



Investigating the use of Progressive Web App in Government Digital Services

Research Proposal
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1. Introduction

A plethora of services available through innovations in computing and information technology, high speed communication, mobile computing and affordable devices and services have changed the ways of life. Digital user expectations keep changing and so is the need for innovation in providing consumer services[1]. With the concept of access anywhere, mobile apps have seen a tremendous boost with their personalised and real-time offerings.

Progressive Web Apps have seen an increasing trend in business, and it would be interesting to see if the proliferation of apps has an impact on Government services. A range of methods including reviewing existing practices, prototype development and surveys are some of the options under consideration to carry out this research.

This proposal outlines the aim, objectives and methodologies to be adopted in investigating the use of a Progressive Web app in the services being offered by a UK Government organisation, Department for Vehicles and Licencing Agency(DVLA).

2. Background to the Proposed Research

In this section, a background on Progressive Web Apps and the chosen Government agency–DVLA are discussed. The Government service selected to aid the product development is one of the services provided by the DVLA. The aim and

objectives of the proposed research is also outlined.

2.1 Progressive Web App (PWA)

With a variety of Operating systems available, mobile devices can be broadly captured using the platform they have been designed for. The most popular ones being IOS and Android platform. Applications and content for mobile devices is rendered through a variety of technologies currently. There are two common interfaces to access content in a mobile device. A web browser such as Chrome or Safari or through mobile applications commonly referred to as an App. A responsive website renders an existing website in device appropriate dimensions through the browser by resizing the browser window to fit the screen size. Applications used on platform specific devices are termed Native applications and require to be developed for each of those platforms. Cross platform applications share a single base code and can be easily adapted for android or IOS[2]. In terms of user experience, the responsive web app is simply a website fit to the device size and native apps require the apps to be downloaded occupying storage.

A progressive web app is a go between all these technologies. Progressive Web App (PWA) is a web application that adapts to a mobile environment. Backlund and Heden identify a PWA as an application that is fully responsive on mobile devices with secure content delivery and offline functionality[3]. PWA renders the website in an app like interface with the additional benefits of features borrowed from native apps. It is platform and device independent, accessed using the browser and a uniform resource locator(URL).

However, it provides for offline caching and utilisation of native hardware functionalities. It enables development of enhanced version of web apps with the capability to work both online and offline. The functionality such as to receive push notification and background data synchronisation with app not running. Backlund attributes these functionalities to the Service Worker that sits between the application and the user[3].

The PWA depends on browsers supporting service workers and Shepperd states in his book in 2017 that the user experiences in PWA is proportionate to browser functionality. He assures that improved browsers will result in progressive enhancement of PWAs. He further attributes consistent and reliable experience regardless of internet speed[4]. Now the progressive web app could be installed on the home screen being in full integration with the operating system of the device on all major browsers[5].

Google in its I/O developer conference in 2017 points out the advantages of PWA when introducing India's major ride sharing app Ola developed as a PWA. They hail it as a technology that would reach far more audience with its low data consumption and unhindered services offline[6]. Patricia Loretoa developed a PWA for a health service in obstetrics giving users a reliable and useful app to monitor their health[7].

2.2 Department for Vehicle and Licencing Agency

Electronic Government relates to the provision of public services through an integrated digital service to citizens. The Department for Vehicle and Licencing Agency is an executive

agency of the Department for Transport and provide registration of vehicles and driver licencing services and other information relating to vehicles and drivers. They hold data on drivers and vehicles amounting to 48 million driver records and over 40 million vehicle records. They provide around 350 different services to a client base that includes individual members of the public, companies and regulatory authorities such as police and environmental agencies. All digital services are provided through the e-government platform GOV. Currently DVLA services are through the responsive website DVLA.gov.uk that caters to both pc and mobile devices. There are no native apps designed for service provision. Most of the services provided by the DVLA like applying for licence do not require for the user to repeatedly access the site. The frequency at which a single user might access information may not warrant a native app. Hence, we aim to investigate if a progressive web app might be an option for DVLA.

