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UMM AL-QURA UNIVERSITY



Research project

Comparative CSS frameworks

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Abstract

The CSS frameworks are ever hyped and in demand among web developers. Over years CSS frameworks have grabbed the attention of web developers due to their dynamic features which facilitate web developers to design websites efficiently and quickly. However, due to the variety of CSS frameworks available in the market, it is quite difficult to determine which framework is best suited to design your web pages for the required project. Developers' preferred choices for web page designing, Bootstrap, Foundation, Skeleton, Bulma, and Tailwind CSS have been discussed in this research.

This research is conducted to well analyze the pros and cons of CSS frameworks based on their profound features. A comparative analysis is presented based on four performance measures that are popularity and support, framework size, supported browsers, and responsive designs. This helps developers while selecting the best option available for the required project according to their knowledge background and work experience.

It probably is a sweeping statement to say the particular framework stands out among the rest of the frameworks because each framework is different from the other concerning their difference in characteristics.

Tailwind CSS however shows the best choice by highly skilled and experienced developers due to its suitability and compatibility while the bootstrap CSS framework is popular for responsive page designs. It facilitates developers to



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complete their projects at high speed because it has built-in templates and components that are ready to use. Also, it does not require in-depth knowledge of programming and skills. It is user-friendly and easy to understand.

Keywords— CSS frameworks, responsive design, Bootstrap, Tailwind CSS

الملخص

إن أطر CSS متداولة ومطلوبة بين مطوري الويب. على مدار سنوات ، جذبت أطر CSS انتباه مطوري الويب نظرًا لميزاتها الديناميكية التي تسهل لمطوري الويب تصميم مواقع الويب بكفاءة وسرعة. ومع ذلك ، نظرًا لتنوع أطر عمل CSS المتوفرة في السوق ، من الصعب تحديد إطار العمل الأنسب لتصميم صفحات الويب الخاصة بك للمشروع المطلوب. تمت مناقشة الخيارات المفضلة للمطورين لتصميم صفحات الويب و Bootstrap و Foundation و Skeleton و Bulma و Tailwind CSS في هذا البحث.

يتم إجراء هذا البحث لتحليل إيجابيات وسلبيات أطر CSS بناءً على ميزاتها العميقة. يتم تقديم تحليل مقارنة بناءً على أربعة مقاييس للأداء هي الشعبية والدعم وحجم الإطار والمتصفحات المدعومة والتصاميم سريعة الاستجابة. يساعد هذا المطورين أثناء اختيار أفضل خيار متاح للمشروع المطلوب وفقًا لخبرتهم المعرفية وخبراتهم العملية.

من المحتمل أن القول إن إطار العمل الخاص يبرز بين بقية الأطر لأن كل إطار يختلف عن الآخر فيما يتعلق باختلافهم في الخصائص.

ومع ذلك ، تُظهر Tailwind CSS الخيار الأفضل من قبل المطورين ذوي المهارات العالية والخبرة نظرًا لمدى ملاءمتها وتوافقها بينما يشتهر إطار عمل CSS bootstrap بتصميمات الصفحات سريعة الاستجابة. يسهل على المطورين إكمال مشاريعهم بسرعة عالية لأنه يحتوي على قوالب ومكونات



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مدمجة جاهزة للاستخدام. أيضًا ، لا يتطلب معرفة متعمقة بالبرمجة والمهارات. إنه سهل الاستخدام
وسهل الفهم.

في نظام إدارة كرسى البحث لعمادة البحث العلمي. يهدف النظام إلى تمكين وكالة الكراسى البحثية من
إدارة كراسيها ومراقبة أنشطتها الفنية والمالية. وبناءً على النتائج والمعايير التي تمت مناقشتها ، تم تحديد
إطار عمل Tailwind CSS لتصميم واجهة المستخدم يتضمن دليل لتثبيت Tailwind CSS وتطبيقها
داخل النظام.

1. Introduction

The objective of this research is to facilitate web developers to answer their concerns about CSS frameworks. Available CSS frameworks provide the same functionalities but having different features and characteristics. Developers often face problems while selecting the optimal framework for their projects since each framework has different characteristics and requirements. This work is done to gauge the performance and features of CSS frameworks to help developers to select the best and appropriate frameworks for their projects. Analyzing and researching for the best available frameworks for designing web pages and then comparing those frameworks requires the developer's most precious time and effort. This research helps web developers to save their time and efforts as it provides a complete analysis and comparison of the most popular CSS frameworks and facilitates developers to determine the most appropriate CSS framework for their required projects.



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Many programmers and app developers rely on several Design Architectural Patterns to build their app. These patterns have appeared in recent times, especially in the field of application development such as MVC.

