A close up of a sign

Description automatically generated

**FINAL YEAR PROJECT DISSERTATION**

By

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ABSTRACT

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# Introduction

# Methodology

Brainstorming

Christian and I decided to collaborate on the project at the beginning of the academic year. We were assigned Daniel Cregg as our supervisor and quickly got underway in brainstorming ideas. We knew from early on that we wanted create an E-Business application.

We also wanted to include some new form technology that isn’t typically found in these type of applications. NFC technology piqued our interest as NFC capable smartphones are becoming more widely accessible at modest price points. We got underway in researching NFC technologies through articles and scientific papers and formed an understanding of how it works.

We liked the idea of having our application complementing a real world marketplace – The Galway Market – so customers could download the app and browse the market’s available products and purchase them from the comfort of their own home. They could also attend the market in person and by simply tapping their phone against an NFC tag connected to a product, easily purchase this product virtually, eliminating the need for cash-based transactions and possibly even eliminating the need for vendors to be manning their stalls.

Upon agreeing to a general outline of the functionality of the application, we began discussing which technologies that would best fit the development process of the project. This included what platform to build the application on and what frameworks and languages to use to build the application.

Project Management

Agile

Agile software development, as defined via “The Manifesto for Agile Software Development” [1] comprises of a set of principles that accommodate changes to requirements at any stage of the development process. The principles are not a concrete definition of agility, but instead are guidelines used to deliver software in an agile manner. [2] Agility is used to rapidly and flexibly respond to change in the development process. [3] It allows the software to be continually improved during development and also enables early delivery of working prototypes.

We had learnt several types of methodologies for managing software development lifecycles during our time at GMIT and felt that agile was best suited to us as its principles state face-to-face communication as the best way to transfer information and for regular meetings to discuss and react to changing project requirements. Other project management approaches such as the Waterfall Model were considered but as this would require diligent planning, it was ruled out.

Scrum

Scrum is a framework that is used to control and manage the software development process. It increases the speed of production by splitting time into blocks called sprints, which are usually two weeks to a month long. Short daily meetings known as daily scrums are used to track progress on a sprint. Meetings are held at the end of a sprint to review the work that was or wasn’t completed and to present this work to the stakeholders. Discussions are then had with the stakeholders to outline work to be completed in the next sprint.

For our project, we had week long sprints in which Christian and I were assigned a specific workload each week. Then, on the following Monday, we would meet with our project supervisor and discuss what work both of us accomplished during the previous week and set out work for the week ahead. Christian and I also stayed in daily communication in which we would discuss how we are both progressing on the current week long sprint and help each other out where needed.

TESTING

Selenium was the IDE chosen to test the features of the application. This was done by loading the application on the Google Chrome web browser through the Ionic CLI development server with the command *“ionic serve”* and then testing features such as login/logout, adding products to cart and switching between pages in the application. As we were using an Apache Cordova plugin for NFC capabilities, this is not supported on web browsers and all NFC features were manually tested on the hardware device and then recorded.

# Technology Review

Project Management Tools

Git

Git is a version control system that is used to track changes in code during the software development process. It allows collaborators on a project to download the newest version of the software they are working on, make changes and upload the newest revision on the code.

Christian and I have used Git extensively during our time in college and always found it extremely reliable to use. Although we did briefly discuss other types of version control software, we decided to stay with Git as it is the best and most popular system to use.

Testing Tools

Selenium

Selenium is a framework for testing web applications that can run on Windows, Linux and MacOS. It provides a range of tools and libraries that enable functional tests through the Selenium IDE. It also supports tests written a number of programming languages such as Java, Python and Ruby. These tests can then be run on all major web browsers.

Hardware – rename heading?

NFC

NFC (Near-field Communication) is a technology used for short-range contactless communication. It is designed for mobile phones that is mainly used for mobile payments, identification and mobile marketing. [nfcporter]It operates in a radius of roughly four centimetres and ALLOWS communication between two devices, with both devices being able to send and receive information. It doesn’t rely on other digital communication types such as Wi-Fi, Bluetooth or LTE. [androidpit what is nfc] The technology is commonly found and widely used in the realm of contactless payment. Google Pay and Apple Pay [support.google.pay pay answer][apple ie apple pay] both support contactless payment with NFC enabled devices. Banks such as AIB and Bank of Ireland also have NFC chips in their more recent debit and credit cards with contactless payment of up to EUR50 being possible (As of April 1st 2020) [aib contactless][BOI contactless]

NFC Tags

NFC tags are passive devices that are used to communicate with an active NFC device such as an NFC reader/writer or NFC capable smart phone. There are multiple types of tags that are each based on different standards such as ISO14443A or Sony FeliCa system.[electronics-notes nfc tag types] Tags can generally be used to read and write information such as website URLs or perform a task such as executing a certain task on a smart phone like opening up a certain app.

Developer Tools

Visual Studio Code

Visual Studio Code is a light-weight code editor designed by Microsoft for use on Windows, Linux and MacOS. It comes with built-in support for JavaScript, TypeScript and Node.js.

The majority of our project’s source code was written in this editor as it comes with pre-installed Git, syntax highlighting, code completion, code refactoring and has multiple extensions that can be installed for various functionalities such as support for other languages including C++, C#, Java, Python, Go, among others. [vscode docs]

As of 2019, Visual Studio Code is the most widely used development environment with 50.7% of survey respondents reportedly using it [vscode survey]

Android Studio

Android Studio is the IDE for the Android operating system. It is built on JetBrains’ IntelliJ IDEA and is designed to be used for Android development. Kotlin is the preferred language for Android development on this platform. However, Java and C++ are supported in this IDE also. Android Studio has a myriad of features such as Grade build support, refactoring and Lint tools.

