Software and Performance Testing Tools

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Abstract

Software Testing may be a method, that involves, death penalty of a software system program/application and finding all errors or bugs therein program/application in order that the result is going to be a defect-free software system. Quality of any software system will solely be acknowledged through means that of testing (software testing). Through the advancement of technology round the world, there inflated the quantity of verification techniques and strategies to check the software system before it goes to production and astray to promote. Automation Testing has created its impact within the testing method. Now-a-days, most of the software system testing is finished with the automation tools that not solely lessens the quantity of individuals operating around that software system however additionally the errors which will be loose through the eyes of the tester. Automation take look acting contains test cases that make the work simple to capture totally different eventualities and store them. Therefore, software system automation testing method plays a significant role within the software system testing success. This study aims in knowing differing kinds of software system testing, software system testing techniques and tools and to match manual testing versus automation testing.

Keywords

Software testing, Performance testing, testing types, testing tools

1. Introduction

Software testing may be a crucial a part of software package development in delivering a high-quality software package that's free from bugs and defects and also the method of automating software package testing is vital to its success. Testing is vital as a result of software package reliability is outlined exploitation testing and more or less fifty per cent of the software package development take into account software package comes is spent on testing. Software package testing is labour intensive and expensive; so, there's a necessity to cut back human testing. Software package testing is important as a result of errors is typically introduced into software package unknowingly because it is designed and made. Software package has become even more complicated nowadays, which suggests there are additional lines of code, and additional thorough testing that has to be done [1]. His purpose of testing is quality assurance, verification, and validation or dependableness estimation. It's a trade-off between budget, time and quality. Computer code Quality is that the central concern of computer code engi-

neering. Testing is that the single most widely used approach to making sure computer code quality [2]. Testing may be additional classified into purposeful and Performance testing.

Performance testing analyses if the performance parameters like work time, dependableness, load capability etc. are up to the shopper expectations. Functional testing aims to visualize, if the functionalities provided are correct as per business necessities and are operating as intended. It must be critically analysed if the investment on testing could give an acceptable come. Though' it's continuously recommended to travel for testing, timelines and budget typically makes the project team skip an equivalent. The main objective of the research paper is that it describes concisely what the research is trying to achieve. They summarize the accomplishments a researcher wishes to achieve through the project and provides direction to the study.

2. SOFTWARE TESTING STRATEGIES

Software testing is that the execution of code mistreatment mixtures of input and state chosen to reveal bugs. In this section we tend to introduce to manual testing and automatic testing. In orders to scale back the price of manual computer code testing researchers are operating towards increasing the automation of software testing.

2.1. Manual Testing

Manual Testing may be a kind of code take a look acting during which test cases area unit dead manually by a tester while not victimisation any machine-driven tools. the aim of Manual Testing is to spot the bugs, issues, and defects within the code application. Manual code testing is that the most primitive technique of all testing varieties and it helps to seek out essential bugs within the code application. Any new application should be manually tested before its testing will be machine-driven. Manual code Testing needs additional effort however is critical to ascertain automation practicable. Manual testing ideas doesn't need information of any testing tool. One in all the code Testing elementary is "100% Automation isn't possible". This makes Manual Testing imperative.

2.2. Automation testing

Automation testing/test Automation could be a code testing technique that performs exploitation special machine-driven testing code tools to execute a test suit suite. On the contrary, Manual Testing is performed by somebody's sitting before of a pc fastidiously capital punishment the check steps. The automation testing code may also enter test knowledge into the System underneath check, compare expected and actual results and generate careful check reports. Check Automation demands extended investments of cash and resources. Successive development cycles would require execution of same check suite repeatedly. Employing a check automation tool, it's potential to record this check suite and re-play it as needed. Once the check suite is machine-driven, no human intervention is needed. This improved ROI of check Automation. The goal of Automation is to scale back the amount of check cases to be run manually and to not eliminate Manual testing altogether.

