SustainUCD

Duncan Trerotola
for Submission
Dublin, Ireland
duncan.trerotola@ucdconnect.ie
19202075

Domenico Ferraro
for Submission
Dublin, Ireland
domenico.ferraro@ucdconnect.ie
19203549

Brian Keefe
for Submission
Dublin, Ireland
brian.keefe@ucdconnect.ie
19201237

Brian Sandker
for Submission
Dublin, Ireland
brian.sandker@ucdconnect.ie
19202195

ABSTRACT

UCD is a campus focused on sustainable waste management as evidenced by the number of recycling bins around campus, both inside and outside of buildings. However, UCD is also a large school with many students and a healthy influx of study abroad students who stay only briefly. Due to the scale of the campus and student body, identifying where to dispose of waste in a sustainable and eco-friendly way can be a daunting task. SustainUCD will make it easier for the average UCD student to recycle and positively contribute to UCD's mission of a sustainable future.

Author Keywords

Sustainability, Recycling, Navigation, Educational, Learning, Student, Eco-Friendly

INTRODUCTION

SustainUCD is a multi-faced app focused on making it easy for UCD students to recycle. The app will have three primary features: 1) users will be able to see the recycling bins near their current location, 2) users will be able to add unmarked recycling bins to their local database along with a picture of the bin, 3) users will have access to a host of information about proper recycling procedures. The convenience of having access to recycling guidelines and the locations of recycling bins in the same application will allow users to quickly become informed and conscientious recyclers. Furthermore, the ability to mark recycling bins that were not originally located by the app developers will keep this application up to date and able to be used as a tool for users who want to recycle wherever they may be.

COMPETITION AND DIFFERENTIATION

Across the market of sustainability apps, our application manages to capture a niche which does not have any big name competitors. The larger overhead concept of our app is "recycling" which has a lot of subsectors to it. This is a very broad concept therefore developers have rightfully chosen to target their projects toward smaller and more focused areas. While most creators have sought to explore individual utilities under this umbrella, the larger goal has overall maintained the same, being to increase the population's general knowledge of recycling and different ways of making the process easier. Our application delivers to users an effective tool at increasing the ease and efficiency of waste management, an area which surprisingly not many other applications directly do. Most other apps which we found when searching for "Recycling" focused on reducing waste footprint and generally on knowledge distribution. This coincides with the broader concept of what most sustainability apps under the category of recycling seek to achieve, however we wanted to build an app which would focus on improving the disposal of waste rather while also educating users. A big idea which a lot of competitive apps have is what can be called "footprint score" or "footprint boosting". This concept centers around having the user input their own personal recycling contribution and being able to first hand see the positive effects they have on the environment around them. This was also an area which we definitely wanted to hit on.

Recycling Apps

RecycleCoach

RecycleCoach is the most reviewed competitor app from our list. This application focusses on the subsection of waste management which is providing users a calendar with collection dates and reminders for when to recycle. It also gives detailed information about drop off locations such as a short description about the location, its address, hours of operations, and also accessibility to google maps which can give a more accurate location and direction. Also, like most other recycling apps, it provides a "3 things you need to know" which details their 3 rules to live by. Uniquely, it has a news section which features updates about sustainability which can increase the user's all-round knowledge and engagement with the process of recycling and a sustainable lifestyle. Although this app is most likely the most popular competitor app, it targets different issues than the one ours is trying to solve. The 3 rules to live by does increase general awareness about recycling which is definitely beneficial, but can generally just be found online. From what it appears, the app partners with third party pickup companies which inform them of their pickup schedules that are relayed through the app to the user. While having alerts and a calendar for when the pickup of recycling is important, our app does not deal with this because our mindset was that the larger mass of people we wanted to target were those that need to quickly recycle something on the go rather than dealing with scheduled recycled pickups. It is hard to identify whether this

app is a large competitor, because although it has the most downloads and reviews, it targets a different area than us.

Wasitfy

Wastify is an app which in its totality makes it easier to learn how to dispose of one's waste. It features an image classification tool, which allows the user to user the sensor in their camera to instantly identify an object and classify its type from 5 categories (Garbage, Recycling, Compost, Donation, Transfer Station). It also provides subjective results depending on the item, for example, for donatable items, it will curate a list of nearby donation centers and will provide easily accessible directions, phone numbers and website links. This application is definitely our app's biggest competitor given that it targets the same issue as us which is providing users quick and easy locations where they can dispose of their items. Not only that, but they have an edge on our app with their image classification algorithm which instantly tags items just from the camera and finds where you can recycle them. While this is a very impressive feature, we are able to combat it with our unique feature of allowing users to add bins. This allows for two large problems to be solved at once. For one, Wastify does not have all bins available, only official drop off locations. Our app can store all bins, not limited to just official ones. Also, research has shown that one of the biggest factors in increasing long term sustainability rates through mobile applications, is user engagement. By allowing users to add bins which they find in just a few clicks is not only easy for them, but also will create a sense of ownership knowing that they contributed to helping another user find a bin. This is analgous to the footprint score concept discussed earlier which many apps choose to implement. In conclusion, with Wastify being our most pressing competitor, our competitive advantage of not limiting trash spots to official locations, and allowing users to engage more with the app and the act of recycling gives us the edge over their camera classification tool.

