GNG 1103 Project Deliverable D

Universal Recycling Sorting

Brainstorming, Subsystems, Selection Matrix, and Final Concept

Submitted by

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Date: 22/02/2021

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Table of Contents

List of Figures

List of Tables

1. Introduction:

The project of "Waste Management" was a project assigned to the teams by the client Mitch Bouchard. Mitch Bouchard is part of a family business in the field of mechanical part supply. This project has a goal of improving the quality of recyclables and decreasing waste in landfills by creating a system to assist people in sorting their recyclables properly. Though many individuals believe that recycling is enough to make a change in the world this is not the case when looked at on a large scale. Many recyclables are missorted and end up in landfills and/or shipped overseas to countries that have more room for landfills than Canada does. In fact, many people do not know how to recycle and opt for throwing everything into the garbage instead resulting in further pollution in our environment. Creating a product to help people learn and understand how to sort their recyclables and garbage easily could help in the big picture of managing and reducing the amount of waste on the planet.

Previously the team was tasked with identifying and developing the client's needs and wants, the problem statement, a list of metrics and some benchmarking of similar products on the market. The client's needs were identified during the client meeting in the form of statements, these were then used to develop a list of needs and wants for the product (user friendly, cost effective, determines eligibility of items to be recycled, determines items respected disposal location and that the product is versatile and can be used by a wide variety of people) the need and want statements would guide the team in creating a product that would meet the client's expectations. From these needs and want statements a problem statement could be developed: A need exists for people to reduce waste in landfills by creating a user friendly, cost-effective product that helps customers and users to recycle correctly and efficiently. Once the problem statement was defined metrics were determined to express the client's needs in the form of attributes that are measurable. Benchmarking was done to explore other products on the market that may meet the client's needs and wants. Finally, we further developed the metrics, set target specifications and determined a set of design criteria.

This report has the focus on reporting the results of the teams brainstorming session, defining the three main subsystems of identifying the material, identifying the correct bin and identifying the disposal locations. The report further explores the results of plugging said concepts into a selection matrix to determine the best possible solution, pros and cons of the solutions, comparison to benchmarking as well as the final selection to move forward with.

2. Subsystems and brainstorming:

In the brainstorming session that the group had we came up with 3 subsystems which were Material Identifying Systems, Disposal Location Determination System, and Recycling Bin identifying System. We came up with 4 parts of each system and then ranked them in Table 1 based on their importance.

Material Identifying System- We came up with 4 ideas for this system. Initially the user would use their camera to identify the type of material that they need to be recycled and the camera scan would inform them of that material and advise them on the bin to put the recyclable material in. Also, there could be a barcode scanning system that for certain items that have barcodes it would automatically scan and based on the product description on where the item needs to be recycled, inform the user of that exact bin so the user recycles the product correctly. The user could also manually pick up the item and read the bottom on where the recyclable product says which bin to recycle it in. Another way that the app could be used is by the app asking the user a series of questions such as "what type of material is this" and this instantly inform the user on the bin to place the item in. Finally using TensorFlow to identify the item and inform the user where to recycle it. If the item is not recognizable then it will tell the user to garbage it.

Disposal Location Determination System- This could be done through having the user have their location on constantly for the app, so the app knows where the user is whenever the app is being used. By using the map feature it will determine all nearby Recycling areas and inform the user on the closest one. This can also be done using google maps in which the app will redirect you to google maps for a more user-friendly way to get to your destination. The app will automatically put the address into google maps, so the user will not have too manually do it. Also, the app can show the city map so if the user is not at home and has materials that they need to recycle they can be informed of the closest Recycling bin.

Recyling Bin Identification System- The app can scan the item right away and chose the right bin based off its material detection through pictures feature that uses the camera. In different countries bins have different colors so it will be a feature to manually input your countries color of the bins in manually and the app will re-adjust to the changes. Also, through a feedback system that will ask the user a series of questions the correct bin for the object can be identifies quickly and easily. It will also ask the user to scan the bin once they are done with the feedback system in a type of game where if you get it correct you get points.

