

Pavements

Project Report

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Abstract

The purpose of this document is to give an overview of the project. This document will also outline the project as a whole and discuss how successful the project has been. The primary user of this application is going to be a current employee of McCurdy associates. This mobile application will provide McCurdy associates employees an application that will help with their surveys that they complete quite frequently.

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1. Introduction

This report will document the development process of the Pavements application. Pavements is a cross-platform mobile application for McCurdy Associates that helps conduct surveys, which previously had to be completed using pen and paper. Some issues that McCurdy Associates had are as follows:

- Some of the surveys conducted could be on a stretch of road that could be 10 kilometres. If it started to rain the paper would get wet, therefore it would become unreadable and not reusable.
- These surveys are all handwritten and when back in the office have to be typed into a report for the county council, therefore with a mobile application where everything can be stored in a database it saves time.
- Sometimes these reports for the county council are not completed by the person who conducted the survey, therefore the person who completes the report is unable to read the survey another employee had conducted as it was handwritten.
- McCurdy Associates also used a separate application to take photos of the defects to record the coordinates of where on the road the defect is.

2. Project Description

The Pavements application is built as a cross-platform application using Xamarin, which utilises the power of Extensible Application Mark-up Language (XAML) for the applications Graphical User Interface (GUI) and the C# language for functionality, and Visual Studio as the main development environment. Xamarin has been in development since 2011 and has a large community of developers continuously adding to the extensive open source library collection. Visual Studio has incorporated Xamarin as one of the default development options with access to the extensive library set using the NuGet packages option and provides ongoing support via a wiki page community forum.

The GUI for this application was built using XAML, which allows the user interface to be drawn with stylised layout or “blocks.” similar to Hyper Text Mark-up Language (HTML).

Also, in this project utilising the technology of the mobile device like the camera to take pictures, microphone to record audio and GPS to record coordinates to get location of defects and to locate where on the map they start their survey are all used using the NuGet packages that available through Xamarin

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2.1 Project Screenshots

2.1.1 Main Page



The home screen is where the user can select a number of options which include Start a New Survey, All Employees page and View Previous Surveys.

Figure 1. Home Screen

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2.1.2 Previous Surveys

Survey ID	Location	Date	Survey By	
31	Coney Green	4/6/2020 1:08:48 PM	Aoife (Manager)	RESUME
30	Coney Green	4/4/2020 2:58:57 PM	Michael (Manager)	RESUME
29	Coney Green	4/4/2020 2:41:04 PM	Michael (Manager)	RESUME
28	Coney Green	4/3/2020 3:15:19 PM	Aoife (Manager)	RESUME
27	Coney Green	4/3/2020 2:48:39 PM	Aoife (Manager)	RESUME
26	Coney Green	4/3/2020 2:42:05 PM	Aoife (Manager)	RESUME
25	Coney Green	3/30/2020 2:11:06 PM	Aoife (Manager)	RESUME
24	Amphitheatre Parkway	3/5/2020 9:51:14 PM	Aoife	RESUME
23	Kilkenny Road	3/3/2020 2:45:14 PM	Aoife	RESUME
23	Kilkenny Road	3/3/2020 2:45:31 PM	Aoife	RESUME
23	Kilkenny Road	3/3/2020 2:45:37 PM	Aoife	RESUME
22	Kilkenny Road	3/3/2020 2:31:25 PM	Aoife	RESUME
21	Amphitheatre Parkway	2/29/2020 10:29:30 PM	Aoife	RESUME
20	Amphitheatre Parkway	2/29/2020 10:15:01 PM	Aoife	RESUME
19	Amphitheatre Parkway	2/29/2020 9:07:30 PM	Fred	RESUME

The Previous Survey page shows all previous surveys that have been set up or completed. From here you can select a previous survey and can continue on with a survey.

Figure 2. Previous Surveys

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2.1.3 Employee's Page

The Employees page displays all the Employees names and their position in the company. From here the user is given the option to add an Employee by selecting the "Add Employee" button. Also, from here the user can select an employee and have the choice to Update or Delete. Before the user can delete their given a popup to saying "Delete? Are you sure" shown in Figure 4.

