GNG 1503
FALL 2023
SECTION A02 – FA24

DELIVERABLE D: CONCEPTUALIZATION

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Submission Date: 15th of October 2023

University of Ottawa

Summary

After listing all the design criteria necessary to satisfy all the needs expressed by the Shared Services of Canada organization, each member of our group created 3 distinct concepts:

Subsystem 1: Design of the automated software *(synaptic diagrams)*.

Subsystem 2: Design of the mobile application interface *(sketches)*.

Subsystem 3: Scanner design *(sketches)*.

Materials table

1. Introduction

In an industrial and commercial viewpoint, inventory management and surveillance can be a complex task, where the smallest inconsistency can lead to major errors. As such, the need for automated management systems is on the rise. The Warehouse Managers are faced with this issue, so we've found a sustainable and reliable solution, based on our design criteria, which offers our clients an automated inventory management system that leaves no room for error. Our solution will perform its functions with speed and simplicity, it will keep you constantly updated on any changes, this is why our solution is the best that you can find on today's market.

2. Research and analysis

In order to receive as much data as possible for the conceptualization of the preliminary concepts, the team required a large data set, which we concluded through various research and data-gathering methods.

First, we researched all the techniques and technologies required to reach the targeted specifications for the project, based on the client interviews and their requirements. This includes, but is not limited to: tracking and localization technologies (localization tags), applications and alert systems (notifications), scanning methods and automated data entry techniques.

As an anecdote, we compared the performance and physical properties of different localization tags, and we chose this element specifically due to the fact that the client explicitly expressed its importance for the project. We also based our selection on various user reviews and remarks. All of this information can be found in the tables below:

AirTag	RFID	NFC
"The AirTag worked every time I tried it. One of the AirTag's few flaws is that you can't use it to ping your linked iPhone or iPad. Competing trackers do offer this feature." - [1]	"RFID is an emerging technology that is increasingly being used in supply chain management. It plays an important role in supporting logistics and supply chain processes because of their ability to identify, trace and track information throughout the supply chain. The technology can provide suppliers, manufacturers, distributors and retailers precise real time information about the products." - [2]	"It does not require search and pair procedures like bluetooth and other methods to establish connectivity. [...] It can only work in shorter distances which is about 10-20 cm." - [3]

Type of tracking tag	AirTag	RFID tag	NFC tag
			
Productor	Apple (Foxconn)	~Variable~	~Variable~
Mean Cost	~30.00$	~112.50$	~1.00$
Operational Distance	~10 m	~10 m - ~100 m (up-to ~460 m for sophisticated chips)	~0.05 m
Dimensions	31.9 x 31.9 x 8 mm	-Minimum (read-only): 3 mm -Maximum (read and diffuse): 5 cm	-Minimum: 6 mm -Maximum: 85 mm x 55 mm
Signal Type	Bluetooth	Radio	Radio
Frequency	2.4 GHz	125 KHz - 30 MHz	125 KHz - 30 MHz
Weight	0.39 oz	0.06 oz	0.01 oz
Longevity	1 Year	20-50 years	10-50 years
Attachment	Straps	Adhesive	Adhesive

PS: The dimensions, longevity, frequency and operational distances of RFID and NFC tags are largely variable, depending on the specifications of the particular system (antennae, diffusion and reading devices).

Using the previous tables, it is apparent that the most functional localization tag for the purpose of this project is the RFID tag, despite its displayed price exceeding the planned budget. However, a more in-depth search concluded that by eliminating unnecessary elements from the RFID tag, such as protective casings and extreme long-duration batteries, their mean cost goes down from ~112.50$ to ~25.00$, which is well within the constraints of the targeted specifications.

While the usage of a web interface was an option, it was determined that web interfaces are harder to adapt from computer resolutions to the smaller, more refined phone screen resolutions. Making a dual-system would solve this issue (i.e: design two different interfaces for both computers and mobile phones), however, the time and budget limitations cause complications regarding this problem. In order to prioritize the portability and adaptability of the system to

different workplaces and environments, it was decided that a mobile interface uniquely would be a good consensual solution. As such, the mobile interface becomes a crucial sub-system of the final preliminary concept. In addition to this, ensuring autonomy, usability and rapidity, the use of RFID scanners will be necessary.

3. Clients and users

Our client, Services Partagées de Canada en Plateformes Numériques et Interopérabilité, expressed their wishes regarding the design of an automatic inventory management system. We have interpreted their need and classified them according to priorities :

1. The system has a simple and easy-to-access interface.
2. The system can operate without human intervention.
3. The system is precise and accurate.
4. The system keeps track of item entry and exit statistics.
5. The system includes trackable smart shelves.
6. The system incorporates modern methods for digital addition and deletion.
7. The system validates data fully and quickly.
8. The system allows users to be notified of each modification made to the inventory.
9. The system can identify items through video recognition.