3. Aims & Objectives

The overarching aim of this project is to investigate the use of Progressive web app to provide Government services in order to provide a better use experience for the citizens who form their user base. The app should facilitate service access from a variety of devices with greater convenience and ease of use with minimum device storage utilisation and thus increase the online services usage.

Objectives

To that aim, we propose the following objectives.

Critically analyse PWAs and development techniques employed in providing services through the web and mobile devices

Analyse the efficacies of PWAs over other technologies with a focus on development techniques and user experience. One could be less expensive to develop and better leverage the features of the hardware over another[11].

Evaluate the need for mobile apps in e-government

Provision of public services through mobile devices is referred as M-government by I. Kushchu, M. Kuscu[8][9]. Would MGov strategy add value to services and is there a need for Governments to play in par with the commercial actors to satisfy user expectations?

Investigate the criteria for a progressive web app and Government guidelines

Identify the characteristics of a PWA as outlined in literature and industry. The Government digital strategy provides guidelines on the standards for digital public services[10]. As part of the project, the criteria will be analysed against the guidelines with a view to satisfying Government standards.

Implement a progressive web app for a public service to evaluate its effectiveness

As a proof of concept, it is proposed to design a PWA for the vehicle enquiries service - VES.

Evaluate the product effectiveness by conducting software testing and usability testing

Measure the effectiveness from a developer's perspective as well as user experience.

Conclusion

This section outlined the background information relating to the research question and the aim and objectives. The research is expected to produce an outcome that consists of an analysis report on the use and advantages of PWA and a proof of concept PWA app for the VES services.

4. Research Methods

This section discusses the research methodology that are appropriate for this research and outlines the risks, limitations and data collection methods.

Methodology

In their paper Stol and Fitzgerald review various software research and Table:1 provides an overview of the various methodology that are available which focus on research associated with software engineering. They argue that there is no fixed research method for an empirical study in software Engineering and is often a mixed bag. According to them, there are two forms of research in software engineering. One which aims to seek comparison of knowledge and the other which seeks solution[12]. The research which is planned in this paper is a solution seeking one, as the aim is to seek to develop a solution which involves the use of PWA in the government offered services that can work both online and offline.

According to a Selection of Sources

Glass et al. [63]	Zannier et al. [230]	Sjöberg et al. [190]	Höfer and Tichy [75]	Easterbrook et al. [48]
Action research	Controlled experiment	Controlled experiment	Case study	Experimentation
Conceptual analysis	Quasi experiment	Surveys	Correlational study	Case study
Concept implementation	Case study	Case studies	Ethnography	Survey
Case study	Exploratory case study	Action research	Ex post facto study	Ethnography
Data analysis	Experience report		Experiment	Action research
Discourse analysis	Meta-analysis		Meta-analysis	
Ethnography	Example application		Phenomenology	
Field experiment	Survey		Survey	
Field study	Discussion			
Grounded theory				
Hermeneutics				
Instrument development				
Laboratory experiment (human/software)				
Literature review				
Meta-analysis				
Mathematical proof				
Protocol analysis				
Phenomenology				
Simulation				
Descriptive/expl. survey				

Table 1 research methodologies

4.1 Philosophy

The research philosophy that could be adopted for this project may be Positivism or Phenomenology. Carr and Kemmis have been quoted stating, Positivism as essentially in thought that explains any event has some laws that govern it, and that once this law is discovered, then it helps to predict any future such events[13]. PWA in a web-based environment has been generally accepted as beneficial. This project attempts to investigate objectively a specific scenario. Actual observations and facts will form the basis for the evaluation. This being the true sense of positivism, positivism as a philosophy blends well with this project. Further, this philosophy facilitates the use of highly specific and precise data with a high level of reliability.