Table 1. Difference between Manual testing and Automated Testing

Manual Testing	Automation Testing
Huge investment in human resources: As take a look at cases ought to be dead manually therefore additional testers are needed in manual testing.	Less investment in human resources: take a look at cases are executed by mistreatment automation tool thus less tester is needed in automation testing
Time intense and tedious because the take a look at cases are dead manually, it is very slow and tedious.	Fast: machine-driven take cases could be dead tons quicker than manual counterparts.
For executing test cases for small number of times.	To run the test multiple number of times.
It permits the tester to perform additional ad-hoc (random testing)	Helps acting "compatibility testing" - testing the code on totally different configurations

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Manual testing is a smaller amount reliable as tests might not be performed with exactitude anytime because of human errors.	Automation tests execute exactly same operation when they're run.
The longer tester spends testing a module the grater the percentages to search out real user bugs	Capable of finding only expected defects.
Short term costs are reduced.	Long Term Cost reduction.
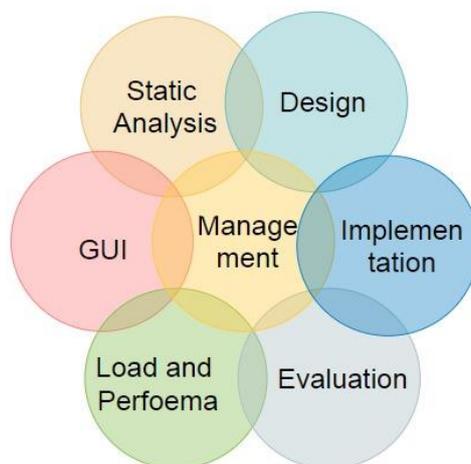
Figure 1. The Division of the tools

Table 2. The Division of the tools

Tools	Description
Test Design Tools	Tools that assist you decide what tests got to be dead. take a look at information and action generators.
GUI	GUI take a look at Drivers Tools that alter execution of tests for merchandise with graphical user interfaces. Client/server take a look at automation tools, as well as load testers, additionally go here.
Load and Performance Tools	Tools that specialise in putt an important load on systems (especially client-server systems). These tools are usually additionally graphical user interface take a look at drivers.
Test Management Tools	Tools that alter execution of tests for merchandise while not graphical user interfaces. Also, tools that assist you work with massive take a look at suites.
Test Implementation Tools	Miscellaneous tools that assist you implement tests. as an example, tools that automatically generate stub routines go here, as do tools that arrange to create failures more obvious (assertion generators, etc.)
Test analysis Tools	Tools that assist you value the standard of your tests. Code coverage tools go here.
Static Analysis Tools	Tools that analyse programs while not running them. Metrics tools fall during this class

3. Testing Tools

3.1. Quick Test Professional (QTP)

1. **Vendor-HP code Division:** - It is illustrious to be the industries best answer for practical testing and regression check automation. It uses keyword driven approach proving the check automation engineer full access to underlying check associate degree object properties via an integrated scripting and debugging interface.

2. **Open XML Report Format for check Results**: Stores test ends up in associate degree open XML format, enabling you to simply customize the reports in keeping with your own necessities, and to integrate the check result data with different applications. Check results will currently be exported to mark-up language.

3. **New IDE Environment:** Offers extremely customizable check development surroundings.

4. New Debugger: allows checkers to pin-point test errors when building and maintaining check cases. Keyword Management: Manage keywords, including turning on/off specific ways from the Keyword read.

5. **Environment Support:** Quick Test skilled supports functional testing of all common environments, including Windows, Web, .Net, Visual Basic, ActiveX, Java, SAP, Siebel, Oracle, PeopleSoft, and terminal emulators. New Environment

Support: Supports net services, .NET 2.0, Firefox 1.5, Netscape 8, Macromedia Flex a pair of, Win XP 64-bit, Internet somebody seven, and also the latest ERP/CRM applications.

