



July 21, 2022
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RE: ENSC 405W/440 Project Proposal for e-minder

This document has been prepared by the purple mango team to clearly list the project proposal for the product “e-minder” for our ENSC 405W and ENSC 440 capstone design project. We believe that e-minder will be a helpful aid for forgetful individuals who have trouble remembering to bring items with them as they leave their homes.

This project proposal document showcases that e-minder will be a valuable product that fulfills a need in the real world for forgetful individuals. This proposal will provide information regarding device background, the scope of the project, a market analysis, an assessment of risks and benefits, and the device’s estimated cost. By the end of the document the reader should have a firm grasp on how e-minder will be designed and implemented for the alpha phase of development (i.e., the proof of concept) and should have sufficient detail regarding later versions of the product (i.e., the prototype & production models).

This document has been written by six engineering science students from Simon Fraser University: Ramanpreet Kaur, Riku Makita, Harely McLachlan, Anika Sheikh, Adham Sorour, and Dylan Rowsell. Each student has a different background and skill set that they bring to the purple mango team.

Thank-you for taking the time to read this document reviewing the project proposal for e-minder.

Sincerely,
Team purple mango



Project Proposal: purple mango

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1.0	Purple Mango	07/21/2022	Dylan Rowsell	07/21/2022	Initial Proposal



Executive Summary

Leaving home without an important object happens to everyone from time to time, but this issue can be particularly common for subsets of the population who tend to be more forgetful. Currently there is no reliable aid which reminds users of missing objects in the exact instance when they are leaving their home. Our product, e-minder, is designed to aid forgetful individuals as they leave home in order to help them remember to bring important items everyday.

The target markets for e-minder are the elderly, children, and people with ADHD. The market size is steadily increasing due to the aging population in Canada. This is leading to a larger subset of the population being present who are forgetful. Our product is designed to aid users who struggle with remembering to bring important items with them as they leave their homes. Further, with little competition for our product, we believe we can tackle this blue ocean and take significant market share.

Our proposed prototype, e-minder, will be installed near the front door and will alert users of any forgotten RFID tagged item as they leave the house. The physical device is connected via wifi to a mobile app that is accessible via the user's smartphone. Users can add and customize user identified items for each household member. This device will help caregivers, adults with ADHD, and parents to manage their children's belongings.

The hardware portion of e-minder consists of a microcontroller, speaker, RFID reader, power supply, enclosure, and RFID tags that are attached onto items that the user would like to be alerted about. The RFID reader is the key component that will detect the RFID tags via ultra high frequency electromagnetic waves.

The software portion of e-minder is built using Flutter which will communicate with the microcontroller via a remote database. The app will be built to be simple and streamlined to ensure all users can use it without trouble. The main functionality of the app once set up by the user is to send push notifications to your mobile phone when a user has forgotten to bring a tagged item.

Purple mango is excited to bring e-minder to market to help adults, seniors, caregivers, and parents alleviate the stress of forgetting important items at home. As a team of one system, two electronics, and three computer engineering students all with experience in product design and app development, we believe we can successfully market this product. Purple mango will continue to seek feedback and improve upon the design to create a product that will make a difference to our customers day to day lives.



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Glossary

TABLE I: Glossary

Term	Definition
ADHD	Adult attention-deficit/hyperactivity disorder
EM	Electromagnetic
IoT	Internet of Things
PLA	Polylactic acid
POC	Proof of Concept
RFID	Radio-Frequency Identification
SoC	System-on-Chip
UHF	Ultra High Frequency
UI	User Interface



1.0 Introduction

People often forget important things at home if, for example, they are in a rush, stressed, or distracted. e-minder by purple mango is an electronic device that reminds users of forgotten items as they leave their homes. e-minder will be placed near the exit door(s) of a house, and if the user forgets any items registered with the device as they leave, they will be immediately alerted.

The performance of the scanner and tags will be critical to the success of the product. The scanner should be able to penetrate various mediums (such as backpacks, purses, pockets, etc.) to detect the RFID tags on objects from an acceptable distance. Another critical challenge will be the integration of the product's components and the communication between them. The physical device must communicate with the mobile app on the user's smartphone and with the remote database. The database must store all the user information and items registered with the device. The communication between the different components will need to be fast enough that the user will be correctly reminded of what they're missing before exiting the house.

