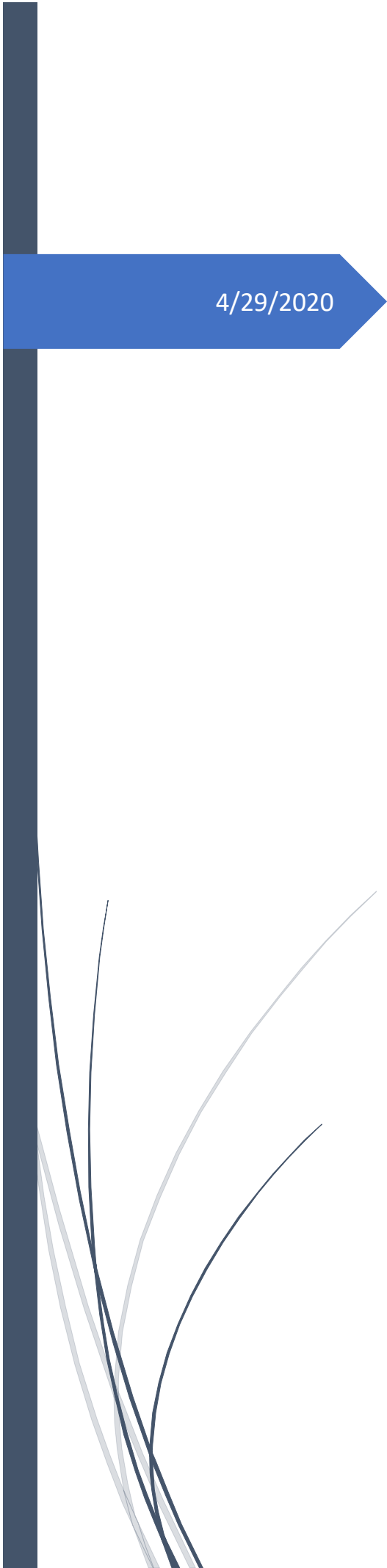




4/29/2020

Project proposal for
the use of React Single
Page Application
Framework for
improving the usability
of Web Applications.

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1. Background to the proposed research.

The Internet as an invention is undoubtedly put in line with the uprising of such innovations as the invention of electricity, printing or a steam engine. Each of these patents significantly streamlined the work process. It is no different in the case of the Internet. In the era of widespread computerization, the market of internet applications is developing very strongly, the main task of which is to support the process of data exchange and processing between users. Therefore, many different methods, architectures, programming languages, as well as ways of creating user interfaces were created. All this to make the process of using the web application as intuitive as possible, convenient and fast for the user. Modern customers of software companies place great demands. In most cases, the application must be intuitive, it must prompt the user what to do when it gets lost, it should store data about each user's activity, it should be dynamic, should process data on the fly, access to data must be provided in at any time and in addition the application should work just as well on every device and platform. These and other requirements have forced programmers and software developers to approach the topic of Internet applications in different ways. Thanks to this, to facilitate the process of software development that would meet the high demands of customers, many different concepts were created, of which only those that had the legitimacy of existence survived. However, each method of software implementation is also associated with the appropriate selection of technology to suit the requirements for software. An example of such a concept of software development can be the recently popular Single Page Application, which has a clear division into the client and server layer. They have a very extensive presentation layer and only query the server to download data for display.

Current trends in the market of internet applications have led the author to interest in the most commonly used technologies for the project implementation. In today's world, to be competitive, many companies are condemned to have their own IT systems. This translates into a relatively large number of jobs offers for programmers in various technologies and at various levels of advancement. Therefore, having the knowledge and skills to implement such systems increases the attractiveness of the programmer on the market. The proposed project idea will be based on Single Page Application SPA technology for implementation on the client side. Single Page Application will be created and adjusted in a way to improve its usability, using React - the most popular among front-end developers JavaScript framework.

1.1 Single Page Application

"The need to provide a native-like quality user experience has forced developers to move code to the client side [1]."