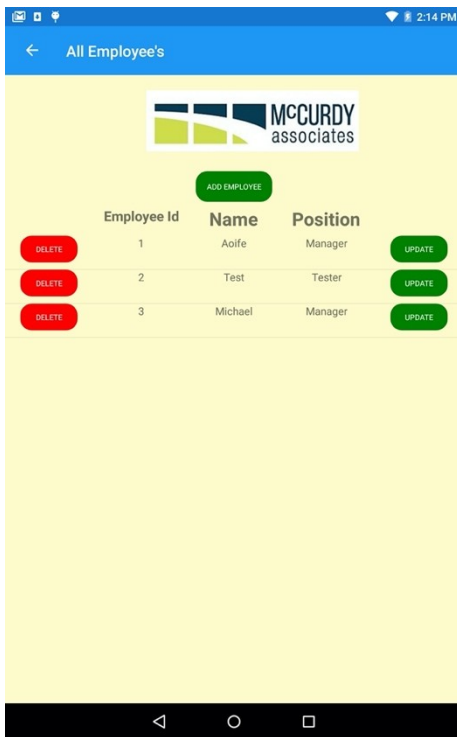


Figure 3 Employees Page A

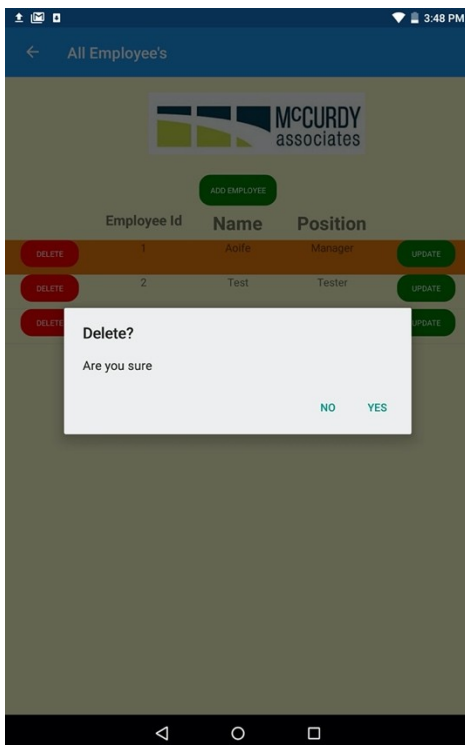
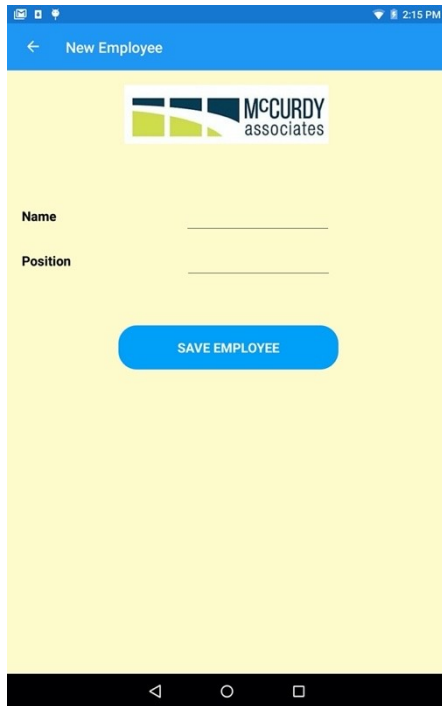


Figure 4 Employees Page B

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2.1.4 Add an Employee



The Add Employee page allows the user to add an employee into the database. Both fields are required to be filled in before the user can save as shown in Figure 6. An Employee ID is auto generated in the background.