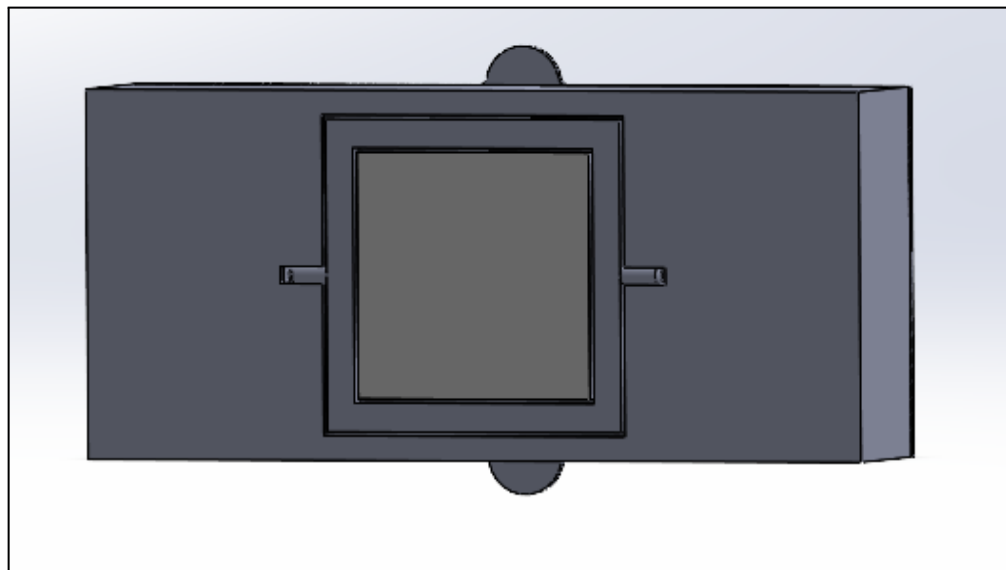


Fig 1 : e-minder POC 1st draft



2.0 Project Overview

2.1 Background

e-minder's physical system will incorporate RFID tags, a RFID reader and a ESP32 SoC microcontroller to allow users to physically track tagged objects to ensure that they are with them as they exit their home. The system also includes an online database and a mobile application that can be installed on the user's smartphone. The microcontroller will have real-time access to the database as long as it is connected to the internet via its on-board wifi module.

Users will register tagged items on the database using the mobile app, and once an item is registered, the user will be notified if they ever exit their home without that item. Every user will have a list of registered items stored on the database, each item having its RFID tag stored with it. Upon detecting a user at the door, the device will retrieve their item list in order to determine if they are missing any items as they leave the house. This implementation will support multiple users within the same household, which allows each user to personalize which items they would like to be reminded of. This will require the system to correctly and quickly identify users at the door.