AJAX has changed the internet a lot. It made the user's interaction with the internet application more attractive and made it like its "desktop" prototypes. If some of the data can be downloaded from the server in the background, at the user's request or when it is necessary, why not make the whole application work this way? SPA (Single-Page-Application) is a subset of web applications characterized by a single page reload on its initial display. Further communication takes place via JavaScript. The first WebView-based hybrid mobile apps were merely nothing more than a Single-Page-Application (SPA), the introduction of Google's Gmail in 2005 can be seen as the starting point of feature rich SPAs and even [2]. Instead of a server, data is most often downloaded as part of communication with various APIs. SPA works best in online calculators, booking services or other websites that are based on data entered by users. Such pages need to quickly change the content of the page or separate elements when the user changes the data entered by him. SPA also fits perfectly for the creation of CRM and ERP systems, where interactions between users and the

system are frequent and consist mainly of changing elements. Although refreshing the elements several times is not so noticeable by users, it does affect the user experience to some extent. SPA allows for a smooth transition between changes in a fraction of a second, eliminating the waiting time and "blinking" of elements during refreshing. The code of such an application and DOM are downloaded once (when entering the site) and modified on an ongoing basis along with the user's interactions and data entered by him, so pages. In most cases, such an application is written in JavaScript using technologies such as React.js, Vue or Angular. So why React? React is lighter than Angular, it is filled with the least conditions and eliminates the need to use extra elements like plugins [3].

1.2 Why React Framework

NPM downloads

- <https://www.npmtrends.com/react-vs-vue-vs-@angular/core>
- <https://npm-stat.com/charts.html?package=react&package=vue&package=%40angular%2Fcore&from=2014-12-12&to=2019-12-19>

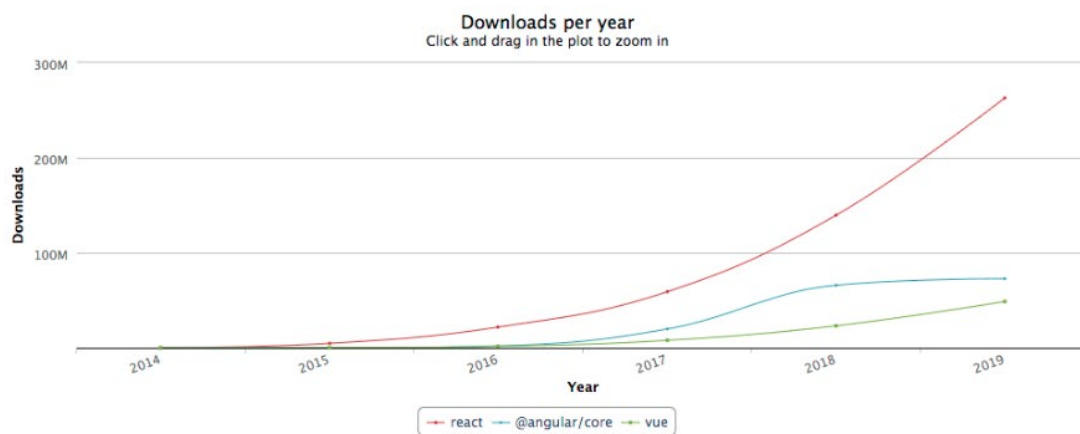


Figure 1- React popularity according to npm-stat [4]

