NGUI - Final report

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1 Requirements analysis

1.1 Problem statement

Everyone knows what a backpack is. They're great! You can put things inside them and bring them with you wherever you go. But they do have a very fatal flaw: We forget to put things inside them. Who hasn't been in a rush in the morning? No time to waste, throw everything into your backpack and leave. Only to then find out, you forgot your phone charger.

But what if instead, your backpack stopped you? What if without any extra effort, your backpack knew you forgot something and told you about it? That is what we want to make a reality. A backpack that knows you have a lecture today and which books you will need to attend it. That knows you should always bring your charger because you like to stay up late using your phone, leaving it at low battery. A backpack that does this all without you having to change your behaviour [10].

1.2 Converging to a target user

"I left my homework at home.", those six words were the bane of almost every teacher's existence. Due to various reasons such as lack of sleep, medication, stress and several other reasons why humans lack organisation, we tend to forget what we have to do or plan to do. Forgetting is part of life and we humans actually forget things fast. Students tend to forget tools and gadgets needed for their classes at home and this can lead to a very unproductive day at school or the students having to waste resources like time and money going back home just to pick up the gadgets they forgot. With this project, we will focus on (Flemish) high school kids aged between 12-18 years because in a lot of schools, students have to transfer their books between home and school, which causes in a lot of forgetfulness.

1.3 Benefits end users

Our solution helps students so that they do not always suffer from their forgetful nature because with our backpack solution, students do not need to worry about forgetting their gadgets at home. The bag will help students remember whatever gadget they forgot based on what the student initially planned for the day. The planning will be managed by an application connected to the bag.

1.4 Requirements to solve the problem

1.4.1 Hardware

The solution should be a natural extension to a normal backpack. Meaning:

- There should be no complex data being shown to the user.

- The backpack should be able to detect that it is packed, meaning the user naturally indicates that they are ready to leave.
- The backpack should be able to detect all items present within itself.
- The backpack should be able to figure out which items should be inside.
- The backpack should be able to connect/communicate with an app to be configured.

1.4.2 Software

Our application should fulfil the following requirements:

- Identify and display new gadgets inserted into the bag as soon as the bag is closed.
- Give users the ability to view all the details of each gadgets
- Give users the ability to perform actions like renaming the gadget, selecting and unselecting dynamic and static days and deleting gadgets.
- Give users a responsive and interactive calendar display for each day and amount of gadgets needed on each day.
- Notify users of gadgets missing from the bags on a daily basis.
- Display a list of all required gadgets needed for each day. and classify gadgets needed as static and dynamic.
- Should be usable by high school students.
- The application should generally have the ability to communicate with the backpack efficiently.

2 Related work

2.1 FridgeCam

This refrigerator camera can tell you when vegetables are about to expire and notifies when the amount of groceries are getting low [4]. It also helps you avoid duplicate purchases of groceries if you forgot what you already had in your fridge.

2.2 Medisafe

Medisafe lanced a helpful tool for seniors and all the ones who regularly takes an assortment of medication. It remembers the user which pills they have to take. They send notifications at the right hour and the interface is connected to a smartwatch [5].

2.3 Innovation and creativity

Our solution of forgetfulness with a smart backpack is novel, there is no company selling the backpacks we invented. For this reason, we discussed other domains and looked how they solved the problem of forgetfulness.

