Final Year

Project Report

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OÉ Gaillimh
NUI Galway

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Finally, I'd like to thank the volunteers who gave up their time to test Beacon in it's final stages, and for their honesty in evaluating it.

Declaration of Originality

"I hereby certify that this project is entirely my own work. Neither the project nor parts thereof have been published elsewhere in either paper or electronic form unless indicated otherwise through referencing."

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Aisling Guinan

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Date

Chapter 1: Introduction

1.1 Project Motivation

When families visit a new place, or go on holiday, finding suitable activities for children to engage in can be difficult. This is a problem that is also experienced by youth groups, school tour groups, as well as Scout and Girl Guide leaders. Activities can be limited by age and weather conditions, as well as budget and access to transport. Access to this information could reduce stress level in adults, levels of boredom in children, and time wasted when a day out has been planned and one of the above factors disrupts plans.

The name 'Beacon' was chosen as the project name, as it is a device that attracts attention to a certain location, much like the app does.

- ### Project Goals

The goal of this project is to create an app that can be used by parents to help families

become more active, and to bond closer by bringing them together to explore new and fun activities together. This app should be straight forward to use, feature a map and locations, feature an ability to add places, as well as an ability to filter places by type. Parents will be able to see local activities that are outdoors, educational or just fun, places to eat, places that are good to know about (such as a pharmacy or ATM), as well as the locations of doctors and police stations if something goes wrong.

- ## Area

As of January 2017, there are 2.2 million apps available on the iOS store (Statistica, 2017), and 2.6 million available on Android's Play Store as of December 2016 (Statista, 2017). The number of smartphone users in Ireland is currently 3.2 million (Statistica, 2016), with virtually all of these smartphones powered by iOS or Android (International Data Corporation, 2016).

Despite the growing number of apps on the market, there seems to be a shortage of apps for parents to find places to go and things to do with their children.

A sample of these apps is shown in Table 1.1.

Table 1.1 : A list of available apps on the market, with their features.

	Locate Parks / Play ground	**Disabled access info**	**Health care**	**Childcare**	**GPS**	**Community**	**Weather**	**Age**	**OS**	**Interests**	**Restaurs Child friendly**
Winnie	yes	?	no	no	?	yes	no	?	Ios, Android		
Baby Places	yes	yes	yes	yes	yes	yes			all		yes
Google Maps	yes		yes	yes	yes	yes	yes		all		
Trekaroo	yes	?	?	?	yes	yes		?	iOS		yes
Trip.com					yes	yes	yes		all		yes

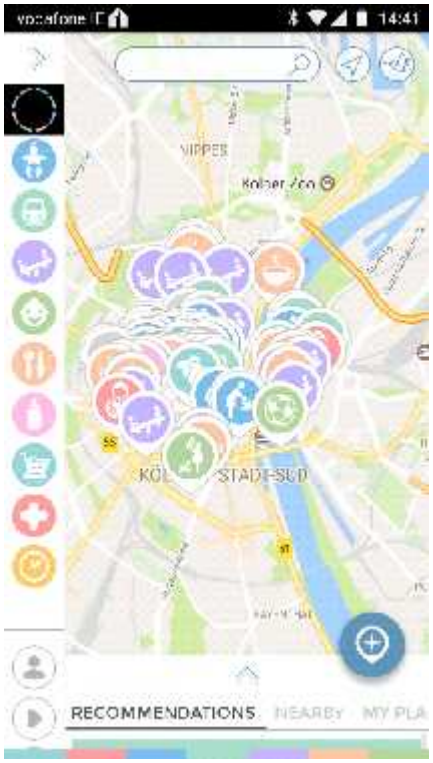
Winnie

Winnie is an app that helps parents find parks, playgrounds, libraries and child-friendly restaurants. However, it has limited features outside of major cities in the US, and seems to offer little to no support for any customers outside of the US (Winnie Inc., 2017). The Android version is a work in progress, and while the website has a link to a Google Play page, it does not appear in the store search and it doesn't seem to be available for download at the time of writing (Winnie Inc, 2017).

BabyPlaces

BabyPlaces is available on Android, Windows and iOS. It displays a map that allows parents to locate places to change and feed babies, things to do with kids, areas that are handicap accessible, doctors and child care facilities. It looks promising at first, but while it appears to cater to the UK, no information is currently appearing on the map for Ireland. The interface is a little cluttered and not particularly straightforward to use, and relies on the user's curiosity. BabyPlaces also has a website where you can use the web version of the app, but it is in German.

Figures 1-1 and 1-2 below compare the search results for Cologne, Germany versus the results for Dublin, Ireland.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Swords
Dublin Airport
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Rathmines
RECOMMENDATIONS
NEARBY

Google Maps

Google Maps is also a surprisingly good option which is available across all platforms. Once a parent knows roughly what they're looking for in a given place, Google Maps can provide them with locations, reviews and images.

Trekaroo

Trekaroo is another iOS exclusive that offers recommendations of kid-friendly attractions, restaurants, and hotels on the go. It is community based and features reviews and tips from other parents, with the option to add your own. However, it is exclusive to US and Canada, and has no plans to expand to Europe.

Trip.com

Trip.com is available on Android and iOS, and while not family-orientated, offers a search filter to find family friendly hotels, restaurants and attractions. It doesn't offer information on smaller playgrounds or activity centres, but is full of useful information including top reasons to visit and current and average weather and temperature information.
Figure 1-4 and Figure 1-5 below compare the results for family friendly things to do in Galway, versus results for families in San Francisco.

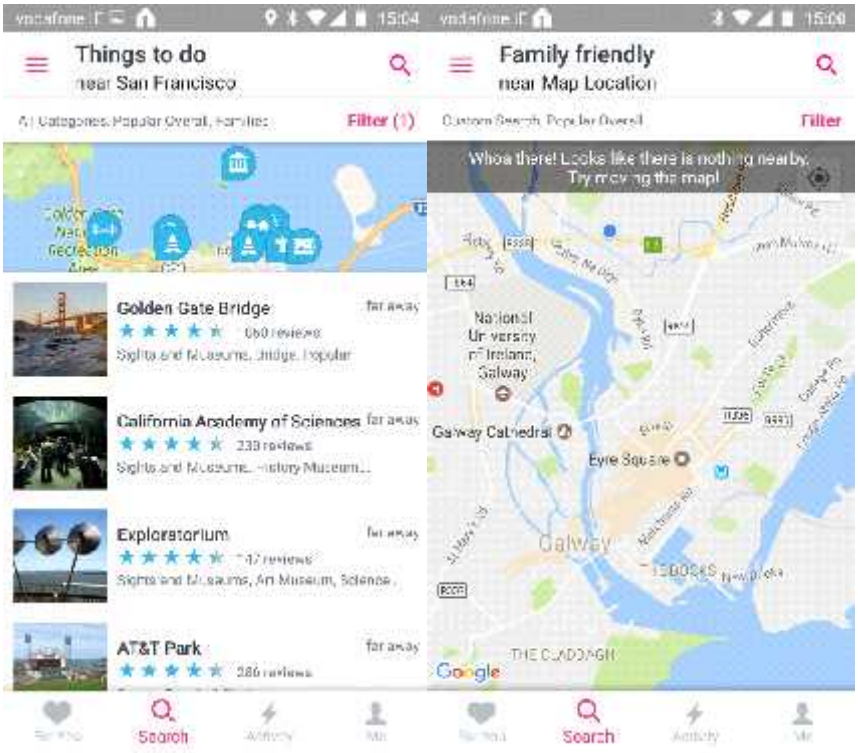


Figure 13 Trip.com Galway

Figure 14 Trip.com San Francisco

- ## Report structure

This report is structured as follows:

Chapter 2: Literature Review

The literature review in this report focusses on the global problem of childhood obesity, what is being done to get children more active, the effect of the outdoors on children's health, the impact of technology of children's health, and how technology can be used to improve children's health.

Chapter 3 : Beacon Architecture and Logic

This chapter breaks down the technology that powers Beacon, why it was included and how it works together.

Chapter 4: How to use Beacon

This chapter explains how to use the Beacon app, as well as how to build it from source.

Chapter 5: Evaluation and Results

This chapter details how Beacon was tested and evaluated by 9 volunteers and results from their evaluations.

Chapter 6: Conclusions

The final chapter details the conclusions made after the project was completed.

Chapter 2 : Literature Review

2.1 Introduction

The modern world faces many issues, including growing economic equality, growing right wing influence, and mounting peer pressure on children. Added to these issues is a global obesity epidemic, not just affecting the adult population, but children also. 41 million children under the age of 5 are overweight or obese according to the World Health Organization (2016). Children are failing to meet guidelines for physical activity and healthy food is often out of the reach for many families (Patrick, et al., 2004). Obesity has major health implications for children, from an increased risk of cardiovascular disease to a low quality of life (Sahoo, et al., 2015). Obesity is a preventable disease, so why is the rate of childhood obesity rising? Interventions and schemes to help people get active are mentioned almost daily, but their impact appears to be limited in controlling the problem. Children are growing up in a world where the internet has never been more accessible, where even toddlers can play games on tablets or smartphones. The rise of fitness trackers and the popularity of active video game consoles such as the Wii and Xbox Kinect might offer a more positive view of technology on health and fitness.

In this chapter, the author presents an overview of the rates and effects of obesity in children, the interventions and initiatives, outdoor activities and their effect on children's health

2.2 Obesity in Children

Obesity, which is a growing health epidemic, is defined as an excessive or abnormal accumulation of body fat, that may impair health (Ofei, 2005). According to the World Health Organization (2016), worldwide obesity has doubled between 1980 and 2014. This also affects children, with 41 million children under the age of 5 estimated to be either

overweight or obese (World Health Organization, 2016). Across 25 European countries, between 18 – 57% of boys between the ages of 6 to 9 are overweight or obese, along with 18 – 50% of girls (Wijnhoven, et al., 2014).

A 2014 publication by the HSE reported that the number of overweight or obese children was stabilising, and possibly beginning to decrease slightly in non-disadvantaged areas (Heinen, et al., 2014). According to safefood.eu, one in four children in Ireland are overweight or obese, and four out of five children do not meet Government Physical Activity Guidelines (Safefood.eu, 2015). These guidelines recommend that children and young adults be active for at least 60 minutes a day, at a moderate to vigorous level (Department of Health and Children, Health Service Executive, 2009).

The prevalence of childhood obesity is influenced by many factors, including a wide availability of high-energy dense food, such as confectionary, fast food and fizzy drinks, limited access to healthy food in rural and disadvantaged areas, heavy advertising of unhealthy foods and the lack of a safe and appealing space to play or be active (Centers for Disease Control and Prevention, 2015). While there is evidence that there is a genetic component involved in obesity, this only affects a small percentage of obese patients (Farooqi & O'Rahilly, 2000).

Regardless of the reasons why, the fundamental cause of obesity is a simple energy imbalance, caused by an excess of calories consumed and a lack of calories burnt off through exercise and activity (World Health Organization, 2016).