1.1 MVC:

Architectural Design Patterns are trending approaches followed now days by industry leaders. These models such as MVC have been adopted by application developers as well. The idea behind MVC is to separate logic from view. In other words it handles user interface and business logic program separately. The view layer uses HTML, CSS and JavaScript technologies. MVC stands *for Model-View-Controller* is a software design model adopted for developing user interfaces. MVC breaks down an application into three main and logical components: the model, the view, and the controller. MVC is frequently in practice development framework used to create scalable and extensible projects. MVC is also considered an industry-standard in web development. The MVC helps to focus on catering to specific development aspects of an application. The *model* component handles all operations-related data that has been exchanged between view and controller components. The *view* component is responsible for UI (User Interface) logic. And *controller* is used as a request handler. Controller receives request from view and returns the appropriate view as a response. The controller works on back end while view as a front-end.

The *View layer* of MVC architecture handles the GUI (graphical user Interface) of the application. It presents what should be display on the user screen and application interface. View layer use HTML, CSS, and JavaScript technologies



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for designing user interfaces. View is the GUI of an application that facilitates the end users to communicate with application. Users use view and raises HTTP request. View receives requests from users and communicates with the controller and model. The View of the web pages is designed using HTML and CSS tools. CSS facilitates the developers to format HTML pages and styles them.

1.2 CSS:

CSS the Cascading style sheets are used to format HTML pages. HTML pages are web pages written in HTML language. CSS decides the format of HTML pages and how they should be displayed on the web. CSS style caters to the look and feel of the web pages, including page background, font size, color and texture, animation, and special effects Temere, B. (2017). CSS can be installed in any HTML project in anyways. Such as

- ❖ Inline style sheet
- ❖ Internal style sheet
- ❖ External style sheet.

Inline style sheet refers to the direct installation of CSS in HTML. Internal style refers to adding CSS by using the head tag in an HTML document. While external style sheet is the third way of installing CSS by an external source or by importing files locally Muslimin, I. (2017).



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1.3 CSS Frameworks:

Creating web pages from scratch using HTML is time-consuming and requires a lot of effort. It eats up a lot of project time and consumes developers' efforts. CSS frameworks come in handy and optimize the developing process. It saves both time and efforts of developers and increases the overall productivity of the project. Also, CSS frameworks are compatible and updated so it also increases the efficiency of the site. The web browsers have new updates now and then concerning their new extensions and supported libraries and mostly CSS frameworks support and adapt those changes and variations. This improves the overall efficiency of the websites and keeps sites up to date. Most frameworks are open-source and freely accessible to the developers that enhance the quality and efficiency because a lot of developers share their knowledge and experiences which helps other developers in their work (Laaziri, M., Benmoussa, K., Khoulji, S., Larbi, K. M., & El Yamami, A. (2019). There is a lot of room available for customization as well for the developers while using frameworks. There are three types of web pages static, dynamic, and responsive. Static pages are easier to create and maintain as they are fixed and simple. They cannot be changed in terms of their content and user. Dynamic websites contain dynamic web pages and are real-time generated. They receive information and provide results depending upon the users' requests. Dynamic websites may associate with some database etc. While responsive are dynamic websites but additional features of optimization. Responsive websites are built with percentages instead of exact measurements. The idea behind these



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responsive web pages is to make them optimal for all screens such as tablets, smartphones, etc. Some responsive web page design developers may find it difficult to design them, so there is a predefined framework to support developers in designing pages easily and professionally.

The frameworks are useful for the developer for several reasons

- ❖ To significantly shorten the time due to the use of ready-made libraries.
- ❖ It is easy to deal with because there is an active developer community that supports each other.
- ❖ Pages designed using these frameworks are supported on most popular browsers.
- ❖ The presence of documentation that shows how to install and use the framework is one of the most beneficial reasons for the developer.

As each framework has many characteristics and many different cons, the developer faces a problem, what is the best framework? And what is the most appropriate framework for the current project? To help the developer choose the best and most appropriate framework a comparative study has been done between the most popular frameworks. And analyze the characteristics of each to make it easier for the developer to determine the most appropriate framework for the project. Bring up and evaluating the popular frameworks and conversing their pros and cons of each framework and then associating the frameworks can help developers to inferior the most appropriate and best framework according to the requirements of the project and the developer's experience. Hence, this



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work analyzes and compares the most excellent CSS frameworks and their features to assist the developer decide the foremost appropriate framework and why the system was chosen.

In the remainder of this paper, Section (2) gives the overview of the literature of some state-of-the-art frameworks in this field, and then in Section (3) methodology of this research work is presented. The methodology used to define the appropriate frameworks. In section (4), a comparison of CSS frameworks at different aspects is presented .Section (5) discusses the findings as a result of analysis and comparison of frameworks. Section (6) implements and designs a webpage with the Tailwind CSS framework. Finally, the summary is included at the end as a conclusion.