3. Selection Matrix

The selection matrix was created to determine the best ideas for all of the ideas brainstormed for our different subsystems. This is done by ranking the ideas against a reference and by multiplying by the relative importance of each criteria. The reference product in this case was the client's needs

and wants as there was no product on the market that came close to meeting his concept. From this the metrics defined and the product concepts generated were inputted into a selection matrix:

Table 1: Selection matrix and importance

Material Identifying System												
Selection title	wieghing	Camera		Scanning barcode		Reading Recycling Symbol		Questions		TensorFlow		
Efficiency (determining recyclability)	5	3	15	2	10	4	20	3	15	4	20	
cose effective	4	3	12	3	12	3	12	4	16	3	12	
Easy to use and interpret	4	4	16	4	16	4	16	4	16	4	16	
Availible to many people	3	3	9	3	9	3	9	3	9	3	9	
Lightweight	2	3	6	4	8	4	8	4	8	4	8	
Secure	1	3	3	3	3	3	3	3	3	3	3	
Total			61		58		68		67		68	
Disposal Location Determination System												
Selection title	wieghing	Location Sharing		Physical Map feature		Information only		Google Maps redirect		City map		
Efficiency (determining recyclability)	5	4	20	1	5	2	10	4	20	4	20	
cose effective	4	3	12	4	16	3	12	2	8	1	4	
Easy to use and interpret	4	4	16	1	4	2	8	4	16	2	8	
Availible to many people	3	4	12	3	9	5	15	4	12	4	12	
Lightweight NA	2		0		0		0		0		0	
Secure	1	1	1	4	4	4	4	4	4	4	4	
Total			61		38		49		60		48	
Recycling Bin Identifying System												
Selection title	wieghing	Camera		Colour display		Feedback System		Scan Bin		Questioner		
Efficiency (determining recyclability)	5	3	15	2	10	3	15	3	15	1	5	
cose effective	4	4	16	4	16	5	20	3	12	4	16	
Easy to use and interpret	4	4	16	2	8	2	8	4	16	1	4	
Availible to many people	3	2	6	2	6	5	15	4	12	5	15	
Lightweight	2	2	4	4	8	5	10	5	10	5	10	
Secure	1	2	2	3	3	4	4	3	3	3	3	
Total			59		51		72		68		53	

The selection criteria for each section were defined as efficiency (determining recyclability), cost effective, easy to use and interpret, available to many people, lightweight and secure. The weighing for these factors was taken from the importance determined for each need and want statements from the prior deliverables. Each criterion was ranked on a scale of 1-5 and the weighing was also on a scale of (1-5).

The selection matrix states that the best concept for the material identification system would be either the reading recycling symbol or the TensorFlow method. These both scored the same in the efficiency and easy to use sections, and scored highly, this means these being some of the most important criteria it is clear that these were the best ideas in this section (with a score of 68). The Questions method scored second as it was not as efficient in determining the recyclability of each material as it was heavily based on the user's input.

For the disposal location determination system, the Google Maps redirect and the Location sharing scored highest (the higher being location sharing). Google maps scored slightly lower since it would require additional costs to involve google as a partner and to have them include recycling box locations on their map system. The information only scored third highest, however, this product can already be found on the market and does not satisfy the client's needs therefore, this would not provide a good enough solution to the client's problem.

The selection matrix has determined that the best solutions for the Recycling bin identification system are the Feedback system and the bin scanning system. The feedback system scored best as it would provide a checking system to ensure that the product is going in the correct bin. The camera scored the third highest, however it would be less secure and less cost effective.

4. Comparison to Benchmarking

The app “Recycle!”, by Bebat Vzw provides users with information about recycling collection and sorting based on the user's location. One of the main drawbacks of this app is the application isn't very user friendly due to the app not having consistent language options or recycling information based on location finding not working as it's supposed to. Our app will ensure that it will be accessible to a wide range of consumers as possible by making sure it has a large database of languages and it will have a better location finding system by using location services and/or google maps re-direct.

The app “Grow Recycle”, by Gro Play is a good app in terms of user friendly as it tailored towards kids. The focus of the app is to teach users how to recycle properly, where each recyclable item should go and how they get treated at recycling plant. Our app will focus more towards educating the public in addition to aiding the users for where to dispose of their recyclables and when recycling day is via location services and/or Google Map re-direct. Our app will also have a wider customer base and will not be tailored towards just kids.

Commented [GW1]: These are the main goals yes?

Finally, our third benchmarked app is “Recycle Coach” by Municipal Media Inc. Recycle Coach provides information about garbage types and drop off locations as well as operation hours. Recycle Coach also sorts recyclables for the user and has an updated calendar with upcoming recycling days in their location. Recycle Coach will also send notifications to its users for any important updates or information. Our app will expand on Recycle Coach by having a better sorting system and learning system for its users. Right now, Recycle Coach tells users which items will be placed in which bins. Our app will expand on their sorting system by allowing users to scan items and the app will tell them where to put them. Our app will also have a learning system to teach the users about recycling.

