Investigation and Adoption of Front-end Frameworks for E-commerce Development

Tamanna Sharma

Under Graduate Student, Department of Computer Science and Information Technology
Dronacharya College of Engineering, Gurgaon, Haryana, India

Abstract: *Web development, as the newest industry trend these days, leads the front-end development to currently heading at a tremendous speed that tends to make it difficult to keep up with. There are a variety of front-end frameworks on the market, including React, Angular, Vue, and jQuery. Finding the best framework for e- commerce and user friendliness has become a top priority in web development. This paper provides an overview of popular front-end frameworks as well as an outline of their benefits and drawbacks based on various factors.*

Keywords: Research Paper, Front-end frameworks, Web development, React, Vue, Angular. Javascript, Angular, E-commerce, Frameworks.

I. INTRODUCTION

Today, with the growing popularity of the internet, people are becoming more reliant on it for performing their daily life operations, like shopping, bookings, buying insurance, paying taxes, etc. Ecommerce is an unarguably effective instrument for vendors looking to boost sales and connect with new customers. Ecommerce is an undeniably powerful tool for businesses looking to increase sales and connect with new customers. This encourages entrepreneurs to set up businesses online and promotes the growth of web development. There were fewer tools available in the past than there are now.

To manipulate the DOM, developers only use JavaScript, HTML, CSS2, and web APIs. The most widely used markup language for creating web pages is HTML. Technologies like Cascading Style Sheets (CSS) and scripting languages like JavaScript can help. With only 18 tags, Tim Berners-Lee first mentioned HTML on the Internet in late 1991 with a document called "HTML Tags" [2].

HTML5 is the latest version of HTML that has many advanced features such as <audio>, <vedio>, <svg> (vector graphics), <nav> that allows developers to build their website. After two years of HTML, HTML 4.0 was released as the first specification to support CSS. Internet Explorer 3 became the first commercial browser to support CSS [4]. In 1995, Brendan Eich created Mocha, a scripting language that was later renamed JavaScript, in 1995. It was first released as a support for CSS and HTML extensions. [4]. Html defines the structure and content of the website, CSS styles and designs it, and Javascript controls the functionality.

Google released the Chrome V8 engine in 2008, which adequately addresses the issue of HTML5 bringing JavaScript to the forefront [3]. Prior to the release of Chrome V8, JavaScript's essential duty on a website was to work with Cascading Style Sheets (CSS) to build a great user interface and to handle some widely accepted script activities like form validation. [3]. Because Chrome V8's JavaScript engine is more than 56 times faster than any version of Internet Explorer (IE) , the Chrome V8 appearance redefines JavaScript [3]. Traditional web browsers typically compile JavaScript by interpreting byte-code and compiling the entire web project to generate code, which is then executed from a file system [3]. Therefore, their JavaScript runtime is considerably longer than that of compiled languages such as Java and C [3]. The optimised solution for the V8 engine makes use of inline caching technology to boost performance without the need for traditional compilation. [3].

JavaScript is the most popular client-side scripting language. Over 80% of websites use a third-party JavaScript library or web framework for their client-side scripting [5]. JQuery was one of the earliest library of JavaScript. Facebook created the React library for its website and later released it as open source; other sites, including Twitter, now use it. Similarly, the Angular framework developed by Google for its websites, including YouTube and Gmail, is now an open source project that others can use. [5].

II. FRONT-END FRAMEWORKS

JavaScript is the most popular language in the field of Front-end development. There are a number of JavaScript frameworks available. The information is gathered from various platforms in order to identify the most popular front-end frameworks.

Fig 1. NPM Downloads since 2016 [6]

	Angular	React	Vue
Downloads	2.3 million	9.2 million	2.2 million

React.js is the most used front-end framework nowadays, as shown in Figure 1. It has the most downloads yet is ranked second in terms of starred frameworks on Github, where Vue is first [6].