2. Literature Review

2.1 CSS Frameworks:

There are nearly twenty frameworks ready for use by developers. Several techniques are used to test responsive pages.

2.1.1 Bootstrap:

Twitter introduced Bootstrap and nowadays it is the most preferred choice of developers in the web community. It is the most popular HTML, CSS, and JS library for web designing and development. Bootstrap provides quality features and among them is responsiveness. Bootstrap creates responsive websites which means the elements are organized depending on the width of the user screen or the browser. This framework uses 12 columns and allows 4 types to display



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different screens. It includes other components such as forms, buttons, progress bar, and Navbar. The bootstrap provides more customization than predefined build-in components. It provides more space for the developer for customization according to his requirements. It provides Js components for dynamic web pages, less preprocessor dependency and more room for customized style for components (Laaziri, M., Benmoussa, K., Khoulji, S., Larbi, K. M., & El Yamami, A. (2019).

Bootstrap is way easier, to begin with, because it does not require a lot of skills and knowledge to start with. That is why it is the best choice of its new developers to start their learning and mast their skills. Bootstrap contains components such as buttons, alerts, progress bar, and dropdown menus. It provides enough components to developers to start from designing interfaces.

Additionally bootstrap provides SASS and LESS features. SASS stands for Syntactically Awesome Style sheets while LESS is for Leaner CSS Style sheets and both are CSS preprocessors. These special extensions make designing easier and enjoyable. These extensions are compiled into CSS to acknowledge by modern browsers. Also Bootstrap provides support devices of display resolution from 480 pixels to 1200 pixels. Bootstrap uses a 12-column grid system for vertical representation.-Bootstrap has more reach to the developers as compared to another framework (Jain, N. 2014). It provides customization for components by assigning predefined variables (Temere, B. 2017).



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2.1.2 Foundation:

The foundation is another most in-demand CSS framework in web development. The founder of the Foundation is ZURB. Foundation is an advanced responsive front-end framework for designing user interface tools like HTML and CSS. Foundation provides the feature of integrating or merging the old features with the latest features of projects. The Foundation framework uses a SASS preprocessor that uses predefined variables of CSS (Laaziri, M., Benmoussa, K., Khouliji, S., Larbi, K. M., & El Yamami, A. (2019).

The Foundation framework is the second most in-demand and popular framework. It is adopted by professionals who can better deal with the design files from scratch because it does not contain UI components. The foundation uses Ruby and SASS, SCSS for this purpose. At the same time Foundation considered as a most difficult and deep framework when compared to bootstrap and Skeleton (Pasha, M. R. (2015). This framework is suggested for training projects, business domain and it has a relatively more reach than other frameworks (Jain, N. 2014). Foundation is designed with a Mobile-first feature which means it is designed initially for mobile and tablet screen web pages and then reconfigured for large screens. Bootstrap also provides the same feature. Foundation syntax is easier to understand and code (Temere, B. 2017).

2.1.3 Skeleton:

The next framework to discuss here is the Skeleton. Skeleton framework is a lightweight and easy-to-code framework. It is smaller in size and limited function framework so suggested for smaller projects. Skeleton is a responsive



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mobile-first 12 column fluid grid, consisting of rows and columns. Skeleton supports devices with a resolution of 960 pixels (Pasha, M. R. (2015)). Skeleton is fully functional and used for all the latest browsers including the SASS and LESS supported extensions.

2.1.4 Bulma:

The Bulma is a free and open-source CSS framework. Like the Skeleton framework, it is also a lightweight framework. It provides ready-to-use front-end components which can be integrated to design responsive web interfaces. The amazing feature of Bulma is the Flexbox support. It makes the use of Flexbox easier. The worth mentioning feature of Bulma is the customization feature using SASS and variable (Thomas, J., Potiekhin, O., Lauhakari, M., Shah, A., & Berning, D. (2018)). The Bulma framework is purely CSS-based and supports CSS files only without the need for Js files. It is the fully modular and responsive framework provided with 9 different sizes, including 5 basic and 4 additional sizes (Harsch, N. 2019).

2.1.5 Tailwind CSS:

Tailwind CSS is another worth mentioning web development framework. It is a utility-first responsive CSS framework. It provides the developer full privilege for customization and is relieved from bounding previously build designed. This framework works on the minimal level of CSS tools and classes to build their complete single design. It does not provide any pre-defined components. Tailwind is an advanced framework for using CSS features without leaving



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HTML behind. Over the past few years, Tailwind CSS has gained immense popularity in the web community and is gaining attention from many designers and developers. The Tailwind CSS framework uses specific constraints where classes' utility represents CSS style definitions.