2.2.1 Effects of Obesity on Children

Studies show that children are heavily influenced by their home environment (Strauss & Knight, 1999). Parents who are overweight or obese are very likely to have children who are overweight or obese. A study in 1999 found a stronger correlation between inactive parents and inactive children, than they did with active parents and active children (Fogelmholm, et al., 1999). In contrast, the same study showed that parents who are physically active tend to have active children whilst children of active mothers tend to be twice as likely to be active

as those of inactive mothers. Children of active fathers are up to three and a half times more likely to be active than children of inactive fathers. In households where both parents were active, children are almost six times more likely to be active than children whose parents are not active at all (Moore & Lombardi, 1991). This seems to suggest that encouragement alone might not be enough for children to cut down on sedentary activity. In other words, parents themselves should lead by example.

Obesity during childhood can prove to have a harmful effect on physical and mental health. Children who are obese have a greater risk of having risk factors for cardiovascular disease, such as high blood pressure and high cholesterol (Morrison, et al., 1999), impaired glucose tolerance, which can precede Type 2 diabetes (Ranjana Sinha, et al., 2002), breathing problems (such as Sleep Apnoea), joint problems, and other health issues such as fatty liver disease and gallstones.

From a psychological perspective, Mustillo et al. (2003) showed in their study that obesity increases the likelihood of Oppositional Defiant Disorder, a disorder defined by a pattern of uncooperative and hostile behaviours directed at adults or other authority figures (American Academy of Child & Adolescent Psychology, 2013), as well as other depressive disorders. Obesity has also been shown to cause lower self-esteem and body image, increased chances of mental health issues, and impaired social skills (Vila, et al., 2004), as well as a negative effect on school performance (Taras & Potts-Datema, 2005).

Obese children are also more prone to bullying from their peers, and are more likely to become bullies themselves (Griffiths, et al., 2006). This can add to low self-esteem and social exclusion. Severely obese children tend to have a lower quality of life in physical, social and school domains (Hamiel, et al., 2006).

In contrast to obese children, there is strong evidence that physical activity has positive psychosocial effects on children (Biddle & Asare, 2011). Physically active children tend to suffer less from mental health issues, and there is some evidence to suggest that they have improved cognitive functioning (Centers for Disease Control and Prevention, 2010). There is also limited evidence that suggests exercise can help alleviate symptoms of depression and anxiety (Biddle & Asare, 2011), (Larun, Nordheim, Ekeland, Hagen, & Heian, 2006).

Physically active adolescents are less likely to attempt suicide, adopt risk-taking behaviours, and become pregnant (Janssen & LeBlanc, 2010).

As per the Irish Physical Activity Guidelines Advisory Committee (Health Service Executive, 2009), there is strong evidence that physical activity in children leads to; improved fitness, stronger bones, healthier body fat composition, improved cardiovascular and metabolic health. Of course, physically active children are more likely to stay active as an adult. There is strong evidence linking physical activity in adults with a lower risk of early death, heart problems and some forms of cancer, as well as reduced levels of depression and better cognitive functioning in later life.

There appears to be several reasons why parents have such an impact on their children's habits and lifestyle. First, there is the likelihood of parents doing physical activities with their children from a young age as part of the family unit. This might take the form of family walks, trips to the swimming pool, or as simple as kicking a football around together. Secondly, active parents and even older siblings can form role models for younger children, where the latter will mimic their habits and hobbies. Thirdly, active parents tend strongly to encourage their children to take up hobbies involving physical activity, and tend to enrol their children in sports or activity camps and after school clubs (Klesges & al, 1984).

2.2.2 Interventions and Initiatives to Promote Physical Activity

Healthy Ireland, the Framework for Improved Health and Wellbeing 2013 – 2025, is a framework to promote healthy living. Launched in 2013, it addresses '6 healthy habits' to develop including; portion sizing, a reduction in 'treat' foods, the importance of sleep for children, as well as the importance of reducing screen time and 60 minutes of exercise (Safefood.eu, 2013). The materials include 9 points on how parents can help get 60 minutes of exercise with their kids. These 9 points are as follows (Safefood.eu, 2013).:

- Start slowly with bursts of activity 15-30 minutes long.
- Add activities until the goal of 60 minutes is reached.
- Free play, such as running around and playing in the garden, is just as important as

structured sports.

- Setting a challenge or task to get children active and keep them focussed, e.g., 'How many skips can you do in a minute'.
- Check out local activities and sports clubs, so children can make friends.
- Form a patrol with other parents if there is a concern about safety.
- Get more active as a family unit, e.g. going for family walks.
- Don't let bad weather interfere – have rain gear ready, or indoor activities if the weather. turns have rain gear ready, or indoor activities if the weather turns very bad.
- Join in – adults need to exercise at least 30 minutes a day too.

Launched in 2009, the Government Physical Activity Guidelines (Department of Health and Children, Health Service Executive, 2009) recommend children and young adults to be active for at least 60 minutes a day, at a moderate to vigorous level. These activities include aerobic exercise, which includes skateboarding, PE class, bike riding, and playing sports. It is also recommended that exercises which improve flexibility, muscle strength and bone strength be undertaken three times a week. These kinds of activities include tug-of-war, rope climbing, hanging from playground equipment, and hopscotch.

In 2004, Ireland became one of the first countries in the world to create a detailed national policy on play for children (Department of Children and Youth Affairs, 2004). It was an acknowledgement that not enough attention was being given to the needs of children and young people. It found that parents were worried about letting their children play outside, due to a lack of good facilities, or a complete lack of any facilities. Children commented on how they had nowhere to play, that adults often stopped them if they tried to play in the street, and that adults didn't understand how important play was to them.

When an exercise becomes fun, it no longer seems daunting or a punishment for overindulgence. In fact, Werle, Wansink, & Payne (2015) showed in their study that people participating in a 'fun' activity were more likely to have less dessert, and fewer snacks. A prime example of making exercise enjoyable is the popularity of the app 'Zombies, Run', where the user is the main character in a story, in which they must evade zombies by

running, jogging or walking. While adults might listen to podcasts or watch TV while exercising, children can also exercise through playing games such as chase or hopscotch.

2.3 Outdoor Activities and Children's Health

Playing and exercising outdoors has proven to be of benefit to children. A study of 180 5-6 year old children, and 360 10–12-year-old children in Melbourne, Australia, has shown that every additional hour spent outdoors was associated with increased levels of activity and 27-41% fewer overweight children during the follow up to the study (Cleland, et al., 2008). A study conducted in Denmark followed 19 children aged 9-10 years, who spent a day in a forest once a week. Activity levels increased by 106% in the Summer, and 113% in the Winter when compared to the average school day. Classes consisted of compulsory subjects, such as math, Danish and history, but also outdoors skills, such as orienteering. This could provide an alternative solution for children who don't enjoy or participate in PE or sports. Studies have also shown that contact with greenspaces can improve the health of everyone involved in the green space, e.g., children and parents in parks and playgrounds, the community in the use of communal gardens or allotments (Mitchell & Popham, 2007) (Vries, et al., 2003).

Traditional playgrounds designed and built specifically for children, generally feature climbing frames and slides. Whilst they support the physical development of children, they ignore the cognitive element and mostly limit social play. More contemporary playgrounds feature multi-functional, modular structures and allow a broader range of alternative activities and more beneficial forms of play. Contemporary style playgrounds are the most common in use today. Adventure playgrounds feature loose parts, such as old tyres, boxes and crates, and allow children to be more flexible in their play. This in turn supports better cognitive, social and physical development, with children preferring this style of playground (Arnold, 2004).

Table 1 Domestic travel by Irish Residents - Number of Trips, Number of Nights, Expenditure & Average Length of Stay, Q1 2014 - Q1 2016

	2012	2013	2014	2015	2014 Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr
Total Domestic - Trips	8,290	8,413	8,391	9,125	1,719	2,165	3,093	2,013	1,731	[illegible]
Total Domestic - Nights	23,730	24,155	25,306	25,267	3,902	5,624	11,736	4,074	3,545	[illegible]
Total Domestic - Expenditure	1,514.2	1,533.0	1,712.5	1,725.3	244.3	402.5	690.9	370.0	259.1	[illegible]
Average Length of Stay	2.9	2.9	3.0	2.8	2.2	2.6	3.8	2.4	2.0	[illegible]

Family holidays are often the highlight of the year for many households. They are an opportunity for the family to relax and enjoy a laidback escape from the everyday, or an adventure filled with new places to explore and new things to do and see. Domestic holidays are the preference for families with young children. According to Fáilte Ireland (2015), families with children between the ages of 0 and 14 years, make up almost a quarter of those taking holidays within the country. In 2015, over 1 billion euro was spent on domestic holidays alone in Ireland, which does not account for those visiting friends or family, which includes 34% of all domestic travel and includes an expenditure of €64.1 million (Fáilte Ireland, 2015). The number of domestic holidays is set to increase, and already accounted for 4,658 trips. In the first quarter of 2016, holidays accounted for 46.3% of all travel within Ireland (Central Statistics Office, 2016). This information is included in Figure 2-1 below.

Figure 2 Domestic Travel by Irish Residents Q1 2016 (Central Statistics Office, 2016)

In 2015, the most popular activities for domestic holidays in Ireland included (Fáilte Ireland, 2015) :

- Visits to houses and castles (26%),
- Hiking and walking trails (23%).
- Visits to national parks (23%) and gardens (22%).

Whilst these are promising numbers, the author contends that further research should be conducted to find out why these activities are not also part of more regular family life.

Tayto Park, a theme park in Co. Meath, is one of Ireland's top fee-paying attractions, with 750,000 visitors in 2015 (Fáilte Ireland, 2016). Despite featuring a popular brand of potato crisp, many of the park's attractions encourage visitors to get active, by featuring trampolines, obstacle courses, zip-lines, a climbing wall and playgrounds throughout the park (Tayto, 2016).

The GAA Museum & Croke Park Stadium Tour, also a top attraction (Fáilte Ireland, 2016), encourages visitors to participate in GAA sports such as hurling, camogie and football, and offers an interactive games zone for children to test their sports skills against each other (Croke Park, 2016). These 'skills' allow children who might not enjoy playing regular sport to join in and perhaps inspire them to practise at home.

2.4 Impact of Technology on Children's Health and Obesity

In the UK, 87% of 5-7 year olds use the Internet, 64% of 7 year olds in Finland use the Internet, while 70% of Flemish pre-schoolers and 79% of children aged between 5 and 8 in Australia use the Internet (Holloway, et al., 2013). However, in the UK, Internet safety is not taught in schools until the children are aged between 9 and 12. No part of the South Australian Curriculum, Standards and Accountability Framework focuses on Internet safety (Ey & Cupit, 2011). In Ireland, the WebWise program was introduced to schools, which aims to educate primary school children on how to use the web safely, deal with online harassment and the dangers of social media. WebWise.ie itself provides resources for parents and teachers on how to talk about staying safe online, the importance of privacy settings, as well as social media trends among teenagers (WebWise, 2017). Ireland was also recently found to above the EU average when it comes to addressing online safety (O'Neill & Dinh, 2015).

