

Comparative Study of Top-Ranked Web Browsers

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Abstract— A web browser is an application program that provides accessibility to the content available on the internet. Different types of web browsers are available, however, which browser to use depends on the user preferences of reliability, speed, ease of use and so on. In this paper, we provide a comparative study of five top-ranked web browsers from the user's perspective. The key parameters were chosen for user survey includes installation, bookmark, browser crash, private browsing, page redirection, plug-in support, online/offline help and support provided by browser. We have also analyzed different features to examine the reasons of user preference. Loading time is analyzed on different configurations, opening time is inspected by opening 50 websites also bookmarks mechanism is compared, history management is analyzed of all selected categories, tab mechanism is compared and download process is evaluated, so that comparison of browser choice and features of browser could be ranked accordingly, also installation support of operating system is checked by installing selected browsers on different popular operating systems. This study will help users to select appropriate browser according to their available hardware, operating system installed, not only this but various other features are tested which make browser selection process easier for web users.

Index Terms: web browsers, bookmark, browsing history, tabs, private browsing

I. INTRODUCTION

The doorway to web is web browser, which significantly changed since last decade. Various vendors including Google, Mozilla and Apple, are providing high featured browsers, but top five ranks are occupied by popular browsers since last five years [3] and no other entry found in that spectrum except Google Chrome, Mozilla Firefox, Internet Explorer, Opera and Safari [2,3]. Users of web are attracted by vendors through different features, which include speed of browser, opening time of browser, opening time of website, frequency of occurring crash, mechanism handling bookmark, history management, private browsing, password saving, synchronization, availability of extensions, offline/online help, print and zoom functionality, so on. Web browsers are playing essential role in different fields, including medical science,

computational technologies, business, education and research, so on. Therefore, it is very important to know which browser offers required facilities. In the text to follow, we present a brief overview of top ranked web browsers along with their properties that they offer.

Google is popular for its search engine, but another popular product relates with the company is **Google Chrome(GC)** web browser. Reputation of the browser mostly increased due to various features including its design, bookmark mechanism, less number of bars, thousands of attractive applications. Success factor of the browser is multiplied since its birth in 2008, and now it is leading browser with the aspect of market share [1,2,3]. Second youngest web browser after Google Chrome is **Mozilla Firefox(MF)**, released in 2004 by Mozilla company. It is supported by all operating system and also by the browser is available by default in various flavors of Linux operating system. Security and Bug fix control are strength features of browser, apart from it attractive themes and valuable add-ons are significantly enhancing its market share [1,2,3]. **Internet Explorer(IE)** is by default available in almost all windows based operating systems launched by Microsoft, it is oldest browser in top ranked browsers and its version was published in 1995. Themes and speed of browser with its slow response time, ruined reputation of browser and declined found in its usage since last decade. On the other hand, by default availability with products of Microsoft and security are key features of this browser, which rank this browser in category of top 5 browsers [1,2,3]. Telenor, a popular telecommunication company of Norway has initiated its own light weight browser in 1996, named as **Opera(O)**. Tab feature was founded by the browser, also less website opening time and improved security level is attracting computer users as well as users having internet connectivity via cellular telecommunication[1,2,3]. In 2003, with the development of Mac operating system, Apple company has also added **Safari(S)** web browser to its products. With attractive look, multi-tab windows, spell checker and its high security, this browser is getting favor of internet consumers [1,2,3].

Various comparative studies [1,5, 6,7] analyzed different features of web browsers including speed, security, update, plug-ins, bug reporting, private browsing and history, as a whole it is found that no any single browser has complete set of requirements for all categories of users, researcher has selected new method of asking questionnaire from end users to identify actual features causing success or failure of any browser. To cover all requirements of users, browser vendors are continuously

