

Importance of Website Optimization in Full-Stack Development

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

In the past few decades, web development has evolved rapidly. More software engineers are becoming full-stack developers as companies transition to the digital world. Full-stack development refers to the entire development process of an application, including front-end and back-end development. Front-end development refers to the parts of a web application that users can see and interact with, which is also known as client-side. Back-end development refers to the parts of a web application that users cannot see, which is known as server-side. Full-stack developers can use many front-end and back-end languages and frameworks to create web applications. Front-end and back-end development are interdependent and together they provide the foundation of functional web applications (Chauhan, 2022). However, as web applications become more complex, it is important to optimize front-end and back-end performances to improve user experience. This research paper will explore the importance of website optimization in full-stack development and how it affects user retention and conversion rates. Front-end and back-end optimization techniques will be analyzed using the Social Construction of Technology framework.

Overview of Social Construction of Technology

Social Construction of Technology (SCOT) is an STS framework that argues that technology does not define human action. Instead, human action defines technology. Supporters of SCOT argue that it is impossible to understand how technology is used without understanding the social and cultural environment in which it is used. In other words, to understand why a

technology is accepted or rejected using SCOT, its social context must be analyzed. Claiming that a technology is successful simply because it is the best is not enough according to SCOT. Instead, researchers must analyze what makes the technology the best, the reasons for defining criteria this way, and the stakeholders that defined the criteria.

Link Between SCOT and Website Optimization

The SCOT framework fits with the importance of website optimization in that it helps developers understand the role of social factors. When optimizing websites, developers must consider not just technical factors, but social factors as well. For example, demographics, user behavior, and accessibility. Demographics of the target audience of a website such as age, gender, and background will influence how users interact with the website. User behavior such as how long and how often users interact with different parts of the website can tell developers which sections are the most effective. Also, ensuring that a website is accessible to people with disabilities can increase user engagement. All these social factors affect which optimizations should be made to maximize the overall performance of a website. Additionally, SCOT can be used to understand all the different stakeholders involved in making and using a website and how their views may differ. By gaining a good understanding of these social factors, developers can ensure that they are making a successful website that addresses everyone's needs.

Why Should Companies Optimize Websites?

As the complexity of web applications increases over time, website performance becomes even more important. Website performance refers to the speed and availability of a website.

Speed involves how fast the website can be loaded after making a request in a web browser, whereas availability involves the percentage of time the website can be accessed (Low, 2022). Many factors can hinder website performance, such as heavy CSS and JavaScript use, bad server/hosting, poor coding standards, too many widgets and plugins, and hotlinking, which involves showing images that are hosted on another server (Chornyy, 2022).

Bad-performing websites are slow in loading and rendering content that causes users to abandon the site. According to statistics, users are more likely to abandon a website the longer it takes to complete tasks. For example, a one-second delay results in 7% of users abandoning a site. That number increases to 25% if there is a four-second delay. The percentage is worse on mobile devices, where 53% of users will abandon the page if it takes longer than three seconds to load. (Oldfield, 2020). Not only does website performance affect user retention, but it also affects conversion rates, which is defined as the rate at which users perform a desired action. Some examples include signing up for an account, making a purchase, or subscribing to a newsletter. When comparing site speed to conversion rates, a site that loads in one second has a conversion rate that is three times larger than a site that loads in five seconds. Additionally, a site that loads in one second has a conversion rate that is five times larger than a site that loads in ten seconds (Wiegand, 2022). Hence, faster loading sites have substantially higher retention and conversion rates.

The best way to improve conversion rates and user retention is to optimize the performance of websites. For example, a group of Pinterest developers optimized the front-end, network, and back-end of the application and as a result, the wait time was decreased by 40% and the signup conversion rate increased by 15%. Furthermore, the team now focuses on website performance to increase user growth (Meder et al., 2017). Another example can be seen through

Walmart.com who experienced a sharp decline in the conversion rate after load times increased from one second to four seconds. However, after optimizing the website, Walmart experienced a 2% increase in the conversion rate for every one second of improvement in load time (Everts, 2014). Hence, optimization of website performance has a direct influence on user retention and conversion rates.

Analysis of Front-end Optimization Techniques

Front-end optimization plays a crucial role in improving overall website performance and user experience. The main goal of front-end optimization techniques is to reduce the amount of time spent downloading resources. Ultimately, this reduces the time it takes to load the website. Many techniques can be used to reduce the number of requests made such as CSS and JavaScript minification, using Expires and Cache-Control headers, and using only external JavaScript and CSS files (Iliev & Dimitrov, 2014). Minification is a technique that involves removing whitespace and comments from CSS and JavaScript files to lower file size. By lowering the file size, the number of resources is decreased reducing the number of connections opened per page load. The Expires and Cache-Control headers are used to tell browsers that resources should be cached. By caching certain resources, browsers will no longer have to make requests to fetch those resources when loading the website until they expire. Another optimization technique that involves using only external JavaScript and CSS files allows the browser to cache these files reducing traffic and load time. Front-end optimization techniques can also be used to affect the progressive loading of a webpage by placing certain styles at the top of the page and certain styles at the bottom of the page (Iliev & Dimitrov, 2014). By placing style tags as high as possible, the browser can simultaneously render the webpage while other resources load. On the

other hand, by placing script tags at the bottom of the page, scripts will be executed after most resources are downloaded which is beneficial since most browsers are unable to execute scripts and download resources at the same time.