6. **Scripting Language:** the selection of VBScript isn't terribly good, as a result of VBScript has some important limitations: like, it doesn't support modules/libraries and can't be thought-about as "truly" object-oriented language because it doesn't support inheritance of categories.[1]

3.2. RANOREX

a) **Vendor- Ranorex GmbH:** Ranorex is that the quickest growing automation tool that has imbided the options of the simplest automation tools out there in market and providing a foothold over them.

b) **Object Repository**: it's a extremely outlined object repository which properly stores and displays the objects within the hierarchy of their presence on the screen.

c) **User Codes**: It permits the user to make any reasonably state of affairs using committal to writing that adds to any feature already gift within the tool.

d) **Code Compiler**: Brings out any code connected issue within the take a look at script whereas assembling the code for execution.

e) **Enhanced Keyword View**: Elaborate keyword read with all the functionalities and add-ons.

f) **Graphical Report**: The take a look at report generated is complimented with graphs for quicker and higher comparison of defects in each run.

g) **Step read Scripting**: The interface provided could be a non-code-based interface that makes it simple to trace missing steps.

h) **Environment Support**: Having a extremely developed image based processing; it will support any graphic primarily based environment.

i) **Scripting Language**: It supports extremely evolved languages like C#, vb.net that provides it a footing over different testing tools. Also, it provides the tester ability to code in his comfort language.[1]

3.3. LambdaTest

Cloud LambdaTest is cloud-based cross browser testing platform that helps in each manual and automatic browser compatibility testing. Users will perform live interactive testing of their web site or internet app on a mixture of 2000+ totally different browser and software package right from their own browser. Additionally, the platform permits the users to run chemical element automation tests on a climbable, secure, and reliable cloud-based chemical element grid and perform live interactive cross-browser testing of their public or regionally hosted internet sites and web app on the cloud. LambdaTest additionally offers the feature of taking machine-driven page screenshots across all 2000+ environments to quickly take a look at the layout, sign up one click however your web site can look out on thirty six totally different devices, and compare style and mark-up language pictures. Additionally, the LambdaTest platform additionally has single-click integration with standard project management and enterprise tools like Jira, Asana, Trello, Github, Gitlab, BitBucket, Slack, and Visual Studio Team Services. "Built amorously for Testers!"[12]

Cross-browser testing is one in all the essential elements to run an online application systematically on multiple browsers. it's a testing technique that enables you to see the net application practicality and alternative dependencies across numerous browsers over the net. Now, you need to be thinking is it extremely necessary to perform cross-browser testing for an online application. Well, as you may understand, that there square measure a range of internet browsers obtainable within the market, and end-users use completely different browsers to go to an online application in line with their conven-

ience. Hence, it's necessary that the net application or web site works on all the browsers effectively[3]. A web app typically has multiple client-side elements like Flex, JavaScript, Flash, Applets, and lots of additional. All of those elements will behave otherwise across completely different internet browsers in line with their rendering engines. Cross-browser testing ensures that your internet app works unfailingly across all browsers while not compromising with its quality. It permits developers and testers to spot whether or not the rendition or look of web content in several browsers and devices is same or not.

3.4. TestComplete

TestComplete is an automatic UI Testing Tool developed by SmartBear software package. TestComplete has the flexibility to make machine-driven useful tests for desktop, web, and mobile applications. It conjointly has native support for behavioural Driven Development (BDD). This tool is alleged to be terribly straightforward to use with computer science (AI). it's quick and straightforward to make, maintain, and execute useful take a look ats which is able to increase test coverage and make sure you ship high-quality, battle-tested software package. It has unmatched hybrid beholding engine with computer science. Its beholding combines property-based and AI-powered visual recognition to seek out dynamic UI components quickly, easily, and accurately. It is conjointly known as a Script or Scriptless tool. the rationale behind this can be that if you wish to script, you'll presently do thus in seven completely different languages (JavaScript, Python, VBScript, Jscript, DelphiScript, C#, and C+). If you are doing not wish to script, then you'll use its record and play feature