3 Research

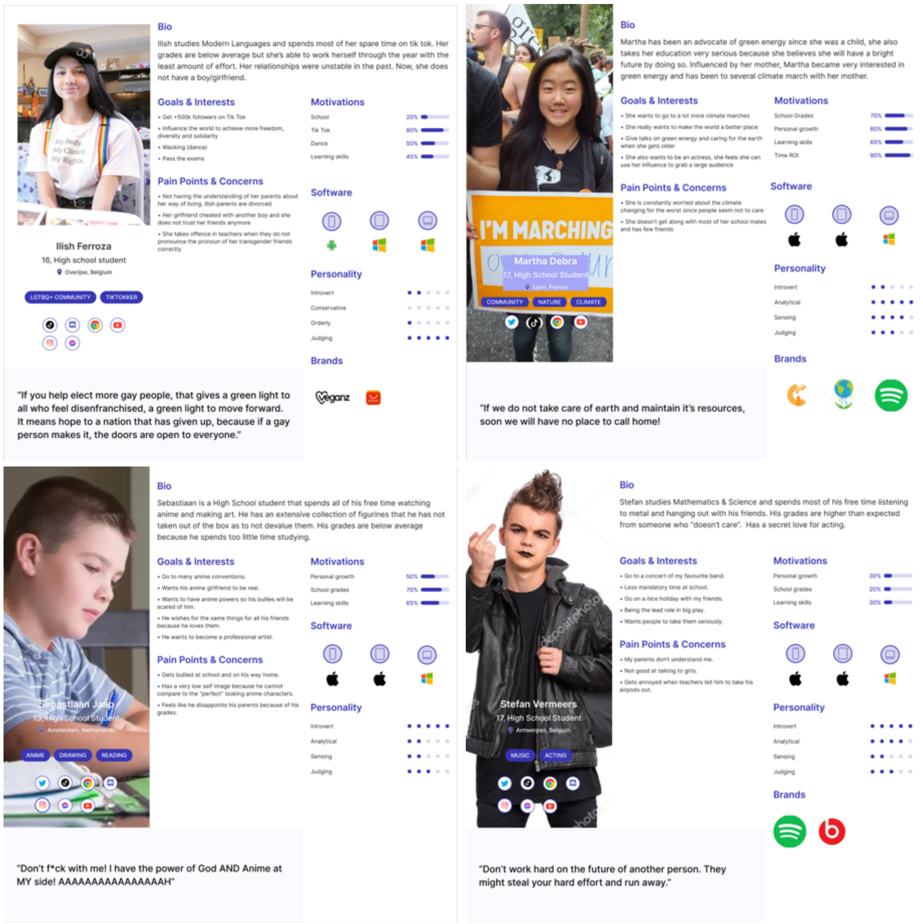
A reliable understanding of the key audience segmentation (user) should be achieved, as well as the understanding of the context wherein the smart backpack will be used. These steps are crucial in working out a useful next generation user interface. To create a realistic representation of our audience, we defined 4 personas that will represent our main users: school kids between 12-18 years old. A user journey was also created to track their daily school life and get rid of the context wherein the backpack will used.

3.1 Conversation with teachers

We had an interesting conversation with 4 primary and high school teachers. To respect their anonymity, we will only use the first letter of their name. J. noticed that there is also a problem of forgetting to take the books back home. The next day they pretend that they were not able to do their homework for this reason. K. even joked (as well as J.), that she has the feeling that some children deliberately forget their books to have an excuse. C. expressed her frustration about that problem and mentioned the learning disability students can gain from forgetting their books. M. is a piano teacher and said that some children often forget their scores, and this is annoying, but there is always another solution to fill the 20 min of personal lesson. The conclusion of the conversations was simple: there is indeed a big problem of forgetfulness in schools.

3.2 Personas

We created 4 personas to have a reliable representation of our key audience segments. They represent the 4 different groups of students. Illish is part of the LGBTQ+ community. Martha participates with the climate marches and is completely into green energy. Sebastian is an introvert guy who prefers to stay at home. Stefan is a metal fan and does not like rules at school.



Bio

Ilish studies Modern Languages and spends most of her spare time on tik tok. Her grades are below average but she's able to work herself through the year with the least amount of effort. Her relationships were unstable in the past. Now, she does not have a boy/girlfriend.

Goals & Interests

- Get +500k followers on Tik Tok
- Influence the world to achieve more freedom, diversity and solidarity
- Wacking (dance)
- Pass the exams

Pain Points & Concerns

- Not having the understanding of her parents about her way of living. Ilish parents are divorced
- Her girlfriend cheated with another boy and she does not trust her friends anymore
- She takes offence in teachers when they do not pronounce the pronoun of her transgender friends correctly

Ilish Ferroza
16, High school student
Overijse, Belgium

LGTBQ+ COMMUNITY · TIKTOKKER

Motivations

School	20%
Tik Tok	80%
Dance	50%
Learning skills	45%

Software

Personality

Introvert	●●○○○
Conservative	○○○○○
Orderly	●○○○○
Judging	●●●●●

Brands

"If you help elect more gay people, that gives a green light to all who feel disenfranchised, a green light to move forward. It means hope to a nation that has given up, because if a gay person makes it, the doors are open to everyone."