Tailwind is also welcoming for new developers who are keen on learning tailwind CSS and mastering it. In other frameworks, the inexperienced developers face challenges for dealing with semantic classes, tailwind takes care of this problem by introducing Tailwind CSS agreements, which leads to better communication between teams during the developing process. Classes with new semantic cannot be overwritten by predefined classes. Rather they are separated from utility classes as they are written in HTML. This helps in maintaining the consistency of the design. This methodology is very effective as the effects are only activated directly within the current markup HTML and not in CSS files in classes, in which a change in them may lead to changes in other related files. If the developer requires verification of the current file only, there is no need to verify through CSS files (Klimm, M. C. 2021). Tailwind is a low-level CSS framework to help develop custom user interface styling very fast.

Tailwind CSS helps support 5 different sizes and styles according to different screen sizes. The smallest size is the mobile-first breakpoint which by default is the active breakpoint. So when adjustment is due it is modified in that default main point and then all the larger points Hernandez, E. (2020).



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2.2 Responsive Design:

Responsive web pages are referred to as web pages that are designed by percentages instead of exact measurements. Percentile values are used instead of static values to design components of the web page. Mostly responsive designs are made for smartphones and tablets and then these designs are reconfigured for larger screens. Initially, it is designed for one page but now it is possible to design one page with multiple styles (Jain, N. 2014).

2.3 Related Work:

A thorough study of state-of-the art literature is conducted in order to analyze the performance measures for CSS frameworks. Many papers discussed and compared CSS frameworks according to different criteria. According to *Nadine Harsch* the price and the license are all free and can be used for commercial and personal use, which means there is no preference for one of them over the other. Moreover, rated Bootstrap as the best because it uses Less and Sass for some versions. Semantic UI comes second because it supports the use of LESS, with the ability methods to Sass. Materialize and Bulma only use Sass, so they are weaker than previous frameworks. The best framework of Responsive Design support is the Bulma framework because it offers 9 different sizes, 5 basic and 4 additional ones. Second, the Bootstrap framework provides 5 different sizes. Third, the Materialize framework provides 4 different sizes, while the worst is the Semantic UI framework, where there is no clear information related to the sizes of the screens. In the field of performance and speed, evaluation experiments were carried out using each framework separately. Calendar



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content was downloaded quickly from everyone if they were all with the same high efficiency. The Materialize framework showed the superiority of the Materialize framework for its support of many versions, coming second and third frameworks for Bootstrap and Semantic UI, for supporting modern browsers only for different operating systems. Finally, Bulma supports modern browsers only, without the old ones. Regarding components provided Bootstrap is best at providing 24 components, then Semantic UI with 16 components, then Materialize with 11 components, and lastly Bulma with 7 components only. Bootstrap provides many useful lessons with great content and in different platforms, so it is best that Materialize comes second by providing many lessons with a search feature to facilitate the provision of information, this feature is not available in the Semantic UI and Bulma frameworks, so each of them comes third and fourth, respectively. Bootstrap firstly provides its own themes and how to use them, as well as ways to buy and sell themes, as well as Materialize provides ways to buy and sell themes without explaining their use, so it comes second, as for Semantic UI and Bulma they provide template themes only and there is no way to buy and sell them.

Community is available for all frameworks the means of communication Semantic UI and Materialize offer Gitter communication so they are better at community support to a lesser degree Bootstrap allows Internet Relay Chat. Finally, Bulma does not provide any means of communication at all. Regarding Developer support, the Bootstrap comes first where the GitHub repository is active and provides a blog for developers. Second is Materialize, where the



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GitHub repository is active and provides a Gitter communication feature. Third is the Bulma where the GitHub repository is active and provides a book with explanations. It provides an email or Gitter communication feature to help developers. The disadvantage is that the GitHub repository is not active. Bootstrap is the easiest to use and suitable for beginners' developers. Semantic UI and Materialize are aimed at experienced developers and not suitable for beginners. Bulma is for experts only and does not provide ready-made JavaScript functions. The expert must write the complete code. All of the frameworks are easy to install, except Semantic UI, it has many problems and it didn't work very well Regarding the Integration, all are easy in Integration, except Bluma. There are some difficulties. Bootstrap and Materialize is the best overall (Harsch, N. 2019). *Majida Laaziri* says bootstrap provides the option to the developer choose Less or Sass preprocessor while Foundation do not. The bootstrap framework is best option rather than Foundation when developers need more multiple options to support many browsers. The Foundation framework support direction right to left this advantage is very appropriate to pages used different languages. The bootstrap framework is best option rather than Foundation when developer's need more multiple options to select themes. The bootstrap framework is suitable more than Foundation. for when the developers has more questions because the bootstrap have a large community support to answer this questions. The Foundation framework is better than bootstrap In case developers want easy used when environment installation or during development not required extra library To use the features like