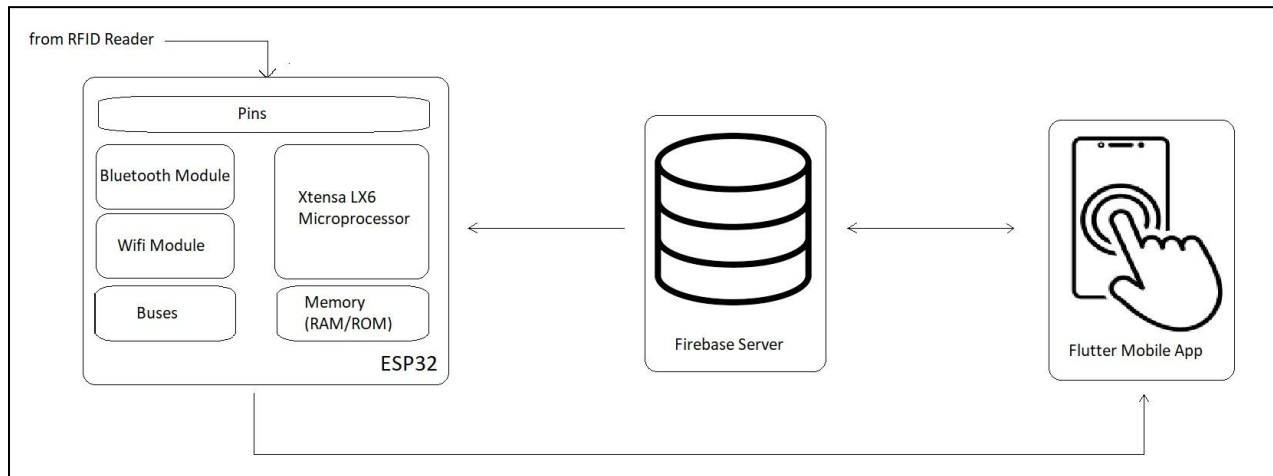


Fig. 2: Block diagram of system's flow of information

The RFID reader uses electromagnetic waves to transmit Ultra High Frequency (UHF) signals that activate the encapsulated RFID tag. The tag must be in a specified range (around 1-2 m) in order to be activated by the signal. Once received, the tag reflects a modulated wave back to the reader, where it is translated into data and sent to the microcontroller to be identified [1]. The working principle of the RFID system is shown in Figure 3.

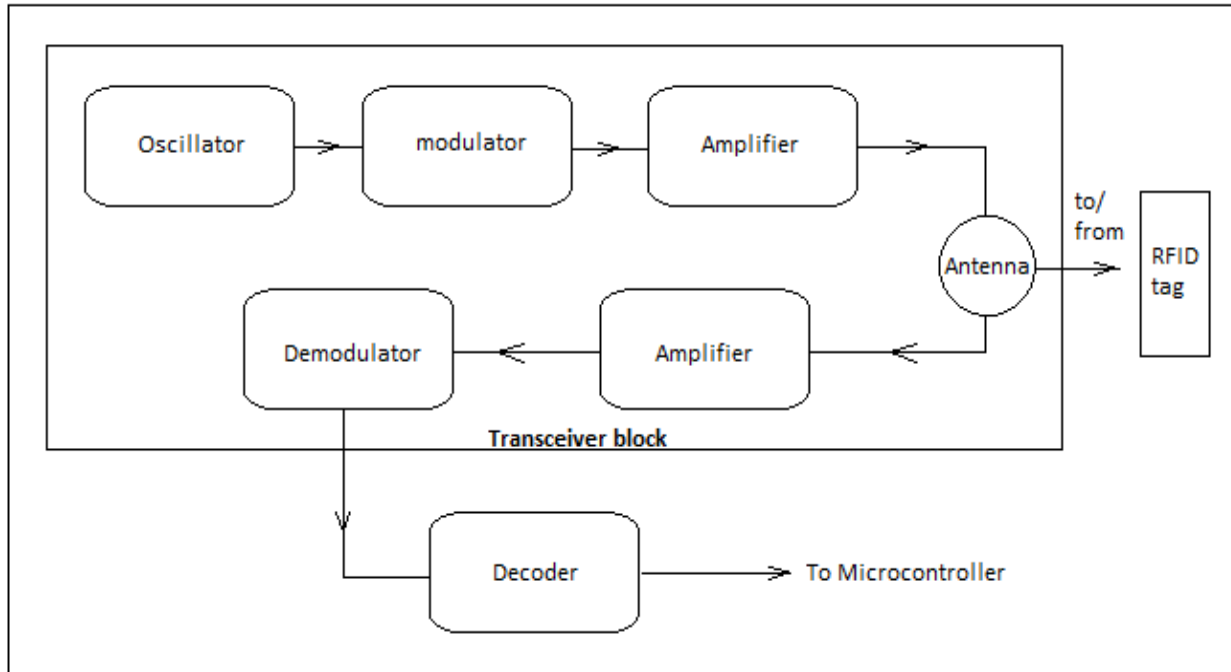


Fig. 3: Block diagram of a RFID system [1]

2.2 Scope

In terms of scope, the first e-minder POC aims to satisfy some of the most fundamental requirements and make as much progress beyond that as time permits. The prototype, on the other hand, aims to satisfy the more intricate requirements by adding secondary features and handling any edge cases or issues that are discovered in the POC. In this section, we will discuss this distinction in detail. The scope for hardware and software will be discussed separately.