Phenomenology is a philosophy where the theme is on consciousness and meanings. The focus is on existence and interpretations of experience. Giorgi A states that it is an analysis of the givenness, partial or marginal not objective but from the point of view of the experiencing subjects[14].

The chosen philosophy is positivism as we aim to establish and prove the theory and evaluate the cause and effect. However, Saunders suggests

that, sometimes positivist research can blend with other methods[15].

4.2 Approach

This research allows for both deductive approaches to be applied to the project as well as an inductive approach. Wilson describes a deductive approach as the ability to develop an existing hypothesis on an existing theory, in a manner that it allows to design a research strategy to test the same hypothesis[16]. Gulati further goes to emphasise that deductive involves reasoning from the particular to the general which allows designing tests to verify the generalisation of circumstances[17]. Deductive approach is usually quantitative and longitudinal but can be qualitative as well.

The alternative Inductive approach is the reverse of deductive with observations leading to the definition of the theory. It is reasoning from the general to the specific and is mostly qualitative analysis and cross sectional. However, it has elements of deduction, as the iterative nature requires the researcher to travel between the data and theory[18].

Considering that there exists a theory that progressive web apps are advantageous, the approach here would be deductive but with an element of qualitative data and cross-sectional analysis due to the limited sample size.

4.3 Strategies

Having established the philosophy and approach, due to the nature of the project on web applications, the strategies that fit naturally for a project

such as this are document review, case study, and software development. The aim is to apply the three strategies in order to triangulate the results to arrive at the outcome.

4.3.1 Document Review

Incorporating document review as a strategy is the proposed first step as well as at various stages of the project. A guideline for literature (document) review produced by the software engineering group at Keele University describes a systematic literature review as a means of recognising the key essence of a subject matter by means of identification, evaluation and interpretation of all available research in the area of interest[19]. Bowen defines document analysis as the process of analysing existing papers in all forms of media, electronic and non-electronic on the same phenomenon. He further insists that document review can raise further questions leading to the understanding of the field being researched. He quotes Goldstein and Reiboldt to present his finding that the different techniques of research can be interdependent and how document analysis can assist in the exploratory quest[20]. Furthermore, they would also be a tool to identify best practices and act as a guide to tried and tested implementations in the field. This will help deduce outcomes relating to evidence based existing research, practices and technologies.

4.3.2 Case Study

Having established what researchers in the subject area have experienced and concluded including the positives and negatives will help to establish a path towards the natural next step of the proposed strategy, which involves a case study. Runeson and Höst [1]

argue that a methodology that involves a case is most appropriate for most research involving software engineering as they are hard to study in isolation. They further argue that though case studies results are not similar to controlled experiment, they do give a good understanding of what is being studied. Runeson et.al have derived software engineering case study as an investigation of a phenomenon in its real-life context[21]. Case study leans towards an inductive approach. However, they recommend the case study for an exploratory research with deductive strategy as well. Case studies are not quantitative. Benbasat, Galliers suggest that action research can be an extension of case study, whilst others argue otherwise. In this scenario, the researcher actively participates in the research, with the possibility of bringing up changes in the organisation and impact on the business service model. It may be that other options such as survey could be used as an extension to the case study. Case study appears to be an appropriate choice for analysing the use of PWA in a similar environment and applying it. We can say that action research is also a strategy that can be employed. Case study will aid the evaluation of the technology in relation to its development and usefulness by looking at other adopters.

4.3.3 Software Development

The third strategy proposed for this project is that of software development. It is imperative that a product be developed and tested to answer the questions as a way of testing the theory. The research is to investigate the usefulness of PWA with regards to development and user experiences within the DVLA. Only a small instance of a very large system will be considered for the study purposes. A component of the service will be

developed as a prototype minimum viable product and be tested. Then iteratively expanded as per evaluation and additional requirements. Developing a software and testing it at a stage where the two strategy namely, document review and case study have completed is also expected to allow for triangulating the results thus concluding the research.