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responsive pages (Laaziri, M., Benmoussa, K., Khouilji, S., Larbi, K. M., & El Yamami, A. (2019). *Befekadu Temere* says Bootstrap and Foundation have many common features: they both rely on the SASS CSS preprocessor. One of the most important comparison factors between Bootstrap and Foundation is the web page loading speed, which is the time it takes to fully load the pages including the source files. In (Temere, B. 2017) compared the download speed with 3 tools, the first of which is the Pingdom tool, as it showed that the entire download speed of the particular page reached (353ms) for the Bootstrap framework, while the Foundation framework reached (358ms) for the same page and the same tool, which means the superiority of the Bootstrap framework. The other tool is GTmetrix, where it compares a page size of 1.3 megabytes and a download speed of 1.2 seconds for Bootstrap with another page of size of 2.54 megabytes and a download speed of 4.2 seconds, and it is clear that the Bootstrap framework is superior. Page Speed Insights tool, which showed the superiority of the Bootstrap framework over the Foundation framework on both sides of smart devices or office devices, as the percentage of efficiency of the page designed under the Bootstrap framework reached 53 percentage calculator for smart devices and 55 percentage calculator for the office, on the other side, the efficiency rate for pages designed under the Foundation framework was 50 percentage calculator for smart devices and 54 percentage calculator For the office. Bootstrap and Foundation give the ability to download all package or specific part. They all have the element return feature and use the grid system. According to GitHub and Stack Overflow, the



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Bootstrap framework outperformed Foundation by the number of stars by nearly 4 times and the number of downloads by nearly 10 times in relation to GitHub. As for the searches within StackOverFlow, the results for Bootstrap were 3 times the Foundation, which means that Bootstrap is more popular than the Foundation (Temere, B. 2017).

The *Sneha, Dashrath* compared file size and download speed: In UIkit, the js files are larger than the bootstrap framework because it focuses on the code instead of the CSS files. Whereas, UIkit is smaller than Bootstrap in CSS file size. Therefore, page loading speed designed by UIkit framework is better than bootstrap pages. It also provides better styles than bootstrap framework. One of the features that distinguish the UIkit framework from the bootstrap framework is that it provides an autocomplete code while typing feature. It can be said that the UIkit framework is less common, but more efficient and professional than the bootstrap framework, and it is also best for large and small projects alike. Bootstrap and UIkit framework structure is similar easy, legible and understandable to developers (Velankar, S., & Mane, D. (2017)).

3. Methodology

This section describes the procedure which is adopted to compare the popular CSS framework from the last few years including Bootstrap, Foundation, Skeleton, Bulma, and Tailwind CSS. The comparison of these frameworks is based on some features derived from the literature review. Performance criteria are based on these features. The popularity and support, framework size, supported browsers, and responsive design supported by frameworks. These



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features are selected based on their number of occurrences in the literature review. Analysis of characteristics of each framework, exploring their pros and cons, and comparing it to determine the most appropriate framework based on the type of project. Results are discussed concerning each framework and their key points are highlighted. A step-by-step guide is provided to Tailwind CSS and also login page is designed with the help of that Tailwind CSS as a form in the end.

4. Comparison Popular CSS Frameworks

4.1 Popular and Support:

The latest trends can play a very important in calculating the popularity and support of the There are several factors for gauging the popularity and supporting the framework, including interaction in the GitHub platform to measure popularity or last commit to provide support by the framework. The second factor for measuring popularity is the number of Stack Overflow topics for this year and the last factor is the Google trend to determine the percentage of searches within Google.

The statistic showed a great advantage for the bootstrap framework with 149k stars inside GitHub, and the latest update was found this week also the most in the side of Stack Overflow topics with 25,823 topics. And a rate of more than 75% in Google searches compared to other frameworks. The Bulma framework comes second in terms of the number of likes inside the GitHub, with 43K likes, the last update of this month, while the fourth in terms of Stack Overflow



topics, with 729 topics, and third in Google searches. Tailwindcss, which got second place in several likes in GitHub with 38.6K and last update this week and second in several Stack Overflow topics while finished fourth in Google search. Foundation framework comes fourth with 29k star likes inside GitHub and the latest update last month with several topics inside Stack Overflow 866 topics. Skeleton framework finally comes with 18.2k star likes inside GitHub and the latest update last month with 160 topics inside Stack Overflow. Altogether the popular Bootstrap framework can be arranged first and Tailwindcss second in order.