Fig 2. GitHub Most Starred Front-end Framework till 2018 [7]

Framework	Angular	Vue	React
Star	59,330	124,609	119,474

Based on the above statistics, VueJS is most starred front end framework on GitHub. It is one of the fastest evolving framework for progressive web apps. There is also a shorter and easier learning curve. It is simple to grasp Vue.js concepts if one is familiar with HTML, CSS, and JS. Another reason could be that, Vue is developed as a community and developers [7].

2.1 React.js and React Native

Jordan Walke, a Facebook software engineer, created React after releasing an early prototype called "Fax.js." [8]. Its ability to deconstruct a complex interface enables users to focus on individual components, making it a more powerful framework. The main goal of React.js is to achieve the best possible rendering performance [9]. It is an open source JavaScript framework used for creating single-page web applications and reusable UI Components, whereas React Native builds cross-platform applications. It uses MVC approach to create applications.

Fig.3 React components lifecycle [10]
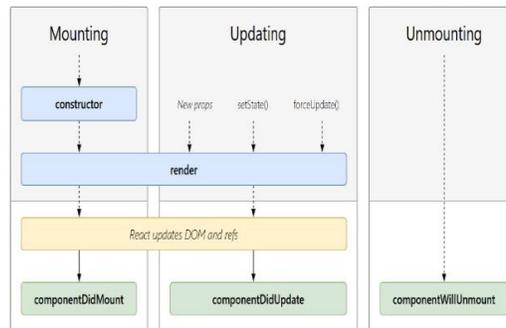
React requires extra libraries as it deals with state management and renders it to DOM. Its most notable feature is the Virtual DOM, which updates and syncs with the real DOM. React constructs an in-memory data- structure cache, computes the differences, and afterwards effectively upgrades the browser's expressed DOM [8]. It is an excellent framework for those who require a stable platform capable of handling heavy traffic. [1]. Whatsapp has officially released ReactJS to develop user interfaces from Facebook [11].

With React, it's easy to update data that changes over time. It is a component-based framework that facilitates the development of reusable and testable code [11]. React's ability to create logic in front-end projects is powerful and, at the same time, quite easy to use [12].

2.2 Angular 1 and Angular 2

Angular is an open-source typescript based framework for developing single-page web application. It is led by the Google Angular Team, as well as a community of individuals and businesses [13]. The MEAN stack, which includes the MongoDB database, Express.js web application server framework, Angular (or AngularJS), and the Node.js server runtime environment, uses Angular as the frontend [13]. Angular 2 is a total redesign of Angular 1, with improved performance. Data binding and property binding both are supported by Angular 2.

HTML properties can be bound to component class properties to control the DOM. Angular comes with a number of built-in modules, such as the http module [14]. Figure 4 depicts how the building blocks interact to form an angular module, which is then combined to form an angular application [14].

Fig. 4 Official Angular 2 documentation [14]
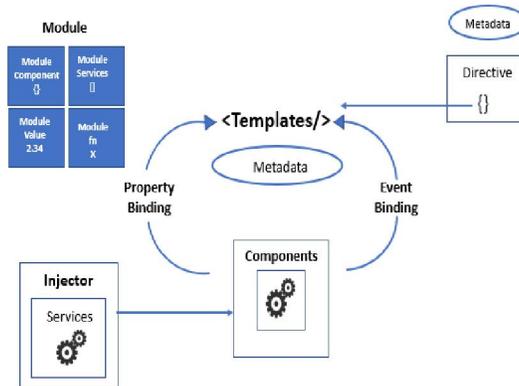
With traditional template systems, the changes to the model does not automatically reflect in the view. It will require code from developers. However, with AngularJS, the template is first compiled in the browser, resulting in a live view. Any changes to the view are reflected immediately in the model, and any model changes are propagated to the view. This is the concept of two-way data binding used in Angular 1.

