have a positive impact on carrying out its TAPI.

Saima Rafi et al. [9] analyzed the ISM and TOPSIS to evaluate the capabilities of the DevOps testing process. They determine the 20 testing capabilities by performing the multi-literature review of 39 case studies. They analyzed the interrelationship between the capabilities by creating the ISM model. The testing capabilities are prioritized using the TOPSIS model.

Alok Mishra et al. [10] presented an analysis of the role of DevOps features on software quality. They reviewed the published work related to DevOps and found that the automation, sharing, and measurement characteristics of DevOps have a solid bond with the success of the development and quality of the software. The effective use of DevOps helps in attaining the objective of delivering quality software.

Nataliya Yatskiv et al. [11] proposed a method for the automation of software testing based on Robotic process automation. The use of Robotic process automation needs less involvement of humans in tasks related to testing and delivering flexible software. Solomiya Yatskiv et al. [12] investigated the various robotic process automation techniques used for the automation of the testing of software. They introduced techniques that have the capability of faster execution of the test cases in a more reliable manner.

David Andrade [13] investigated the utilization and challenges of robotic process automation in modern software testing. They

found that the testing of the business logic by using the RPA is risky, expensive, and complex. They suggested that the use of Artificial intelligence and Machine learning enhances the efficacy of the RPA.

Willem Dirk van Driel et al. [14] proposed a technique for forecasting of reliability of software for agile testing framework. The proposed approach can obtain a reliable number of predicted tickets by associating the features with the Bayesian statistics-based tickets. They demonstrated the proposed approach by applying it to two use cases, Mozilla, and Lighting. The obtained result was found satisfactory in terms of reliability models that can be used to improve the quality metrics.

Jarbele C. S. Coutinho et al. [15] presented a systematic survey to explore the practices, strategies, techniques, tools, and challenges that need to be addressed in the association of Requirements Engineering with Software Testing (REST) in the context of agile. The findings of the investigation include the fact that creating frequent communications with the stakeholders' weekly meetings should be required.

Viktoria Stray et al. [16] performed a qualitative study with the objective of investigating the human factors of testers employed on agile projects. Based on the investigations they introduced the seven traits that should be considered by organizations at the time recruiting agile software testers. The proposed traits are good communication skills, detail orientation, structuredness, creativity, curiosity, and adaptability

Zoe Hoy et al. [17] performed a survey to evaluate the challenges and solutions of the requirement engineering. They classified the identified challenges and solutions into three categories. These classified dimensions included organizational/business context, project management, and agile methodology. They proposed a framework to suggest a composed approach, which takes the three-dimensional view of agile requirements engineering solutions.

Jarosław Berłowski et al. [18] presented a case study of an agile-based testing process. The outcome of the survey shows the high level of the adoption of agility. They also compared each factor used for assessment with the project reality in a qualitative technique. The analysis outcomes also specified some areas of probable improvement.

John Esquiagola et al. [19] performed stress testing of the IoT platform under different conditions. They defined the three layers of the testing. These layers include software, hardware, and users. For testing of IoT platform, they have used the Tsung tool.

Joao Pedro Dias et al. [20] presented an overview of available test practices, tools and policies for the Internet of Things, its software, and its devices for testing. The process of testing IoT-based applications is complex due to the diverse and large-scale objects and networks of IoT applications.

Shikha Gautam et al. [21] discussed the various algorithms that are used for test case generation, refinement, and evaluation. [Vinicius H. S. Durelli](#) et al. [22] explored Machine learning with the objective to automate and streamline software testing. They also discussed the research by combining machine learning and software testing. The selected 48 primary studies are further divided into study type, testing activity, and ML algorithms. They found that algorithms and machine learning have been used for the generation of test cases, refinement, and evaluation

Hongkai Chen et al. [23] also discussed the various applications of Machine learning for the testing of quality assurance of the software. They found that the testing techniques based on machine learning help in early detection and prediction of software bugs. The testing tool can be developed using Machine learning to automate the various activities related to the testing, especially in the case of complex software.

Ashritha S et al. [24] investigated the various ways to use machine learning to automate and upgrade the testing process. They found that the use of machine learning in testing will provide high accuracy by consuming less cost for performing the quality assurance process. The use of machine learning-based testing helps to identify bugs quicker.

Feisal Alaswad et al. [25] discussed machine learning techniques and related various software metrics for the prediction of software quality. They found that the expert developers should perform the tasks related to verifying and predicting the quality of the software. The algorithms of artificial intelligence and machine learning have played an important role after quickly gaining experience through training on previously defective software.