Sr.	Frameworks	Github Star	Last Commit	Stackoverflow Topics (2021)	Google Trend
1	Bootstrap	149k star	March 17, 2021	25,823	1
2	Foundation	29k star	February 16, 2021	866	2
3	Skeleton	18.2k star	December 29, 2014	160	5
4	Bulma	43k star	Match 5, 2021	729	3
5	Tailwind CSS	38.6k star	March 22, 2021	1157	4

Table 1 comparison frameworks in the GitHub platform

4.2 Framework Size:

Table 2 depicts the stats for all the frameworks in terms of their sizes. The final size of CSS file is very important because it affects the page loading speed for



the end-user. Because smaller the file size, the faster the page loads. The frameworks are compared for each the original, the minified version and compressed files. Minified version is the one in which the extra icons and spaces are removed.

Sr.	Frameworks	Size (Uncompressed)	Size (Minified)	Size (Gzipped)
1	Bootstrap	187 KB	147 KB	20 KB
2	Foundation	90 KB	64 KB	12 KB
3	Skeleton	5 kb	11.5 kb	2.7 kb
4	Bulma	225 kb	190 kb	25 kb
5	Tailwind CSS	477 kb	350 kb	58.8 kb

Table 2 comparison frameworks size

The smaller framework is a Skeleton framework with a size of 5 kb for the original file, 11.5 kb for the Minified version, and 2.7 kb for the version of the zip file. Second, is the Foundation framework with a size of 90 KB for the original file, 64 kb for the Minified version, and 12 kb for the compressed version. A third bootstrap framework with a size of 187 KB for the original file, 147 kb for the Minified version, and 20 kb for the zip file. Bulma framework is fourth with a size of 225 KB for the original file, 190 kb for the Minified version, and 25 kb for the zipped file. Fifth is the tailwindcss framework with a size of 477 kb for the original file, 350kb for the Minified version, and 58.8 kb for the zip file version.



According to the table readings the Skeleton is the best framework because it produced the minimal sized CSS file as possible. After Skeleton there is Foundation framework. Tailwind CSS is also consider as second best because it eliminates unused classes and shrinks the overall size of file. For this purpose it uses PurgeCSS tool. After using PurgeCSS tool the size of Tailwind CSS file shrink to 13kb.

4.3 Supported Browsers:

Frameworks considered in this research provide full support for state-of-the-art browsers such as Chrome, Safari, Firefox, and Edge with the latest releases. As for the IE browser, Foundation and Skeleton support the browser, while Bootstrap and Bulma are constrained or limited. The Tailwindcss framework does not support this browser. But all the frameworks mentioned above do support the basic browsers.

Sr.	Frameworks	Chrome	Safari	Firefox	Edge	IE
1	Bootstrap	X	X	X	X	Limited
2	Bulma	X	X	X	X	Limited
3	Foundation	X	X	X	X	X
4	Skeleton	X	X	X	X	X
5	Tailwind CSS	X	X	X	X	Not

Table 3 comparison frameworks in supported browsers



4.4 Responsive Design:

Frameworks for responsive designs provide different screen sizes. The Bulma framework provides 9 different sizes in which 5 are basic and 4 extras. Basic sizes include small, medium, large xlarge 2xlarge. Secondly, Skeleton and tailwindcss provide 5 different sizes: small, medium, large xlarge 2xlarge. Fourth, Bootstrap offers 4 different sizes, small, medium, large and xlarge. Finally, the Foundation framework comes in 3 different sizes, which are small, medium, and large. Overall, Bulma showed the best, followed by Skeleton and Tailwindcss.

Sr.	Frameworks	Sm	Md	Lg	xl	2xl
1	Bootstrap	X	X	X	X	Not
2	Bulma	X	X	X	X	X
3	Foundation	X	X	X	Not	Not
4	Skeleton	X	X	X	X	X
5	Tailwind CSS	X	X	X	X	X

Table 4 comparison frameworks in responsive design

5. Discussion and Results

Each framework has features and characteristics that distinguish it from other frameworks. This section mentions all five frameworks and their key features.



Sr .	Framework s	Popularit y And Support	Framewor k Size	Supporte d Browsers	Responsiv e Design	Rankin g
1	Tailwind CSS	★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★	★ ★ ★ ★ ★	1
2	Skeleton	★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★	★ ★ ★ ★ ★	2
3	Bootstrap	★ ★ ★ ★ ★	★ ★ ★ ★	★ ★ ★ ★	★ ★ ★ ★	2
4	Foundation	★ ★ ★ ★	★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★	4
5	Bulma	★ ★ ★ ★	★ ★ ★	★ ★ ★ ★	★ ★ ★ ★ ★	4
<i>Table 5 Ranking of CSS Frameworks</i>						

5.1 Bootstrap Framework:

Bootstrap framework is the first choice of many developers because it does not require any high-level programming and development skills and experience. Developers with limited experience and knowledge can make a very attractive and responsive website in a limited period. Because the reason is Bootstrap have many build-in ready-to-use libraries and components which help developers to complete the project easily and at a high pace. Bootstrap has a huge community that supports developers in solving problems that they face during the development process.