3.5. Katalon Studio

Katalon Studio is one amongst the rising tools for automatic testing. in conjunction with atomic number 34, Ranorex, Test-Complete, and Apache JMeter, it's price discussing as additional and additional testing engineers pick Katalon. The platform facilitates running automatic tests for net interfaces, APIs, and mobile apps (both iOS and Android), provides check recording, and analysis reports. Katalon Studio could be a free-license tool discharged in January 2015 with a Selenium-based engine. Mostly, Katalon is intended to form and utilise automatic check scripts for UI while not committal to writing. Katalon Studio permits running automatic tests of UI parts, together with pop-ups, iFrames, and wait-time. The tool is launched on Microsoft Windows, macOS, and Linux.

Katalon's main advantage is that it's straightforward to deploy and features a wider set of integrations compared to Se, the market leader. Katalon has twin scripting interfaces for users with totally different programming skills. this suggests that testers with restricted technical data will use an easier program that doesn't need writing code. The mode for enhanced users has access to scripting with syntax lightness, code suggestion, and debugging. Katalon Studio has pre-defined whole structure: variety of templates for check cases, check suites, check objects, and reports.

Katalon Studio supports native and remote testing, still as parallel and consecutive executions. It runs on Groovy (Java) scripting language. This answer features a fast setup and variety of pre-installed templates that enable continuation some testing patterns. Katalon Studio may be a cross-browser tool that supports internet, mobile, and API testing. These solutions escort analytics and recording modules

3.6. SELENIUM

Selenium could be a free (open-source) machine-controlled testing framework want to validate internet applications across totally different browsers and platforms. you'll be able to use multiple programming languages like Java, C#, Python etc to make chemical element take a look at Scripts. Testing done mistreatment the chemical element tool is sometimes said as chemical element Testing. Selenium software package isn't simply one tool however a collection of software package, every bit job to totally different testing wants of a company. Here is that the list of tools Selenium Integrated Development surroundings (IDE) Selenium remote (RC) WebDriver Selenium Grid.[9]

3.7. API

Application Programming Interface (API). Ports take a look at scripts you write in like Ruby, Java, Python, or C# to Selenium's own scripting language (Selenese), through bindings.

- **Library:** Houses the API and language-specific bindings. though many third-party bindings exist to support totally different programming languages, the core client-side bindings supported by the most project are: element Java (as element jar files), element Ruby, element dotnet (or element C#, out there as .dll files), element Python, and element JavaScript (Node).
- **Driver:** Executable module that parades a browser instance and runs the take a look at script. Browser-specific—for instance, Google develops and maintains Chrome driver for element to support automation on Chromium/Chrome. Framework Support libraries for integration with natural or artificial language take a look at frameworks, like element with Cucumber or element with TestNG.

Table 3. A Comparison Software Testing Tools

Features	TestComplete	SELENIUM	Quick Test Professional	Katalon Studio	RANOREX	LambdaTest
Test development platform	Windows	Cross platform	Windows	Cross platform	Cross platform	Cross platform
Application under test	Mobile, Web, Windows desktop, apps, API/Web services	Web Applications	Mobile, Web, Windows desktop, apps, API/Web services	Mobile, Web, Windows desktop, apps, API/Web services	Mobile, Web, Windows desktop, apps, API/Web services	Web Applications
Scripting languages	Java, C#, Python etc.	Java, C#, Python etc.	VBScript	Java	VB.NET and C#	Java, C#, Python etc.
Programming skills	Not required	Advanced skills needed to integrate various tools	Not required. Recommended for advanced test scripts	Not required	Not required	Not required
Script creation time	Fast	Slow	Fast	Fast	Slow	Fast

4. RESEARCH TOOLS

Research tools can be defined as vehicles that broadly facilitate research and related activities. Scientific tools enable researchers to collect, organize, analyse, visualize and publicized the research outputs.