Recycle Nation

Recycle Nation is an app whose goal is to increase responsible recycling rates by reducing the difficulty of the process. To do so, it uses location to search for nearby registered recycling drop off spots, sharing recycling tips with friends and family, and also tracks and displays how much environmental impact the user's good recycling habits have impacted with fun metrics. Recycle Nation has some very unique tools which establish it as one of our app's biggest competitors. It's news section that has articles about sustainable living along with daily recycling fun facts/tips are a great way for increasing general awareness and knowledge. It also has what it calls "Log" which is a clever tool for boosting self-esteem and footprint score by having users input the item and quantity of it which they recycled and display how many miles of driving, gallons of oil, and gallons of water they are saving. It also lets you choose from 15 different categories of items and finds nearby registered drop off locations similarly to us using Google Maps API. This app is a very tough competitor because it prioritizes user engagement and locating services similar to us. Their inclusion of allowing users to share both interesting recycling facts they learned from the app and their own recycling activity via social networks is an excellent way of spreading the concept of sustainability while also increasing the user's engagement. The edge our application has over it is that we again, can have a constantly user updated database of bins which are much more accessible than official third party drop off locations. Recycle Nation would succeed over our app initially in a location due to its hard coded recycling spots, but over time, once users add bins and engagement grows, we are confident that our app will have greater reach and popularity than it.

Maps-Based Applications

Google Maps

Google Maps is the default maps application for all android devices. The app has a range of functionality, such as: getting directions, checking traffic, finding public transportation, looking at geography, finding nearby attractions (ranging from restaurants to stores to museums), and more. The app, developed by the tech giant Google, has excellent functionality and is consistently kept up today. However, Google Maps does not have information about recycling bins. Because of the large-scale of the app, smaller details like recycling bins are left out and make this a poor option for users seeking this information. Google Maps does enable users to mark and save their own locations, which is a great feature, but there is no existing database of recycling bins that would help users who find themselves in a location they are unfamiliar with.

Waze

Waze is a premier navigation app. The app focuses primarily on helping users get from point A to point B as efficiently as possible, with less consideration of users who simply want to find a nearby coffee shop or park. Waze relies on constant user feedback to offer users traffic information they are unlikely to find elsewhere, such as locations of police cars and car accidents. Because of its focus navigation, Waze does not have information on recycling bins and is not positioned as a tool for users to find information of that sort.

LITERATURE AND DIFFERENTIATION

While searching for relevant research literature, we focused on articles which could inform us on not only the relevance of recycling based applications, but also increase our knowledge of the human behavioral motivations behind recycling in order to gain a deeper understanding on how to improve them.

The first article we found was extremely relevant to the scope of our project. It details a group of app designers journey to design a recycling app which will enhance recycling rates and make the task less cumbersome for people. They began by first studying behavioral reports linked to recycling and then surveyed the top 50 recycling apps on the android market and assessed their pros and cons in the development

of their own app which they hoped would learn from others mistakes. Research behind recycling showed that individuals' recycling rates could be most attributed to personal attitude, perceived behavioral control, and moral obligation. The goal for a recycling app would thus be to not only create positivity around recycling, but also instill that it is the right thing to do and that more and more people are doing it which will motivate the user to join the cause. Coincidently, they also found that from the surveyed applications, what was lacking in the market was a strong and grounded user centric approach. The majority of the apps focused on provided general knowledge in the form of a "waste dictionary", detailing the different kinds of waste and how to properly recycle them as well as a waste collection calendar. The gap they found was user-engaged apps that provide nearby wastebin locating, exactly what we have been able to provide. This piece of literature supports our design decisions to focus on easing the waste process for simple and composite materials, given that those are the most common kinds of items which people will have to deal getting rid of on a daily basis. Also, our choice to pivot our bin database in the direction if allowing users to add their own individually located bins in the area aligns with their research which found that lack of motivated and active users makes it impossible for a recycling app to actually be able to provide sensible changes.

DESIGN CONSIDERTATIONS

Users

UCD First Years

Roughly 25% of the 30,000 students at UCD are first-years. These students come to campus for the first time in the fall and are unfamiliar with the layout. With responsibilities like figuring out how to get to class, balance their schoolwork, and make friends, many of these students do not take the time to familiarize themselves with the locations of recycling bins and educate themselves on how to contribute to a sustainable campus.