5. Advantages and Disadvantages of Top Ideas (based off selection matrix)

There are several advantages and disadvantages to each of the ideas that were developed during the brainstorming sessions. Below the top solutions from the selection matrix were compared using pros and cons to help determine the best solution to the client's needs wants and problem statement.

5.1 Material Identifying System

5.1.1 Reading Recycling Information

This concept had the advantage of being able to easily identify the item based off the symbol on the item. This would provide an accurate and quick method for the product to identify the correct bin in other systems.

On the flip side, this would require the user to have a reasonable camera, a camera and good picture quality. It also could potentially take a fair amount of time to scan which could cause frustration in the users, especially if they are using older phones.

5.1.2 TensorFlow

This concept would be very accurate in identifying the product. However, it is more complex to create and may be difficult for the team to execute.

5.1.3 Questions

The series of questions would assist the users in choosing the correct bin in a simple and clear manner (user friendly). However, if the user does not have enough time to fill out the questions or does not fill them out accurately this method will be very inaccurate.

5.2 Disposal Location Determination System

5.2.1 Location Sharing

This method would provide a good location determination of the nearest recycling location, it would be very user friendly and efficient due to the fact that it would determine the bin closest to you. However, this would not work if the user does not wish to use their location sharing and may cause privacy issues.

5.2.2 Google Maps Redirect:

This feature would be helpful as it would also be user-friendly and efficient, it would also be at an advantage as it could provide navigation and directions to the nearest bin. However, if the user does not have the google maps installed, they would need to install it which could be a hassle and a partnership with google/google maps would be costly and not budget friendly.

5.2.3 Recycling Day Info

The user can manually input when the recycling day is and be notified and the date can be changed whenever so if there is an issue its easily fixable. However, If the user decides to input wrong information, then it defeats the whole purpose, and the feature will not be as useful.

5.3 Recycling Bin Identification System

5.3.1 Feedback System

The main benefit for this is that the user can answer questions that will then allow the system to identify what the current state of the recyclable material is in and if it can even be recycled. However, as said before if the user inputs wrong information it will not work as desired.

5.3.2 Scan Bin

If the user choses all the right information through the feedback system, then you would scan the bin you are about to throw your trash in and see if you are correct (like a game). This makes the app and recycling more fun in general and may even create a desire in the user to keep playing it like a game and bettering their recycling skills. However, if the user does not have a great phone or camera this feature may cause a lag in the app and hence decreasing the overall happiness of the user experience.

5.3.3 Camera

The main reason the Camera usage is great for the app is that it can identify the object and inform the user of the material based on its looks. However this feature comes with many flaws such as, the user needs to have a working camera with good picture quality for the app to recognize the object easily. Also, if the user's camera is broken then this feature will not work hence in a way defeating the purpose of the app.

6. Final Selection and Justification

Based on the information we have in our selection matrix as well as the list of pros and cons available above, we can determine that the best solution we're able to provide for each subsystem is an application that uses TensorFlow for identifying recyclables, location sharing to determine disposal location, and a feedback system that identifies recycling bins.

For the identification of recyclables, the main idea is to use TensorFlow to integrate a code into the application that will be able to properly identify the correct bin relevant to the recyclable in question. However, coming up with such a solution may require significant proficiency in coding, which can prove to be tricky. If problems are met by using TensorFlow, using a system that can read the recycling symbol is another viable option since it received the same score in the selection matrix.

Location sharing will be used to determine the disposal location due to being the easiest and most efficient method to implement into the application. Also, no third parties need to be involved in its development so it can also be considered the most cost-effective approach.

The identification of recycling bins will be done using a feedback system. This method, compared to other solutions that can be used, is relatively simple and less prone to error than other methods as well as being cost-effective.

7. Sketches of Final Concept

The concepts were sketched to demonstrate the look and function of the product, this will help in the development of the prototypes in the deliverables to follow.