4.1. PERFORMANCE TESTING TOOLS

The top performance testing is been search and as listed below some of them. The diagram representation of performance testing is below.

Figure 2. Performance Testing

In terms of performance, we wish to achieve high speed, scalability and stability of a system. There are several types of performance tests in which each simulates different possible scenario. The below figure demonstrates that how the some of them works:
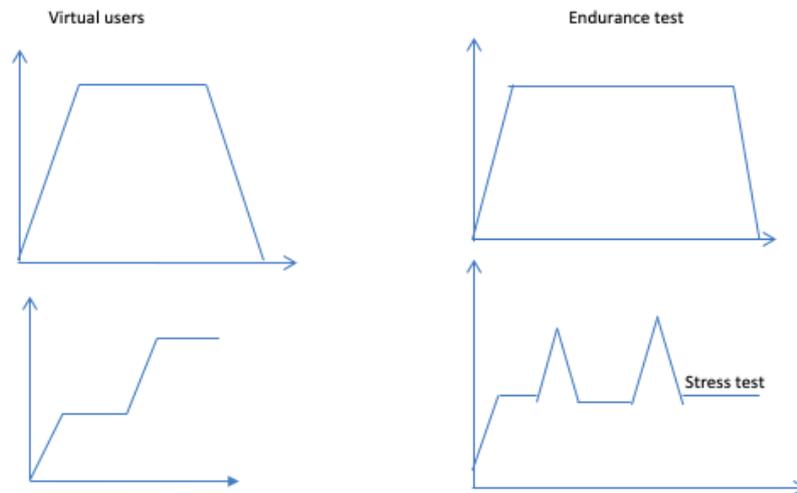
Figure 3. Analysis of Performance Test Techniques

Importance of Performance Testing in Web Applications:

- **Scalability**: Not only speed an important goal for performance, but scalability tests are extremely important if you want more users to interact with a system.
- **Stability:** Obviously, we want your application to work at all times. There will be some times when it is under more stress than others.

4.1.1. WebLOAD

WebLOAD is the tool of choice for enterprises with heavy load and complex testing requirements. It allows you to perform load and stress testing on any internet application by generating load from the cloud and on premises machine.

WebLOAD's strengths are its flexibility and ease of use is – enabling you to quickly define the tests you need with features like DOM – based recording/playback, automatic correlation, and JavaScript scrioting language. WebLOAD's supports the hundreds of technologies – web protocol to enterprise applications and has buit in integrations with Jenkins, Selenium and many other tools to enable continupus load testing for DevOps.

4.1.2. LoadNinja

LoadNinja by SmartBear allows you to quickly create scriptless sophisticated load tests, reduce testing time by 50%, replace load emulators with real browsers, and get actionable, browser-based metrics, all at ninja speed.The automated performance software testing tools which are currently available are [9].

4.1.3. HP Load Runner

HP Load Runner is the product of HP. It is an industrial standard based performance automated tool for load testing of applications which is used for studying system performance and behavior. It works by using virtual users. It simulates thousands of real-time users to put the application through user loads and thoroughly analyses the results to identify the particular behavior.

4.1.4. Apache J Meter

Apache J Meter is a product of Apache Software Foundation designed to load test functional behavior and measure performance. It is an open source java application. Apache JMeter was basically designed for testing web applications but now it can be used for performance test both on static and dynamic resources. Distributed testing feature is one of the strong points of Apache J Meter.

Figure 4. The apache J Meter works and then it results in a tabular form that what total data is there in particular software.

4.1.5. Selenium

Selenium is used to test web application. It is consists of four tools i.e. Selenium IDE, Selenium RC, Selenium Web Drive and Selenium Grid. Selenium is an open license and supports different web browsers.