2.2.1 Hardware Scope

The nature of e-minder will require lots of testing with hardware to determine the best products and their orientation to meet specifications, rather than development of separate components themselves. During these tests we will determine the sensing range of our chosen components and the overall feasibility of e-minder.

With the POC, the main goal is to meet our specifications of sensing objects at 2 meters and objects inside thin bags/purses (REQ.HW.9, REQ.HW.10, REQ.HW.11). Other specifications such as size, price and power consumption will not be our main focus, but will be kept in mind.

An acceptable prototype may consume twice the power and be twice the size and price of our production product. The prototype will also be an entirely self contained unit (REQ.HW.3). Not connected to any external equipment besides a power supply. It will be enclosed in a plastic case designed in SolidWorks and 3D printed using the resources available from SFU. We plan for the enclosure design to assist the function by using the shape of the enclosure to enhance the



scanning capabilities. This could be done with angling the RFID antenna in an optimal way or using radio-reflective material to aim the signal in a specific area.

2.2.2 Software Scope

e-minder's software components comprise of a mobile application and an online database. The POC must allow users to use the app to manage the database (REQ.SW.1, REQ.SW.19). This includes basic operations such as creating a user profile (REQ.SW.5a), accessing a stored item list (REQ.SW.5b), adding items to the list and removing items from the list (REQ.SW.6, REQ.SW.7). Additionally, the POC must allow the user to store the RFID tag numbers associated with each item (REQ.SW.17) - this is necessary in order for the embedded system to identify the user and their items.

The software components for the e-minder prototype will remain the same as the POC but will include more features. The prototype will capture several other secondary requirements not captured by the POC. App notifications will have the highest priority; this will require knowing when the user is at the door (REQ.SW.4) and what items they are missing (REQ.SW.16). This will potentially be done via bluetooth/wifi communication with the embedded system. As a secondary priority, the system will allow users to control the classification and reminding setting for each item. Items will be classified as tagged or untagged - untagged items will have no RFID tag associated with them and will be reminded of on every exit via push notifications (REQ.SW.12, REQ.SW.14, REQ.SW.15). Item reminding settings will allow the user to select if, for a given item, they would like to be reminded on every exit, just a select number of times, or throughout a given interval of time (REQ.SW.9, REQ.SW.11).

Additional features such as tag reassignment, Google profile authentication, etc. will be subject to our schedule. Further, any considerations of security or efficiency will be deferred to the beta development phase.

2.2.3 Embedded Scope

e-minder's embedded system revolves around the microcontroller and its interactions with the RFID reader, the database, and the mobile app. The microcontroller will have real-time access to the online database and will be able to access all item lists for all users. For the POC, the system must be able to detect items within the specified range (mentioned above in [Hardware Scope](#)) and use that information to identify the user at the door (REQ.SW.3). Upon identification, the system must retrieve the user's item list from the database and check if there are any missing items whose RFID tags are not detected (REQ.SW.10). If there are missing items, the system must notify the user (REQ.SW.13). For the POC, a simple beep (using the speaker) will be sufficient for notification. For the prototype, however, we would need more descriptive notification capabilities. Aside from the app notification, the system will produce a text-to-speech output notifying the user of what exactly is missing. This can perhaps be a feature that can be toggled on/off.

As mentioned in [Software Scope](#), in the prototype (beta) phase we will consider ways of communicating directly between the embedded system and the mobile app.



2.3 Risks

Purple Mango has and will continue doing due diligence to minimize risks associated with the software and RFID technology of e-minder.

The following are the potential risk factors:

- RFID technology's inconsistency to detect through clothing, plastic, fabrics and other materials. The hardware team is currently researching potential ways to boost the RFID antenna or improve upon the existing tags to ensure all items with tags are recognized.
- Liquidity and Cash flow risk - Purple Mango could struggle to generate sufficient cash flow from operations due to their small scale and lack of customer knowledge.
- Cybersecurity incidents could disrupt business operations and confidential information can be leaked. Firebase - the online database of choice - has measures in place to guarantee the security of its users.
- Issues with data privacy and data protection are very important. Information stored in our system should be private even when multiple users are using the same device. We will take extra measures to prevent misidentification which could lead to privacy concerns.
- Users are expected to rely on our system to remind them of their items. Any malfunctions or slow responses could result in the user leaving without their essential items. This could potentially cause major inconvenience or, in certain cases, harm. We will ensure that our system is fool-proof and is fast enough to remind users of their items before they exit the door.