31% of children in a study by O'Connell et al. (2014) internet use among primary school

students revealed that they had been involved in an online conversation with someone who later revealed themselves to be five years older than the child, with 18% responding that this made them uncomfortable. 13% of children in the same study said that they had found people talking to them about sex (O'Connell, et al., 2014).

With the increase in Internet usage, cyberbullying, defined as bullying harassment that takes place over text message or the internet, is an increasingly worsening problem for children using technology. While less frequent than more traditional forms of bullying, it is more likely to take place outside of school, and thus not attract attention from teachers or parents. Children who are overweight and obese are more likely to be victims of cyberbullying than their healthy weight peers (Janssen, Craig, Boyce, & Pickett, 2004). There is increasing evidence of a link between computer usage and obesity (Attewell, Battle, & Suazo-Garcia, 2003) (Mendoza, Zimmerman, & Christakis, 2007). Studies show the real risk of addiction to the internet or to messaging services such as WhatsApp. In a study by Sultan (2014) of 552 participants, 31.33% of participants felt that they were 'addicted' to either WhatsApp or BlackBerry Messenger, with an average of 32.25% using either app more than 12 times an hour (Sultan, 2013). In a study of internet addiction amongst teenagers, it was found that more than 30% of teenagers spent more than 2 hours a day online compared to 9.5% of those not considered addicted. Dependants were also found to be lonelier, to delay work and lose sleep (Nalwa & Anand, 2003).

The use of electronics may affect in children in more ways than thought - the presence of electronic media in the bedroom has been noted to displace sleep, through disturbing the circadian rhythm with bright light and/or mental/emotional/physiological arousal (Cain & Gradisar, 2010). A lack of sleep can then cause impaired daytime functioning. This impaired functioning could potentially affect levels of attention and participation in schools, as well as participation in physical activity (PE) and the likelihood of physical activity after school.

Furthermore, excessive TV watching, when combined with a poor diet, has been associated with obesity (Mendoza, Zimmerman, & Christakis, 2007). Nonetheless, there is less evidence connecting playing video games with obesity than there is connecting computer use and obesity (Rey-Lopez, et al., 2008). However, common sense dictates that the more time that a child spends in front of any screen, the less time they will spend doing other activities that

would be of more benefit to their physical health.

2.4.1 Technology to Promote Physical Activity

While technology can have negative effects on physical activity in children and adults alike, it also has the potential to improve such activity. One example is the Wii Fit, an interactive fitness game for the Nintendo Wii Console. A 2010 study revealed that while not offering the same benefits as a treadmill, the exercise intensity was within daily health-benefiting physical activity recommendations (ref). People also enjoyed doing the exercise, thereby making them more likely to keep it up in future (Graves, et al., 2010). Results are similar across a range of active video games, including the Sony EyeToy and Dance Dance Revolution, in that they encourage light to moderate physical activity (Biddiss & Irwin, 2010).

Wearable fitness trackers are currently popular, with one brand of fitness tracker, Fitbit, selling 20.8 million units alone as of March 2015 (Dolan, 2015). Fitness trackers are reported as 'significantly related' to perceived improvements in health and fitness, with people claiming that they have been useful in weight loss, increased physical activity and the leading of a healthier lifestyle (Lunney, et al., 2016). A range of fitness trackers have emerged for children. These range from child-friendly versions of regular fitness trackers, such as Garmin's vívofit jr (which features a step counter, sleep tracker and even chore data (Garmin, 2016)), to those designed specifically for children, such as Leapfrog's LeapBand. The LeapBand sets users a set of physical challenges, such as dancing, jumping and running. On successful completion of the challenges, users are rewarded with points to spend on digital pets (LeapFrog, 2016).

Smartphone apps (applications) to encourage exercise are also available. The app Zombies Run, takes the form of an immersive running game and audio story, where the player must try and outpace zombies. Playing the game will reward the player with supplies, so that they can build up their digital base. Zombies Run, currently has over a million players (over Android and iOS), and allows players to walk, jog or run, outdoors or on a treadmill (Six to

Start, 2016). Meanwhile, Kurbo Health offers an app to help children aged between 8 – 18 to lose weight by monitoring their food choices, exercise and personal goals. It also features an exercise log, a weight-tracking tool, health-education games, and videos to help explain why eating healthy and staying fit are important. Kurbo Hea also syncs with a Fitbit to collect data (Kurbo Health/iTunes, 2016). Zumba (for the Xbox Kinect and Wii) is aimed at children aged 7 years and older. Offering sets of 20, 45 and 60 minute classes, it is a game which teaches users various dance styles and dance moves to keep players moving.

2.5 Conclusions

Obesity is a global concern. In Ireland, 25% of children are obese or overweight (safefood.eu, 2013). However, whilst obesity impacts negatively on a child's current and future health, it is a highly preventable disease.

In Ireland, there are initiatives in place to stop and reverse the obesity crisis. These include the Healthy Ireland framework and the new Get Ireland Active campaign. However, there is little sign of a decrease in the number of children with obesity in either Ireland or globally. Many factors are cited for the current obesity crisis. One such factors is that parents are afraid to let their children play outdoors. As such, play and exercise are being restricted at the same time that junk food is becoming increasing available.

Interestingly though, the most common types of activities on holiday in Ireland are active pursuits. Fáilte Ireland (2015) revealed that of those who holidayed in Ireland, almost a quarter went on hiking or walking trails, with almost another quarter visiting national gardens (which often feature long walks and trails). A GAA museum and a theme park ('boasting' obstacle courses and trampolines) feature as some of Ireland's top tourist attractions. If these activities are popular as holiday destinations, then it begs the question; why they aren't more popular in regular family life.

Another influencing factor in the rise of obesity is the amount of time spent engaged with

technology.

It is very easy to blame technology for the current obesity crisis, but there are many other factors, including diet, involved. Technology offers people new ways to exercise and keep track of their fitness levels, as seen with the popularity of wearable fitness trackers. Technology, like video games incorporating the Wii Balance Board and the Xbox Kinect are very accessible to children. The risks that technology pose to children have a greater impact on their mental wellbeing. Young children being at much greater risk of coming across inappropriate content, potential groomers, and online bullying. Addiction is a real and serious threat. Children's mental health can be affected. A lack of sleep can also affect how a child performs at school, and potentially affect their prospects later in life.

The enjoyment of and engagement with physical activities will help overcome the obesity epidemic. The benefits of such activities to children include; increased fitness, improved physical and mental health, and better academic achievement. While parents might also benefit from improved health and fitness, it also offers an opportunity for parents to connect and bond with their children.

Chapter 3: Beacon Architecture and Logic

3.1 Introduction

Beacon is a hybrid application – an application built for mobile devices using HTML, CSS and JavaScript, that can also access the device's APIs. Hybrid applications are highly portable, can be launched on multiple platforms almost simultaneously, and can still access many of the same features that a native application can (Cordova, 2016). Beacon can be available to all parents with a reasonably modern smartphone right away, rather than spending extra time and resources to develop for multiple platforms. Beacon can also be accessed through a web browser, further increasing ease of access.

The number of smartphone users in Ireland is 3.2m or 68% of the population (Statistica, 2016). No statistics of smartphone Operating Systems used in Ireland exist, according to worldwide rankings, Android leads at 86.8%, followed by iOS at 12.5% and Windows Phone at 0.3% (International Data Corporation, 2016). Beacon can be deployed on all three of these mobile operating systems, as well as Ubuntu, Blackberry and OS X (Apache Cordova, 2016) but the focus for this project will be on Android.

In this chapter, the author describes the technical aspects of the project, including a discussion of the technologies used in building Beacon.

3.2 Use Case Diagram

A Use Case is defined as a list of actions or event steps, typically defining the interactions between a role and a system, to achieve a goal.

The Use Case diagram for Beacon is shown in Figure 3-1 . A new user must first sign up to use the app, when they become a registered user. A registered user must log in to use the app, and once they are signed in, they can edit their profile, add missing places, or search for places. They can like or dislike search results, and can ask for a recommendation. An admin user can do the above as well, but has the special permissions of being able to add

custom places to the map for all users to see.

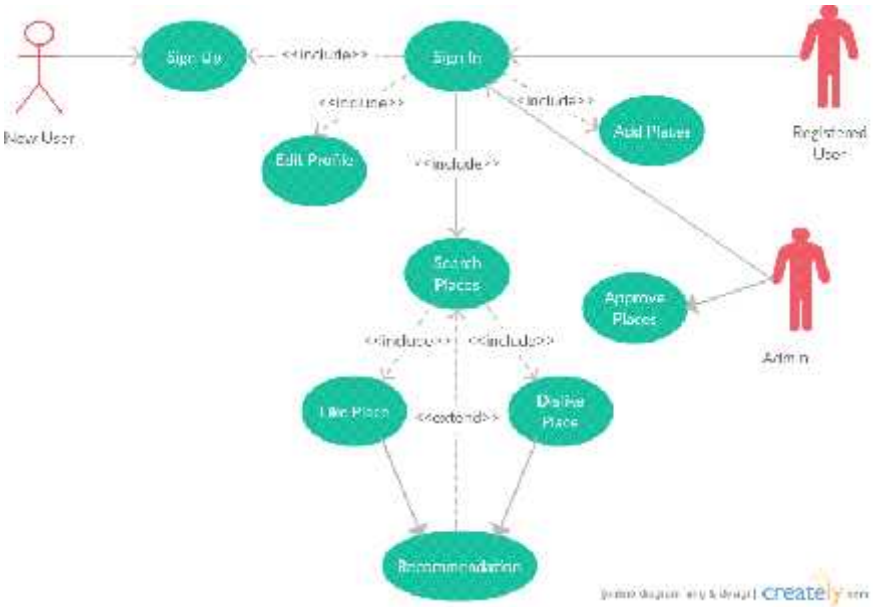


Figure 3 Beacon's Use Case Diagram

3.3 Architecture

Before development began, a rough architecture for Beacon was created, which began changing as more research was completed and a better understanding of what was involved was gained [Figure 3-2]. An example of this is MongoDB and Mongoose being dropped, with MySQL and Sequelize used in their respective places. In the end, the basic shape of the architecture stayed the same, even if some of the technologies within changed [Figure 3-3].