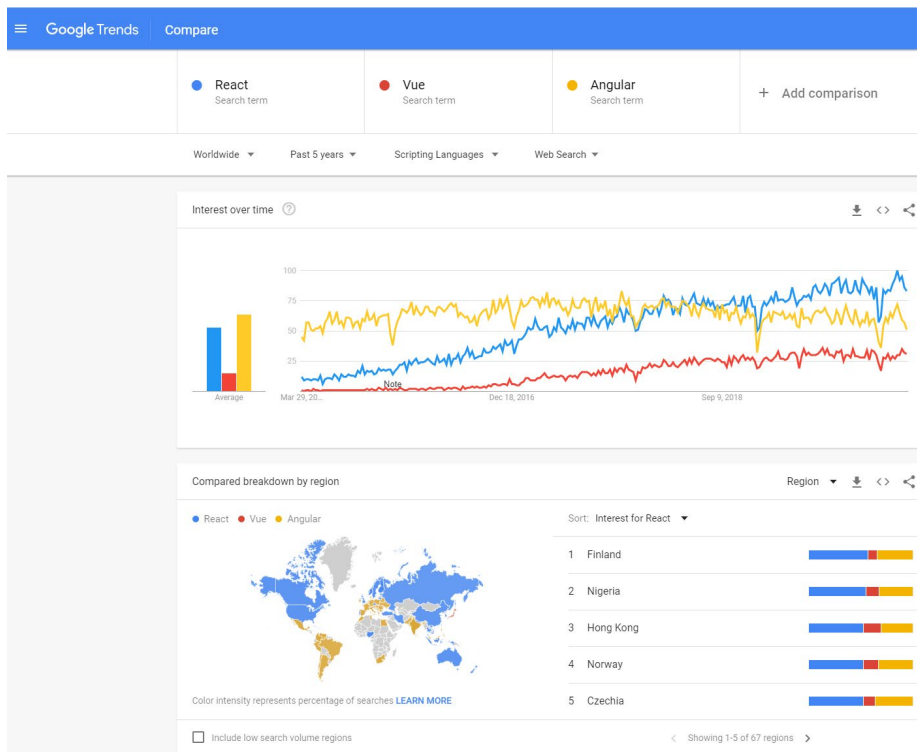


Figure 2- React popularity according to Google Trends

React is a declarative, efficient and flexible open-source JavaScript library for building user interfaces developed by Facebook for their own purpose [5]. Findings: React is by far the most popular front-end framework and continues to grow faster. In addition, React is more loved and "wanted" than other front-end frameworks (although it is more used: satisfaction tends to decrease with popularity) [6] Creating interactive interfaces is really effortless. Building component-oriented applications is greatly facilitated, and backward compatibility is taken seriously here, so you can be sure of long-term effectiveness. In the charts above, it's easy to see that in the last few years, many more people have heard of React [7] . Also, job demand for developers with knowledge of React JS framework rising every year, making it top wanted skill.

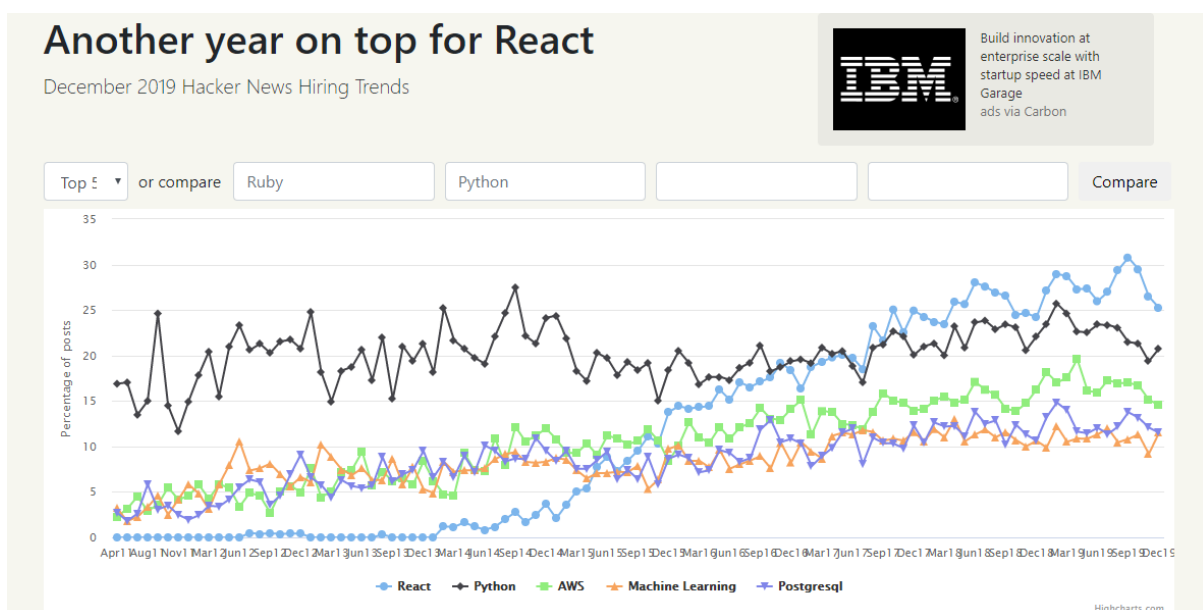


Figure 3- Job demand do React Apr 2011-Dec 2019 [8]

This is a very good option to start a journey with a front-end, because of its simplicity and effectiveness in developing process. The powerful features, a few of many, making the React framework very interesting and worth of researching are its flexibility, versatility thanks to its short rundown of lifecycle approaches this is straightforward and utilize [9], usefulness of JSX (syntax extension to JavaScript) [10], it is free and open source making it most loved of software engineers and applicable group [9]. Another and maybe one of the main reasons why the framework is so popular is that the React JS features like server-side communication [8]. The library ensures Search Engine Optimizations (SEO) and offers lightweight DOM for better performance, enforces unidirectional data flow [11]. Thanks to Flux library (application architecture where there is one design pattern and one simple assumption) developers can start using it with incredible ease, without having to install additional libraries or frameworks [12]. All the key features and benefits, listed above, have caused many large enterprises like Netflix, Yahoo, Khan Academy, Pinterest and even Dropbox shift to use React JS making it definitely worth of attention. Using React framework is a perfect way to adopt and improve the usability of Web Applications.