2.4 Benefits

e-minder seeks to help children, seniors, and individuals with ADHD to ensure they leave their home with all of their essentials. Our mission statement is to detect and remind users to carry user specified items when exiting their home. In this section, Purple Mango will discuss a series of benefits that e-minder provides to various groups to justify production of this product.

2.4.1 Stakeholders

Purple Mango is seeking initial investment to bring e-minder to market. Through creating custom circuits for our specific needs and increasing production, the margins of our product should increase dramatically. Currently there are no direct competitors in the market that can apply the reminder system to individual items and our addressable market is rapidly expanding. Competition is directly addressed in [Competition](#).

2.4.2 Customers

e-minder provides the greatest benefit to children, seniors, and individuals with ADHD. With 40% of seniors over 65 suffering from memory impairment, this product will allow seniors



to leave their house sure that they have brought all of the necessary items of the day with them. [2] Seniors with more severe memory impairment who live in senior homes can have their settings and routine set up by workers once and not rely on human assistance again. With 4.4% of the adults having ADHD and this number increasing yearly, these individuals will also have the benefit of taking the stress off and adding structure into their lives. [3] Further, with the customizability of e-minder's app, parents can take a hands-off approach by updating their children's daily routines and relying on the system to remind them of items their children have forgotten to bring. This balance of customizability and practicality alongside the convenience of setting up the system only once allows customers to enjoy the benefits of never forgetting important items again.

2.4.3 Caregivers

e-minder will help caregivers save time and energy by making manual mundane everyday tasks for their patients automatic. The ability to set one e-minder system at the front lobby of a senior home or hospital to keep track of items from multiple patients allows caregivers to focus on more important tasks.



3.0 Market Analysis

Purple Mango is a Canadian Company specializing in providing item detection systems to forgetful individuals to remind them to carry specified items before leaving their home. While researching and experimenting, this start up company is at the beginning of their alpha phase in creating their first product, e-minder. The sales of e-minder are targeted towards 3 main demographics: Elderly, People with ADHD, and Parents. At the current time and state of the company, the product is targeted towards people living in British Columbia, Canada.

About 40% of people aged 65 or older have age associated memory impairment [2]. For the most part, their memory loss is mild enough to be able to live their day-to-day lives without major interruption. However, they are likely to require frequent assistance in remembering to carry their medications and other important things with them outside their residents or rooms in Elderly care homes. e-minder can help decrease load on human assistance, and provide a reminder system that can be used at a large scale with multiple people associated with one system. Upon surveying multiple Elderly care homes, it was gathered that they are willing to pay between \$100 - \$200 as one e-minder system can be used for an entire department consisting of 5 - 6 patients.

According to the National Institute of Mental Health, the overall prevalence of current adult ADHD is 4.4% [3]. People with ADHD can appear to be inattentive at times which can lead to frequent forgetfulness. As an adult, this can be quite disruptive and cumbersome to deal with day-to-day. This is where we introduce e-minder to help take the stress off of people living with ADHD. After successful installation of an e-minder, it will help these individuals increase structure in their lives by remembering to carry important specified goods with them.

After talking to several parents, a commschool materials with them when exiting their home in the morning. This tends to occur ofon day-to-day mishap in a household with children is them forgetting to bring important ten as parents are unable to always note their children's belongings as they are also getting ready for their work. e-minder is a simple solution to this problem as parents can set up an account for their children in the mobile application so they themselves don't have to worry about remembering important school materials for their children.

3.1 Competition

While there aren't any identical products to e-minder existing in the market, a similar product which acts as e-minder's largest competition is the AirTag by Apple. Apple's AirTag is currently being sold at \$39 CAD for one. e-minder is currently being intended to be sold at \$200 CAD on the high end. Ten of the AirTags would cost \$390 CAD, which is significantly more expensive than the e-minder. In the design research and specifications, e-minder is also much thinner and more compact compared to Apple's AirTags, providing a more efficient solution to the problems for forgetful individuals including the elderly, people with ADHD, and parents and their children.