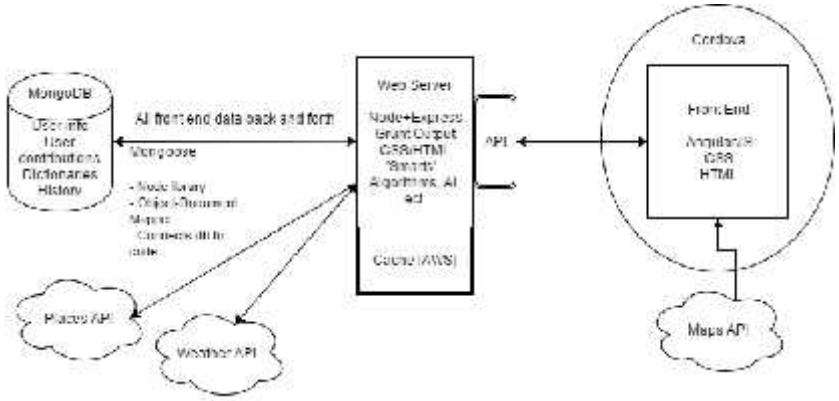


Figure 32 Beacon architecture pre-development

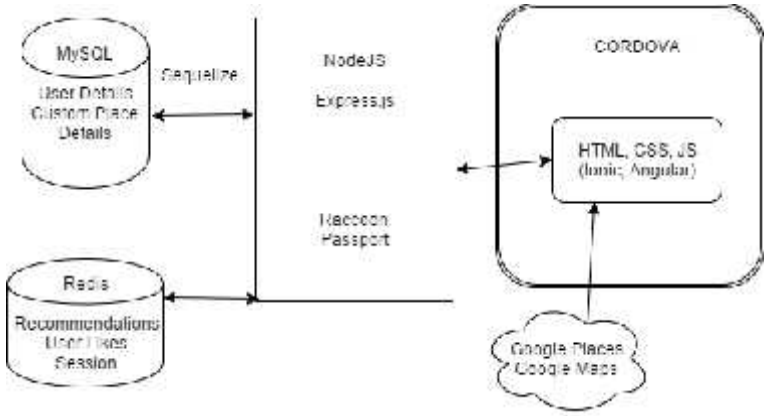


Figure 33 Beacon Architecture during Development.

3.4 Technical overview

This section details the use of technologies used in Beacon. Tools used include Cordova, Android Command Line Tools. The front end was built with HTML, CSS, JavaScript, Angular, Ionic, Google Places and Google Maps API, and the backend is powered by NodeJS, ExpressJS, Recommendation Raccoon, Passport, Redis and Sequelize. MySQL was chosen as the database and Git was used as version control.

3.4.1 **Cordova**

	Native	Hybrid
Development Language	Native only	Native and web / web only
Device Access	Complete	Complete
Device Specific Features	High	Moderate
Speed	Very fast	Medium
App Store	Available	Available
Approval Process	Mandatory	Low overhead
Code Portability	None	High
Advanced Graphics	High	Moderate
UI / UX	High	Moderate
Access to Native APIs	High	Moderate
Development Cost	Expensive	Reasonable

Apache Cordova is an open source, mobile application development framework (Cordova, 2017). It enables developers to build applications for mobile devices with web technologies instead of relying on platform-specific APIs. It extends the features of HTML and JavaScript to work with the

device, and incorporated plug-ins to allow the app to take advantage of the device's hardware. These apps are known as 'hybrid' as they are not 'native' applications written in the platforms native language, and they are not purely web-based, as they are packaged as apps and have access to native device APIs.

The diagram seen in Figure 3-4 below is a comparison of hybrid and native mobile applications.

Native apps can only be developed in their 'native' language, which allows better access to device features such as the camera and GPS, features better graphics, and is faster. In comparison, hybrid apps can be written in a combination of web languages, like HTML and JavaScript, with native features, or can just be a web app that is wrapped up to appear as a native app. They are faster to build, are easier to update and easier to port over to other operating systems when compared to native apps. It has much of the same access of device features as native, including access to the camera, vibration and device orientation.

	Native	Hybrid
Development Language	Native only	Native and web / web only
Device Access	Complete	Complete
Device Specific Features	High	Moderate
Speed	Very fast	Medium
App Store	Available	Available
Approval Process	Mandatory	Low overhead
Code Portability	None	High
Advanced Graphics	High	Moderate
UI / UX	High	Moderate
Access to Native APIs	High	Moderate
Development Cost	Expensive	Reasonable

3.4.2 Android Command Line Tools

To develop for Android, you need to download the Android Studio IDE, or Android's command line tools. As Beacon already had a development environment, Sublime Text, only the command line tools were needed. These tools integrate with Cordova, and allow it to

compile Beacon's code for a web application into Android compatible code. These tools also include emulators, a Gradle wrapper, and the SDK manager. Figure 3-5 below shows the Android Tools running an Android emulator and running alongside Cordova in development.

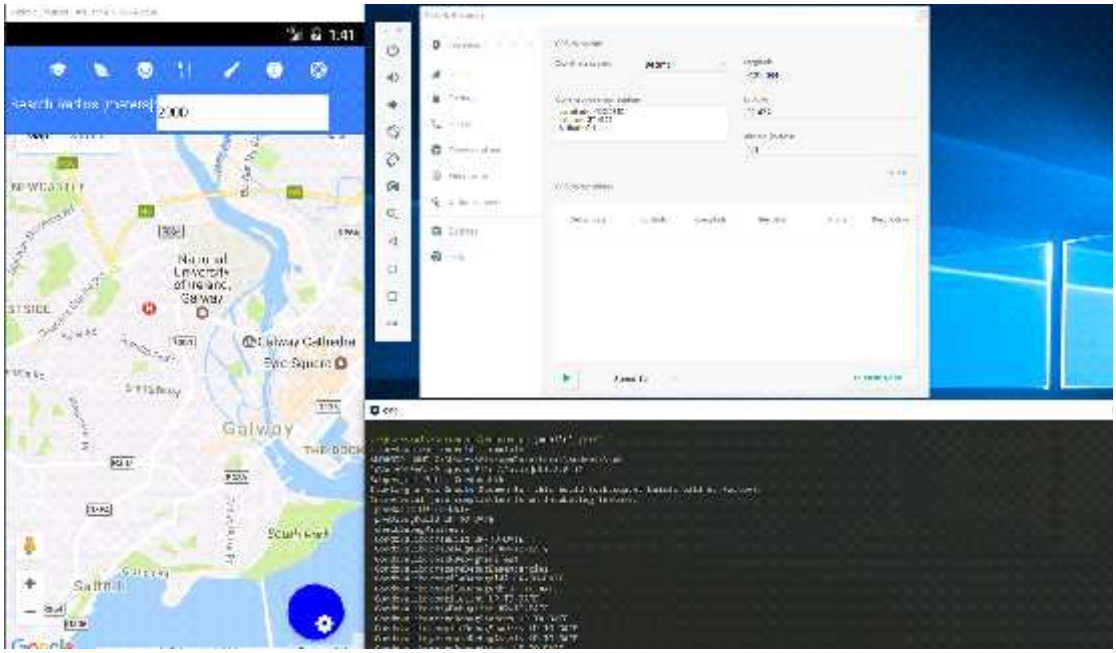


Figure 35 Beacon in development running on an Android emulator

3.4.3 Front End

The front end, or client side, is the part of the app that users see. It takes inputs and passes them to the backend, and displays information that the back end returns to the user.

HTML5

HTML [Hyper Text Mark-up Language] is the standard mark-up language that forms the backbone of any webpage. Although it works alongside CSS and JavaScript, it is considered the most important web technology. Elements represented by tags are used to describe the

structure and layout of a webpage. HTML5 is the latest and current HTML standard, published in 2014 (W3, 2014).

CSS3

CSS [Cascading Style Sheets] is the standard style sheet language most commonly used to describe the presentation of a HTML page, but can also be used with any XML document. It is considered one of the cornerstone web technologies. It consists of rules applied to selectors, which correspond to the HTML elements to be styled, with parent classes 'cascading' down to their children. CSS3 is the latest and current standard used (World Wide Web Consortium, 2014).

ECMAScript

ECMAScript, more commonly known as JavaScript, is a high-level programming language. It is a cornerstone web technology, used to add functionality to and change the behaviour of web pages (ECMAScript International, 2017). Beacon uses both 'vanilla' JavaScript, and some of the wide range of libraries and frameworks that extend JavaScript functionality.

In Beacon, JavaScript is used for both front end logic and the server using NodeJS. The advantages of using the same language for front- and back-end include heightened productivity as there is no need to switch context to work in a separate language, as well as ease of moving logic from the app's front end to the backend if it becomes too resource intensive.

AngularJS 1.X

AngularJS is a JavaScript framework, providing a model view controller [MVC] and model view view-model architectures [MVVM]. Angular 1.X was chosen for Beacon, due to its features, ease of use, reliability and compatibility with Cordova. It is one of the most popular front end frameworks, being the 7th most starred repository on GitHub as of 26th March 2017 (GitHub, 2017). Angular implements many features useful for building large, non-trivial applications; including view templating, routing, service providers and allowing developers to create custom directives (Google, 2017). Two-way data binding is its most

notable feature, where templating is rendered in plain HTML according to data contained in the scope. AngularJS detects changes in models by comparing the current values with values stored earlier in a process of dirty-checking.

Ionic Framework [1.X]

Ionic is a theme and framework built on top of Angular and designed to work alongside Cordova. It emulates native user interface guidelines and uses native SDKs and combines them with web technologies to give apps a more 'native' look and feel when packaged with Cordova. Ionic also works well in the browser version of Beacon.

Ionic removes the need for customizing a hybrid application's design for a separate mobile OS. When building for a specific platform via Cordova, Ionic detects the target OS, and customizes view components to match the operating system's native design guidelines. For example, it will place a tab bar at the top of the screen on Android, and the bottom for iOS (Drifty Co, 2017).

Google Maps/Places API v3

Google Maps was chosen for its reliability, depth of documentation, features, as well an extensive database of places and information about those places (Google, 2017). During development, several problems arose, namely concerning pieces of outdated documentation on the latest version of Maps and its libraries. However, it remains hard to compete with, and without its search methods, as well as the range of results generated, Beacon would have been a struggle to build.

3.4.4 Back End

The back end, or server side, refers to the side of the app that users usually don't see. It manages user requests, passes information to the database, and returns information to the front end for the user to interact with. Beacon features a pure JS backend.

NodeJS

Node is JavaScript runtime environment. It is event-driven, non-blocking and lightweight, making it ideal for an application like Beacon (Node.js Foundation, 2017). As well as serving as the project's server environment, Node also features npm - the largest ecosystem of open-source libraries in the world (npm.inc, 2017). Npm was used extensively in building Beacon to install packages to increase Beacon's functionality. Beacon's recommendation engine also makes use of Node's asynchronous library.

Express

Express is a minimal and flexible Node.js web application framework that helps organise Beacon on the server side (Node.js Foundation, 2017). It is also one of the most popular packages on npm, with over 11 million downloads in the month of March 2017 alone (npm Inc, 2017). It is used in Beacon to handle tasks such as handling requests and responses, and managing views and routes.