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narrowing time for release cycle, especially Mozilla Firefox and Google Chrome release its new version after every six weeks, quick releases offer less duration to observe drawbacks but have fast bug fix rate [10]. Very important component of web browser is rendering engine, having capability to show HTML, XML contents as well as images. Web browser has three components, rendering engine, scripting engines and user interface, first two are attractive for technical users, but user interface is equally important for every user [1]. Rendering engines are also called as web browser engines or layout engines; they generate view of web page for users. Apple Safari is using web kit engine, Internet Explorer is using closed source Trident engine, and which is also called Microsoft Hypertext Markup Language (MSHTML). Firefox uses Gecko an open source rendering engine. Opera is using Presto and Google Chrome is now using Blink rendering engine. All discussed rendering engines are programmed in C++ programming language [1]. An important aspect of web, private browsing has included in web browsers with two intentions: first to remove traces of visited websites from the computer, second to hide the identity of user from websites for the purpose of security [9]. For different reasons, web browsers are crashed during their performance, each browser using different techniques to handle this issue, Mozilla Firefox uses Mozilla Crash Reporter, which identify and report crash with its reason(s). Socorro server is used to manage crash reports, where some bugs are handled by Bugzilla tracking system, but huge quantity of bugs are manually given to developers. To avoid duplicate assignment of bugs to developer, description is used in natural language [10]. The scale of internet users on mobile devices increased dramatically, less bandwidth and low processing strength of mobile web browsers as compare to web browsers used in Personal Computer, affect their speed negatively, and normally it takes multiple seconds to open a simple html page [11], the major reason for this delay is round-trip time [12]. To tackle the reasons of delay, two type of strategies are implemented i.e client-side optimization (caching optimization, web page pre-fetching) and cloud-based optimization (cloud based parallelization, cloud based preprocessing), which empower mobile web browser to gain strength of cloud computing [13].

II. METHODOLOGY

Mixture of users experience web on periodic basis using web browser, with the addition of every new web user web browsers are increasing its significance. A survey is conducted 105 undergraduates and post-graduates, to diagnose opinion of users associated with different categories. Participants were from different fields including English literature, Information Technology and Business Administration. Total 28 questions were included in a questionnaire, which were related to usage habit and user experiences regarding web browsers.

A. Pilot Study

Pilot study was conducted with 10 faculty members,

which were having M.S (18 year of education) in the field of Business Administration, English Literature and Linguistics and Information Technology. Participants included mixture of expert technical users as well as common users, questionnaires and practical tasks were given to users and previous experience were collected through questionnaire after that practical tasks were given to selected candidates and all tasks were get performed by the candidates, in last another questionnaire was given to collect their post-usage ideas. During the pilot study, it is found that with oral instructions it is necessary to make handouts for practical tasks performance, as user feel difficulty when he/she uses new browser or attribute of browser which was never experienced by participant, after completion of pilot study handouts were developed to make easiness for research population. Pilot study results that Google Chrome remain favorite browser of all candidates before and after practical tasks.

B. Pre-usage Survey

Demographic information is collected from 105 participants having different background and field of study; closed ended questions were asked from every participant to collect his previous experience of web usage.

Pre-usage response of participants

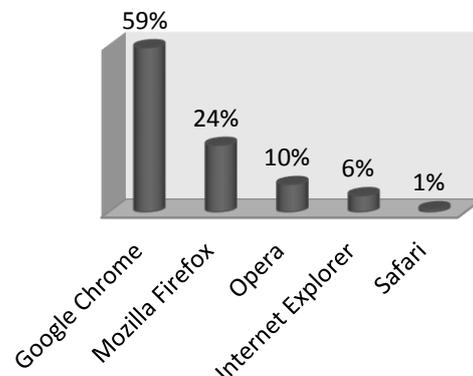


Fig. 1. Pre-usage response by participants

Google chrome was choice of more than half of population with 59%, Mozilla Firefox were selected by 24%, Opera by 10%, Internet Explorer by 06% and 1% members selected Safari as their favorite browser, as shown in figure 1. Users were further asked to share their opinion regarding various attributes of their selected choice, including installation, bookmark mechanism, crash, private browsing, plug-ins etc.

III. PRACTICAL TASKS

Few important tasks were selected and assigned to

participants to practically perform on all five top ranked browsers including Google Chrome, Internet Explorer, Mozilla Firefox, Opera and Safari.

- i. Bookmark given link of website
- ii. Open three websites in different tabs
- iii. Install theme of your choice
- iv. Delete history of browser

All participants performed these tasks by following oral instructions and with the help of handout having stepwise screen shots for each task.