Competition also exists in this market through a product called atendit Sensor. This product relies on the user to enter items that they would like to be reminded of through their



phone and will send an alert to your phone when you leave the house using motion sensors. This product retails for \$65 and is available on Amazon. The biggest flaw with atendit Sensor is the user being fed the same notification every day. Even when the user has all of their belongings with them, they will still be notified on their phone. This leads to lack of attention and the overall importance of the product fading away. The e-minder system is much more passive and only notifies users when an item is missing. Through the speakers installed on the system, the user will instantly be notified.

This section discusses the cost estimate of the prototype and funds we have access to for the project. Note that the prices discussed in this section are approximate and may vary from different retailers.



4.0 Cost Estimate

The estimated cost of the project for the prototype has been outlined below in Table II. The left column lists the components that have been ordered for PoC and Prototype. Most of the material has been received.

Table II: Prototype Costs

Component	Description	Prototype Cost (CAD)
RFID Reader	Main equipment to detect RFID tags	96
RFID tags	Labels/stickers for registered equipment	5.83
Speakers	Output device for notifications from device	5.43
Power supply	AC power adapter to power the device	20
Microcontroller board	ESP32-WROOM	2
Enclosure	Plastic enclosure for device 3D printed	0.50
Total		129.76

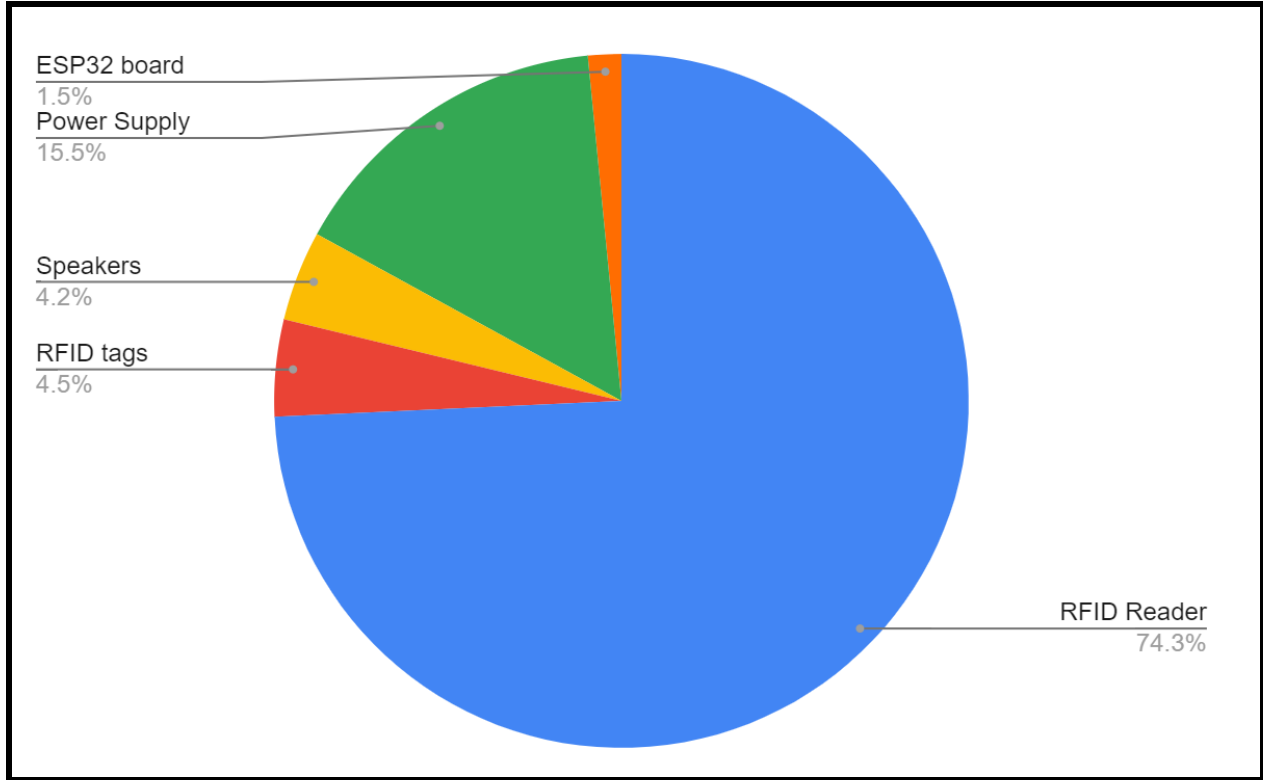


Fig. 4: Price Distribution

The Pie chart distribution shows the cost of goods to build an e-minder. It is evident the majority of cost is driven by the RFID reader. It is the most important component in the system and it is worth noting that the price of the RFID reader used can be substantially more expensive. More expensive RFID readers will have better signals and improve accuracy from the tags. The second biggest cost is the power supply which makes up 15.5% of the price.