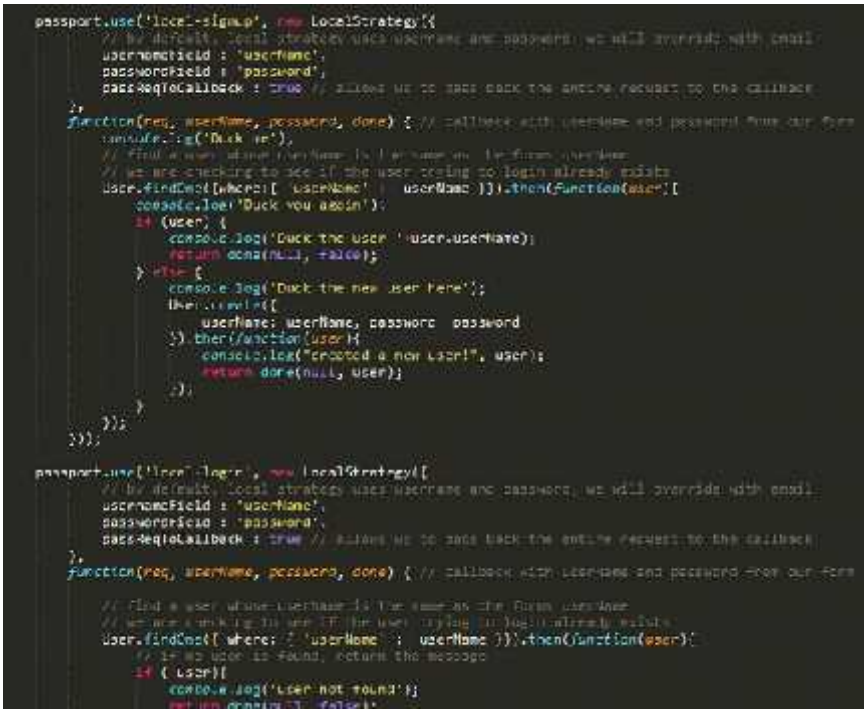
Server side routing was used extensively in Beacon to manage user authentication via middleware and context based navigation through the apps sections.

Passport

Passport is an authentication middleware for Node. It is compatible with Express. It authenticates requests through 'strategies', that can be customised and range from verifying username and password credentials, delegating authentication using OAuth or federated authentication using OpenID (Hanson, 2017).

Passport can also persist its authentication for users using server side sessions. This is a common feature in web applications which allows the application to remember your authentication via cookies and avoids the need for excessive login requests (Hanson, 2017).

Passport handles log in and sign up operations in Beacon, and samples of the code can be seen below in Figure 3-6.



```
app.post('/sign-up',
    passport.authenticate('local-signup', {
        successRedirect : '/', // redirect to the secure profile sectior
        failureRedirect : '/fail' // redirect back to the signup page if
    })
);
```

Figure 36 Samples of passport code

bcrypt

In conjunction with Passport and Sequelize, bcrypt is used for securely hashing passwords with a salt before they are stored in MySQL. It is based on the blowfish cipher. (Provos & Mazières, 1999).

Redis

Redis is an open source, in-memory data structure store. Redis performs extremely well compared to traditional database systems which write every change to disk before committing the transaction. Beacon uses Redis for storing user sessions. It is also used as a fast data store for its recommendation engine, Recommendation Raccoon. (RedisLabs, 2017)

Sequelize

Sequelize is a promise-based object relational mapper [ORM] for Node.js, and works with MySQL to store and retrieve information from the database. Object relational mapping is a technique that allows the querying and manipulation of data from a database using an object-oriented paradigm. SQL is no longer used, we can interact directly with an object instead.

Beacon creates User and Place models, which are then used to create the relevant tables in the MySQL database. It can then perform various operations such as creating new users and places, editing user profile details and changing user location without the need to worry about writing efficient SQL queries. Figure 3-5 below shows how Sequelize creates a place object.

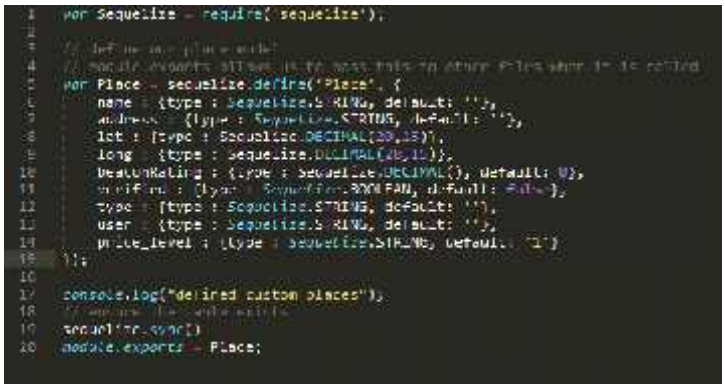


Figure 37 Sequelize code to define place object

3.4.5 Database

MySQL is an open-source relational database management system. MySQL was chosen for its reliability, extensive support and documentation and ease of use, as well as it's guarantee to maintain ACID properties. ACID properties include Atomicity, Consistency, Isolation and Durability. Atomicity refers to an 'all or nothing' approach, where if one part of the transaction fails, due to system failures, errors or crashes, then the entire transaction fails, and the database is left unchanged. Consistency ensures that any transaction will bring the database from one valid state to the next, according to all defined database rules. Isolation ensures that the concurrent execution of transactions results in the same state if transactions were executed one after the next. Durability ensures that once a transaction has been committed, it will not change, even in the event of system failures, errors or crashes.

MySQL stores information about users and places. It is through MySQL that a database administrator can create admin users by switching the 'verified' value to true.

Beacon used MySQL Workbench Community Edition to view and edit database entries. Figure 3-6 below shows a MySQL Workbench displaying a list of test data, as well as running an SQL query to validate a new admin user.

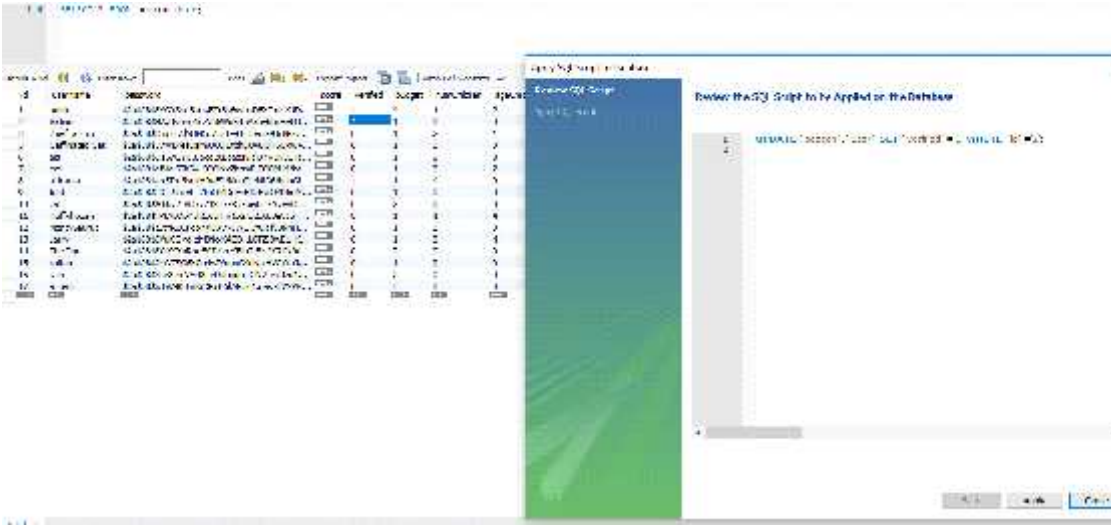


Figure 38 MySQL Workbench showing list of user details during development

3.4.6 Recommendation Engine

Beacon uses a recommendation engine to suggest places for a user based on what they have liked and disliked compared to other users.

Recommendation Raccoon is a collaborative filtering based recommendation engine and NPM module built on top of Node.js and Redis. It is solely written in JavaScript. Beacon users can like or dislike search results, and using Raccoon, users can start getting recommendations for places that other, similar users liked. The recommendations and ratings are stored in Redis, which holds the entire dataset in memory. For the actual handling of the parallel asynchronous functions, raccoon uses the async library for Node.js.

The engine uses the Jaccard Coefficient for Similarity to gauge the similarity of two users, A and B, and works well with measuring binary data, such as ‘like’ and ‘dislike’. Raccoon also provides functionality to ‘unlike’ and ‘undislike’, effectively undoing their vote if made in error, or if they no longer like that place.

$$J(A,B) = \frac{|A \cap B|}{|A \cup B|}$$

The engine also uses k-nearest neighbours [k-NN] to optimise the comparison of users. After a user's similarity is calculated with the Jaccard Coefficient, a sorted set is created which represents how similar that user is to every other. The top users from that list are considered their nearest neighbours, and their likes and dislikes are used to make recommendations to the logged in user. Snippets of this code are displayed in Figure 3-7 below.

```
raccoon.liked(req.user.userName, req.body.place).then(() => {
    console.log('Upvote confirmed!');
```

```
raccoon.unliked(req.user.userName, req.body.place).then(() =>
    console.log('like undone!');
    res.send({incremented:false});
});
```

Figure 39 Raccoon sample code to like/unlike a place

Raccoon also provides functionality to determine the most liked elements, the top users most similar to user x, items user x has liked or disliked. Figure 3-8 below shows the code that returns an array of all the objects a user has rated.

```
raccoon.allWatchedFor(req.user.userName).then((results) => {
    // returns an array of all the items that user has liked or disliked
    for(var x=0; x<results.length; x++){
      if(rec.body.place==results[x]){
```

Figure 310 Raccoon code to return an array of all objects a user has liked.

3.4.7 Version Control

Version control is important, it creates a history of code changes to a project, who made them, and when. This allows code to be reverted to another version if needed, as well as

allowing code to be traceable back to a particular developer.

Git is an open source version-control software. It is considered an essential tool by many developers. By committing changes to the code to a remote repository, that version of Beacon is backed up onto a remote server. We can then download – or 'pull' - this code as many times as we need from as many machines as we need. We can also 'branch' off from the main project if needed, which can allow us to develop new features without interrupting the main or 'master' branch. This allows Beacon to have up to date code on as many machines as needed.

Figure 3-9 shows a sample of Beacon's commit history on GitHub.

Figure 311 Sample of Beacon's Github History

3.4.8 Server

The app is available online at beaconapp.space. The app is running on Ubuntu 16.04, on a Hetzner vServer CX20, kindly donated by a friend.

The specs of the server are as follows:

RAM: **2 GB RAM**

SSD: **50 GB**

Connection: **1 Gbit/s NIC**

Traffic: **5 TB**

OS: **Ubuntu 16.04**

3.4 Conclusions

There are a wide range of tools available to build applications for mobile. While building native applications comes with its own benefits, like increased speed, better graphics, and better access to native APIs, hybrid applications capture a similar experience and allow it to be recreated across several platforms. Beacon wouldn't take advantage of the benefits offered by a native app. The faster development process and possibility of deploying on multiple platforms offered by hybrid apps suits the project much better.

Keeping up to date with the everchanging landscape of JavaScript libraries is becoming a difficult task, as is the process of choosing the right ones for a project. Beacon stuck to established libraries, Angular 1.X and Ionic, that have proved to work well with Cordova and give a relatively more 'native' feel to the app.

NodeJS and Express is a proven combination for web development, forming a core part of the popular MEAN stack alongside Angular. Express is one of the most matured web application frameworks for Node, stable and backed by a large community. There are little to no alternatives for those who want to go 'full JavaScript'. Passport was the obvious choice for user authentication, with a large amount of authentication strategies, support for persistent sessions, and an option to create custom strategies.