2. The aim and objectives of the study (the research purpose).

The aim of the project proposal is to investigate how the React Single Page Application Framework can improve the usability of web applications.

The **objectives** are:

- Research Website Usability and the React framework
- Implement a proof of concept React UI with the aim of improving usability by conducting pre-study usability testing on existing app or website to identify defects and fixing them in the implementation.
- Evaluation (an evaluation and analysis testing of the usability testing results).

3. Expected outcomes of the project

The expected outcomes of the proposed project, at the end of the study, will be improved and well corrected already existing app or website to make it much more functional, usable and user-friendly thanks to using React Single Page Application Framework. The website application will be adapted to the user's expectations and it is the user's experience, when browsing this website, will be one of the goals of the project. The web applications will be modified and streamlined in such a way to improve and attract the attention of the user. The interface ergonomics will focus on the issue of intuitive navigation to facilitate access to the information sought and provide each user with understandable communication with the application. A website will be created to be accessible to the average Internet user, the content will be legible and will enable him to quickly reach the desired information and at the same time will initiate positive feelings while using it. It will fully meet the user's requirements.

4. Research methodology

Before starting the project need to be determined what will be needed and where to look best (whether to search for materials on a given topic or only specialized information). To successfully gain needed information to achieve the aim of the project emphasizes learning through experience and seeking knowledge. The research can be divided into obtaining information:

- Secondary information- which already exist, have been previously collected, processed and secured by specific institutions, organizations, bodies and research agencies, diverse sources such as academic, governmental and industrial literature etc. This information will be able to be used to solve the research problem of the project,
- Primary - are collected specifically to solve the research problem of the project and will require extensive procedures for comparing information as in the case of project observations, experiment or even a survey.

4.1 Research philosophy and approach

"If it is true that every theory must be based upon observed facts, it is equally true that facts cannot be observed without the guidance of some theory. Without such guidance, our facts would be desultory and fruitless; we could not retain them: for the most part we could not even perceive them." August Comte [13]

The proposed project philosophy will be based on positivism and deductive approach. The main role of the experiment will be based on deduction, cognition through experience and the possibility of exploring through facts and relationships between them. The project research will record all the facts and insights. It will be based solely on observation, experience and verification of the assumed hypothesis. The task will be to systematize the results of research, create a synthesis and draw general conclusions. Facts already developed earlier (from trusted sources like academic, governmental or industrial) will be analysed and an improved implemented project's version will be created based on them. Observation will rely on making intentional, planned and systematic observations in order to find answers to specific and clearly posed questions (hypothesis=new version of web application is more usable). Also, observing and analysing the behaviour and feelings of other users will be an important part of the experiment.

4.2 Research strategy

As briefly mentioned above an experiment will be set as primary research strategy. The experiment will be concentrating improving usability of an existing web app by using React Single Page Application.

In the modern reality of advanced technologies and high competition on the IT market, it is obvious that the basic condition for the functioning of a product is its usability. You don't have a useful webpage - you don't exist. The experiment will consist of making such changes to an existing web application to improve its usability and be more user-friendly accordingly to all previously gained knowledge. The results will be compared at the end of the experiment. The scope of the experiment will include the following stages:

- Researching all important information needed to build a usable web app,
- Designing and building (adjusting already existing web app),
- Implementing all needed changes to the project,
- Testing and validating software and usability of the web app,
- Situational observation of example users,
- Individual interviews of possible users,
- If needed further corrections of the project,
- Final verification and validation of corrected and usable website.

The experiment will intent to enhance user experience when browsing the website. According to the ISO 9241 standards [14], usability is a measure of the efficiency, effectiveness and satisfaction with which a given product can be used by specific users to achieve specific purposes in a specific context of use. Jakob Nielsen [15] defined it as a set of 5 elements that allow to specify:

- How easy it is to perform simple tasks at the first contact with the product – Learnability,
- How quickly the product is used by users who already know it – Efficiency,
- How easy it is to remember how to use the product after a long break – Memorability,
- How often mistakes are made and how easy is to get out of them – Errors,
- How pleasant the product is to use – Satisfaction.