When it comes to the effect of the five front-end optimization techniques mentioned above, the size of the webpage was reduced by 13.5% on initial loads and 99.7% for reloads (Iliev & Dimitrov, 2014). Furthermore, the loading time of the page decreased by 29.7% for initial loads and 31.9% for reloads (Iliev & Dimitrov, 2014). It is evident that reducing the file size and reducing the number of requests required for external resources significantly enhanced the load time and website performance. Hence, front-end optimization is an effective way to improve overall website performance. As websites gain more users who are using the website concurrently, front-end optimization becomes more important.

When analyzing front-end optimization techniques via SCOT, many stakeholders are involved with varying levels of power and views. The website developers are the stakeholders with the most power as they have a direct influence over what optimization techniques are implemented. They want to maximize website performance to satisfy their clients and users. Another stakeholder with less power is the company executives as they can only influence developers to optimize certain areas of the website. Their goal is to maximize revenue by increasing conversion rates and user retention. Another important stakeholder with no power over the front-end optimization of a website is the end users as they have no control over what optimizations are made. They want websites to load as fast as possible otherwise they will become frustrated and abandon the site. By examining the different stakeholders involved in front-end optimization and their needs, it is evident that website optimization does not solely involve technical factors, it also involves social factors. Furthermore, understanding the social

context in which front-end optimization operates is essential for its success as it allows website owners to optimize their websites accordingly.

Analysis of Back-end Optimization Techniques

Like front-end optimization, back-end optimization also plays a crucial role in enhancing overall website performance. Different techniques can be used to optimize the back-end of a website such as query optimization, caching data that is frequently accessed, database optimization via indexes and normalization, avoiding time spent processing bad requests, and using lighter request and response formats (Pandey, 2022). These techniques will make accessing data much faster, increasing overall speed. As the amount of data stored increases and databases become more complex, back-end optimization becomes more important.

When analyzing back-end optimization techniques via SCOT, all the stakeholders involved with front-end optimization are also involved with the back-end. However, back-end optimization techniques have additional stakeholders. One additional group of stakeholders is the database administrators that manage and optimize the databases that store the website's data. They do not have as much power as the website developers; however, their goal is to create a database schema that can handle complex queries and large amounts of data ensuring maximum performance. Another additional stakeholder is the database provider that provides the database infrastructure used to store data. They have a similar level of power to the database administrators and their goal is to provide clients with secure infrastructure than can be optimized for scalability. Like front-end optimization, back-end optimization does not solely involve technical factors. The different stakeholders and their various goals highlight the

involvement of social factors. By understanding the technical criteria success is measured by according to all the different stakeholders, businesses can successfully optimize back-end performance of the website.

Discussion

The main goal of this paper is to highlight the importance of website optimization in full-stack development. Slower websites are more likely to experience higher rates of abandonment as users become frustrated waiting for the website to load. The best way to improve user retention and increase conversion rates is to optimize websites. Various techniques can be used to optimize front-end and back-end performance. Front-end techniques focus on reducing the number of resources that are loaded by the browser, whereas back-end techniques focus on reducing the complexity of databases and stored data. Both sets of optimization techniques significantly enhance load times and website performance. However, it is difficult to determine which techniques are the most effective. Hence, it is important to use various optimization techniques to maximize website performance. Furthermore, as shown by the SCOT framework, developers must also consider all the relevant social groups and factors with the technical factors to truly maximize website performance. Many stakeholders are involved in front-end and back-end optimization with varying levels of power and views such as the developers, company executives, and end users.

It is also important to consider potential counterarguments against website optimization in the context of the different stakeholders. For example, there may be a situation where company executives want to prioritize new features or design over optimization. Nonetheless, it

is still important to focus on optimization even when implementing new features since users will overlook the design of websites if they are not loading quickly. Another potential counterargument is that website optimization may not be cost-effective or achievable for all websites, especially smaller websites with smaller budgets or less developers. However, most of the techniques analyzed in this paper are low-cost optimization techniques that are not very complex. Despite their simplicity, these techniques can still significantly improve website performance.

Conclusion

This paper analyzes different techniques that can be used to optimize front-end and back-end performance of a website. Additionally, these techniques were analyzed using the SCOT framework to determine that there are many social groups involved in both front-end and back-end optimization who have different levels of power and views. Nonetheless, all the stakeholders have one common goal of improving overall website performance. Website speed has a direct effect on user retention and conversion rates for desired actions. Websites with fast loading times retain and attract more customers than websites with slow loading times. Also, quick websites improve user experience, making it more likely for users to make a purchase or sign up for an account. By understanding the technical and social factors involved in different front-end and back-end optimization techniques, companies will be able to prioritize different areas of development depending on the needs of the stakeholders, ensuring that resources are not wasted. Furthermore, website performance also influences conversion rates, revenue, user satisfaction, and search engine ranking, which all play a role in the overall success of a company.

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