Sequelize is an ORM compatible with MySQL and NodeJS. It streamlines production by letting the code interact with objects rather than SQL. Sequelize is the second most starred ORM on GitHub as of 27 March 2017, and the most starred tagged under NodeJS (GitHub Inc, 2017).

While MongoDB seemed like an obvious choice to complete the MEAN stack, I chose MySQL for its reliability, extensive support and documentation, as well as it's guarantee to maintain

ACID properties. When development began on Beacon, there was major concern over MongoDB security, with over 10,000 databases deleted (Constantin, 2017), as well as potential issues returning matching documents (Glasser, 2016).

Recommendation Raccoon is one of the only active recommendation engines for Node at time of development. A library was chosen instead of building an engine from scratch to cut down on development time, despite some initial bugs in Raccoon's code. Redis was initially included with work with Raccoon, and was then used to persist user sessions.

Notes:

Beacon was briefly hosted on Amazon Web Services, before being hosted on the Hetzner Server. Beacon was not making full use of Amazon's products, so it was moved to another server to avoid going over limits and incurring accidental costs.

iOS development with Cordova, like Android, also requires a tool kit. Unfortunately, this toolkit is only available on modern OSX software, which was not accessible during Beacon's development.

Chapter 4 : How to Use Beacon

4.1 Introduction

The author designed and developed Beacon to create an app that can be used by parents to help families get out and about more, and to bond by bringing them together to explore new and fun activities together. The enjoyment of and engagement with physical activities will not only help in the bonding process, but also help combat the obesity crisis that is effecting Ireland. This app features a map and locations, GPS to find the user's location, the feature an ability to add places, and the ability to filter places by type. These types include outdoors, educational or just fun, places to eat, places that are good to know about in a pinch, as well as the locations of doctors, police stations and embassies.

This chapter contains instructions on how to use the Beacon Android and web apps, as well as instructions on building the web app from source.

4.2 The Beacon app

On opening the app, Beacon will display a login and a sign in form (Figure 4-1). For a new user, you need to sign up.

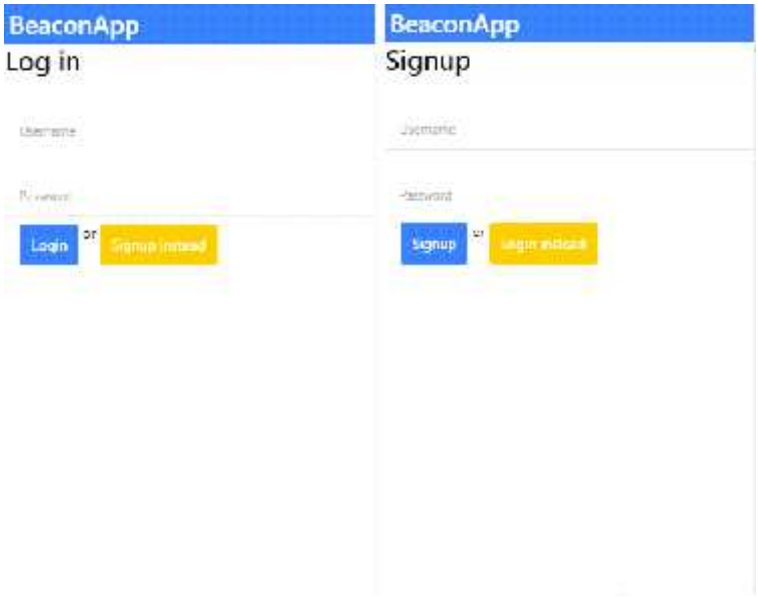


Figure 4-1 : Beacon's sign in/sign up screen

Once you've entered your username and password, and submitted the form, you are directed to your profile page to choose your preferences. The current options for location are Galway, Dublin, Cork and Limerick. On submission, you are redirected to the main page, with a map visible, as seen in Figure 4-3.

Figure 4-2 User Preference Screen

This is the main part of Beacon, as seen in Figure 4-3. To filter locations, you adjust your radius to meet your needs and click on the icons on the top bar to see what locations are within that radius. From left to right, the icons refer to educational activities, such as museums, outdoor activities such as parks, indoor activities like bowling alleys, places to eat, cultural activities such as art galleries, places that are good to know, like ATMs and banks, and the last is for emergencies, such as doctors and police stations.

Figure 43 Main View Beacon

Upon clicking one or more categories (note: the icons change colour based on the selected category), icons related to that category (e.g. playgrounds) are displayed on the map. By clicking on any of these icons, a pop up with information for the relevant place appears, as seen in Figure 4-4. Each pop up has options to like or dislike the place – click once to vote, and twice to undo your vote.

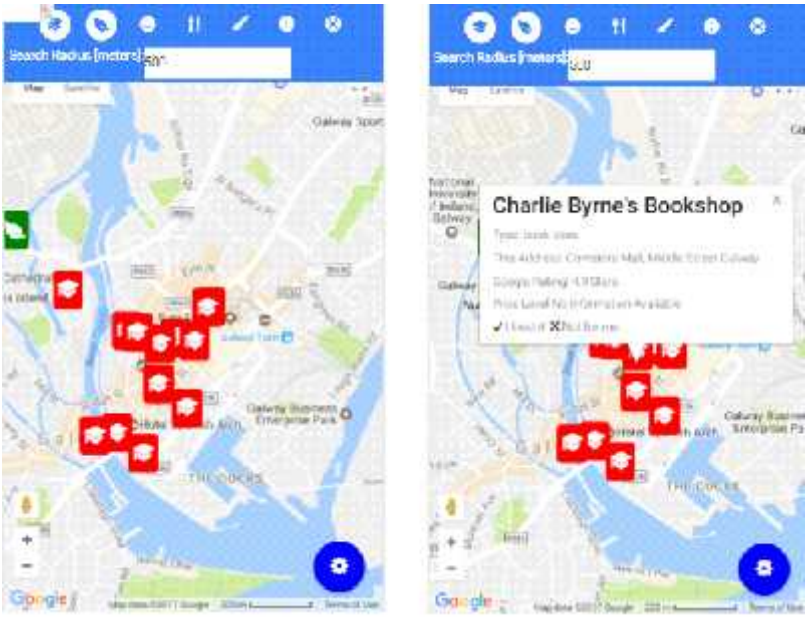


Figure 44 Beacon showing nearby locations and information

By double clicking on the map, you can create a new custom place. A window will appear to allow you to enter information such as a name, type and price level for this new place, as seen in Figure 4-5. The address is automatically fetched from the position of the marker.

Figure 45 Beacon adding a new place

By liking and disliking places, beacon can start recommending places to you. By clicking on the button on the bottom right hand side of the app, you will open a small menu, that

contains recommendations, options and logout. Click ‘recommendations’ to view your recommendations, as seen in Figure 4-6.

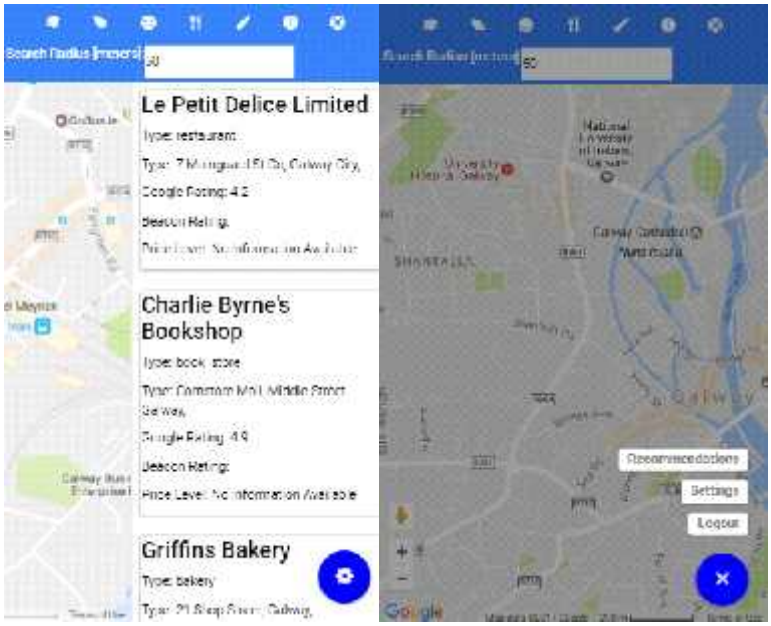


Figure 4-7 Beacon showing user recommendations

Click on any of these recommendations to center the map on that location. By liking or disliking that location, you can generate more recommendations, like those seen in Figure 4-7.

By clicking on the button on the bottom right to access the menu, the user is brought to the profile page, where they can adjust their profile, as seen in Figure 4-2.

Users with admin access can approve user added places from their settings.

4.3 Starting the app from the command line

The steps for staring the app from the command line are as follows :
Make sure you have Node v6 or greater installed.

Under command prompt, change directories until you reach the root folder of Beacon. It should contain ‘server.js’. [Figure 4-8]

Figure 48 Command Prompt - Beacon Root Folder

Run the command 'npm install' and wait for installation to complete [Figure 4-7].

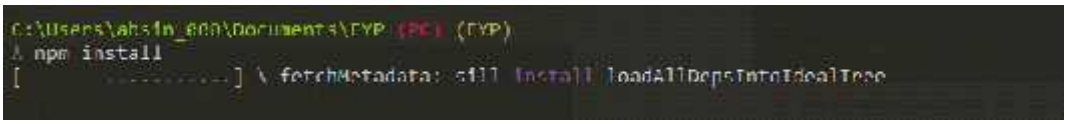


Figure 49 Command Prompt - Beacon installing npm files

Run the command 'npm start' or 'node server.js' as seen in Figure 4-10.

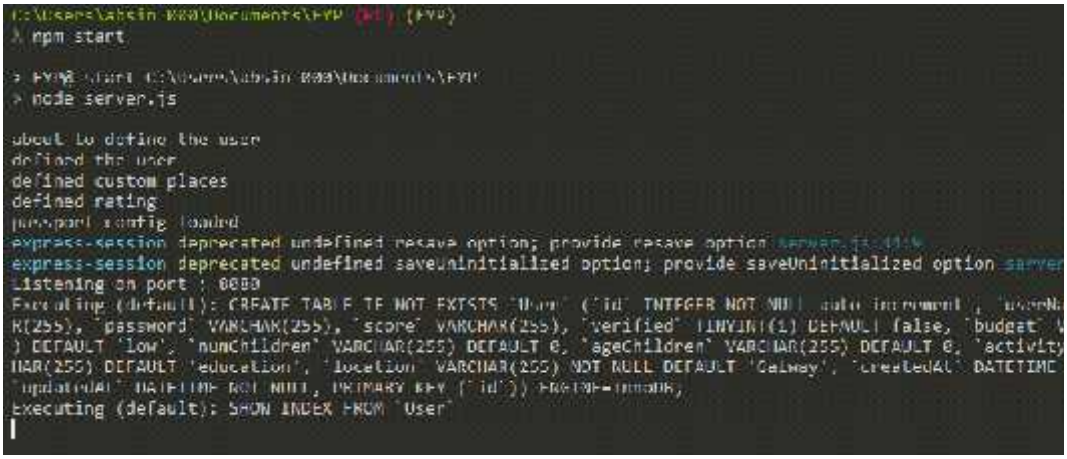


Figure 410 Command Prompt – Beacon starting up

The app should now be running on localhost:8080

Chapter 5 : Evaluation and Results

5.1 Introduction

On nearing the completion of Beacon, it became clear that testing and evaluation was needed from an outside perspective. Surveys were created and distributed to a set of volunteers, and some of those volunteers were supervised as they completed their assigned tasks.