The Android SDK tools compile source code, data and resource files into an APK (Android package) which is then used to install the app on Android devices. [android studio docs]

ASTRO

ASTRO is a utility application for Android that is used for file management. It is used for navigating folders on Android devices and performing tasks on files such as Copy, Move and Delete. It supports zip and tgz files, making it possible to compress or extract archive files.

This application was used to circumvent a problem we experienced in that our phones were not being recognised by our laptops so we weren’t able to target our devices while building the APK to test. Instead, the APK was built in android studio and then we would email it to ourselves and use ASTRO to extract the file onto our phones for testing.

Application Development Tools

Typescript

Typescript is a superset of JavaScript that provides functionality for static typing, classes and interfaces. [typescript docs] It is designed for the development of large applications and compiles to JavaScript through the Typescript compiler. [typescript wiki] Bugs and errors are caught early in development as the Typescript compiler informs the IDE on its rich type information. Static typing enables tooling and IDE support and establishes a robust codebase.

Apache Cordova

Apache Cordova is a web development framework that allows the use of standard web technologies for cross-platform development. Applications are executed in wrappers that target each platform, and use API bindings to access device capabilities such as sensors, data and network status. [cordova docs]

Plugins are central to Cordova. A set of plugins, Core Plugins, are maintained by Apache and allows applications to access device capabilities such as battery, camera and NFC sensors. [cordova docs] Developers can also create their own plugins using JavaScript.

Angular

Angular is a TypeScript based app-design framework. [Angular docs] It is a complete rewrite of AngularJS that includes new features such as dynamic loading, asynchronous template compilations and iterative call-backs provided by RxJs [angular wiki]

Node Package Manager

npm is a package manager that is used for the runtime environment Node.js. It has an online registry containing over 800,000 code packages in which developers share software. Organisations also use npm to manage private deployment. [w3s what is npm] The online registry is accessed via the npm command line client.

Ionic Framework

Ionic is an open-source user interface toolkit that is used for building mobile and desktop applications using standard web technologies HTML, CSS and JavaScript. [ionic docs] Originally built on top of Angular and Apache Cordova, the web components included in recent universally pair with JavaScript frameworks such as Angular, React and Vue. The components can also be used without any interface framework. Backend connections to Ionic apps are plentiful with options such as AWS, Azure and Firebase available. [ionic what is ionic, ionic docs, wiki]

Ionic is installed and updated through the Ionic CLI. It also comes with built-in debugging tools and a development server.

Stripe

Stripe is a payment processor that supports electronic transfer of money from a customer’s bank to a merchant’s bank. It accepts most payment types such as Visa, MasterCard and American Express, along with mobile wallets like Google and Apple Pay. It comes with a custom UI toolkit that allows merchants to create their own custom payment form for applications. It also has a pre-designed payment form to be imbedded in applications. Creating custom invoices and payment requests are also easily created with Stripe. [fundera stripe reviews]

Database

Firebase

Firebase is a Backend-as-a-Service (Baas) on the Google Cloud Platform. It takes away the need for developers to manage their own servers and write APIs. [howtofirebase what is firebase] It provides a suite of tools and services for the development of mobile and web applications. [Firebase docs web setup] The features that we used for the development of our application provided by Firebase are authentication, real-time database, hosting, cloud functions and storage.

Firebase Authentication

Firebase Authentication provides backend services to authenticate users to applications through ready-made UI libraries. It supports authentication using passwords, phone numbers and authentication APIs such as Google, Twitter and Facebook. [firebase auth docs]

Authentication credentials are collected from the user within the application, be it an email address and password or federated identity provider. These credentials are then passed to the Firebase Authentication SDK in which they are verified using the Firebase Authentication backend services and a response is returned to the client.

Real-Time Database

The Firebase Real-time Database is NoSql cloud-hosted database. Data is stored as JSON and is synced across all clients in real-time. The database remains responsive when offline as it persists data to disk. Upon re-establishing connectivity, data is synchronised server state and receives any changes it missed. [firebase database docs]

Cloud Firestore

Like the real-time database, data is synced across client apps through real-time listeners and offline support is offered with the Cloud Firestore database. Data is stored in documents, ordered into collections. Documents can then contain nested objects and sub-collections. Queries can be performed on the database to retrieve specific documents or all documents in a collection. [Firestore docs]

Cloud Storage

Cloud Storage is an object storage service used to store and serve user-generated content such as pictures and videos. [storage docs]

Firebase Hosting

Firebase Functions

Cloud Functions is a server-less framework lets applications to run backend code automatically in response to events triggered by HTTPS requests and Firebase Functions. [Firebase functions docs] These Firebase Functions are deployed through the Ionic CLI (or whatever framework the app is being built in) and is stored in the Google Cloud. Various Firebase and Google Cloud features can be triggered through these functions such as authentication, storage and online payments.

# System Design

# System Evaluation

# Conclusion

# References

# References

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| [1] | J. Dillon, “Irish Retail and Consumer Report 2019: Investing in Experience,” *PwC network,* pp. 2-3, 2019. |

# Appendices

GitHub Repository

The link to our GitHub Repository is: https://github.com/kodama96/FinalYearProject