4.4 Risks & Limitations

A good risk management strategy would consider all aspects of risk and find mitigation to avoid the outcome from the risks.

Availability of data for literature review

To enable a systematic review, substantial data availability is the key. The risk of not having enough research available for literary review could lead to confirmation bias which is a tendency to interpret evidence in a way that favours the expectations that exist. Similarly, a false dilemma could skew the outcome of the literary review where lack of sufficient data presents only two possible categories, whereby if one set is accepted, the other stands rejected[22]. It could also result in a tendency appealing to ignorance, whereby an argument is considered true simply because there is absence of evidence. PWA is an emerging technology but has been around for some years. However, there is the risk that enough academic literature may not be available. There are abundant resources from the industry, and these will be useful if the source can be authenticated.

Maintaining schedule

The schedule poses a risk in that if deadlines are not met, the outcome may fail. There is the risk of insufficient

time as the research is to be carried out while at full time employment. Managing the project in an agile methodology will mitigate the risk of not meeting deadlines. To avoid the risk of schedule failure, a weekly review is proposed to determine the tasks completed, outstanding and compare the outcome with the plan. The schedule considers that enough flexibility is available to manage changes as change during such projects is inevitable.

Availability of DVLA resources

Availability of DVLA resources is governed by GDPR requirements. Any public oriented data which fall within the purview of GDPR requirements would require to move through the process of due diligence to ensure no information could be identified to individuals. However, the project is planned in a manner that ensures data related to personal details is nil, with only publicly available data being used. This in turn ensures free flow of information, within the allowable time. Availability of API relating to VES is dependent on the release dates planned by the DVLA. Continued engagement with the development team would help plan for delays. In the event of the public API not being available, an alternate plan would be to work with the service built around fake data.

Programming languages- skill acquisition and technical complexity

There is a requirement for some training, and this will be addressed at the early stages of the project. Software development is complex and is a people-oriented process with medium to large teams. Issues relating to lack of a team will be resolved with regular conversations with the supervisor. The guidance of a technical developer

within the DVLA has also been sought. All software is open sourced.

Timescale for collection of test data

Owing to the cross-sectional nature of the research, it may not be possible to test with a large sample of users. Every effort will be made to collect data from a wide range of demographics as a representative sample of the citizens.

Ethical considerations

Having pursued the ethical policies of the University, careful consideration has been given to the research process to not breach any ethics. All data will conform to GDPR. The sample population is planned to be over the age of 18 with no risk of exploiting vulnerable groups of people. consent will be obtained from participants. No personal data will be collected, and all feedback will be anonymous.

4.5 Data Collection and Evaluation

Saunders suggests that positivism could lend itself to other data collection methods and qualitative data can be quantified. He further concludes that in a multi-method technique, several data collection techniques can be used in combination with surveys, interviews etc.[15] As such data can be primary or secondary. Secondary sources could be sought from previous research and other cases of PWA usage.

Data collected will be of a qualitative and quantitative nature that fits the mixed method of data collection technique. It will also be cross sectional with a small sample size within a short period. Evaluation includes testing the app on several devices of different sizes and platforms against user requirements. A questionnaire will be utilised to record feedback from users.

It is hoped that the sample tested would give an indication of the projected value added.

Seaman, Carolyn identifies qualitative data as a source for the explanation of the hypotheses and relationships and how it can further help reason the outcome of quantitative analysis[23]. Based on that, we propose to collect qualitative data and derive some quantification to measure the effectiveness as well as identify the reasons for the effectiveness.

Conclusion

Having consulted the research union of Saunders et.al., the chosen methodology for the research is Positivism with a deductive approach. Strategies include document review, case study and software development with mixed method of data collection that includes qualitative and quantitative data.

5. Development Methods

Reed Sorensen defines Software methodology as a software model combined with one or more techniques such as prototype, cleanroom and Object-oriented.

5.1 Software Development Methodology

The choices range from waterfall, spiral Extreme programming to Agile practices and Test driven Development (TDD). Test Driven Development is the chosen development methodology.