Fig. 5 Angular1 Two-Way Data Binding [15]
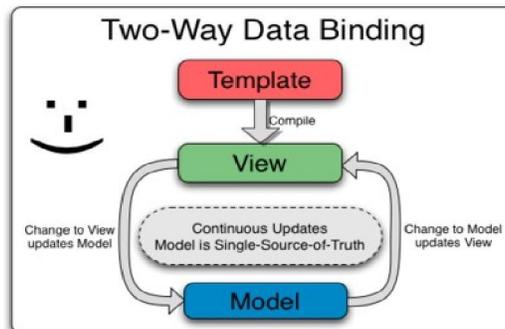
Angular 2 is a new framework that allows developers to concentrate on developing JavaScript classes. With Angular 1 the distinctions between controllers, services, factories, providers, and other potentially confusing concepts must be kept in mind. Angular is a great choice to develop mobile or web apps. Most essential features, such as two-way data binding, are enabled by default, minimizing the amount of code [1]. By defining them as external elements, the components are decoupled from their dependencies [1]. The dependency injection makes components reusable and manageable [1]. With advantages, some flows are also there. Some of them are: Dynamic apps occasionally fail to perform well due to their complex structure and size. To build applications with limited scopes, you will not be able to use the resources that Angular provides.

2.3 Vue.js

Vue, like Angular and React, is an open-source front- end framework that is used to create single-page applications. Evan You drew inspiration from Angular and React, combined the best elements of both of these frameworks, and created Vue [16]. Vue.js features an incrementally adaptable architecture that focuses on declarative rendering and component composition [16]. The core library is focused on the view layer only [16]. Version names are often derived from manga and anime, most of which are within the science fiction genre [17]. Vue users can use template syntax or choose to directly write render functions using hyperscript either through function calls or JSX [17]. Vue uses an HTML-based template syntax that allows binding the rendered DOM to the underlying Vue instance's data [17]. Vue provides an interface for changing what is presented on the page based on the present URL path.
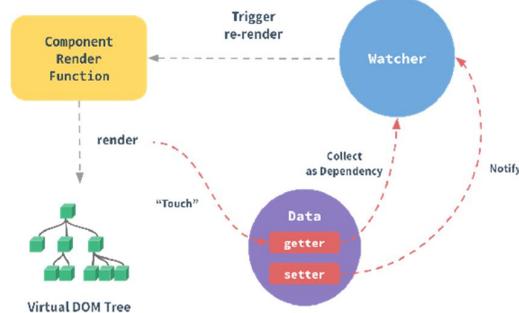
Fig.6 Reactivity in Vue.js

Fig.6 illustrates the working of rendering feature. On the first render, if a data property is accessed, its getter function is called. Which (Getter) then calls the watcher to get the data property as a dependency [18]. Any properties collected/tracked as dependencies during the component's render are recorded by the watcher. Later on, when a dependency's setter is triggered, the watcher is notified and the component re-renders and updates the view [18].

Vue has grown to be the most popular framework. Some of its features are responsible for its popularity. First is that, it maintains a virtual DOM that finds which elements to update without rendering the entire DOM to update any piece of information and render it on screen [19]. Another advantage of DOM manipulations is two- way data binding, which makes updating and tracking related components easier [19]. One more advantage is that Vue can be used in almost any project due to its components and lightweight nature. Finally, single-file components are used to reduce the page's initial loading time.

III. ADOPTION OF FRONT END FRAMEWORKS

With time, lots of new front-end frameworks are evolving. There are many popular frameworks available today. React, Vue, and Angular are some of them. Different frameworks have different properties and characteristics. Choosing the right technology stack is critical for the success of a project. There are many reasons why some companies prefer one technology over another and some of them are as follows:

3.1 Flexibility

How many options are there for configuration and how easily they can be customised is what defines the flexibility of the frame-work. Whether the framework makes decisions about state servers, routers, and handlers on its own or gives you the option to do so [20]. Although static frameworks are simple to set up and run, you may run into problems with modules. There are, on the other hand, frameworks that allow you to switch between components as needed [20]. Based on what This factor must be considered when deciding on the type of application to be developed. For example, Angular 2 offers good options in this regard, as it's easy to get it up and running very quickly [20]. React and Vue, on the other hand, provide the flexibility to swap components when required [20]. Vue.js has grown in popularity since its initial release, and the reason appears to be its flexibility.