Nilofar Mulla et al. [26] discussed the role of machine learning and artificial intelligence-based techniques in software testing. They found that there are various issues to the use of ML algorithms in software testing but testing techniques based on machine learning enhanced the testing process and delivered quality software to customers. They have given an overview of the various applications of AI and ML in software testing. The testing [27] techniques based on machine learning can deliver a reliable and robust application within time

Aimen Khalid et al. [28] explored the various ML and optimized ML techniques on the data set. They used the K mean clustering algorithm for class label classification. The ML model is optimized using the Particle Swarm Optimization. The experimented results showed that all the ML and optimized ML models attained the maximum outcomes however, the SVM and optimized SVM models outclassed with the uppermost achieved precision

[John Esquiagola](#) et al. [29] introduced the performance testing of IoT plate form. The testing of the applications of IoT has many issues as there are no typical test strategies and methodologies. The testing of an IoT application depends on many factors. These factors include specific configuration, network environment and platform, etc.

By critically reviewing the literature it has been observed that due to emerging the new technology the complexity of the software has also increased. The software tester must perform the testing under various constraints. These constraints include Time, resources, etc. Most of the researchers have published testing techniques using machine learning. To speed up the testing process automated tools are being used and give promising results. it has been observed that researchers also introduced methods to test IoT-based applications.

### 3. CONCLUSION

Software testing is continuously evolving with the emergence of advanced technology for developing the software. Now the various testing techniques using machine learning, DevOps, and Agile methodologies for effective testing of the software. The company is also using various automated tools for testing, which helps to deliver the software within time and accuracy. The use of automated tools also required fewer resources as compared with traditional manual testing. Currently, machine learning, Artificial Intelligence, DevOps, Agile, Automated

testing, and robotic process automation are used to test the software.

### 4. REFERENCES

- [1] <https://www.appsierra.com/blog/reduce-cost-of-software-testing>
- [2] 5 Proven Strategies for Minimizing Software Testing Cost (netsolutions.com)
- [3] Vedpal, Chauhan, N. (2019). A Multi-factored Cost- and Code Coverage-Based Test Case Prioritization Technique for Object-Oriented Software. In: Hoda, M., Chauhan, N., Quadri, S., Srivastava, P. (eds) Software Engineering. Advances in Intelligent Systems and Computing, vol 731. Springer, Singapore. [https://doi.org/10.1007/978-981-10-8848-3\\_3](https://doi.org/10.1007/978-981-10-8848-3_3)
- [4] <https://www.softwaretestingmaterial.com/software-testing-trends/>
- [5] <https://www.browserstack.com/guide/software-testing-challenges>
- [6] <https://www.altexsoft.com/blog/engineering/software-testing-qa-best-practices/>
- [7] V. Akila, A. Vasuki, J. A. Christaline, R. Sathiya, P. Rishi and A. S. Edward, "Enhancing Software Testing with Machine Learning Techniques," 2023 International Conference on Sustainable Computing and Data Communication Systems (ICSCDS), Erode, India, 2023, pp. 329-333, doi: 10.1109/ICSCDS56580.2023.10105028.
- [8] [Y. Wang, M. Pyhäjärvi and M. V. Mäntylä, "Test Automation Process Improvement in a DevOps Team: Experience Report," 2020 IEEE International Conference on Software Testing, Verification and Validation Workshops (ICSTW), Porto, Portugal, 2020, pp. 314-321, doi: 10.1109/ICSTW50294.2020.00057.
- [9] Saima Rafi, Muhammad Azeem Akbar, Wu Yu, Ahmed Alsanad, Abdu Gumaei, Muhammad Umer Sarwar, "Exploration of DevOps testing process capabilities: An ISM and fuzzy TOPSIS analysis, Applied Soft Computing, Volume 116, 2022, 108377, ISSN 1568-4946, <https://doi.org/10.1016/j.asoc.2021.108377>.
- [10] Alok Mishra, Ziadoon Otaifi, "DevOps and software quality: A systematic mapping"Computer Science Review, Volume 38, 2020, 100308, ISSN 1574-0137, <https://doi.org/10.1016/j.cosrev.2020.100308>.
- [11] N. Yatskiv, S. Yatskiv and A. Vasylyk, "Method of Robotic Process Automation in Software Testing Using Artificial Intelligence," 2020 10th International Conference on Advanced Computer Information Technologies (ACIT), Deggendorf, Germany, 2020, pp. 501-504, doi: 10.1109/ACIT49673.2020.9208806.
- [12] S. Yatskiv, I. Voytyuk, N. Yatskiv, O. Kushnir, Y. Trufanova and V. Panasyuk, "Improved Method of Software Automation Testing Based on the Robotic Process Automation Technology," 2019 9th International Conference on Advanced Computer Information Technologies (ACIT), Ceske Budejovice, Czech Republic, 2019, pp. 293-296, doi: 10.1109/ACITT.2019.8780038.
- [13] [12] David Andrade "Challenges of Automated Software Testing with Robotic Process Automation RPA - A