Bio

Martha has been an advocate of green energy since she was a child, she also takes her education very serious because she believes she will have a bright future by doing so. Influenced by her mother, Martha became very interested in green energy and has been to several climate march with her mother.

Goals & Interests

- She wants to go to a lot more climate marches
- She really wants to make the world a better place
- Give talks on green energy and caring for the earth when she gets older
- She also wants to be an actress, she feels she can use her influence to grab a large audience

Pain Points & Concerns

- She is constantly worried about the climate changing for the worst since people seem not to care
- She doesn't get along with most of her school mates and has few friends

Martha Debra
17, High School Student
Lyon, France

COMMUNITY · NATURE · CLIMATE

Motivations

School Grades	70%
Personal growth	80%
Learning skills	65%
Time ROI	90%

Software

Personality

Introvert	●●○○○
Analytical	●●●●●
Sensing	●●●●○
Judging	●●●○○

Brands

"If we do not take care of earth and maintain it's resources, soon we will have no place to call home!

Bio

Sebastiaan is a High School student that spends all of his free time watching anime and making art. He has an extensive collection of figurines that he has not taken out of the box as to not devalue them. His grades are below average because he spends too little time studying.

Goals & Interests

- Go to many anime conventions.
- Wants his anime girlfriend to be real.
- Wants to have anime powers so his bullies will be scared of him.
- He wishes for the same things for all his friends because he loves them.
- He wants to become a professional artist.

Pain Points & Concerns

- Gets bullied at school and on his way home.
- Has a very low self image because he cannot compare to the "perfect" looking anime characters.
- Feels like he disappoints his parents because of his grades.

Sebastiaan Jaap
13, High School Student
Amsterdam, Netherlands

ANIME · DRAWING · READING

Motivations

Personal growth	50%
School grades	70%
Learning skills	65%

Software

Personality

Introvert	●●●●●
Analytical	●●○○○
Sensing	●●○○○
Judging	●●●○○

"Don't f*ck with me! I have the power of God AND Anime at MY side! AAAAAAAAAAAAAAAAH"

Bio

Stefan studies Mathematics & Science and spends most of his free time listening to metal and hanging out with his friends. His grades are higher than expected from someone who "doesn't care". Has a secret love for acting.

Goals & Interests

- Go to a concert of my favourite band.
- Less mandatory time at school.
- Go on a nice holiday with my friends.
- Being the lead role in big play.
- Wants people to take them seriously.

Pain Points & Concerns

- My parents don't understand me.
- Not good at talking to girls.
- Gets annoyed when teachers tell him to take his airpods out.

Stefan Vermeers
17, High School Student
Antwerpen, Belgium

MUSIC · ACTING

Motivations

Personal growth	30%
School grades	20%
Learning skills	30%

Software

Personality

Introvert	●●●●●
Analytical	●●●●○
Sensing	●●○○○
Judging	●●●○○

Brands

"Don't work hard on the future of another person. They might steal your hard effort and run away."

3.3 User Journey

Several user journeys were worked out, but we will briefly discuss one of them, which has already already showed some limitations our initial concept contains. First of all, we saw that there were 2 main peaks where a school kid packs his bag: not only in the morning, but in the evening as well. We conclude that the app does not only have to notify the pupil to take his books to school, but take them back at home too (and don't leave them in a locker for example) if they have to prepare a subject for one of the next days. With this new problems arise: how will we know which books the kid will need the next day? Will they only study the subject for next day, or will they also prepare for the next days? What if their parents are divorced, should the kid take all the books for next week or not?

Al these problems are schedule and person-dependent, which makes it extremely difficult to manage it. A possible solution could be to create a machine learning model to learn from the habits and routines of a child, but even then, we will need a lot of data and time before the model will be accurate enough to predict a certain routine.