Also, usability is an important part of the overall Peter Morville’s famous UX Honeycomb [16] visualization tool of the user experience.



User Experience Honeycomb

To assess the degree of usability of the website it is necessary to reach for tested research tools for usability testing. The basic ones are usability audit and usability tests. Usability audit, also referred to as expert analysis, is a detailed analysis and comprehensive assessment of a website or web application in terms of their usability. This audit will cover the following areas:

- User Task Analysis,
- Readability,
- Site Navigability,
- Accessibility,
- Website Speed,
- User Experience

5. Data collection methods

1. Research Website Usability and the React framework

For the first objective, data collection methods will be based primarily on professional literature. The information will be derived primarily from various scientific publications written by IT specialists. The library is a valuable source of information which may contain professional literature. They will include books, journals, studies, conferences as well as scientific articles. A good source of information will also be the press dealing with the subject of the project as well as websites dealing with the selected topic of the project. They have many interesting literary items in which various types of articles, journals, conference clippings but also tutorials or reportages can be found. Such sources can be websites of various institutions or portals in which users post articles on various topics, including interviews with professionals from computer science and engineering fields. To exclude non-scientific content from search results Google Scholar can be used. It gives access to information about existing publications and their connections with other texts. Based on the information obtained, it is possible to check using Google whether the texts found are fully available on the Internet or search for them in library catalogues. The Google Book Search virtual library, which allows access to pdf documents, publication reviews, etc. It also allows to check whether a given item is for sale or for rent.

2. Implement a proof of concept React UI with the aim of improving usability by conducting pre-study usability testing on existing app or website to identify defects and fixing them in the implementation.

For the second objective, data collection methods will be based primarily on observation and individual interviews of example user's, also situational observation of possible users might be taken into consideration. The observation will be based on theoretical rules, method software usability checks that help identify user usability issues. This applies, in particular, to checking and compliance with adopted usability rules. Individual interviews will be conducted involving interviews with selected representatives of the website's target group. Individual interviews will be carried out in a small group of users from 1 to 3, maybe 4 people, in different ages and from different environments. The technique of observing users will be that the work will be examined and observed in the same group, users while performing common tasks with the help of the website for which the study is being organized. During the interview and observation, notes will be made regarding the events observed, e.g. errors and difficulties in using the website, as well as feelings and emotions during its use. These methods will allow you to identify subjective expectations, individually perceived benefits as well as personal concerns associated with the use of a given website. These tests will identify which of the two alternatives (original web app or the proposed and improved one) is more effective by measuring the actual behaviour and opinions of users.

3. Evaluation (an evaluation and analysis testing of the usability testing results).

The evaluation part will be mainly based on the information collected during the implementation process and on own insights and knowledge gained during research.

6. Risks/limitations/ethical/legal issues

Every project, program or any undertaking is subject to certain risks. It is impossible to predict all the details and possible delays in advance, the force to meet the deadline or to curse fate so that it does not make any malicious prank. However, the risk can be reduced by properly planning the entire process, identifying project points most vulnerable to errors and estimation of the probability of their occurrence. Such action allows to respond quickly enough to emerging problems and significantly accelerate the pace of work. In the nineties of the 20th century, the independent analytical and consulting company Standish Group International began researching the successes and failures of IT projects. Every two years, the company publishes a report entitled CHAOS Report, in which it presents statistical data covering areas of IT project activities in many branches of the US economy, including industry, trade and services, banking, education and healthcare. The first report summarizing 1994, covered 365 different enterprises implementing over 8,000 applications, presented a rather pessimistic picture. According to surveys Overall, the success rate was only 16.2%, while challenged projects accounted for 52.7%, and impaired (cancelled) for 31.1% [17]. Incomplete success means that the project has been implemented, although with at least one deviation from the previously assumed plan. CHAOS Report authors include exceptions:

- failure to meet the assumed schedule
- fewer requirements being met,
- producing a product of inferior quality.

There are many other elements involved in preventing the project from succeeding, which may have:

- Technical nature- related to project complexity, software malfunction,
- Security nature- related to data breach, security issues such as hacking,
- Human nature- related to the availability of person involved,
- Time- related to time management and schedule,
- Organizational nature- related to the decision-making process,
- High volume of work needed to be done.