- Comparative Analysis of UiPath and Automation Anywhere” *International Journal of Intelligent Computing Research (IJICR)*, Volume 11, Issue 1, 2020
- [14] [13] van Driel WD, Bikker JW, Tjink M, Di Bucchianico A. Software Reliability for Agile Testing. *Mathematics*. 2020; 8(5):791. <https://doi.org/10.3390/math8050791>
- [15] [14] Jarbele C. S. Coutinho , Patrícia D. L. Machado, Wilkerson L. Andrade “Requirements Engineering and Software Testing in Agile Methodologies: a Systematic Mapping” SBES '19: Proceedings of the XXXIII Brazilian Symposium on Software Engineering September 2019 Pages 322–331 <https://doi.org/10.1145/3350768.3352584>
- [16] [15] Stray, V., Florea, R. & Paruch, L. Exploring human factors of the agile software tester. *Software Qual J* 30, 455–481 (2022). <https://doi.org/10.1007/s11219-021-09561-2>
- [17] [16] Hoy, Z.; Xu, M. Agile Software Requirements Engineering Challenges—Solutions—A Conceptual Framework from Systematic Literature Review. *Information* 2023, 14, 322. <https://doi.org/10.3390/info14060322>
- [18] [17] Jarosław Berłowski , Patryk Chruściel , Marcin Kasprzyk, Iwona Konanec , Marian Jureczko “Highly Automated Agile Testing Process: An Industrial Case Study” *e-informatica Software Engineering journal*, Volume 10, Issue 1, 2016, Pages 69-87, DOI 10.5277/e-Inf160104
- [19] [18] John Esquiagola, Laisa Costa, Pablo Calcina, Geovane Fedrechski and Marcelo Zuffo “ Performance Testing of an Internet of Things Platform” In Proceedings of the 2nd International Conference on Internet of Things, Big Data and Security (IoTBDS 2017), pages 309-314 ISBN: 978-989-758-245-5 DOI: 10.5220/0006304503090314.
- [20] Joao Pedro Dias, Flavio Couto , Ana C.R. Paiva, Hugo Sereno Ferreira “ A Brief Overview of Existing Tools for Testing the Internet-of-Things” 2018 IEEE International Conference on Software Testing, Verification and Validation Workshops 0-7695-6432-1/18/\$31.00 ©2018 IEEE DOI 10.1109/ICSTW.2018.00035
- [21] Shikha Gautam, Ajay Khunteta and Pooja Sharma “ A Review on Software Testing Using Machine Learning Techniques” 2022 ECS Trans. 107 3393 DOI 10.1149/10701.3393ecst
- [22] V. H. S. Durelli et al., "Machine Learning Applied to Software Testing: A Systematic Mapping Study," in *IEEE Transactions on Reliability*, vol. 68, no. 3, pp. 1189-1212, Sept. 2019, doi: 10.1109/TR.2019.2892517.
- [23] Hongkai Chen, and Mohammad Hossain, “ Application of Machine Learning on Software Quality Assurance and Testing: A Chronological Survey” *Proceedings of 37th International Conference on Computers and Their Applications EPiC Series in Computing Volume 82, 2022, Pages 42–52*
- [24] Ashritha S, Padmashree T “ Machine Learning for Automation Software Testing Challenges, Use Cases Advantages & Disadvantages” *International Journal of Innovative Science and Research Technology* ISSN No:- 2456-2165 Volume 5, Issue 9, September – 2020
- [25] Feisal Alaswad, E. Poovammal, “Software quality prediction using machine learning, *Materials Today: Proceedings*” Volume 62, Part 7, 2022, Pages 4714-4720, ISSN 2214-7853, <https://doi.org/10.1016/j.matpr.2022.03.165>.
- [26] Nilofar Mulla, Dr. Naveenkumar Jayakumar “ Role of Machine Learning & Artificial Intelligence Techniques in Software Testing” *Turkish Journal of Computer and Mathematics Education*, Vol.12 No.6 (2021), 2913-2921
- [27] Vedpal and N. Chauhan, "Role of Machine Learning in Software Testing," 2021 5th International Conference on Information Systems and Computer Networks (ISCON), Mathura, India, 2021, pp. 1-5, doi: 10.1109/ISCON52037.2021.9702427
- [28] Khalid, A.; Badshah, G.; Ayub, N.; Shiraz, M.; Ghouse, M. Software Defect Prediction Analysis Using Machine Learning Techniques. *Sustainability* 2023, 15, 5517. <https://doi.org/10.3390/su15065517>.
- [29] John Esquiagola, Laisa Costa, Pablo Calcina, Geovane Fedrechski, Marcelo Zuffo “ Performance Testing of an Internet of Things Platform” *Proceedings of the 2nd International Conference on Internet of Things, Big Data and Security IoTBDS - Volume 1, 309-314, 2017 , Porto, Portugal*