Figure 5. Add Employee A

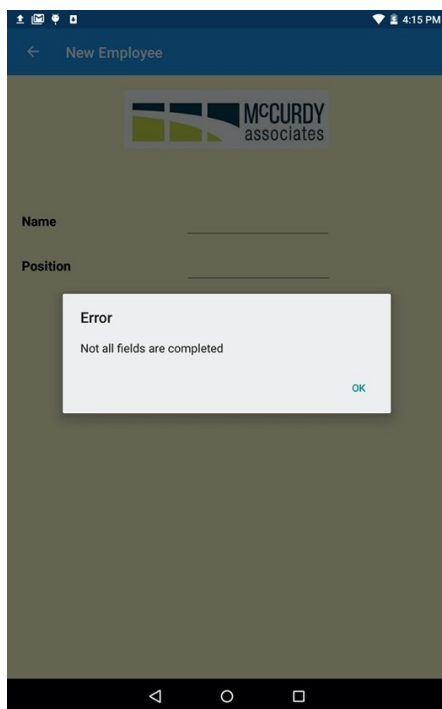
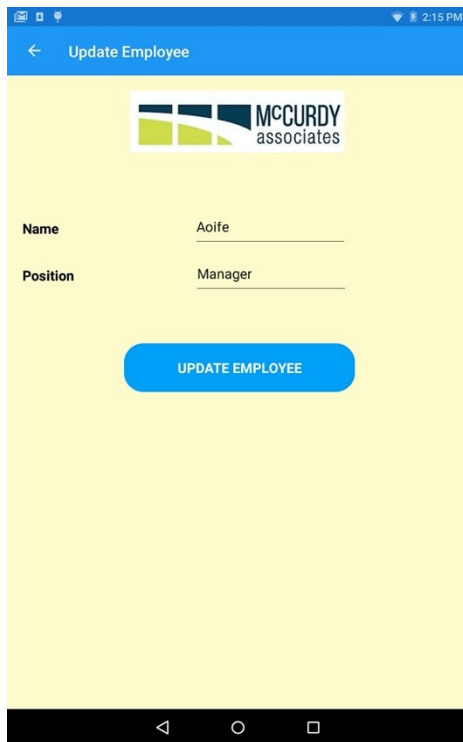


Figure 6. Add Employee B



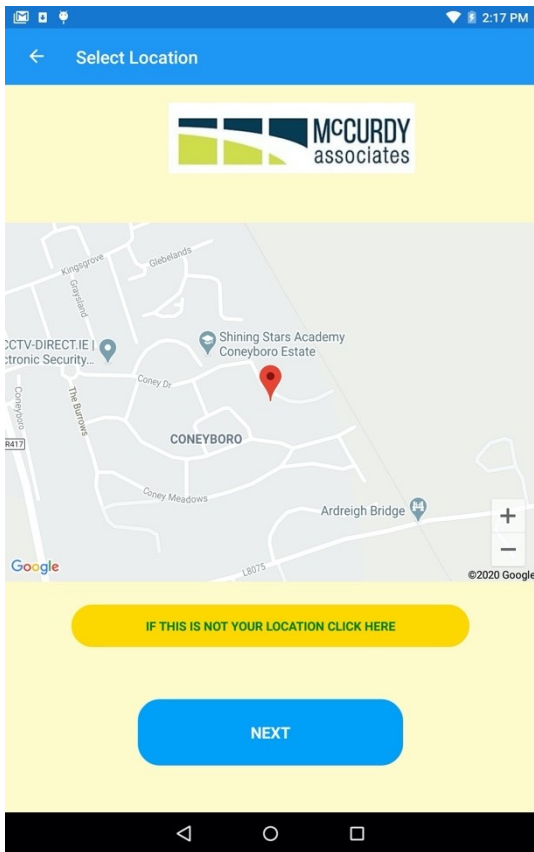
2.1.5 Update an Employee

The Update Employee Page is prepopulated as the page is displayed from the previously selected Employee from the previous page.

Figure 7. Update Employee

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2.1.6 Your Location

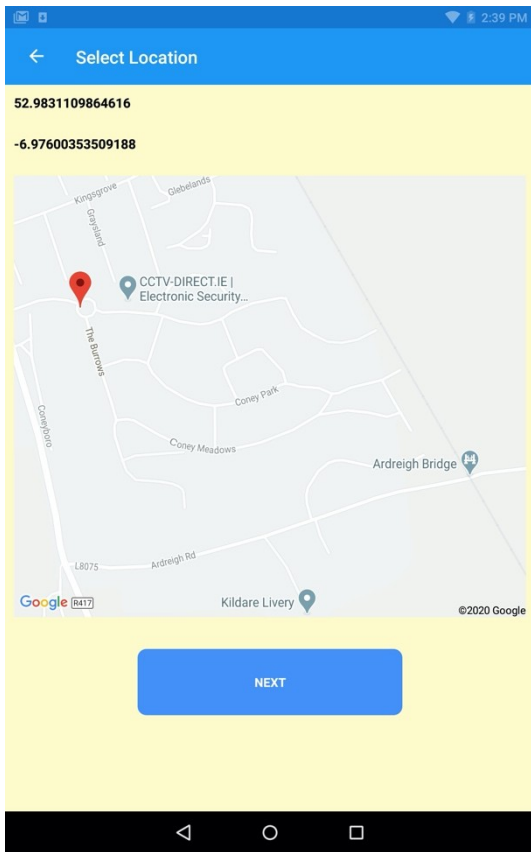


The Your Location displays a map with your location. The map is being displayed using a NuGet Package and using Google API. Also, to display your current location using coordinates from a Geo Location NuGet Package and using the GPS feature from the mobile device. Also, from here if this is not your current location, there is an option to click that will bring you to another page where your given the option to select your location.