One of the sources of threats may be bad motivation and lack of desire to achieve goals, insufficient mobilization and unsatisfactory commitment, no plan, no criteria for assessing the future solution and no definition of the expected results, no active participation in the work on the project, not maintaining the schedule, insufficient the amount of information obtained, data inconsistency, inability to use the information collected, insufficient knowledge of technology.

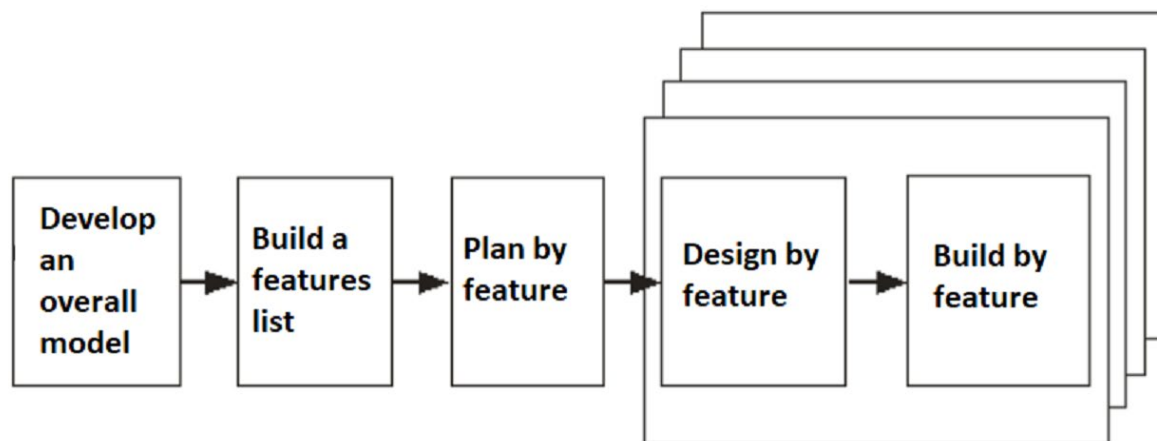
6.1 Ways to deal with those risk

To minimise all risks related to software malfunction notoriously changing requirements must be met, software compatibility issues must be eliminated, project architecture needs to be improved and security vulnerabilities fixed. It is important to have a vision, mission and goal, appropriate role in the project, flexibility of work, sufficient time frame for analysis and decision making, creating a schedule consisting of: identifying all activities, establishing the order of their implementation and

estimating the time of execution, appropriate data integration. There should be, also, a contingency plans and time reserves implemented for the project.

7. Feature-driven development methods used as part of systems development.

The project according to FDD consists of five sequentially following stages, which will be described in turn. The assumption underlying FDD is incremental development of individual system functionalities (features). Work begins with the definition of the 'overall system model'. The previously developed system requirements will be used. The project domain will be determined and iteratively divided into smaller and smaller areas. In the next stage, based on the system requirements specification and the developed model (s), functional lists will be developed. These lists will be hierarchical and will contain main functionalities that will break down into sets of functionalities in subsequent hierarchies. These lists are reviewed to verify correctness and completeness. Functional design and implementation of functionality will be done iteratively and if possible in parallel.



8. Result evaluation.

As mentioned earlier, the results will be evaluated on the basis of the implementation process, own observation as well as observations and interviews of users. The analysis will be conducted in the field of web usability, good principles of website usability design. The following aspects will be considered during the study:

- website appearance analysis (design),
- information architecture,
- functionality
- page layout and navigation,
- correct construction of the website.

It allows to identify most of the basic errors and problems that cause difficulties in using the website. The analysis will be conducted in the field of web usability and good principles of website usability design. The following aspects will be considered during the study:

- website appearance analysis (design),
- information architecture (AI),
- functionality

- page layout and navigation,
- correct construction of the website.

It will identify the most basic errors and problems that cause difficulties in using the website. It will be carried out in two ways:

- tests resulting from user observations,
- benchmarking audit.

Analysis carried out to identify problems in the field of website usability. It will be made on the basis of generally accepted principles of usability, resulting from previous research of web usability specialists. The benchmarking audit will consist in comparing the examined website with the new, proposed version which will be created using React Single Page Application. Such a statement will allow to identify the right solutions that are worth using when improving an optimized website. During the benchmarking audit, the following areas of the site will be assessed:

- content,
- functionality
- utility,
- look.