4.1.6. NeoLoad

NeoLoad is used to measure the performance of the web application. NeoLoad provides pragmatic solution facilitating design and development of the optimized websites. Neotys is a French company which owned, maintained and developed NeoLoad. It provides monitoring of the user response times and infrastructures statistics. It can run on most of the operating systems. A non-specialist can easily create a test by using the NeoLoad automation testing tool.

4.1.7. WebLoad Professional

WebLoad Professional is developed by Rad Views for Performance testing of internet applications. WebLoad Professional includes built-in support for Ajax technologies, JSON data types and different types of SOAP and XML web services. It supports Windows operating systems as well as Linux machines. The proxy recorder is used for recording business processes. The WebLoad result test script is written in JavaScript. It is an open source project.

4.1.8. LoadUI

LoadUI is an open source performance testing tool used for load testing. LoadUI is used to check the performance of web application. LoadUI can also work withSoapUI really efficiently. LoadUI is the most flexible and interactive performance testing tool.

4.1.9. WAPT

Web Application Performance Tool or WAPT, is used to test web application and the interface of web. WAPT is used for performance, Load and Stress Testing of web application. WAPT specify to the tester that how many virtual users are using the testing environment i.e. either increasing, constant or interrupted users load.

4.1.10.   Loadster

Loadster is a Load Testing Tool which is used for test solutions for websites, web application and web services. Loadster is built for real web applications and handling cookies, user sessions, custom header, dynamic form data. Loadstar creates a testing environment where single user state and Loadster gathers statistics for each virtual user individually.

4.1.11.   LoadImpact

LoadImpact is a performance testing tool where it simulate traffic exactly how it would happen in real life in a testing enviroment. LoadImpact generate scripts automatically and there is no need of programming. LoadImpact also measure the usage of CPU, Memory Usage, Disk I/O and Network I/O.

5. Identifying Usability requirements of Software Testing Tools

According to Andreas Hollinger, usability is defined as the comfort of use and suitability of a system for a particular class of users carrying out precise work in a precise environment. Author specified criteria level for ease of use, ease of learning, simplicity, effectiveness, information, and the user interface as usability requirements for the evolution of selected software testing tools.

5.1. Selection of Participants

For conducting the usability studies, the author selected a total of 20 participants. These participants are students of Blekinge Institute of Technology who are currently studying in the field of Computer Science and Software Engineering. Author divides the participants into two groups. Group 1 will conduct the usability test using LoadRunner while group 2 will conduct the usability test using JMeter. The participants were selected randomly. Initially 28 Students were contacted for the survey but only 23 students agreed. Later on, 2 students informed the author that they are busy and would not be able to attend the survey and 1 participant didn"t show up for the survey. 28 In these 20 participants, 4 participants have work experience in software testing and are familiar with automated testing tools. 6 students have already the experience of conducting the usability survey and they are equally divided into the groups. Remaining 10 participants have no experience in usability survey and are divided equally into two groups.

5.2. Scenarios based Tasks

Tasks selected for the usability test are a scenario based and is written in the English language. These tasks cover all the functionalities of the selected parameters of the selected tools. It is not easy to test all the functionalities of the selected tools so author designed the scenarios in such way that the objective of this research is achieved.

5.3. Test Location

The usability test is conducted in Blekinge Institute of technology group rooms. All the tasks were provided on paper and participants were left alone so that they can conduct the test without any interruption.

5.4. Usability Test Equipment and Material

To have a control experiment, author provides computer to every participant. The Same computer was provided to each participant. After the completion of the test, the author made sure that the software testing tool is completely uninstalled. All the tasks and questionnaires were written on paper and were provided to each participant individually.