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5.2 Foundation Framework:

The use of the foundation framework is high in demand however it is less popular than bootstrap but still it is recommended by professionals for enterprise applications and e-commerce site development. Foundation framework supports responsive web pages and creates out-class email templates for designing marketing campaigns. The frameworks started gaining the interest of developers and the also framework provides online training courses for interested candidates. Foundation framework privilege developers by giving full control over the user interface, so it has more room for customization.

5.3 Bulma Framework:

Bulma considers the most powerful frameworks for responsive web designs suitable for smartphone size screens. This feature strongly distinguishes it from other popular frameworks. Bulma is the best choice for developers who are interested in fully responsive web designs. It has a huge community of developers and recommends for owners of start-ups and service providers for smart devices.

5.4 Skeleton Framework:

Skeleton is a small lightweight responsive framework and is recommended for small and simple web pages. It is usually considered for small websites and projects which do not require heavy communication. It is easy to learn and compatible with smart devices because of its small size. It does not reduce the overall efficiency of mobile phones.



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5.5 Tailwind Framework:

The most prominent and proficient feature of the Tailwind CSS framework which differentiates it from the rest of the frameworks is the power of high customization. Tailwind provides developers the full freedom of customization of web pages without the dependency of pre-customized styles. It is the most trending framework recorded on maximum commits on Github. Tailwinds do not facilitate the dependency of one web page to the other. It does not affect the modification of one page to any other page. Also, Tailwind speeds up the development process as it excludes the CSS style sheets. By excluding CSS features Tailwind reduces the overhead by reducing the size of the final file to the maximum possible size. The idea of Tailwind is to eliminate the CSS styling and stick to HTML basics. Tailwind is optimal for producing lightweight web designs but also facilities developers to build fully customized and unique pages.

6. Tailwind CSS:

In the Research Chair Management System for the Deanship of Scientific Research. The system aims to enable the Research Chairs Agency to manage its chairs and monitor its technical and financial activities. Based on the results and criteria discussed, tailwind CSS Framework was determined to design the user interface.



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6.1 Guide to install Tailwind CSS

A simple 4 step guide to install Tailwind CSS is presented in this coming section. This guide is for the Laravel project.

Step 1: Tailwind CSS Installation

Firstly, you need to begin with Tailwind CSS installation. Tailwind CSS can be installed by using different ways such as using npm, Yarn, or CDN, etc. Installing tailwind by npm is the best option for the Laravel project. To install Tailwind CSS a command needs to enter in the root of the application.

Command:

```
npm install tailwindcss
```

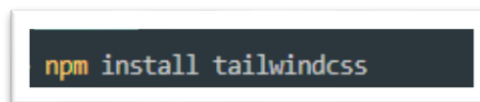


Figure 1 Tailwind CSS Installation

Step 2: Import Tailwind CSS

After tailwind installation, you need to import it to the required project. Import Tailwind CSS in the app.css file and replace the original file with Tailwind base, components, and utility styles.



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Command:

```
@import 'tailwindcss/base';
```

```
@import 'tailwindcss/components';
```

```
@import 'tailwindcss/utilities';
```

```
3 @import 'tailwindcss/base';  
4 |  
5 @import 'tailwindcss/components';  
6  
7 @import 'tailwindcss/utilities';
```

Figure 2 Import Tailwind CSS

Step 3: Tailwind CSS Configuration

After installation and importing, tailwind CSS needs to be configured. As an output tailwind.config.js file is generated at the backend. The configuration file is used for settings and customization.

Command:

```
npx tailwind init
```



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```
npx tailwind init
```

Figure 3 Tailwind CSS Configuration

Step 4: Include Tailwind to Laravel Mix

In the last step, we need to tell Laravel to use the tailwind CSS. So, include webpack.mix.js to use tailwind CSS.

Command:

```
const mix = require('laravel-mix')  
  
require('laravel-mix-tailwind')
```

```
const mix = require('laravel-mix')  
require('laravel-mix-tailwind')
```

Figure 4 Include Tailwind to Laravel Mix

6.2 Implementation:

In the next coming paragraphs, a login interface is created using Tailwind CSS. For a detailed understanding, screen images demonstrate the commands and their outcomes.



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```
<div class="w-full sm:max-w-md mt-6 px-6 py-4 bg-white shadow-md overflow-hidden sm:rounded-lg">
  <slot />
</div>
```