Figure 8. Your Location

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2.1.7 Select Location



The Select Location page displays another map same as the previous page but the difference in this map is it gives the user the option to select their location on the map by tapping on the street. When the user taps on a street the pin moves and displays their coordinates on the top of the screen.

Figure 9. Select Location

2.1.8 Survey Details

The Survey Details page allows the user to enter in detail about the survey that are required. These fields are options that had to be written on the page in which McCurdy Associates currently use to conduct their surveys.

Some of the fields are prepopulated from the previous page like the Latitude and the Longitude. Also, the Date is prepopulated. As shown in Figure 11, the options for the Survey Completed by field are a list of employees from the database and shown previously in Figure 3 in the Employees page. All fields are required and given and cannot continue if any fields are empty.

Survey Completed By: Please Select Employee

Select Date: Saturday, April 18, 2020

Weather: Please Select Weather

Latitude: 52.9831109864616

Longitude: -6.97600353509188

NEXT

Figure 10. Survey Details A

Survey Completed By: Please Select Employee

Please Select Employee

- Aoife (Manager)
- Test (Tester)
- Michael (Manager)

CANCEL

Longitude: -6.97600353509188

NEXT

Figure 11. Survey Details B

2.1.9 Extra Survey Details

As like the Survey Details Page, this Extra Survey Details page are fields that are required before the survey is started. All fields on this page is from a picker and all options was given to me by McCurdy Associates. Along with the options in each field from the picker another option is to select "Other" and if that option is selected a text field appears where the user can type in text as shown in Figure 13. All fields are also required so will be given an error and won't be able to continue if any fields are empty. This is also the first same point in the application and the user has filled in all the required details and start the survey from here.

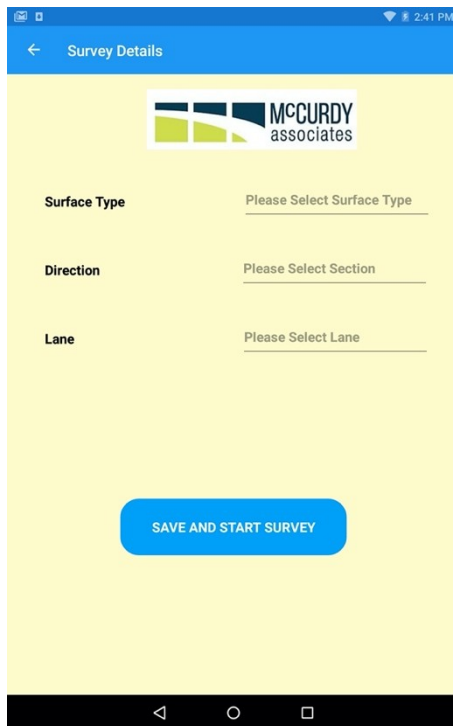


Figure 12. Extra Survey Details A

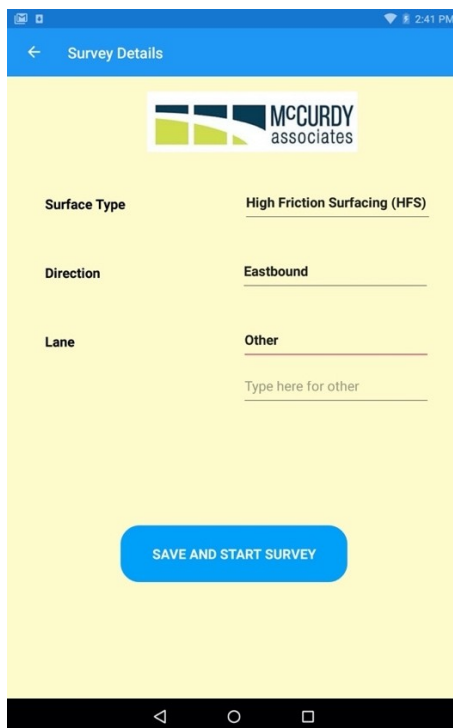


Figure 13. Extra Survey Details B

2.1.10 Defect Selection

The Defect Selection page is the page that will be displayed as the user conducts their survey. As they come across defects their given options that can be selected to match the defect the user comes across on the road. When the user comes across a defect and select an option, the user's coordinates are recorded to the whereabouts of the defect. When the user has finished conducting their survey and select "Save and Continue", the user is then brought back to the Home Screen page.