3.2 Performance

The overall performance of the framework is one of the most important factors to consider when deciding on the best framework. The framework or library that a web app uses determines its performance. A JS framework's performance can be measured in terms of its scalability, robustness, and integrability. However, two factors are considered here: the DOM and the JS Framework Benchmark [21].

DOM:- React applications maintain a virtual DOM in memory that is synced with the real DOM. Consequently, it becomes faster and more efficient. Vue: Because it employs a variety of algorithms to avoid re- rendering the entire DOM, whenever the document is changed or updated. The virtual DOM is more efficient than the traditional DOM. Angular works with a real DOM, which means that when a single change is made, the entire DOM is refreshed. This slows down the process.

JS Framework Benchmark: In terms of memory requirements and boot time, Angular and React surpass Angular. Angular is still a preference for many developers to create large-scale SPAs [21]. When it comes to startup time, due to the small

size of vue, it is drastically reduced. As compared to React and Angular. Vue is most efficient.

3.3 Adaptability to the Teamwork

To enhance an organization's chances of developing effective software systems that can adapt to changing business needs, the framework must be appropriate for the group's work.

React doesn't implement the MVC structure. The MVC is a structure splits the problem into 3 parts: data (Model), presentation (View), and actions during user intraction (Controler) [22]. Without the division, teams cannot be implemented simultaneously, which in turn can significantly complicate the development process and make it time-taking. Angular is a great pick for developers as it uses the MVW architecture, which separates the application logic from the user interface [22]. Consequently, it offers a modular solution that is used by multiple development teams simultaneously with the same data. Vue, on the other hand, is an MVC framework. Furthermore, it provides a template for developers in the form of directives and filters [23]. This results in more readable code, which reduces the likelihood of bugs [23].

3.4 Popularity

The premise for selecting the best suitable framework for any organisation is popularity: It will be easier to obtain talents, resources, and so on for a well-known framework. The popularity of a framework is determined by a variety of factors, including its advantages over native language Javascript, market demand, frequent upgrades, ability to solve problems, and so on [21]. The ability to solve problem is found to be more in relatively new technologies. Angular 2+, for example, is built with more precise and advanced ways to tackle technical challenges than Angular.js.

Fig.7 State of Web Frameworks in 2021 [21]

	React	Angular	Vue
Popularity %	35.9	25.1	19.1

Fig.7 shows that React and Angular are the most widely used and popular frameworks. If a framework is not widely used, it means that it has a small number of developers. It is possible that businesses will become bogged down in their search for them. This could be problematic for the company.

3.5 Advanced E-Commerce Solutions

Frameworks such as Angular.js, React.js and Vue, have been used by e-commerce platforms all over the world. React isn't just used on Facebook, it's also used on Instagram and WhatsApp. Due to the virtual DOM implementation and other rendering optimizations, React code runs very quickly. Its features make it a powerful framework for client-side applications [23].

Angular is an expanding framework which can change static HTML pages into dynamic HTML pages. It enables intelligent algorithmic operations such as HTML template auto-completion [24]. The one-way data binding feature reduces the risk of app failures, and the MVVM architecture allows developers to work independently on the same app section while using the same data set [24]. It was designed specifically for large- scale project scalability. VueJS focuses on the view layer and can be seamlessly integrated into large projects. Because of its small size, it is much faster and more flexible than other frameworks.

Large reusable templates for multiple codes can be created quickly with Vue [24]. It can be used to create both simple and complex apps with advanced interfaces. New parts can be added to the code without affecting the overall system [24].

IV. CONCLUSION

According to various studies and polls, React.js and Angular.js are the most widely used of the three. The most popular framework in 2019 was React, which was followed by Angular and Vue. Angular, React, and Vue are all actively developing frameworks. The key is to choose a technology that suits the true needs of the company. The popularity of a framework, flexibility, futuristic support, adaptability for teamwork, performance in terms of DOM manipulations, startup time and memory allocation etc. should be taken into consideration while adopting a framework.

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