Figure 6 Snip code for form using Tailwind CSS

W-full keyword is used to set the width of an element. Then mention command is a combination of multiple variables having unique meaning. sm:max-w-md declares small screen with max width of an element to medium. mt sets top margins to 6, px inserts padding on left and side to 6 and py refers to the top and bottom padding. The value of py here is 4. The background is set to white and overflow-hidden is used here to handle excess elements within the hidden elements. sm:rounded-lg controls the border radius of an input.

```
<template>
  <input
    class="border-gray-300 focus:border-indigo-300 focus:ring focus:ring-indigo-200
    focus:ring-opacity-50 rounded-md shadow-sm"
    :value="value"
    @input="$emit('input', $event.target.value)"
    :placeholder="placeholder"
    ref="input"/>
</template>
```

Figure 7 Snip code for input using Tailwind CSS



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The input has been specified as border-gray-300 to make the border light gray. Focus: border-indigo-300 to change the border at focus to input and make it a light indigo color. focus: ring to display the ring around the input The moment of focus .focus: ring-indigo-200 Displays the ring around the input the moment of focus with a light indigo color. focus: ring-opacity-50 to specifically change the opacity ring the moment of focus on input. rounded-md to control the border-radius of input with this property border-radius: 0.375rem. shadow-sm to control the shadow of input with this properties 0 1px 2px 0 rgba (0, 0, 0, 0.05).

```
<template>
  <label class="block font-medium text-sm text-gray-700">
    <span v-if="value">{{ value }}</span>
    <span v-else><slot></slot></span>
  </label>
</template>
```

Figure 8 Snip code for the label using Tailwind CSS

The first element is a block that means the label takes full width without any element beside it. Font-medium This element controls the font-weight of the label text-sm This element control the font size for the label. text-gray-700 makes the font color dark gray.



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```
<span class="ltr:ml-2 rtl:mr-2 text-sm text-gray-600">
  {{ $t('auth.remember_me') }}
</span>
```

Figure 9 Snip code for span using Tailwind CSS.

Span is often used for text, either to format or color the object. `ltr: ml-2` to make margin-left -2 (margin: 0.5rem) in case the writing from left to right. `rtl: mr-2` to make margin-left -2 (margin: 0.5rem) in case the writing inside input from right to left. `text-sm` This element controls the font size for the label. `text-gray-600` makes the font color dark gray.

```
<button
  class=" rounded-lg px-3 py-2 w-full h-full ">
</button>
```

Figure 10 Snip code for the button using Tailwind CSS.



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rounded-lg control the border radius of input with this property border-radius: 0.5rem. px-3 would add 0.75rem of padding to the left and right of an element.py-2 would add 0.5rem of padding to the top and bottom of an element. Width utilities refer to controlling the width of an element. w-full to make width with this property's width: 100% of a button. Height utilities refer to controlling the height of an element. h-full to make Height with this property's width: 100% of a button. The result looks like figure 11 represents Login Page. Its content form is shown In figure 6, the Input type is shown in figure 7, the label is shown in figure 8, the span shown in figure 9, and the button type shown in figure 10.

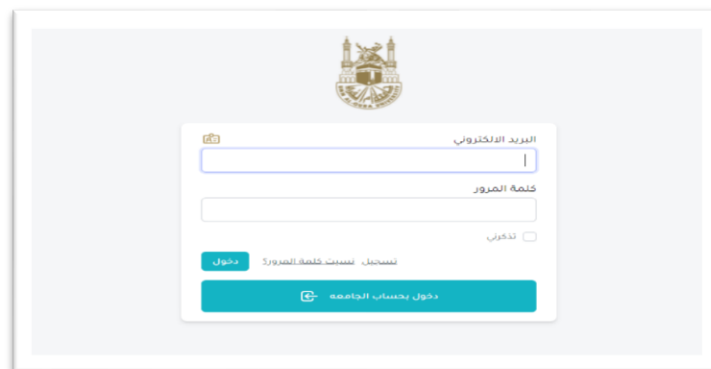


Figure 11 UI of loginPage

7. Conclusion

A detailed discussion on the latest CSS framework is presented in this research work. Each framework has its pros and cons which differentiate them from one and other. This research is conducted to compare and contrast the latest available CSS frameworks based on some performance measures such as



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popularity and support, framework size, supported browsers, responsive design, etc. This research helps web developers to better understand their choice of framework for the required project. The developer's choice depends on the developer's experience and project requirements. The developer tries to determine the most appropriate framework which is easy to code and performs efficiently according to project requirements. This research helps web developers in this regard. A tailwind CSS guide is also provided for developers to provide a short hands-on experience. Results and discussion also clarify the objective of the research by giving a clear idea of CSS frameworks.

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