Figure 14. Defect Selection

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2.1.11 Defect Information

The Defect Information page is the page which the user enters all the details about the defect they have come across while they are conducting their survey. At this stage the application has recorded the users GPS coordinates in the background, along with the user has a measuring wheel that they would also use to record the first field “Chainage”. The measurement type is prepopulated, and the measurement Value is the size of the defect the user has come across. The user is also given the option to add comments and this is the only field that is not required on this page.

The user is also given an option to take a photo of the defect, when the user selects this button the camera is displayed, and the user can take a photo. The image is then displayed in the application as shown in Figure 16.

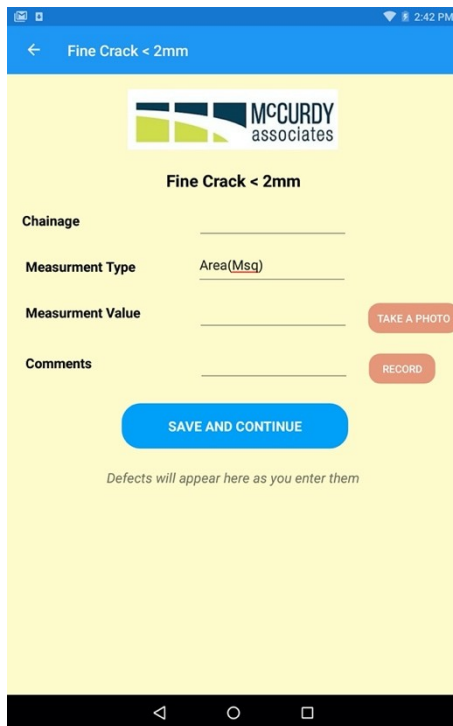
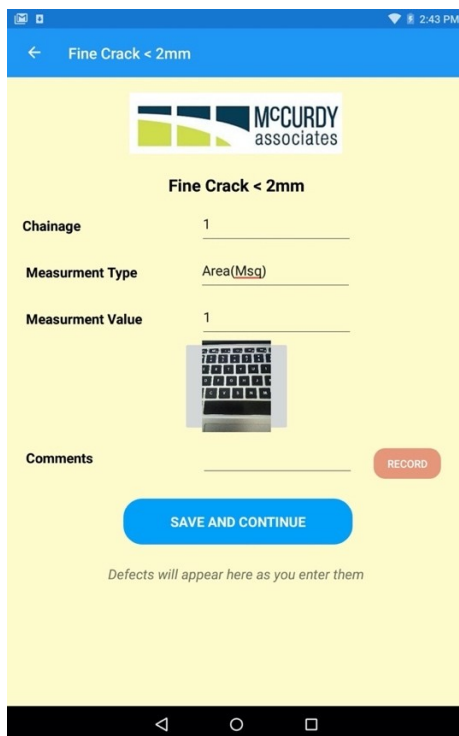
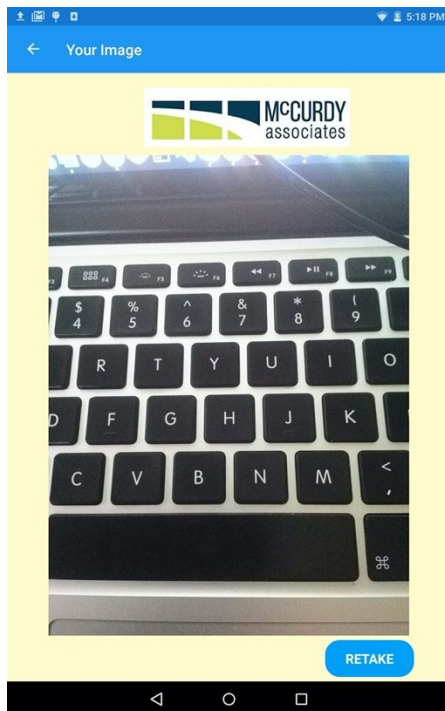