The results of the analysis included in the audit will be the basis not only for website optimization, but also for the development of new and improved solutions. On its basis, conclusions and recommendations regarding changes necessary for implementation on the website will be made.

9. Resources required

Recourses required for successful completion of the project will include following:

- Desktop PC,
- Visual Studio 2019 IDE,
- JavaScript programming language,
- React- JavaScript library,
- node.js to download React and associated packages,
- Dropbox – for general safe file storage,
- GitHub - source control to store the code in modern way,
- GitKraken - graphical user interface for GitHub,
- Pluralsight - tutorials and general knowledge about React,
- <https://reactjs.org/docs/getting-started.html> - original React documentation,
- MS Office,
- Web browser for easy access to journals, any academic, governmental and industrial literature etc

10. Gantt chart with project planning timescales.

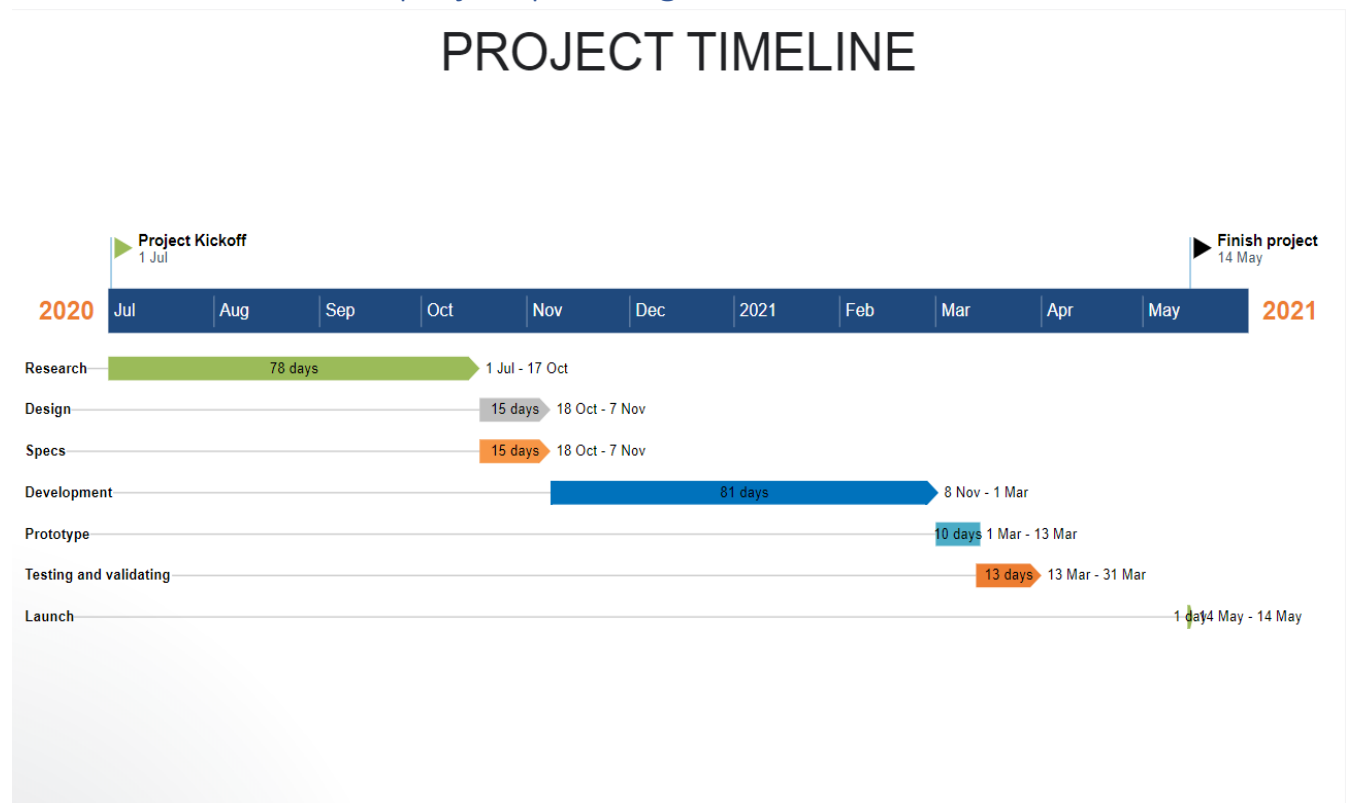


Figure 4- Project timeline [18]

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