IV. POST USAGE SURVEY

After having usage experience of all five selected browsers, users were ready to response comparative questions. Another questionnaire was given to collect post-usage data.

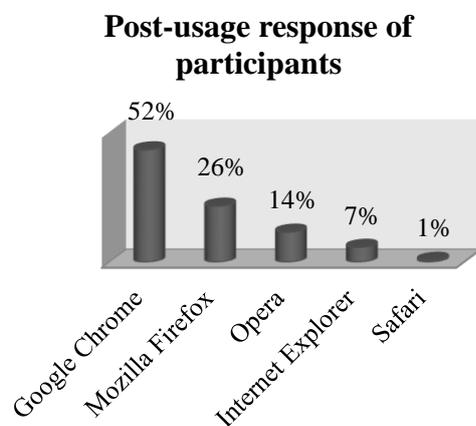


Fig. 2. Post-usage response by participants

The declined trained was observed in Google Chrome with 52% votes, on the other hand Mozilla Firefox grown to 26%, Opera enhanced its popularity to 14%, Internet Explorer bit move up by 07% and Safari remain same with 01% votes, as shown in figure 2. Statistics was gathered by asking choice of users from each browser on six major attributes, i.e. open time, bookmark mechanism, tab, theme, history and overall usage including look and feel.

V. EXPERIMENTAL ANALYSIS AND RESULTS

In order to observe the selection of web browser for a particular user, various experiments are performed in this work. All experiments are performed on configuration of Core i7 microprocessor having 3.40GHz speed with 4GB main memory and for internet connectivity, 4MB dedicated connection and windows 7 was selected as a operating system, results of experimental analysis are summarized in table 1.

TABLE I. Data collection by experimental analysis

Attribute	GC	MF	IE	S	O
Installation Time (Sec.)	129	186	299	167	73
Avg. Loading Time (Sec)	5.96	7.59	6.45	8.83	8.77
Memory Usage (MB)	1,468	1,241	1,752	196	1,413

Installation time of all browsers is compared, through stop watch. The experiment revealed that Google Chrome has taken 129 seconds, Mozilla Firefox 186 seconds, Internet Explorer 299 seconds, Safari 167 seconds and Opera has taken 73 seconds for installation, as shown in table 1. Also loading time is observed by selecting 50 websites related to different categories, it is found that average time to open website for Google Chrome was 5.96 seconds, 7.59, Internet Explorer 6.45 seconds, Safari 8.83 seconds and Opera consumed 8.77 seconds. Similarly, 50 websites were opened in a browser to observe memory usage by web browser, results denotes that Google Chrome utilized 1468MB of memory, Mozilla Firefox has used 1241MB, Internet Explorer has used 1752MB, Safari has used 196MB and Opera consumed 1413MB to accommodate fifty websites, as mentioned in figure 3.

Analysis of experimental data

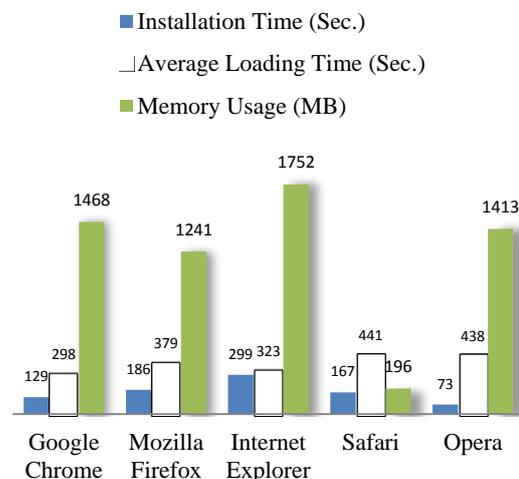


Fig. 3. Analysis of experimental data

After collection of experimental data, each browser is observed in perspective of compared features, it is explored that Opera is at top rank by taking least installation time and Safari got first rank in least memory usage among all contestants, while in these both attributes Google Chrome occupied second and fourth sports, respectively. Google Chrome ranked first in attribute of loading time.

It is obvious that mostly common users have focus on loading time that's why Google Chrome was choice of more than 50% participants.