4.1 Possible Cost Saving Measures

For a product run, the cost of each unit would be significantly reduced through bulk purchases and low level development.

The RFID reader is the main costly component. This could be reduced by purchasing an antenna for up to \$10 and developing the circuitry needed to send and decode the signals. PCB manufacturing is very inexpensive, bringing the final component price to below \$20.

Bulk speaker, power supply and microcontroller purchases could reduce the cost from \$28 to \$10. The enclosure would not be freely produced on a 3D printer however, rather custom-made in bulk for under \$5 each.

The final production cost for a unit is estimated to be \$53.



4.2 Funding

The overall cost of e-minder is targeted to be below \$100.00. Below are the options that we will explore to fund the manufacturing of our prototype.

4.1.1 Engineering Science Student Endowment Fund

The Engineering Science Student Society (ESSS) manages the Engineering Science Endowment Fund (ESSEF) [4]. The funds are divided under four categories under which they provide the fundings to Undergraduate students for personal and school projects. Our project qualifies under Category B and Category C as Category B funds the workable prototypes and Category C funds the usable, team-oriented projects originating from any classes. Purple Mango meets the requirements for these two categories and the project costs are relatively low so getting funding from ESSS shouldn't pose any problems.

4.1.2 Wighton Development Fund

The Wighton Development Fund is run and managed by Dr. Andrew Rawicz. The fund is given to student projects satisfying Wighton's requirement of practicality with preferential treatment given to projects that benefit society. Our market analysis explains how e-minder is beneficial to a wide group of ages. The Wighton Development fund will provide an additional boost to our project.



5.0 Project Planning

The scheduled approach to the prototype development and demonstration is shown [Fig. 5]. The hardware team will focus all their efforts on RFID testing to make it as consistent as possible. The software team in the meantime will be creating the backend services to let the e-minder app function. By the third week of July, the item scanning capability of our components will be understood and the enclosure design for the prototype will be under development. At this stage the hardware POC requirements are planned to be met, and the front end functions of the app are being developed. The first two weeks of August will be polishing to meet prototype requirements and integrating the two systems, and prepping for the presentation.

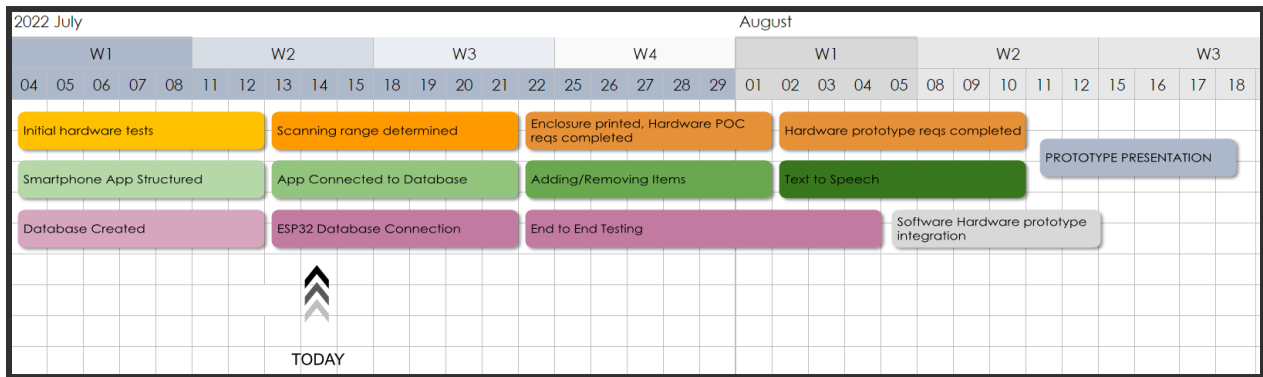


Fig. 5: e-minder Timeline



6.0 Members of purple mango

The project for e-minder is being created as part of the course set ENSC 405W and ENSC 440, which requires students to create a capstone engineering project. All members of the project are enrolled students in Engineering Science at Simon Fraser University.