A waterfall model involves going through software development cycle in

phases. Forsgren argues that a waterfall model is orchestrated with strict deliverables and lacks flexibility, speed and changing requirements and recommends DevOps that incorporates lean and agile culture[24]. An agile model provides for responding to user demands with fast continuous delivery. Based on the Agile manifesto, Agile methodology is a rapidly changing, learning process that embraces change while adding value to the customer[25]. It is a method that relies on cooperation and communication amongst self-organised team players and is the most popular software development and management practices at present. The popularity is driven by flexibility and quick delivery as opposed to waterfall.

Test Driven Development enables the development of software to be guided by tests. Besson et.al claim that empirical studies show that test driven development enhances developer confidence, code quality and assurance that code behaviour is as expected[26]. The key principles of TDD according to Mishra is to write the test first, focus on code to pass the test. He further states that TDD results in modularised software with bugs detected at an earlier stage[27]. Acceptance tests are a collection of unit tests that are based on user requirements and behaviour and forms the basis for Behaviour Driven Development.

Selecting an agile methodology allows for flexibility in adding features and to maintain a schedule with completion of goals monitored in timeboxed sprints which suits the project timescale. However, with the absence of a team, the ceremonies that go with agile practices are impractical and irrelevant and the suitable methodology to follow

in this instance would be a combination of Test-Driven Development and agile principles. Acceptance TDD focuses heavily on user experience and is appropriate for this project which caters to user expectations. The development will be broken down into two-week sprints. Features matching to user requirements will be identified as user stories. This will enable the minimum viable product to be ready on schedule.

6. Resources & Planning

Software development is technically complex and will require a variety of resources for its completion. In addition, there will be unexpected situations such as changes in requirements and resources needed thereof. Initial analysis has identified the following resources.

6.1 Resources Required

- Academic and non-academic material in various formats that have information on previous research from resource libraries and databases is required.
- Secondary Data on case studies, previous developments that have been carried out.
- Vehicle data from the DVLA database and Public API key.
- System requirements and UI design to keep the user interface in line with DVLA standards.
- Standardisation document in line with Government Digital services requirements.
- Checklist for PWA compliance provided by Google Inc.

- Access to software including React, Ruby, JavaScript, NodeJs, Redux, MaterialsUI, Ruby Gherkin, Cucumber, Jest, IDE, Google Developer tools including Lighthouse, Firebase, survey tools such as Microsoft forms or survey monkey and any other relevant software.
- Hardware including laptop and mobile devices in various sizes and platforms.
- Test data.
- Project management tools such as Microsoft projects, Microsoft planner or Trello.

AngularJS and React are most popularly used for user interfaces. React is more flexible and is being used by the DVLA. Materials UI is a good tool for the UI design, but it may be better to use the Government stylesheets to get a consistent look to the existing website. Ruby Gherkin and Cucumber for acceptance testing. Hence, it is proposed to build the app with React and nodejs. Microsoft planner is utilised to assign task deadlines and monitor progress.

6.2 Gantt Chart

Any project involves planning and it is useful to have a visual representation of the plan for easy understanding. Project management tools also assist in assessing progress giving early warnings and facilitates meeting deadlines.

The project has been broken down as a work breakdown with three phases as illustrated in figure:1.

- Preliminary Research
- Existing Research
- Software Development

Table:2 lists the tasks associated with all three phases with their dependencies. Figure:2 is a Gantt chart representation of the schedule and figure:3 is the Gantt chart with major milestones identified.