Figure 15. Defect Information A



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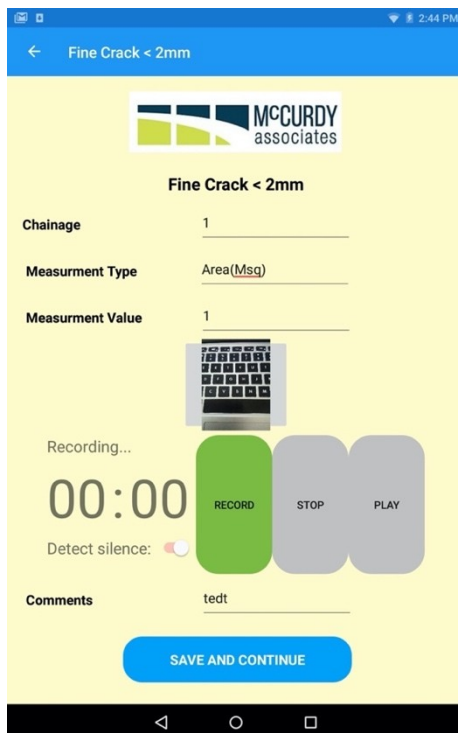
Figure 16. Defect Information B



As shown in Figure 16 an image is displayed in the application after the user has taken a photo of the defect. This image is also clickable to enlarge the photo and also given the option to retake the photo as shown in Figure 17.

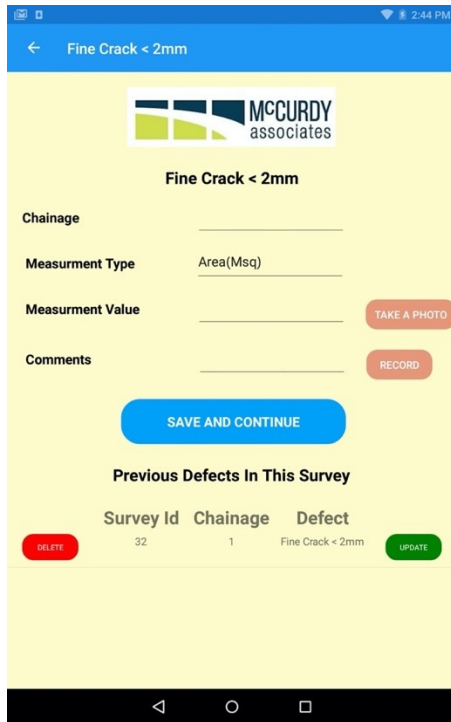
Also shown in figure 16 the user is given an option to record audio, when the user selects this a recorder is displayed in the application as shown in Figure 18. From here the user can start recording and the timer will start until the user selects Stop. When the user selects stop the play button turns green so if the user wants to hear the recording back, they can. The user also has a toggle switch "Detect Silence", when this is selected if the recorder doesn't detect sound it stops recording. When the user has finished entering all the information and selects "Save and Continue", the user is brought back to the Defect Selection page.

Figure 17. Defect Information C



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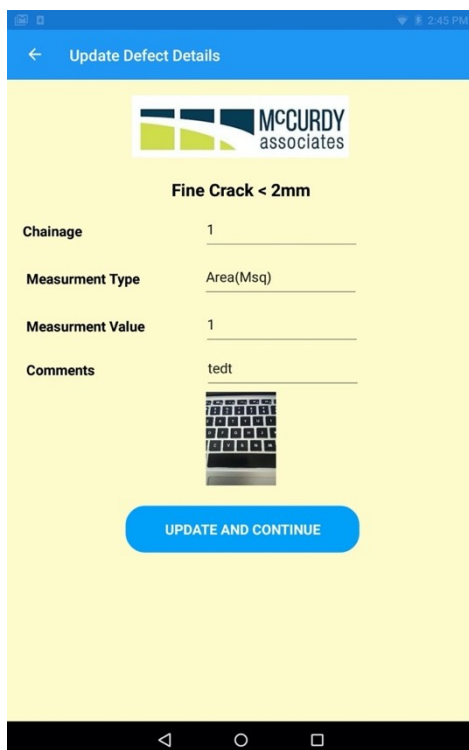
Figure 18. Defect Information D



Shown in Figure 15 when the user first accesses this page there was no previous defect, but now as the user has entered in a defect the user is given the option to delete or update that defect as shown in Figure 19. Defects will only appear here if the user has entered in defect on that specific defect that the user has selected. If the user finds more defects like “Fine Crack < 2mm” like shown in Figure 19 then they will be added to the list of defects but will not be shown if another defect is selected from the Defect Selection page.

Figure 19. Defect Information E

2.1.12 Update Defect



The Update Defect page is prepopulated with the data from the previous page where the user selected a defect to update. The image is also shown, only if a photo was taken using the camera within the application. Once the user selects “Update and Continue”, the user is brought back to the Defect Selection page.