TABLE II. Ranking of browser based on experimental analysis

Attribute	R1	R2	R3	R4	R5
Installation Time	O	GC	S	MF	IE
Loading Time	GC	IE	MF	O	S
Memory Usage	S	MF	O	GC	IE

Operating System Support: Support to be used with any of the operating system is major feature of browser and plays vital role in its popularity, selected browsers support their installation in different operating systems and some of the browsers come-up with by default in with specific operating systems. Table 3 is given shows detail, showing detail of browsers and their relevant operating systems:

TABLE III. Operating system support statistics

Operating System	GC	MF	IE	S	O
Windows	Yes	Yes	Yes	No	Yes
Linux	Yes	Yes	No	No	Yes
Android	Yes	Yes	No	No	Yes
iOS	Yes	No	No	No	Yes
OS X	Yes	Yes	No	Yes	Yes

Google Chrome has maximum support of selected operating systems categories among all other choices.

Bookmark: In Google Chrome bookmark mechanism is managed with option “bookmark”, toolbar allowed but major drawback found is when bookmarks are exceeded from toolbar they are added in menu and that menu add new bookmark at the end of menu which create difficulty for user to see recent bookmarks in toolbar. Opera also allows user to create not only customize folders for bookmarks but also few be default folders are available in bookmark manager to guide user regarding. Internet Explorer provides bookmark facility with separate menu in menu bar with the name of “Favorites”, bookmarked sites could be managed using that menu, but problem arises when elements of bookmark exceeds from screen of window, down arrow is provided to see newly added bookmarks which is allow creating trouble for users. Safari provides similar bookmark management methodology to Internet Explorer by providing separate menu with the name of “Bookmark”, also provides the functionality of creating customize folders also separate folder is managed by browser for imported bookmarks from other browsers. Mozilla Firefox offers distinct menu for bookmarks, instead of showing bookmarks at the end of menu, sub-menus are created e.g. Recently Bookmarked, which also help user to find bookmarks efficiently. All selected categories of web browsers provide various common features including backup, synchronize and so on. For backup, all bookmarks are exported to .html file by using bookmark manager and imported whenever needed. Synchronize feature facilitate users by creating harmony in bookmarks used by a person

on different computers or cellular phones, whenever user will update bookmark and history on computer, later on same data could be used on cellular phone by using synchronize feature, but sign-in is required to avail this facility.

By history management, user could allow or restrict browser from memorizing and storing user habits. Google Chrome and Opera manage history of browsing sites, downloading, cookies, passwords, auto-fill form data, etc in a single “History” option, where search option is available to search particular visited site and could delete any or all of the visited sites. Mozilla Firefox and Safari have separate menu for history management in menu bar, where recent history, previous sessions and history from the start is managed, few recent sites are displayed at the end of history menu, which affects privacy of user. Internet Explorer has one option is tools menu which could be used to delete history, and a side bar which could display history of required time period, it is comparatively more safe.

Tabs: When user try to close window having multiple tabs opened, Mozilla Firefox, Internet Explorer, Safari and Opera warn user before closing multiple tabs, while Google chrome and Internet Explorer provide the functionality of “Reopen closed tab”, so that user could open tab again closed unintentionally.

It is observed that it create problem for user when switching from one browser to another, as various changes in location of options creates hurdles for user and restrict him/her to continue with previous option. Improper help and unavailability of “Tooltip text” for various options are also hindrance for new user, only textual help without screen shots is also consuming too much time to understand the options.

VI. CONCLUSION

Comparison of five different web browsers is performed in this work. It is analyzed that in pre-usage and post usage part mostly users are only using familiar products and do not try other web browser options, but after practically using different choices of browsers, some of the users found less popular product like Internet Explorer, Opera and Mozilla Firefox more useful as compared to more popular like Google Chrome popularity. It is also observed that loading time is key attribute for success of any browser, users may compromise on memory utilization and installation time but loading time is very important aspect for them.

VII. FUTURE WORK

In future, this work could be extended to users, who are using internet through cellular devices. There is also wide scope to include variety of hardware devices, including tablet computers in further coming days. Research could be enlarged by adding some more other browsers and analysis of their key features.

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