We also faced some other problems. What if a child wants to read/take a book out of the backpack while he is sitting in the bus? What during classes? Will the kid always be notified? This problem has a relatively simple solution: we can adjust the velocity of the hardware, so if the book is close enough to the backpack (for example within a radius of 1-2m), no problems appear. We can imagine a case wherein the child is packing the books in his room and does not get a notification when he did not put the book in the backpack, because they are laying close enough on a table for example. But from the moment the kid is far enough from the books, he should be notified.

3.4 Future work

We created the basic prototype of the smart backpack because of a limitation in time. The project could be expanded by creating a system that is also able to communicate with a locker at school. But before we think about this concept, a thorough evaluation of the current product should be done to understand the needs of the user in the usage of the backpack.

4 Design process of the App

4.1 UX

UX is a design process which tends to offer a great experience to its users. We divided the problem in several components and discuss them underneath one by one.

4.1.1 Calendar representation

The choice of having a calendar of all the items needed that day is thoroughly thought through. When looking at the user journeys, we see that most of the students use their books on different moments in a day. Sometimes books disappear in a locker or closet at school during the day, and we do not want to be disrupted by this information. That is why it is interesting to set a certain time as well on the gadgets. Our project does not support the time yet, since it is only a prototype and the project could still go in all directions, but it supports dates on which you will need certain gadgets.

4.1.2 Forgotten gadgets

The user should be notified as soon as possible when they forget a gadget. Because it also plays the most important role in the web app, this is the first thing that the user will see when opening the app. Underneath, as a secondary need, the user can find all the gadgets in the form of a calendar.

4.1.3 Add/delete gadgets

Finally, the user should be able to change the information of the gadgets they will need: will the gadget be used on a specific day? Do you need it every week? These parameters are changeable by the user, as well as the name of the gadget.

4.2 UI

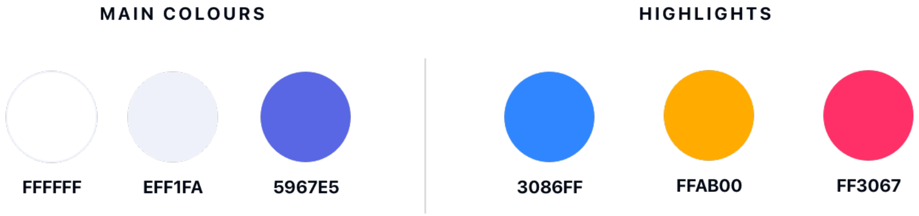
The user interface is made up of all the elements that enables the user to interact with a product or service. This contains, among others, the choice of buttons, colours and icons.

4.2.1 Buttons

In general, two types of buttons were used: primary and secondary buttons. On the edit page of our app, we decided to use a secondary button to change the name of the gadget, since it is more intuitive for the user to change the name that way. In contrast, the change of dates are instantly changeable. The user gets immediately feedback on which dates he added or deleted, and the primary save button sends a final patch request to the server.

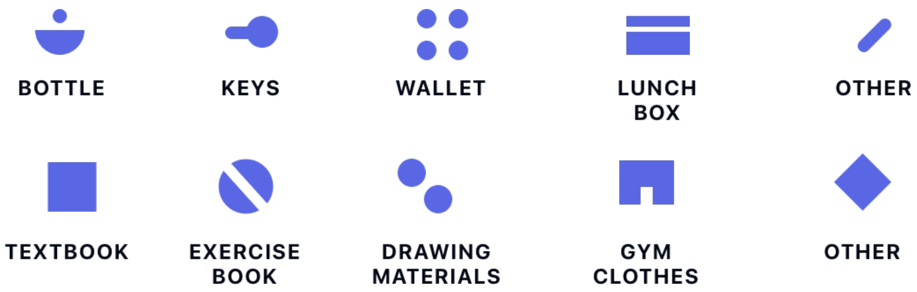
4.2.2 Colours

We defined our user target to be 12-18 years old middle school kids. Since they are relatively young, the app must be playful and fresh, but we also want to radiate rest and prevent chaos, since the goal of the app is not to forget things in chaos. This is why we decided to use a close-to-blue violet dominant colour in the app, since blue radiates rest in terms of psychology of colours. The highlights are accentuated with 3 fresh colours, which will bring that final playfulness in the outlook of the app.