UCD Study Abroad Students

UCD is a major study abroad destination. As such, the school sees an influx of new students each semester. These students are similar to first-years in that they are generally unfamiliar with the campus. While they may be less overwhelmed by the pressures of University, these students need resources to help them locate recycling bins on a vast and unfamiliar campus. Furthermore, recycling habits may be different in Ireland than the country they are originally from, so educating these students on recycling habits is crucial.

Other UCD Students

UCD has a huge student body beyond just first year students. These students are likely much more familiar with UCD's campus but may not be fully educated on proper recycling habits. Additionally, because of their familiarity with campus, they can be expected to mark the locations of bins that the developers overlooked.

Campus Visitors

UCD boasts a large campus that is open to visitors year-round. Additionally, the university hosts a range of events that attract non-students to campus on a regular basis. Campus visitors are likely to be very unfamiliar with campus.

UCD Campus Planners

UCD is a growing campus that experiences renovation on a regular basis. As such, there is a team of people who design and plan this campus, including details such as recycling bins.

Use Cases

SustainUCD will be used by a wide range of people on UCD's campus. The key use cases for this app are finding a nearby recycling bin, becoming educated on proper recycling habits, and mapping known recycling bin locations throughout campus.

Find Nearby Recycling Bins

First and foremost, SustainUCD will make it easier than ever to find a nearby recycling bin on campus. UCD first year students are likely to require this feature, as they are less familiar with campus and more likely to find themselves in a location they have not been before. Study abroad students at UCD are similarly unfamiliar with campus. SustainUCD will enable these users to find the closest recycling bin quickly and easily, regardless of where they are on campus. While students who live and study on campus will familiarize themselves with UCD over time, the steady stream of visitors to UCD are often on campus for very short periods of time. Campus visitors will consistently need SustainUCD as a resource throughout the calendar year because visitors are often new to UCD and do not stick around long enough to learn the layout. SustainUCD will enable these users to find nearby recycling bins whenever they need to and will be frequently used by this demographic even after new students are familiar with campus.

Access Educational Material

SustainUCD will also serve as an educational resource for users looking to learn more about recycling. While recycling is quite common on a campus like UCD, there are several different bins that can lead to confusion. SustainUCD will provide sorted information about recycling different items to users who are unsure and need an answer quickly. First year students are likely to use this feature because of their youth, while study abroad students may come from countries with different recycling rules.

Save Location of Recycling Bins

SustainUCD also enables users to mark and save recycling bins that are not included in the original app database. UCD has a vast campus, so identifying and saving each bin on that campus was an unrealistic goal for the app developers. Older students at UCD, as well as campus planners, will use SustainUCD to note the location of less obvious recycling bins on campus. To some, this feature will help them jog their

memory and save some time recycling. To campus planners, this feature will make SustainUCD an integral part of the campus planning effort, as locations of recycling bins can be referenced, changed, and removed.

User Interface

The user interface of SustainUCD was designed with a focus on functionality and user experience. Because SustainUCD is a tool for its users, efficiently and clearly communicating information that will allow users to recycle more easily is the focus of the user interface. The home screen performs the primary function of the app, which is finding recycling bins closest to the user's current location. From this home screen, the user is able to add a bin or access recycling educational resources.

IMPLEMENTATION

Features

Nearby Recycling Bins

The home screen of this app will provide a list recycling bins near the user's current location, sorted by proximity. Each line item of the list will be an individual bin, accompanied by a picture of the bin and the distance from the current location to that bin in meters. Also, on this line will be small icons that denote the kinds of items that can be recycled in this bin. Line items will also have a button that the user can click to open Google Maps and be directed to the exact location of the bin clicked.

Clicking on a certain bin will take the user to a screen that provides details about the bin. A picture of the bin, the distance to the bin, and information about what kind of items can be recycled in the bin. This screen will also have a button that, when clicked, will open Google Maps and direct the user to the latitude and longitude of the bin.

Add a Recycling Bin

Users will be able to easily add to the existing library of recycling bins. When a user clicks on the plus icon, the camera is accessed (after the user grants the app permission to use the camera). The user can then take a picture of a recycling bin that is currently not marked by this app. Once the user confirms that the picture is acceptable, he or she is prompted to input a brief description of the bin by noting what type of bin it is. When the user confirms this information, the new bin is saved along with the user's current latitude and longitude. New recycling bins are stored locally for each user and will come up when a user is looking for a bin on the home screen, just like any other bin.