Figure 20. Update Defect

2.2 Development Challenges

2.2.1 Xamarin

One of the main development challenges in this project was the initial set up of this project and getting an understanding of the extensive cross-platform libraries available via NuGet packages for Xamarin, as many of them were very useful but some just did not work as was there was a lot a versions to choose that were available on the same NuGet package but simply did not work. Sometimes it was a case of one working on Android but didn't work on iOS so was unable to use.

As I had some experience in developing in Xamarin, this is the main reason in choosing Xamarin to develop Pavements. But the experience I had was that the application I had worked on previously was already set up and just needed to add to the existing code. In this Application there was libraries like Prism, which is a framework that helps with navigation, binding properties to the Extensible Application Mark-up Language (XAML) and the availability to use variables from page to page. As I was unable to get this library to work, it was rather steep learning curve to Xamarin's take on the Model View View Model (MVVM) pattern as Prism was the library I had initially wanted to use.

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2.2.2 Firebase Storage

As part of this Application, Images needed storing from the user using the camera and also audio files needed storing as the user can voice record instead of typing. As Firebase Realtime Database was the Database being used to store all the data in this application, all the Images and audio files were stored in Firebase storage. Storing these files were more difficult than initially thought but as in one of the pages Images needed to be shown that were stored in Firebase storage. This gave all sorts of issues, first being images being stored in Firebase storage needed the authentication token that was applied to the Image as they were stored in Firebase storage. Also, another issue was actually displaying the image, as in Xamarin the image that needed displaying needed coming from the URL of where the image was stored along with the authentication token of the specific image that needed to be displayed in the application.

2.2.3 Custom Renderers

Custom Renderers in Xamarin gives the developer the ability to change the behaviour of certain NuGet packages in Xamarin. One of the NuGet packages used in this application was Xamarin.Forms. Maps which gives the user the ability to see the map in the application and see the pin on the map that indicates the user's location on the map. But the user is unable to click on the map to move the pin, this is where Custom Renderers are used to change the behaviour of the map that is shown to the user. A Custom Renderer needed to be developed so the map can have a clickable event on the map so the pin moves and gives the coordinates of where the user clicked on the map and a replace the pin that the page initially shows.

This was not an easy task as making the map clickable and listen for the behaviour change and not only that but place the pin to show that it works. But the most difficult part of this task was to get the coordinates from where the new pin was placed by the user clicking on the map and placing the pin. This was achieved by over writing the previous position with a new position i.e. the new pin position and getting the coordinates of that new position which all needed to be done in Custom Renderer that was developed.

3. Adherence to Specification and Design

In many respects, the Pavements application stayed through to its original design laid out at the start of the application. Most of the core functionality implemented that was originally set out to do with some extra functionality added in. One of the major functionalities that was added in was given the user the ability to record audio to a certain defect while conducting their survey. Not only does this save time for the user rather than type it into the comment section in the Defect Information page but will most probably encourage the user to give more information about the defect the user has come across.

The user can now take photos of the defect and know the exact location of where the photo was taken as previously the user conducting the survey needed to use a separate application along with given the information about the defect in paper form to achieve this, it can all be done in the one application.

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At the midway point of this application in development, a preview of what the application was shown to McCurdy Associates. After some positive feedback, some functionality which was asked to be added in which was not initially thought of at the start of the project. This being given the user the ability to edit a certain defect within the application. This was another major functionality that needed to be added in and was achieved in this application by clicking into the specific defect on the Defect Selection page and a list will appear at the bottom of the page if and only if there was and defects in the specific defect selection in that current survey. From here the user has the ability to delete and update that specific defect. The GUI of the Pavements application has remained true to the original design which was set out from the beginning for the most part. Some minor alterations were made due to XAML limitations within Xamarin and near the end of the development of the application a navigation bar at the top of all screens was considered but due to time constraints it wasn't achievable.

4. Learning Outcomes

4.1 Technical

During the development of this project, some technologies I was familiar with and had already used but there were several new libraries that I was unfamiliar with that were available. Some technologies used for this project had to be learned for the completion of this project therefore given a greater increase in the learning outcomes from this project. The technologies used to build the Pavements application are discussed below.