Table 4. Comparison Between LoadRunner and JMeter Tool

Parameters	LoadRunner	JMeter
Procurement Cost	Licensed tool with high maintenance cost	Open-Source free tool
Installation	Time consuming High disk usage	Quick Low disk usage
Load Generation	Restricts number of users although licensed tool	No restriction on number of users. Allows as many users as hardware supports
Scripts	Hides scripts in levels in order to make script look better	Shows entire script describing the HTTP flow of the scenario
Result	Excellent analysis, dynamic graph generation, server-side metrics	Limited graph generation with no server-side metrics
Transaction Response Time	More as response time includes image download time	Less as it excludes image download time
Analysis and Monitoring	Features provided are market leading	Not very strong in this category
Record and Replay Feature	Provides unmatched record and replay feature compared to any open source	Record and replay feature not very strong
Preferred Use	When working with different types of IT applications, dealing with different protocols	When working extensively on web protocols
Resolutions	Faster	Slow as testers have to find ways to resolve issues

- Graph Representation
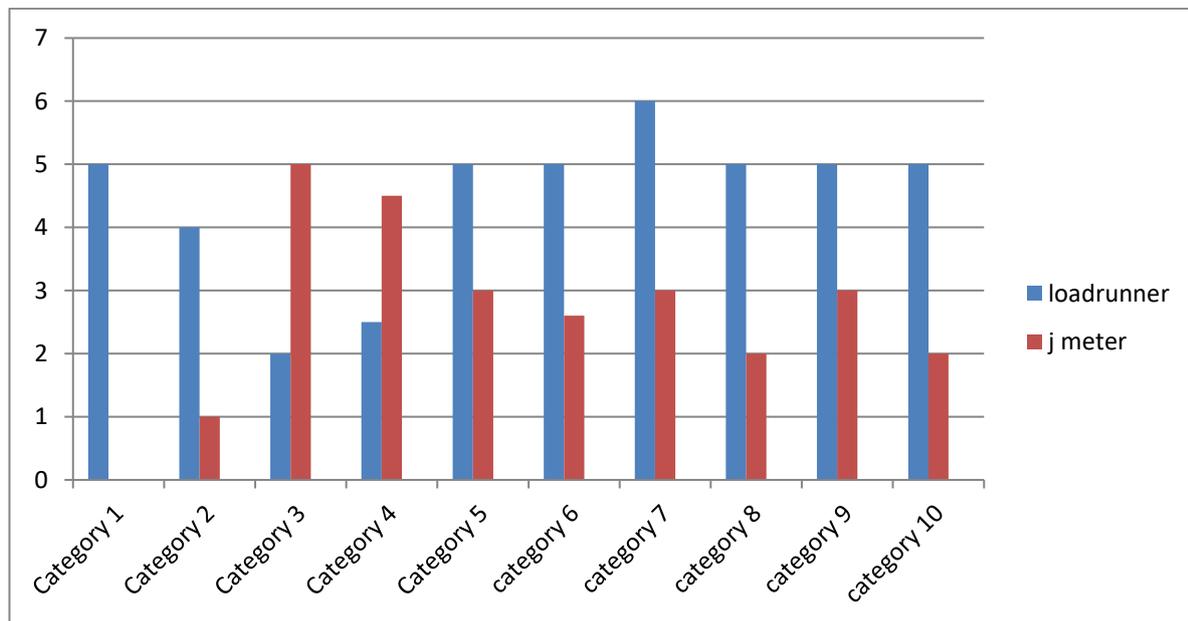
- Line Representation
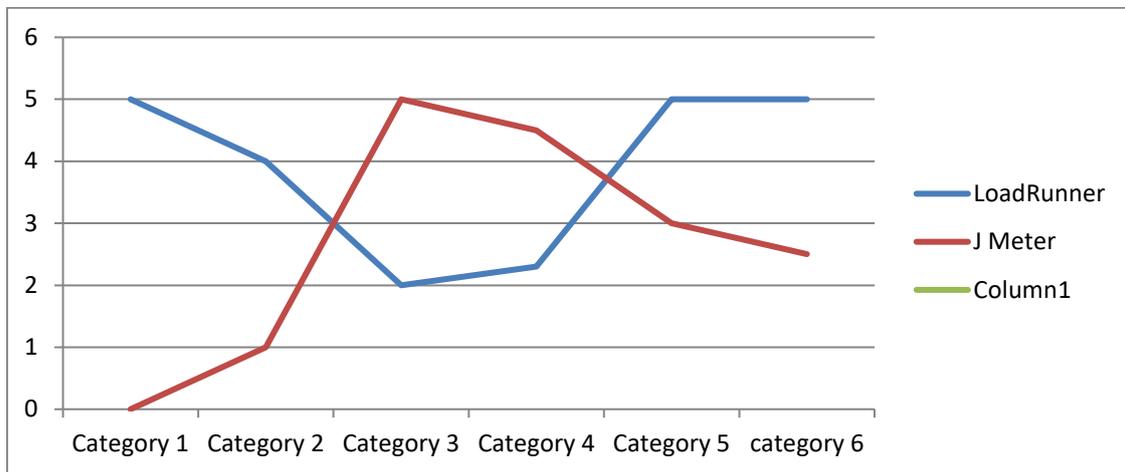
6. WEB APPLICATION PERFORMANCE TESTING