Feedback from the survey, questions asked and comments made all gave important insight into areas and features of Beacon that were lacking, and could be improved on in future. Bugs also appeared during testing, some of which were revealed during unanticipated use cases. However, the concept of the application proved popular with participants.

Figures 5-1 through to 5-13 in Section 5.5 graph the results of the survey. A table of results is available in the appendix.

5.2 Evaluation

To evaluate Beacon, a form was creating using Google Forms and distributed to 10 volunteers of mixed gender [7 females, 3 males] across a broad age range [19-54]. 10 replies to the survey were received, and 3 volunteers were observed as they used Beacon for the first time. One reply was discounted as it was rated all fives. The three volunteers were 2 females and 1 male, two participants were parents, 1 was a non-parent, one participant was in their 20s, the other two participants were over the age of 35.

The observed participants were handed a list of basic tasks to complete, which included the following:

- Add a new place.
- Like any place.
- Locate an art gallery in Galway.
- Dislike any place.
- Like a recommended place.
- Find a café within a 500m radius of Dublin City Centre.
- Update your budget.

The most common complaint referred to a lack of intuitiveness or 'obvious direction to go in'. The choice of icons was not obvious enough for most users to describe their function, and none of the observed volunteers knew what 'radius' referred to. Users requested clearer markings, or even a tutorial on how to use the app. One user complained about the lack of feedback when liking or disliking buttons, which has since been fixed.

Several minor bugs were uncovered during testing, including some interesting issues regarding adding places when the app was accessed through a mobile or tablet browser, rather than through the app itself.

However, despite some initial confusion, all observed volunteers completed their tasks in just over six minutes.

Questions asked by volunteers included the following:

- What are these things for? [Referring to icons]
- Do I need to login to use it?/Why?

- Why aren't I getting any results? [Radius too low]
- I think it's broken/I think I broke something… [Bug appeared]

5.3 Bugs

Several bugs appeared during testing. While none of these bugs were serious, they did impact on user experience. These bugs included the following:

- 'Unresponsive' buttons, caused by an oversight in CSS code.
- Three info windows appearing at once in certain locations – this was an oversight in JS, and fixed by making it so a double tap created a new place, rather than a single tap.
- 'Odd' places appearing under filters – these included the Galway Cathedral Car Park being listed as a museum, and a place appearing near the Wolfe Tone bridge in Czech. A certain amount of this appeared to be a bad keyword for Google's Place Search, but further investigation will be needed on how to fix the issue.
- Addresses being wrong – caused by an error in JS code.
- Icons not appearing for adding new places – caused by a general oversight

These bugs have been addressed as far as the time constraint for project submission allowed.

5.4 Suggestions

Suggestions for functionality included social media login, directions from current location to a suggested location, a 'child friendly' mode to allow young children to use the app, and more information regarding locations, including more information about prices, admissions, opening times and suitability for young children.

The lack of shops and stores was noted by one participant – this is an intentional design decision to encourage users to visit libraries and parks, where it is more likely for the users to learn something or play games.

5.5 Survey Questions and Graphs of Results

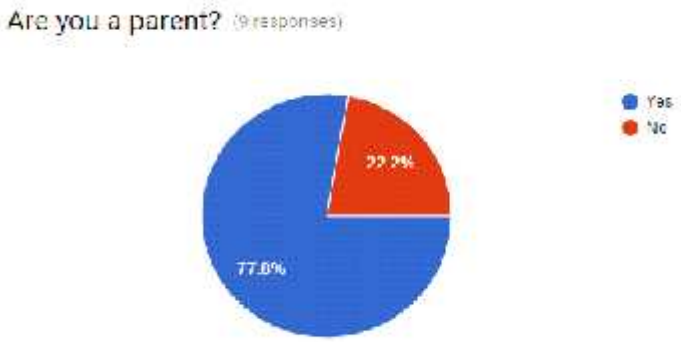


Figure 5 Question 1

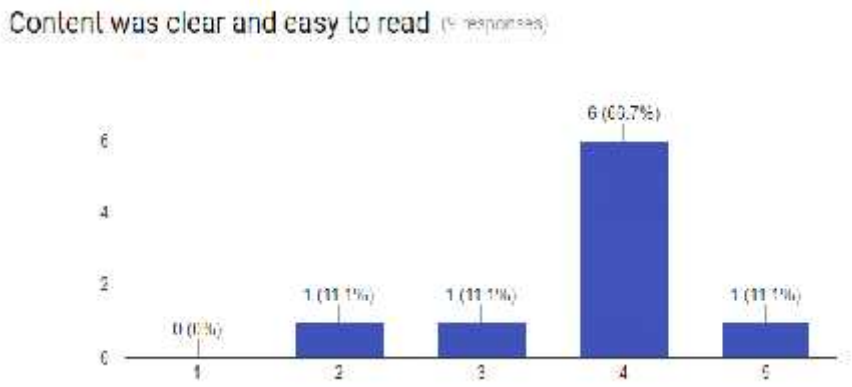


Figure 5 Question 2

Figure 5 Question 3

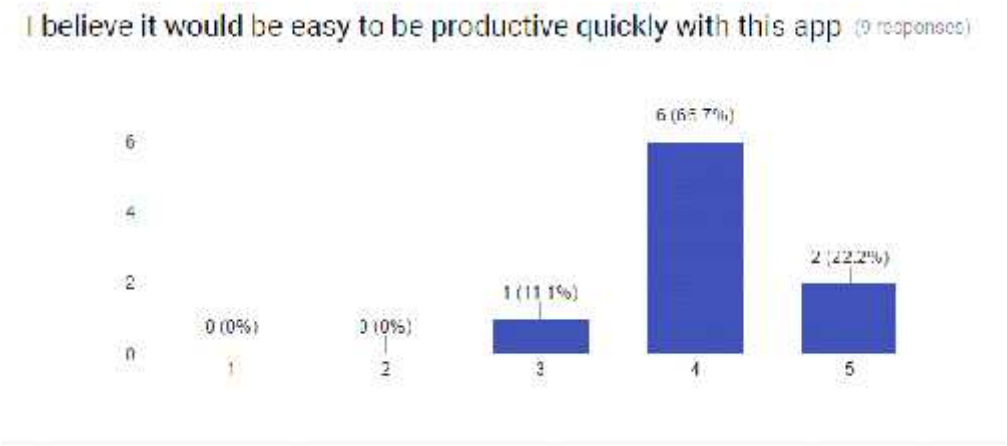


Figure 5 Question 4

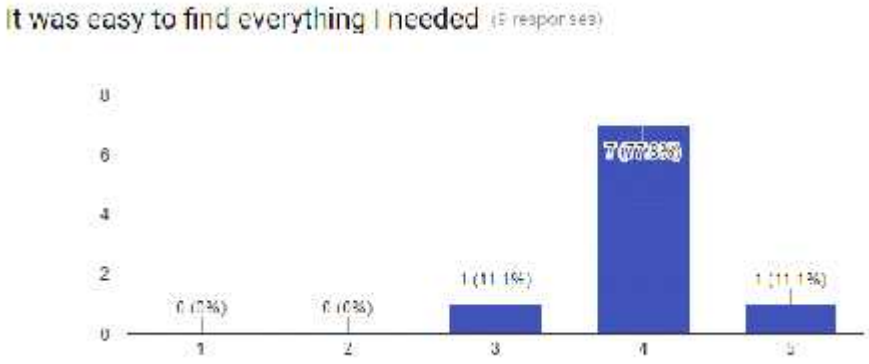
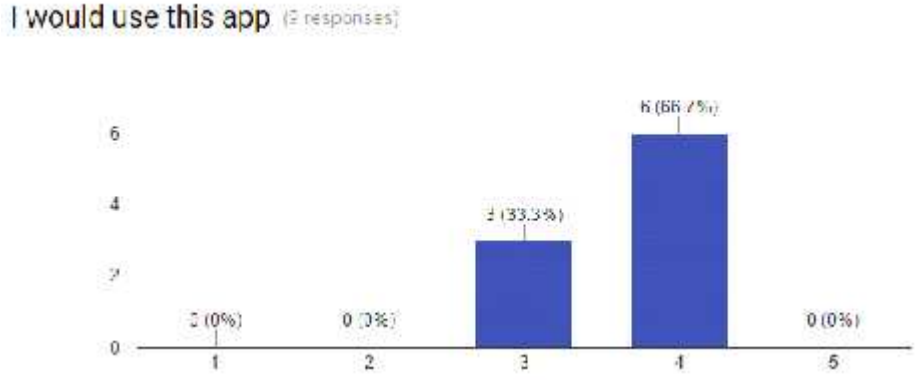


Figure 5 Question 5



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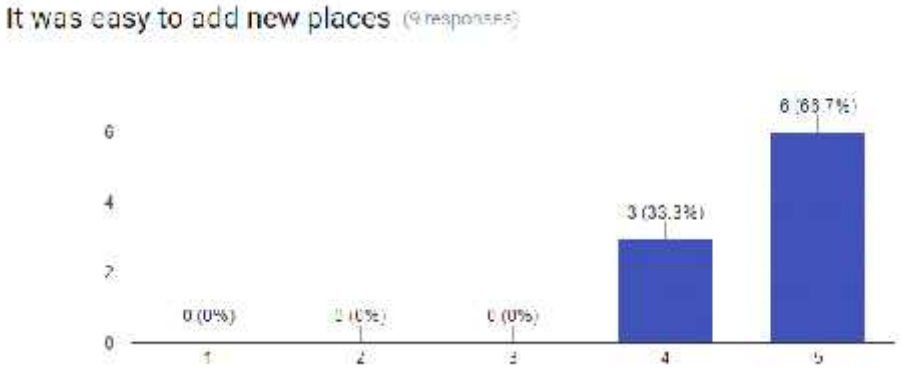