Access Recycling Bins / Remove Previously Added

From the home screen, users will be able to access a database of the recycling bins that they've saved. The bins will appear as a list, and a user can click on a bin to view the bin's information page (the same page accessed by clicking on a bin from the home screen). Additionally, from this list, a user can remove a bin from the database. Doing so will prompt the app to ask the user to confirm this action, and, if confirmed, the bin will be removed from the user's database of bins.

Recycling Education

Users will be able to access extensive information about how to recycle different items by clicking the information button in the app. Clicking on this will take the user to a screen with several different item types (the same types used to tag recycling bins in the database). Users can navigate through these categories, getting more and more specific until they find the item they are looking for. Instructions for how to recycle the item is then available.

Technical Achievements

Pictures

SustainUCD has a lot of pictures in it and enable users to upload more pictures if they choose to. Pictures are a major runtime challenge, as they take up a lot of storage. We dedicated a lot of time to implementing all pictures-related code in the most efficient manner. As a result, we successfully handled our biggest runtime challenge and were able to build a smooth and efficient app.

Compatability

The mission of SustainUCD is to make it easy for anyone to recycle. To facilitate this mission, we built the app to be as compatible as possible. SustainUCD is compatible with every android version back to Android 4.0.3, which is the oldest stable version. Any smartphone that went to market from 2012 until the present is able to run this app. Additionally, this means that 100% of smartphones that have the Google Play Store can download and run SustainUCD. To further ensure this, we tested our app with not just an emulator, but also on real Samsung, Huawei, and OnePlus phones.

KEY TAKEAWAYS

The development of SustainUCD was an incredible learning experience for each member of our team. In terms of programming skills, the challenge of building an app from scratch is highly applicable to the real world. Frequently, computer science courses focus on small bits of coding, but this project was open had very few strict guidelines. As a result, our team was forced to create the architecture of the app from scratch, which proved to be a unique challenge. Because this app was developed by a team of people, rather than an individual, our group had to become very familiar with GitHub. The usage of GitHub was important not just for sharing code, but for the organization and incremental development steps. We divided our team into frontend and backend teams, and each of these teams had their own branch on GitHub. The ability to logically organize a GitHub repository and upload commits with informative comments are critical skills for any developer. Another challenge that our group faced was building an optimized app in the Android environment. A lot of time was dedicated to conceptually discussing how our app would be laid out so that it could function in an efficient manner. In this same

vein, we learned that pictures are a serious runtime challenge.

The knowledge gained through this project goes beyond the technical skills honed during development. Software engineers are often assigned work and deadlines by their superiors. For this project, there was no product team or software lead guiding us. Our team experienced each step of app development, including the critical early stages of brainstorming, market research, and user stories. Spending time looking at our app from a high level and actually making conscientious design decisions based on research was a highly rewarding learning experience and a rare opportunity. These discussions not only honed our design skills, but also provided us with far more understanding of our goals as we moved through the development stages.

Finally, our team was able to learn a lot about how apps can be used to better the world. So much of the time we spend on our phones is dedicated to social media and things of that nature, but we discovered that applications have the power to drive user behavior towards sustainability. Our market research taught us a lot about the world of sustainable apps, and we had the opportunity to find a niche and make an incremental contribution to a more sustainable future.

CONCLUSION

Overall, the development and implementation of SustainUCD was a success. There is a clear need in the marketplace for an application that can identify nearby recycling bins and provide users with literature about proper recycling habits. Many different demographics within the UCD community would benefit from SustainUCD, and widespread usage of the app is beneficial to the sustainability of UCD's campus.

SustainUCD is an app designed for UCD, but UCD should really be viewed as a trial ground for the app. Sustainability through recycling is a modern issue that is essential to the health of the planet, so an application that can make recycling easy and educate the general population stands to positively impact the global community. In reality, UCD is a campus flush with recycling bins, so finding one is not incredibly difficult. However, many campuses, parks, and cities have much fewer recycling bins. In many places, users face the internal debate of whether to simply throw garbage on the ground or walk around with it in their hand until they randomly stumble upon a recycling bin. Unfortunately, users often choose the former. In a similar vein, many areas of the world are far less educated on how and what to recycle.

SustainUCD is built to grow and spread recycling education. The app enables users to mark and save recycling bins they find and tag them with the items that can be disposed of in them. Further development needs to be done so that when users save bins, the bins are added to the database of all other users. To ensure this process is efficient and safe, vetting procedures and cross referencing need to be implemented for each bin that is marked. Overall, the future is bright for the industry of sustainable apps, and, with continued development, SustainUCD is poised to make a major impact on the world.

REFERENCES

[1] Bonino, Dario, et al. “WasteApp: Smarter Waste Recycling for Smart Citizens.” *Researchgate.com*, July 2016, www.researchgate.net/publication/303703481.