4.1.1 Xamarin

Xamarin is an open source extension of the .NET platform which provides tools and libraries specifically for the development of cross platform applications. Xamarin began as a specific development tool to develop native applications but then expanded into Xamarin Forms to become a cross platform development tool to give the developer the opportunity to write code one in a single language C# and have it available on both Android and iOS.

4.1.2 Firebase

Initially the plan at the start of the project was to store all data in the application using SQLite. But as SQLite only stores all the data locally on the phone this was no benefit to the application as having a cloud based storage technology would benefit the application a lot more as this would be easier for the Employee's at McCurdy Associates to access all the data needed to put into their reports required by the County Council.

After some research, Firebase seemed a likely fit for this application and what was required to store both data that the user enters into the application but also have the ability to store images and audio files and utilizing Firebase storage.

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4.2 Personal

Time management became an essential part of not only completing this project, but also balance this with other studies but overall, I have greatly improved on this during the process of completing this project. To complete this size of project as well as other assignments and tasks given to us over the course of the year, I have had to implement strict time limits and balance how much time to spend on each assignment and how much time to spend doing this project.

The project itself was a difficult task from start to finish not to mention all the other assignments for other modules. To optimise my time, I broke down all tasks into their simplest aspects, then set weekly goals to quickly work through all the things that needed to be completed.

Organising my time became an essential part of my whole 4th year and this was done with the use of the Trello application as this gave me a clear picture of what I wanted completed in any given week.

5. Project Retrospective

5.1 Project Success

In the projects current form for the most part the application is ready to use. Functionality wise the user can use the application to complete any survey once the user has internet access. Everything an Employee could write on the paper base report is achievable within the application and extra. The user can select its location on the map if the location they are shown on the map is wrong using the GPS coordinates from the mobile device. All data that is recorded within the application is stored in a cloud-based database, by doing this more than one person can complete the one survey. Using a cloud-based database also allows for app persistence through devices, allowing the user to retain all their data from one device to the next. The user has the ability to take photos of the defects they come across and also record a voice recording about a defect, therefore saving time for the user as it can be all done in the one application.

Xamarin was a successful choice in developing the Pavements application. Xamarin allowed integration with Firebase NuGet packages that allowed access to not only store data but also access it to display lists of previous surveys, employees and all added defects.

5.2 Project Failures

Due to not having an Apple Developer licence, the application was not fully tested on the iOS side. Using external features of the device like the camera and the microphone, testing features like taking photos and recording audio was not possible on an emulator and was unable to install on an apple device. As McCurdy Associates intended this application being primarily used on an Android device this application was mostly concentrated for an Android device.

This application will only work with an internet connection, as McCurdy Associates do some work in other parts of the world like China, they were looking for something that would work

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without having an internet connection. But due using google maps API this has not got an offline feature to work with Xamarin. Without this the application would simply not work as the application is getting coordinates and using them throughout the application.

5.3 Future Development

There are many features this application would benefit from in future development. As mentioned before about Pavements not being able to work without an internet connection. This application would benefit from using an offline map to work like maybe Open Street Maps. This would be beneficial to the application so McCurdy Associates could work with this in other countries like China. As Firebase supports offline persistence this could also be added into the application but as maps wouldn't work offline this was not added into the application.

Also as mentioned above, a navigation bar at top of each screen would benefit the user for quick and easy access back to the Home screen and other pages like an admin tab for the user to access the employee page.

Acknowledgments

Many thanks to my supervisor Paul Barry, whose advice, expertise and guidance was invaluable on the development of this project. Also, would like to take the opportunity to thank Aoife Quinn from McCurdy Associates for making this project possible and was a pleasure to work with both Paul Barry and Aoife Quinn.

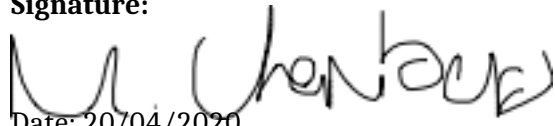
Declaration

- I declare that all material in this submission e.g. thesis/essay/project/assignment is entirely my/our own work except where duly acknowledged.
- I have cited the sources of all quotations, paraphrases, summaries of information, tables, diagrams or other material; including software and other electronic media in which intellectual property rights may reside.
- I have provided a complete bibliography of all works and sources used in the preparation of this submission.
- I understand that failure to comply with the Institute's regulations governing plagiarism constitutes a serious offense.

Student Name: Michael Chambers

Student Number: C00220585

Signature:

A handwritten signature in black ink, appearing to read 'M. Chambers', written over a light blue horizontal line.

Date: 20/04/2020