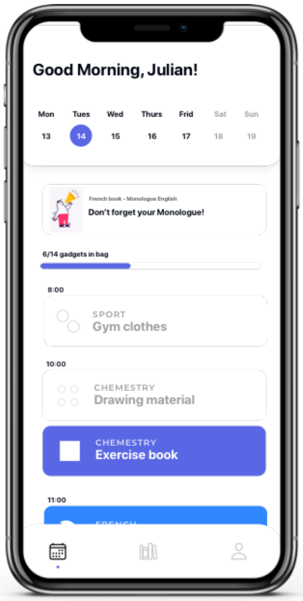
4.2.3 Iconography

We decided to use abstract representations of the gadgets needed in our backpack. This is because there is a lot of diversity in the gadgets that the user will put into the backapck. Having a 10-15 different figures for the gadgets, is also enough to have give the user a visual diversion in the gadgets.



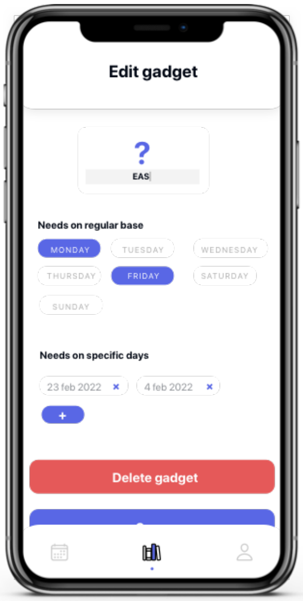
4.3 Screens

The two most important screens were worked out: a calendar with notifications of missing items and a list of gadgets which the user can edit.


Good Morning, Julian!

French book - Monologue English
Don't forget your Monologue!

6/14 gadgets in bag


Edit gadget

EAS

Needs on regular base: MONDAY, FRIDAY

Needs on specific days: 23 feb 2022, 4 feb 2022

5 Prototyping and implementation

5.1 App

5.1.1 Choosing a framework

In choosing a framework, we considered how we could make the application once and have it served on different platforms, and with this in mind, we decided to use the Ionic framework. Ionic framework is a well known application development platform that can be used to build mobile, web and desktop applications. The Ionic framework is engineered to integrate seamlessly with frontend frameworks like Angular, React, Vue and also with vanilla JavaScript. We used Angular as our choice of frontend framework because it allowed us to implement a calendar.

5.1.2 Frontend

The application serves as the frontend and most of what it does is to interact with the backend using an API. Basically, when a new gadget is added into the bag, the app detects the added gadget and the user can edit the added gadgets by changing the name and specify when the gadgets will be needed on specific days and regular days [7].

As mentioned in the section 4.3, the two important screens are:
The screen which has the calendar and notifies owner of items missing from the bag and this is contained in the first tab of the app. The following can be seen on the page:

- A list of items that are meant to be in the bag but are missing from the bag.
- A bar showing the amount of gadgets already in the bag
- A calendar which gives an overview of gadgets that are meant to be in the bag for each calendar day. The calendar was achieved using Mobiscroll. Mobiscroll is a responsive UI component used for calendaring and scheduling experience.
- A list of gadgets that should be in the bag for that day.

Secondly, the screen which has the list of gadgets, allows owner edit the gadget and this is contained in the second tab of the app. Below are the functionalities:

- A user can click on a gadget and the user is taken to a page where the user sees details/overview of the gadget and the details of a gadget include:
  - Gadget Name
  - Static Needs - Display of the days the gadget is needed on a regular basis
  - Dynamic Needs - Display of the days the gadget is specifically needed.
- This page also contains an edit button and when the edit button is clicked, users then have the ability to make changes to the gadget. Users can change gadget name, add and remove static days, add and remove dynamic days.
- Users can then use the ”save” button to save changes made to the gadgets. The save button performs the following functionalities:

  - if the user changed the name of the gadget, a patch request is sent to the server and the name of the gadget is changed in the backend
  - if the user adds or removes static days for a gadget, the new static days selected is stored in an array and it is compared to the static_needs of the gadget in the backend and only the static days selected for the gadget on the app is stored in the gadget's "static_need" on the server. This was achieved using the get, delete and post request to the backpack server.
  - if the user adds or removes dynamic days for a gadget, the new dynamic days selected is stored in an array and it is compared to the dynamic_need of the gadget in the backend and only the dynamic days selected for the gadget on the app is stored in the gadget's "dynamic_needs" on the server. This was achieved using the get, delete and post request to the backpack server.

