Deliverable C – Design Criteria

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Introduction

When it comes to solving complex engineering problems, it is crucial to brainstorm and evaluate multiple different ideas to achieve the most efficient solution. That efficiency is subjective, as different individuals might prioritize different results which is why in design thinking, it is critical to understand all your clients' needs and their respective importance to one another. Equipped with this knowledge, it is then possible to create design criteria based on these needs to evaluate all thought-out solutions as objectively as possible and determine which one should be implemented. These criteria are based on needed functional and non-functional requirements, as well as potential constraints. To further facilitate the evaluation process, elements that can be measured are compared against metrics. For the design of a system to facilitate household recycling, 6 criteria were chosen, 5 of which can be measured, and 1 which cannot. Those 5 criteria are performance time, dimension & size, complexity, effectiveness, and implementation cost; the last criterion is that of adaptability. Also, benchmarking was performed to research if existing solutions to this problem already exist.

Performance Time

One of the most important elements in day-to-day life is time. It is always on the move and so are people. the longer the tool takes to provide a result, the fewer people will use it. Therefore, this design criteria is critical to ensure that the end-user will use the product regularly. Marketing studies show that a website or app has an average of 15 seconds to capture the user's attention before they move on to something else. This is an important aspect because if the product cannot capture their attention, it will fail. Thus, the tool has 15[1] seconds to get the user to start interacting with the product and capture his/her attention before they move on to something else. Once the user has completed his initial interaction, they now expect a result. The tool should produce a result within 30 seconds of the initial interaction. Any longer and the user might lose patience and decide on their own. Recycling should not require a long time to do. If the goal is to have this application used multiple times per day, it must be quick and effective. With that being said, the total run time of the process should not exceed one minute. While a more ideal time would be 45 seconds. To evaluate this metric test runs must be done with multiple recyclable items and with an array of different users ranging in age. An average run time will be calculated. If it exceeds one minute, the tool should be modified to improve its efficiency.

Dimensions and Size

This criterion covers the potential physical size of the product and its potential digital size. For the physical dimensions of the product, it should be noted that this will be used in households. Ideally, this tool will be found near the recycling area of the house. The size must ensure that it can scan small to large items and that it is lightweight and small enough to manipulate. the dimensions of the scanner should not surpass 2.5 inches in length, 2 inches in width and 6 inches in height and it should not surpass 250 grams in weight. If the tool used is digital, then the application must not take too much memory on the device. This will be a burden to the user, and they will be prone to deleting it to create space. The application should not surpass 100 megabytes. Photos taken will be stored in the cloud to reduce storage space.

Complexity

The client specified that one of the most important elements of a potential solution is its simplicity of use since it was stressed that the solution should focus on ease of use and user-friendliness. As such, any solution must be simple for users to use. It should have a low learning curve, it should be intuitive to use, and it should not require a lot of energy to use. Since recycling items (i.e. sorting items in their respective recycling bins) can happen multiple times a day for individual households, a complicated-to-use system would discourage potential users from utilizing this system to help them recycle better. Therefore, any potential solution has to require as little input and effort from the users as possible. To evaluate this, two metrics will be used: the number of decisions required, and the number of interactions required. These two metrics might be the same in some test cases, but that is not always true. For example, clicking “next” on an app would count as one interaction, but would not count as a decision. For this evaluation, “decision” is defined as a situation where users need to use critical thinking abilities. Another example would be answering a question; this would count as both a decision and an interaction. For this project, an acceptable range would be 5 decisions and 8 interactions required, while the ideal would be below 3 decisions and 5 interactions.

Adaptability

A promising solution must require the ability to be effective universally, or otherwise stated as versatility. Versatility is a concept that is growing with significance in society since being able to adapt to changes is a necessity. The ability for a solution to be flexible in all situations, environments, or problems makes it compelling because there are no boundaries; it will be prepared for everything and will overcome any issue. Since recycling is a world-wide issue, the idea should be capable of working in any circumstances. The app should be made so that everyone can be able to use it without hassle. For instance, the bins used for recycling in Australia are red, green, and yellow, and the colours for the bins in the United Kingdom are blue, brown, and green. An adaptable solution will be able to overcome this issue without any further instructions. Adaptability is significant for the users of the app, for it increases the efficiency of it. People will be more compelled to utilize an app that is easy to comprehend and to use. It should not inconvenience the users. One way that the app can be of challenge to other countries is if the app categorizes the items based on the colours of the bins. As previously mentioned, there are no universal colours for recycling bins, so the app will need to adapt to that and provide a different solution. Therefore, the app must be able to adapt to any scenario for users to use it with no difficulty.

Effectiveness

An important consideration in the effectiveness of the product is its ability to perform its function without inconveniencing the user. This is of itself can be accomplished by making the design of the product as ergonomic as possible, while still maintaining its primary functions. The main reason for this being, if someone needs to spend a long-time recycling, they may not be inclined to inconvenience themselves the next time. For this reason, to be effective, the final product will need to be efficient in its process of helping the user, or it would not be conducive to be used by people who would otherwise not recycle. Something else which could boost the effectiveness of a final product could be some system that catalogues and uploads a user's consistency in recycling to others that use the app locally. This sort of thing has been used in other activities like biking, running, and swimming with Strava, which allow for a sense of community between users.