This chapter discusses the test preparation, execution and reporting of web application performance testing implementation. The main focus of this experiment is load testing. The below figure shows the web application architecture
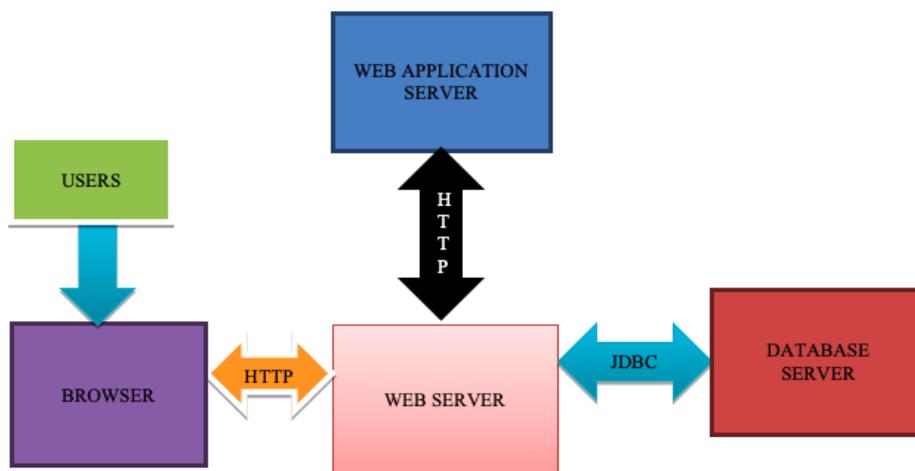

Figure 5. Web Application Testing

7. Conclusion

In this research paper one point is indubitable that automation testing is much more suitable than manual testingTesting is one among the helpful and necessary side once it comes to testing the applications. Open supply technologies are becoming common day by day due to the community support to those open supply software system. Here during this paper when evaluating the 3 preferred Open supply Softwares viz. checkComplete, SELENIUM, Quick Test Professional, Katalon Studio, RANOREX and LambdaTest.

Software performance testing has become an integral part of projects. HP LoadRunner and Apache JMeter are good performance testing tools available in the market, but which tool is ultimately best depends on a number of factors like your budget, type of system, testers, no of users etc. The low-cost advantage may not be very helpful if we are dealing with legacy systems where lots of scripts are developed, compared to the efforts required for rescripting. On the other hand if we are working on different types of applications and using different protocols then going with LoadRunner will be preferred as it supports many protocols. Based on this research we recommend to go ahead with HP LoadRunner as it is very stable and robust. LoadRunner provides faster resolution of scripting issues. Recent study says that, efficiency of software professionals working on licensed tool is more than those working on open source tools. LoadRunner provides excellent monitoring and analysis features which are leading in the market. Its only disadvantage is high procurement and maintenance cost. But if you have budget crisis then you can stick to JMeter.

Acknowledgement

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