- Finally there is a delete button, this button deletes the gadget the user is currently displaying or editing. When the delete button is clicked, what happens under the hood is that a delete request is made to the backend and the gadget currently being viewed is deleted from the backpack.

5.2 Backend

The backend is the main driving force of this entire project, both the configuration and the actual contents of the backpack are stored here. While creating it did take some time, the actual function of it is relatively simple.

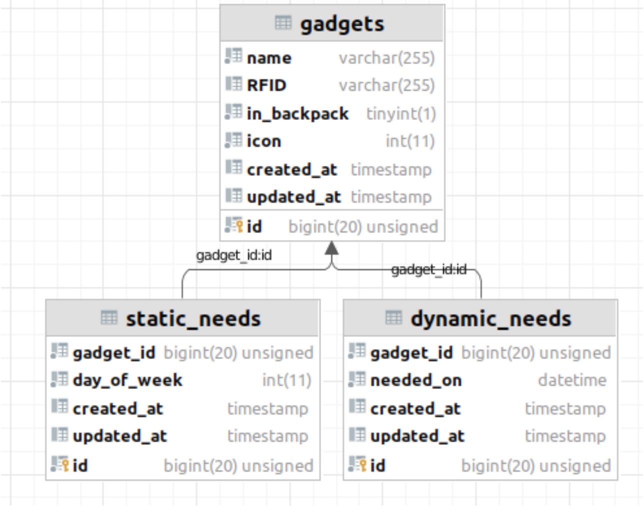


Figure 1: Backend ERD

In this ERD we can see that there are only 3 relevant database tables to store all of the data.

- gadgets: a table that holds the names, icon number for the app, status of presence in the backpack and the actual RFID tag value.
- dynamic_needs: a need dictating that a specified gadget is needed on a specific data.
- static_needs: a need dictating that a specified gadget is needed on a specific day of the week, meaning it is a need that recurs every week.

For each of these tables there exist API routes to perform the basic CRUD operations. The slightly more interesting part of the backend exists withing the "BackpackController". This controller does not perform the basic CRUD operations on the tables but does the more complicated operations to support both the app and the backpack. It implements 3 operations:

- POST: set_contents: A route intended for use by the backpack. It accepts an array of RFID values and sets all gadgets with one of these RFID values to be inside the backpack. Any values do that not have a matching gadget in the database create a new gadget instead.
- GET: missing: A route intended for both the app and the backpack. This route uses the current date to materialize a list of gadgets that are required. Then it filters that list to only contain gadgets that are **not** currently in the backpack. Resulting in a list of all gadgets missing from the backpack.
- GET: needed: A route intended for the app. Like the previous route, it materializes a list of gadgets that are required on either the provided date or by default the current date. However it does not filter the list instead returning it as is. This results in a list of all gadgets required on a specific date.

All three of these methods are exposed as an API route.

For more details on the API routes, the "/" route returns a full overview of all available routes and some example inputs for them. For more details on how to set up the backend, a readme file is present in the source code.

5.3 Backpack

The backpack itself is likely the simplest part of the entire project. All it needs to do it wait until the Hall sensor is triggered. When that happens it should read all of the RFID tags that are present, POST them to the server and check whether any gadgets are still missing. If any are missing it starts a beep, and in both cases the program gets stuck inside a loop of unactivity until the Hall sensor is untriggered. At which point the beeping will also cease. Then it is primed again for a new check.

One interesting point about the code is that the library for reading RFID tags seems to not function completely as expected. When attempting to read multiple tags, it receives all of the present tags. When attempting to do the same again, instead of time passing as it usually does while reading, it immediately results in no tags being found. This happens every second attempt. To ”fix” this issue, a loop has been placed around the read instruction. Making it so the read has to retry until either more than 0 tags have been found or the 5 attempts resulted in 0 tags. At which point we assume no tags to be present. This small fix has completely fixed all problems that previously existed.