A good metric that can be used to measure the efficacy of the final product is its accuracy. The client has stated that the accuracy of the resulted recycling performed by the users should be approximately 90% correct. Ideally, this is achievable. However, due to the potential of varying recyclable materials that are not accounted for, an accuracy rate of around 70-80% could be more viable as something to strive for. Another measure of effectiveness could be the implementation of some feature that tracked how often the product was used. This tracker could be one that operated daily, meaning that if someone used it once a day, it would be catalogued. If people stopped using it after the first couple of days, it can be safely assumed that the solution was not effective enough.

Implementation Cost

The total cost to implement possible solutions is also an important criterion that needs to be taken into consideration. The client has indicated that they have very limited resources for the potential expansion of any possible solutions. If the client cannot cover the cost, then that cost would be carried over to the end-users, which in this case would be the individuals who are not presently recycling properly. Any cost tied to this solution that would have to be paid by the end-users would greatly affect the probability that users are not willing to adopt this system. To encourage as many people as possible to learn to recycle properly, one of the client's main goals, any potential obstacles must be avoided. As such, proposed systems must not require more than the resources available to the client. They would need to be low-cost to initially implement, maintain and possibly expand. For this criterion, the cost in Canadian dollars will be used. For the initial implementation, the cost should not exceed $100, and its maintenance, as well as future expansion costs, should be as close to $0 as realistically possible.

Benchmarking

Technical Benchmarking

Based on the six criteria, each product was investigated as to how they achieved the said goal. The results for our group product are all theoretical results, they are the goals we hope to meet. This type of product is not yet being used commercially on a wide or global scale, ergo there is a lack of information on what other companies are doing. Complexity and effectiveness, which are rated highly above all must help the user quickly and easily identify recycling or garbage. COHDA's product was the least complex requiring the user to make one motion/interaction, however, there are limitations to the technology being used. The user must also be engaged within 15 seconds1 and then be helped within a minute. Liverpool Hope University's product was not commercially viable due to the speed while providing no precise numbers this serves as a reminder that the product must be quick. The product must be as simple, efficient and quick as possible.

Criteria	Group 5 Product	COHDA[2] Recycling Identification Device	Taobao / Alipay App / Scanner[3]	Liverpool Hope University App[4]
Performance Time	Initial result: 30 seconds Total run time: 45-60 seconds	"Immediate"	N/A	"…slow to be commercially viable".

Dimension & Size	Physical model size: 2.5 inches in length, 2 inches in width and 6 inches in height Physical model weight: 250 grams (g) Digital size: 100 megabytes (MB)	Physical product. Fits inside palm of hand. Dimensions N/A.	Taobao 256.4MB Alipay 255.7 MB	App. Size N/A.
Complexity	3-5 decisions and 5-8 interactions	1 decision/ interaction	N/A	N/A
Adaptability	Adaptable worldwide	Adaptable worldwide	Adaptable worldwide	Adaptable Worldwide
Effectiveness	Ideally 90% success rate Realistic 70-80%	N/A	N/A	92% success rate
Implementation Cost	Under 100 CAD	"Low cost"	Added to existing platform. No cost.	Under 175 CAD (100 GBP to CAD)

User Perception Benchmarking

Users need to engage in this product for it to succeed. It is essential that the product be simple so that users can understand how to differentiate the types of recycling. It is also necessary that the product be as effective as possible, to solve the core problem of recycling ending up in landfills. These criteria were the highest rated based on user perception. Performance time is ranked second since this impacts user engagement. Other factors such as dimension/size and adaptability were rated lower. These criteria do not affect the user experience as much. Lastly, while implementation cost is a factor to consider in the project's construction it is of little importance to the user, so long as the cost does not appear on their end.

Criteria	Importance	Group 5 Product	COHDA[2] Recycling Identification Device	Taobao / Alipay App / Scanner[3]	Liverpool Hope University App[4]
Performance Time	4	3	3		1
Dimension & Size	3	3	3	2	
Complexity	5	2	3		
Adaptability	3	3	3	3	3
Effectiveness	5				3
Implementation Cost	1	2	2	3	2
Total		42	47	18	30

3 – Good (Green) 2 – Satisfactory (Yellow) 1 – Needs Improvement (Red)

NB: Due to unavailable and "loose" data this benchmarking based on user perceptions is not accurate. This chart helps visualize and compare the available products and their features based on a ranking system determined by user perception. The empty cells did not contribute to the total. The metrics were

given a point value and each product was given a score from 1-3 which was then multiplied by the point value (importance). The higher the score the better.

Conclusion

In conclusion, the design criteria were chosen to help guide the project to achieve the goals set by the client and users. Six criteria are to be considered, performance time, dimension/size, complexity, adaptability, effectiveness, and the implementation cost. The user and technical benchmarking demonstrated what products were on the market and how they ranked based on the six criteria created. In the future, these metrics will be used to conceptualize an idea to solve the recycling waste sorting problem.

References

[1]David ZhengDavid Zheng is an alumnus and former contributor to The Daily Egg. (2020, May 25). The 15 Second RULE: 3 reasons why users leave a website. Retrieved February 06, 2021, from https://www.crazyegg.com/blog/why-users-leave-a-website/

[2]R.I.D. (2019, October 11). Retrieved February 06, 2021, from https://www.cohda.com/projects/r-i-d/

[3]'Trash-Recognition' tech sorts out recycling woes. (2019, July 31). Retrieved February 06, 2021, from https://www.alizila.com/alibabas-trash-recognition-tech-sorts-out-recycling-woes/

[4]Ward-Foxton, S. (2020, October 24). Ai speeds object recognition for recycling. Retrieved February 06, 2021, from https://www.embedded.com/ai-speeds-object-recognition-for-recycling/