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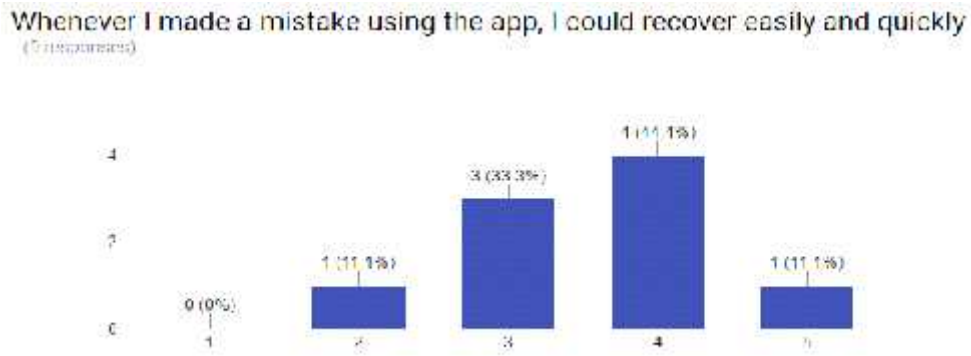

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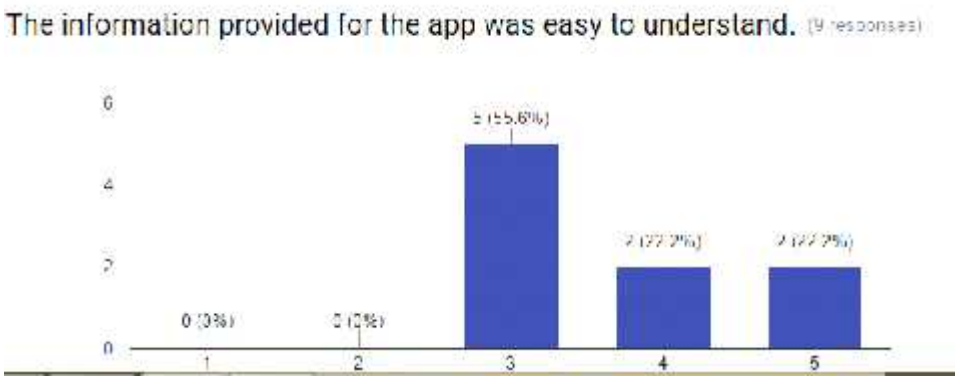

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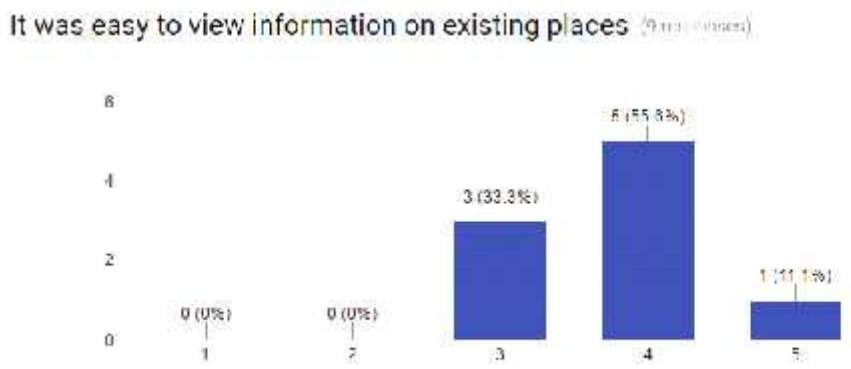

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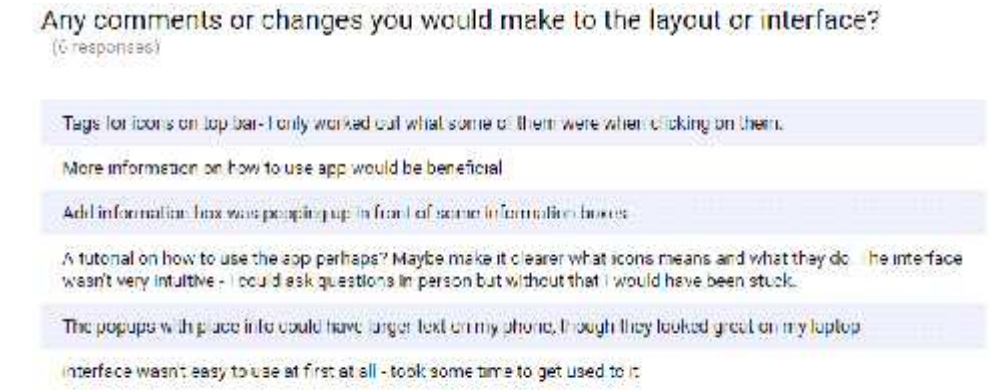

Figure 5 Question 11

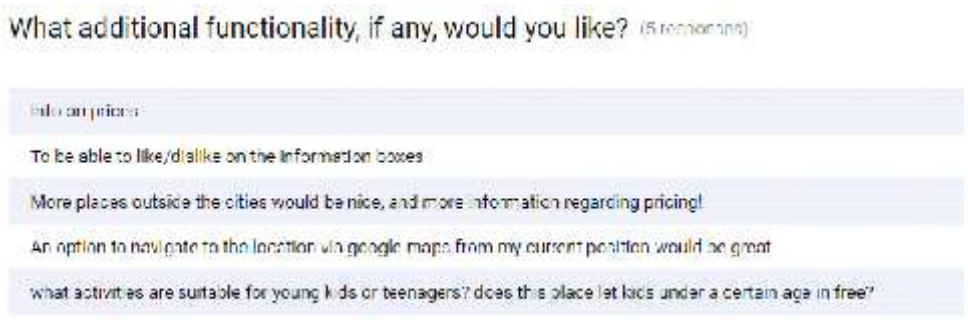

Figure 5 Question 12

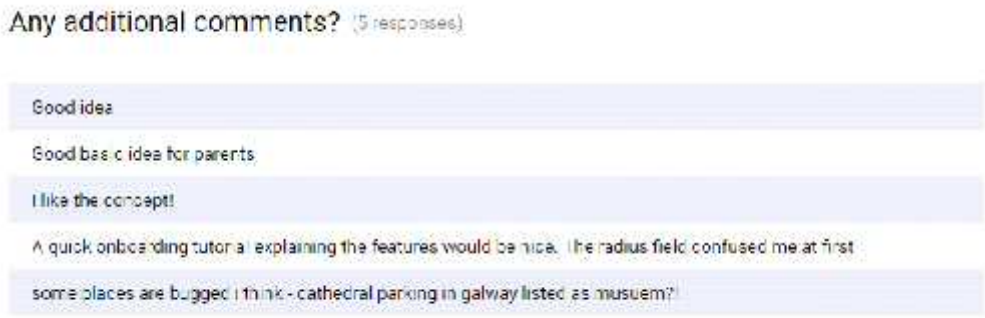

Figure 5 Question 13

5.6 Conclusions:

The development of Beacon has focused more on the functional elements than the user experience and the user interface, and it has shown itself in the dissatisfaction of users with Beacon's interface. One volunteer made a comment in person – "I'm a parent – when I've got my kids with me, my focus is on them, and I don't have time or the energy to figure out something that isn't obvious". Beacon failed in this respect during testing. This can be improved with a little more time, and perhaps more user input before and throughout the

design process. The questions and comments asked by volunteers during testing were a good source of insight into different users and their needs and wants. Creating a tutorial or graphic walkthrough could also improve user experience in using Beacon in the future.

The appearance of bugs during testing was an annoyance, but ultimately beneficial in spotting and fixing small issues which risked going undetected otherwise. Again, having potential users test the app during the process in future should help find these bugs quicker.

Chapter 6: Conclusions

6.1 Discussion of Results

In Chapter 2, the effects of obesity and a lack of physical activity in children was discussed. The enjoyment of and engagement with physical activities will help overcome the obesity epidemic. The benefits of such activities to children include; increased fitness, improved physical and mental health, and improved academic performance. While parents might also benefit from improved health and fitness, it also offers an opportunity for parents to connect and bond with their children. By spending more time together bonding, this in turn promotes better child development and further fosters an improved relationship between parent and child (Milteer, Ginsburg, et.al, 2012).

Beacon hopes to encourage parents and kids to bond and get out and about exploring, learning, and adding new places. The only stores that app features are book stores, rather than clothes or toy stores, to help users moving and learning. Walking and cycling are arguably the two easiest ways to get around town and city centres, given traffic congestion in Irish cities (INRIX, 2016), which impacts the use of cars and public transport. There is no way to tell if Beacon would be used in this manner, but the results of the survey at least show that parents are interested in the idea of the app itself. 5 parents who took part in the survey said they would use consider using Beacon again [Figure 5-6].

In Chapter 3, the technical details were discussed, and it was explained how each contributes to Beacon Another example would be a deeper understanding of Google Maps and Google Place APIs and how they work.

In Chapter 5, Beacon was analysed and tested by volunteers, and the app's problems with UX were brought to attention. While the concept proved a success, it wasn't enough to win over people who didn't like, or struggled to use the interface. User experience is an important element of development and engineering, one that was overlooked in Beacon's development. The UI of Beacon was updated in response to complaints and suggestions, but

the lesson was learned.

6.2 Future Work

Beacon might be finished as a final year project, but there are still many things left that can be improved in the future. They include:

- Interface
    - Beacon's interface can be further improved by implemented the likes of Google's material design principles (Google, 2017), and/or by using better CSS libraries.
    - Setting time aside to design a layout before further code is written might cut down on updates to code.
- More cities
    - Currently Beacon is limited to a certain set of locations. This could be expanded to include the whole of Ireland, and perhaps internationally further down the line.
- Pictures and tags
    - Adding pictures and tags to places would add an extra layer to Beacon's places – these are already available through Google Places
- Social networking
    - Beacon has potential to let users connect to each other. Users could share places and connect with people who have liked similar places.
    - Beacon could also connect to other social media sites, such as Twitter and Facebook, to not only allow users to share and tweet about places, and to perhaps encourage uses to add pictures and tags to places.
- Integration with a weather API
    - A weather API would help visitors to an area choose their activities. For example, outdoor activities in Galway in winter might not be a good choice.

Ideally, places would be highlighted for certain weather conditions, and warnings on places not suitable to visit in certain conditions.

- Integration with MeetUp and similar apps
    - MeetUp would allow visitors to find out about events going on that they might not otherwise know about, for example, something as big as the Babóro festival, or something more low key event, like a book reading in a library.

Appendix

A: Full Survey Results

Are you a parent?	I am satisfied with how easy it is to use this app	It was easy to learn to use this app	I believe it would be easy to be productive quickly	I would use this app	If I made a mistake I could recover quickly, easily	The information was provided easy to understand.	Content was clear and easy to read	It was easy to add new places	It was easy to view information on existing places	It was easy to find everything I needed
No	4	4	4	3	3	5	4	5	3	4
No	4	4	4	4	4	3	5	4	4	3

Yes	**4**	3	4	4	4	4	4	5	4	4
Yes	**5**	4	5	4	4	4	3	5	4	4
Yes	**4**	3	4	4	5	3	4	5	4	4
Yes	**4**	3	5	3	4	3	4	5	3	5
Yes	**4**	3	4	4	3	3	2	4	4	4
Yes	**4**	3	4	4	3	5	4	5	5	4
Yes	**3**	2	3	3	2	3	4	4	3	4
~~**No**~~	~~**5**~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~

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