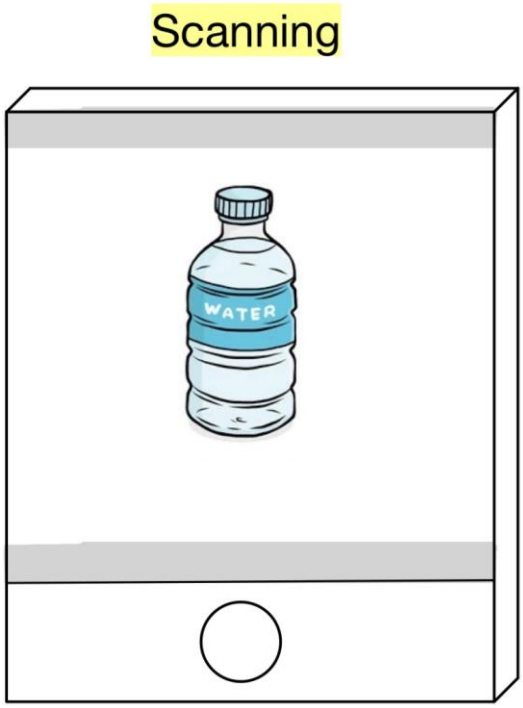

Figure 1: Scanning the object.

The first sketch demonstrates an object being scanned to determine its recyclability, this would be the result of combing the camera method and the TensorFlow method to determine the recyclability of the object.

Figure 2: Asking the user whether scan was correct.

The second sketch demonstrates the verification feature which would involve the item being detected by the camera and categorized by the TensorFlow system, this would then provide a picture or word describing what the systems thinks the item is to verify that it is correct. This verification step would make the product more accurate.

Figure 3: Tells the user which bin he/she should use.

The next sketch shows the screen where the system would identify which bin to put the recyclables into. This depicts a clear image of the bin identified for the proper recycling, it would also ideally link to the location of the bin as described in the other subsystems.

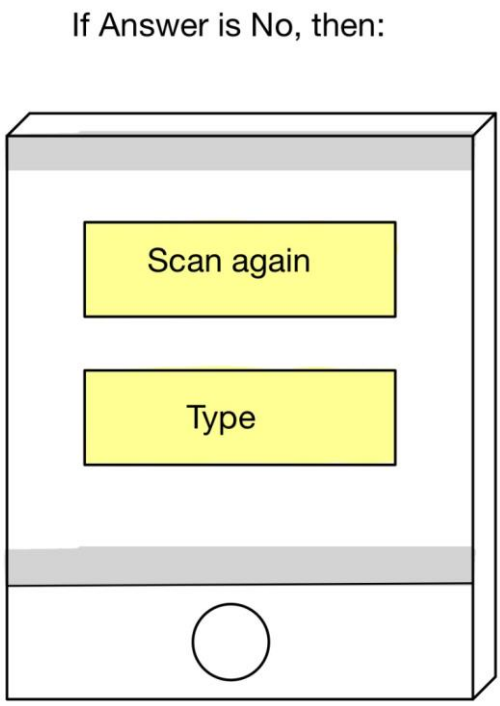

Figure 4: Asks the user whether user wants to type the material or scan it again in case of a failure in the first scan.

This sketch shows the screen if the system were to fail identifying the material and bin to recycle. It would give the option of scanning again (in case of poor photo quality) or of inputting the material into the system to help it improve/learn and grow its database.

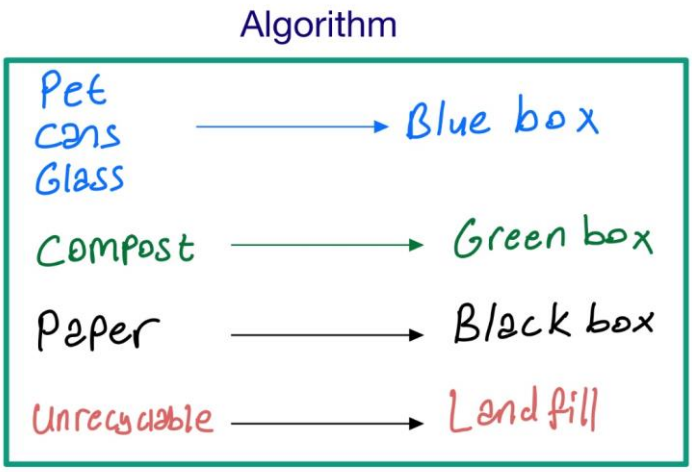

Figure 5: depicts the algorithm that decides the color of the box user should use.

Finally, this sketch demonstrates a very basic algorithm that would decide which materials go into which bins. This sketch is based off the Ottawa recycling system but could have an edit feature or built-in location selection tool so that it can be used by a wider variety of people.

8. Conclusion

We translated our design criteria into a set of ideas and elements we want to include in our application to achieve our customers' needs/wants. We also gave a general outline of the interface of the application to get a feel for how to interact with the application. The selection matrix will help us determine the best solutions out of all the ideas brainstormed for our subsystems.