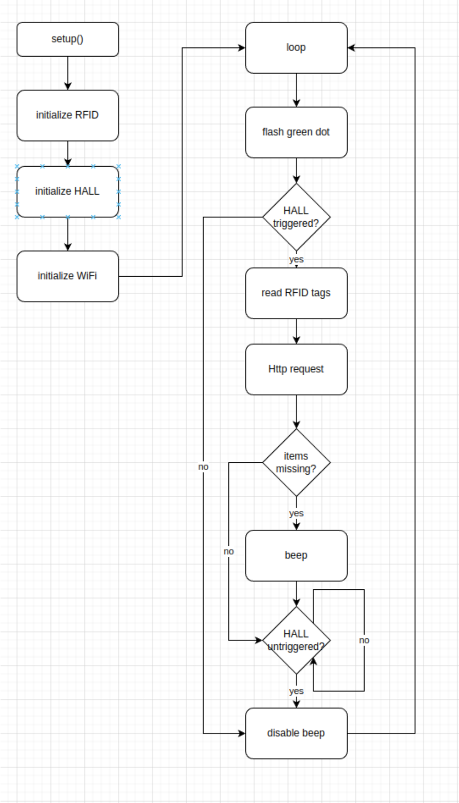


Figure 2: Backpack Flowchart

6 Evaluation

6.1 SWOT-analysis

A SWOT-analysis evaluates the strengths, weaknesses, opportunities and threads of a product. The strengths of the smart backpack is that a method has been developed to provide instant feedback when a gadget is forgotten. A multi-gadget detection is supported as well. This will give the opportunity of having less learning disability and less conflicts between students and teachers at school. The weakness of the whole concept is the fact that not all the gadgets you will need to take with you, will contain an RFID tag. Think for example of a monologue you wrote yourself and have to take with you the next day. There are also several threads of this concept: the digitization of schools is ongoing, and there is a possibility that they won't use any books in the next years. The backpack will also be more expensive than regular backpacks, which could also be a pitfall of this concept.

6.2 Interview questions

To get a better insight in the daily routine of a student and understand where our backpack could fit in, we interviewed students. By doing this, different insights lighted up. This method gives you the ability to ask personal questions which the users will fill in on a creative way. We did not send surveys since we focus on quality instead of quantity.

3 students with a variation in age between 12-18 years were interviewed (A minimum of 10 interviews would be better for a clear analysis, but because of lack of time we were not able to perform them all). The 3 students have a big variety in schools: from agriculture to SCA and Twining. The research give us only the ability to interview Flemish students.

6.2.1 Questions

The following questions were asked as introduction to understand the daily routine of the students:

- Describe your daily school routine
- When does your school start and ends?
- What do you eat at lunch?
- Which classes do you like the most?

Afterwards, several questions were asked to understand the morning routine of the students. Since this is the moment where packing a backpack often goes wrong.

- Describe your morning routine

- Do you prepare your backpack in the morning or evening?
- How do you go to school? By bike/bus/train/... ?
- Do you have enough time in the morning? Or are you raising against the clock?

The thirds goal was to ask about the forgetfulness of the student.

- How often do you forget to take your books with you
- Are there specific gadgets you forget more often than others?
- Are there other problems you have with forgetting? For example not handing in a task.

The final question was an evaluative question about our project.

- Imagine you would have a backpack which will send you notifications when you forget something. Do you think this will add value to your study?
- Would you use this backpack in another context as well?
- Do you use a smartwatch?

6.2.2 Data analysis

The collected data is translated from audio to a written document. The findings from the interviews are coded by conductive research [1, 2, 3]. The names used in the following section are pseudonyms. This way we do not violate with the anonymity of the interviewees. The interviews were taken in Flemish, so we provide always a Flemish and an English translation of the answers.