6.1 Ramanpreet Kaur | Chief Financial Officer

Raman is a fourth year electronics engineering student with main interests in microelectronics. She has done a one year co-op as a Software Test Engineer at Sierra Wireless. There, she got to work with power management systems of the IoT modules and develop integration test cases for these modules. She also developed and executed automation test cases and led her coop team to carry out automated stress testing on different operating systems and host platforms. At Purple Mango, Raman is part of the Hardware team and is responsible for maintaining the cost efficiency of all components.

6.2 Riku Makita | Chief Communications Officer

Riku is a fourth year electronics engineering student with an interest in product design. Riku has completed his co-ops as a mechanical engineer at Skytrain and mechatronics engineer at MetroVancouver. There he reverse engineered fabrication, assembly, and electrical drawings for Skytrain parts and streamlined maintenance procedures by creating jigs and mechanisms for the technicians. He also has experience in vibration and root cause analysis for rotating machinery. At Purple Mango, Riku is a part of the Hardware team and is responsible for production design.

6.3 Harely McLachlan | Chief Technical Officer

Harley is a fourth-year Systems Engineering student with a strong interest in rapid-prototyping and system integration. Harley has worked in Germany as a testing infrastructure engineer, as well as many technical co-op positions. He led a small team of 3 to design and build from scratch, the entire testing infrastructure of a 100 person consumer appliance company. Along the way he learned many practical skills and tools such as 3D modeling and printing, system control and communication with different protocols.

6.4 Anika Sheikh | Chief Marketing Officer

Anika is a fourth year Computer Engineering student and an aspiring Full stack software developer. She has completed her co-ops as a Full stack developer at Greenlight Innovations, and Software Developer at Avestec Technologies. There she has worked with multiple teams to collect requirements for innovative features on their internal websites, and develop interfaces for web applications written in Python, Django, JavaScripts, and Postgresql. At Purple Mango, Anika is part of the software team and is responsible for marketing of e-minder.



6.5 Adham Sorour | Chief Communications Officer

Adham is a software-leaning fourth-year Computer Engineering student. He worked at Biointeractive Technologies as a Software Engineer for an 8 month co-op and at Geotab as an Embedded Systems Developer for another 8 months. He worked extensively with embedded and high-level software systems during his two co-op jobs and his courses at SFU.

6.6 Dylan Rowsell | Chief Executive Officer

Dylan Rowsell is a fourth-year Computer Engineering student whose main interests include embedded systems. He has interned for 12 months at GeoTab as an embedded systems developer and researched at SFU for a total of 16 months under Professor Shahram Payandeh, studying motion sensors and device communication. In the purple mango team, Dylan is in charge of organizing meetings and overseeing the development process for the e-minder product.



7.0 Conclusion

The e-minder product is designed to act as a helpful reminding aid to forgetful individuals without interfering with their daily lives. This document presents, in detail, the purpose of the product and how that purpose is to be fulfilled. The document also provides an all-encompassing discussion regarding the product, its purpose, market, cost, risks and benefits.

In summary, e-minder will allow users to create private profiles on the system and register any items they wish to remember. We strive to make this process as simple as possible through an intuitive mobile app. The registered items will need to be tagged. The product will arrive with a set of purple mango-branded RFID tags that are to be placed on the items of interest. Any tagged item that is registered with e-minder will be scanned and detected upon exiting the home. If any of the registered items are not present, the user will be alerted. e-minder provides a convenient non-intrusive solution for a complicated repetitive problem.

The enclosure of the product will be designed to be as small and thin as possible such that it will sit on the wall next to the exit without taking much space. The enclosure will also contain some visual and auditory indicators that help the user quickly figure out what items, if any, are missing.

A market and cost analysis were compiled in preparation for the production version of the product and are provided in sections [Market Analysis](#) and [Cost Estimate](#).



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