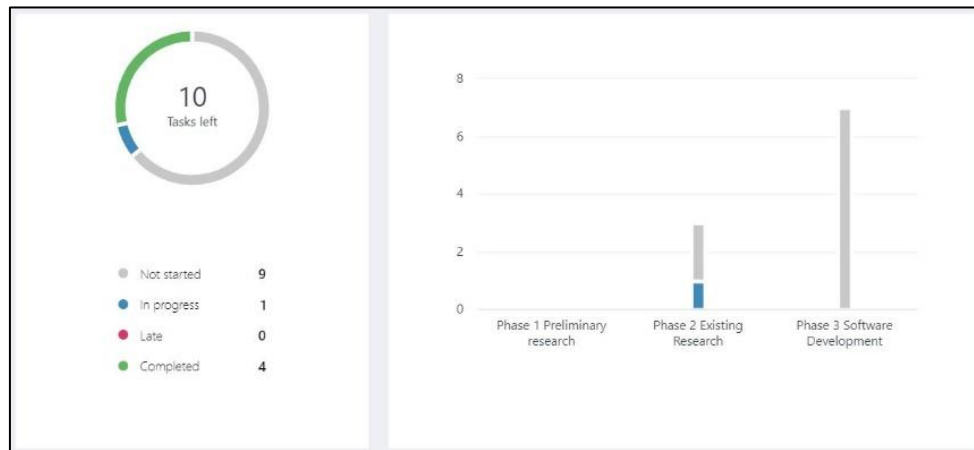


Figure 1 Work breakdown planner

Investigate the Use of Progressive Web App					
Activity No	Activity	Duration weeks	Start	Finish	Dependencies
1	Initial Research	5	10/03/2019	28/03/2019	
2	Initial Document review	5	01/04/2019	08/05/2019	1
3	Risk Analysis	1	12/05/2019	16/05/2019	2
4	Identify Resources	24	18/05/2019	20/11/2019	
5	Document Review	12	01/04/2019	30/07/2019	4
7	Collect Secondary Data	4	15/06/2019	15/07/2019	4
6	Analysis of Case study	6	15/06/2019	30/07/2019	4,7
8	Requirements Analysis	4	15/06/2019	31/07/2019	4
9	User Story Mapping	1	01/08/2019	10/08/2019	8
10	Holiday	3	11/08/2019	01/09/2019	
11	Development Sprints	16	02/09/2019	15/01/2020	8
12	MVP Release	12	02/09/2019	30/11/2019	11
13	UX Testing	2	01/12/2019	15/12/2019	12
14	Questionnaire	2	01/12/2019	15/12/2019	
15	Data Evaluation	1	16/12/2019	24/12/2019	13,14
16	Version 2 Release	4	30/11/2019	30/12/2019	12
17	Data Evaluation	2	02/01/2020	15/01/2020	16
		104			