6.2.3 Interviews

When we asked our participants how their school routine looks like, we saw a big variety in answering. Sevanne (16 years), who studies SCA and Twining, answered the following:

> "Ik heb eigenlijk niet zoveel standaard schooldagen omdat ik veel socio-culturele activiteiten doe in het buitenland, ga ik soms bijvoorbeeld een dag in het rusthuis helpen, of 2 weken naar Nederland voor uitwisseling."
>
> *"I do not have so much typical schooldays because we do a lot of socio-cultural activities abroad. Sometimes we have to help in a retirement house, or go for two weeks to the Netherlands for example."*

Two other students had a more regular schedule. Tom (12 years) answered the following:

> ”Ja mijn school begint om 8:25. We hebben 4 lessen [...] en in de middag geeft mama mij warm eten mee in een container [...], mijn les is gedaan om 15:35.”
>
> *”My school starts at 8:25. We have 4 classes in the morning [...] and my mom gives me warm food in a container for lunch [...], my classes end at 15:35.*

The question of their daily school routine was followed up by this question: ”Do you prepare your backpack in the morning or afternoon?”. Femke answered the following:

> ”Ik maak mijn rugzak nooit klaar want alles wat ik mee moet nemen blijft in. Enigste dat ik eruithaal is mijn gsm, brooddoos en drinkbus. [..] ja maar mijn gewassen lo-kleren vergeet ik gewoon altijd.”
>
> *”I never have to prepare my backpack in the morning. Everything I need stays in my backpack. The only thing I take from my backpack are my phone, lunch box and bottle of water. [..] haha yes but I just always forget my gym clothes.”*

From the interviews, we could deduce that there is a digitalization ongoing. Some students always leave their books at school. To make their homework, they just look at the pdf version of their book.

Sevanne also gave us :an interesting insight in the consequences she has when forgetting a book:

> ”Ik moet elke dag mijn boeken mee naar school nemen en naar huis, maar we hebben ook lockers [...]. Als iemand een boek vergeet, moet hij achteraan in de klas gaan zitten en noteert hij op zo een touchscreen chrome computer om geen achterstand op te lopen. [...] Ja we krijgen wel minder punten voor onze attitude als je iets vergeet.”
>
> *”I have to take my books every day to school and back, but we also have lockers [...]. If someone forgets a book, he has to go make notes on a touchscreen chrome computer at the back of the class to be able to still follow the class. [...] Yes the teacher deduces points on attitude if you forget something”*

Finally, we asked the students if they like the concept of the backpack and if they would use it. Sevanne and Femke had two different opinions on it.

> ”Ik denk niet dat ik het zou gebruiken. Het is ook stom omdat ik soms met opzet dingen vergeet, en als leerkrachten weten dat ik een berichtje krijg, gaan ze me harder bestraffen.
>
> *”I don't think I will use the backpack. It is also not in my interest because I sometimes forget things deliberately, and if teachers know that I get notified, they will punish harder.”*

Sevanne had another opinion on it:

> "ja keicool! Heb echt zoiets nodig want vergeet te vaak mijn boeken en dan gaan punten weg van mijn attitude.
>
> *"Yes so cool! I need something like this because I forget my books too often and it has consequences for my score on attitude."*

6.3 Alternative solutions

We saw that the concept of the backpack would still fit several students, but there is a digitization ongoing and in an x amount of years, it is possible that no books will be needed at school anymore. For this case, we developed alternatives solutions which could fit the needs of a target user.

6.3.1 Change the target user

We can focus on another target user, where the backpack will still be needed. An example could be photographers, who have to take a lot of expensive gadgets to shoots or vacation.

6.3.2 Change the context

Another possibility is to change the context wherein our system works to notify people when they forget something. Think for example about an app to remember people to pay the bill, or to take the pills at the right moment.

6.3.3 Translate to the right era

Finally, a last solution could be provided if problems would appear with the current target. The app could be translated to a notifier of charging your computer for example and it could check if your charging cable is in the backpack as well.

6.4 Conclusion

We converged to a target user that is not completely perfect, which we discussed in the SWOT-analysis and deduced from interviews. Still, a smart backpack could give a lot of solutions in an other context, and so the technology developed for the prototype is an interesting next generation user interface which gives a proper solution to the forgetfulness of humanity.

7 What we learned

We learned with this project that early testing and primary research are crucial steps to define your target user and context. It is also important to test a product early and often.

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