Table 2 Task Breakdown

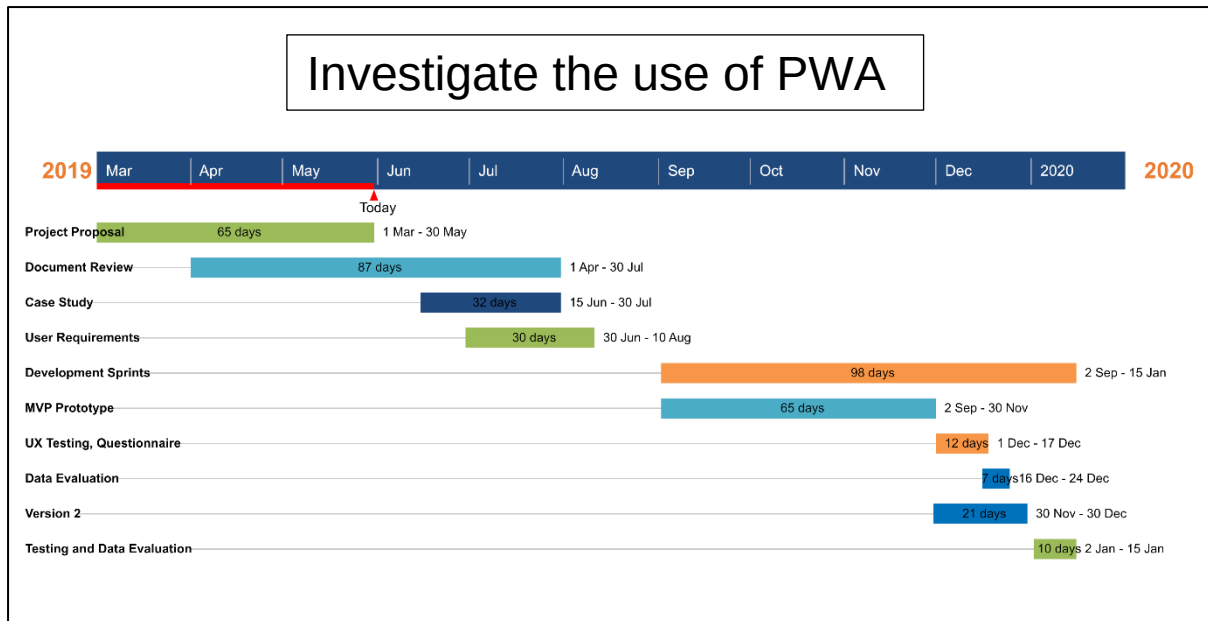


Figure 2 Gantt Chart

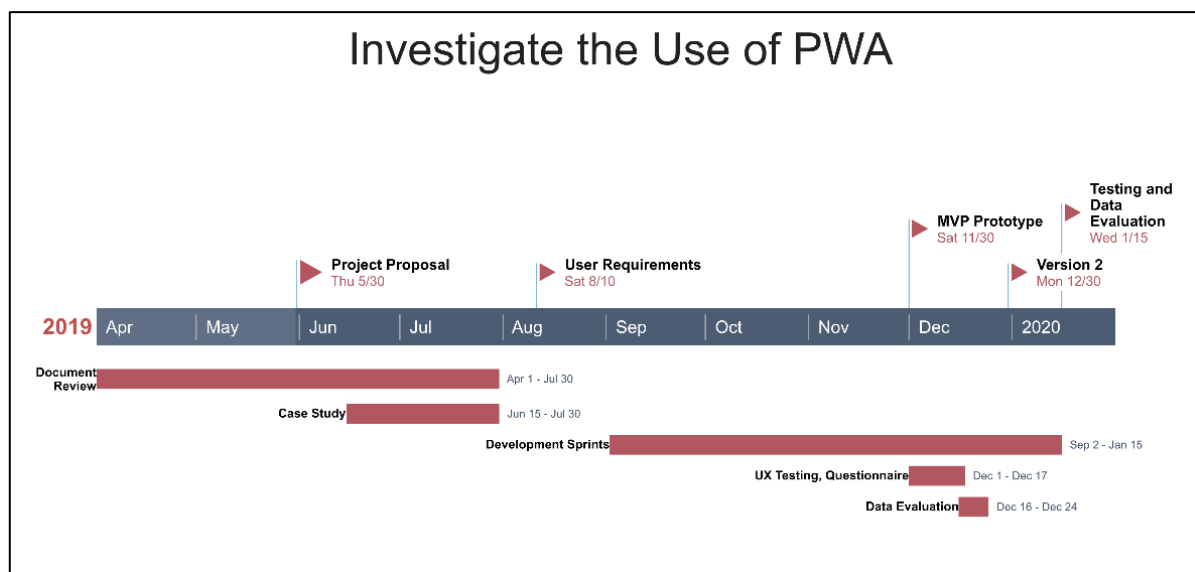


Figure 3 Gantt Chart with Milestones

Conclusion

With the aim to investigate the use of PWA in DVLA, research on the need for mobile apps in Government, a comparison of PWA and native app will be carried out. A mixed bag of document review, primary and secondary data collection by way of

surveys and case study will be performed. The data is envisaged to be qualitative on an unbiased sample. A piece of software artefact of PWA will also be developed and tested for user experience to either accept or reject the hypotheses.

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