Attention* : Priority scale = ([Low priority] 9 —>1[High priority])

Regarding the excessive use of ``it depends` `by the client during our first meeting, we came to the conclusion that the system is customizable, adaptable and widely variable.

The deduced needs can be categorized in two types :

Software needs : which will focus on the simplicity of usability, the automation, the precision and the speed

Physical needs (hardware): which include spatial localization, detection of physical entries and exits.

4. Problem statement

Our clients, **Les Services Partagées de Canada en Plateformes Numériques** et Interopérabilité are in need of delivering an intelligent, automated, and precise inventory management system to warehouse managers for achieving peak efficiency. It's also imperative that this solution is user-friendly and swift, ensuring it doesn't impede the

productivity of the **Plates-formes Numériques & Interopérabilité (PN&I)** sector. The users, in this case, warehouse managers, aim to avoid the repurchase of inaccurately cataloged, faulty, or misplaced equipment. To achieve this, the system maintains item in/out statistics through an alert management system (in this case, notifications). Consequently, our clients are requesting an efficient inventory tracking solution, with an estimated cost of around $50.

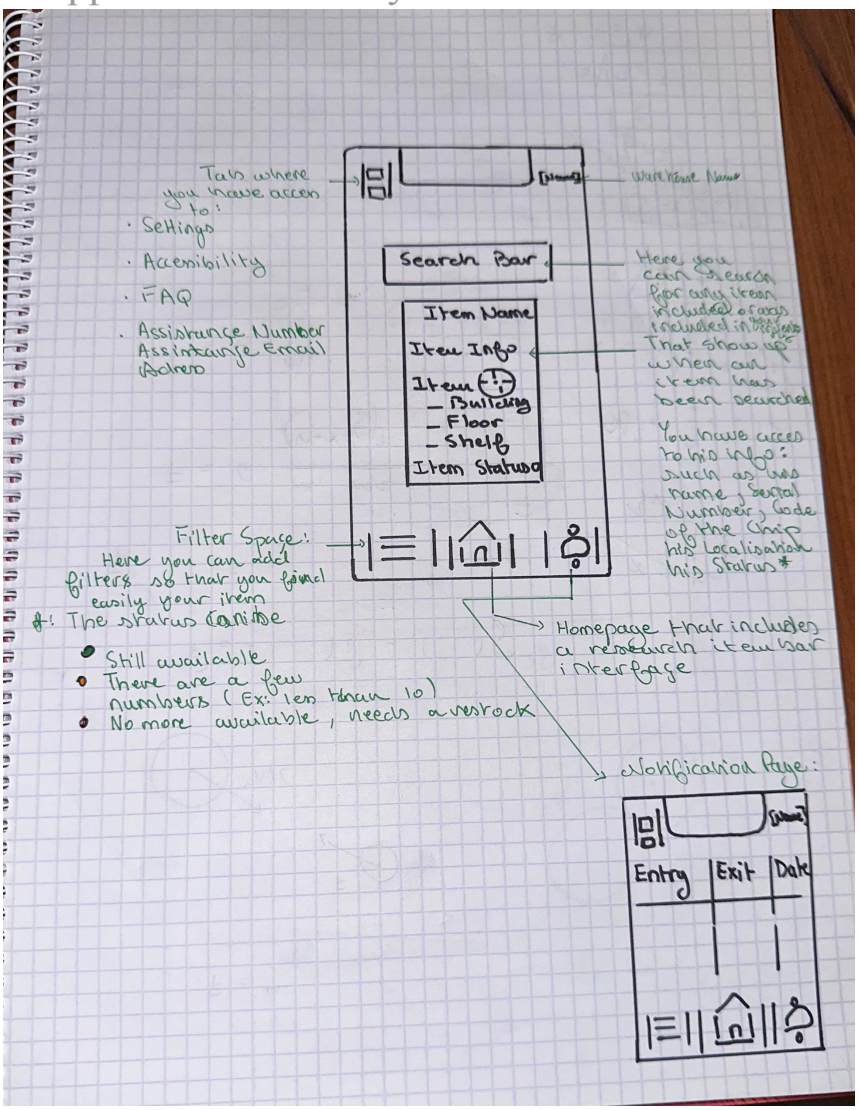
5. Certain solutions to the problem statement

5.1. Solution 1 by (Belmkaddem Ziyad)

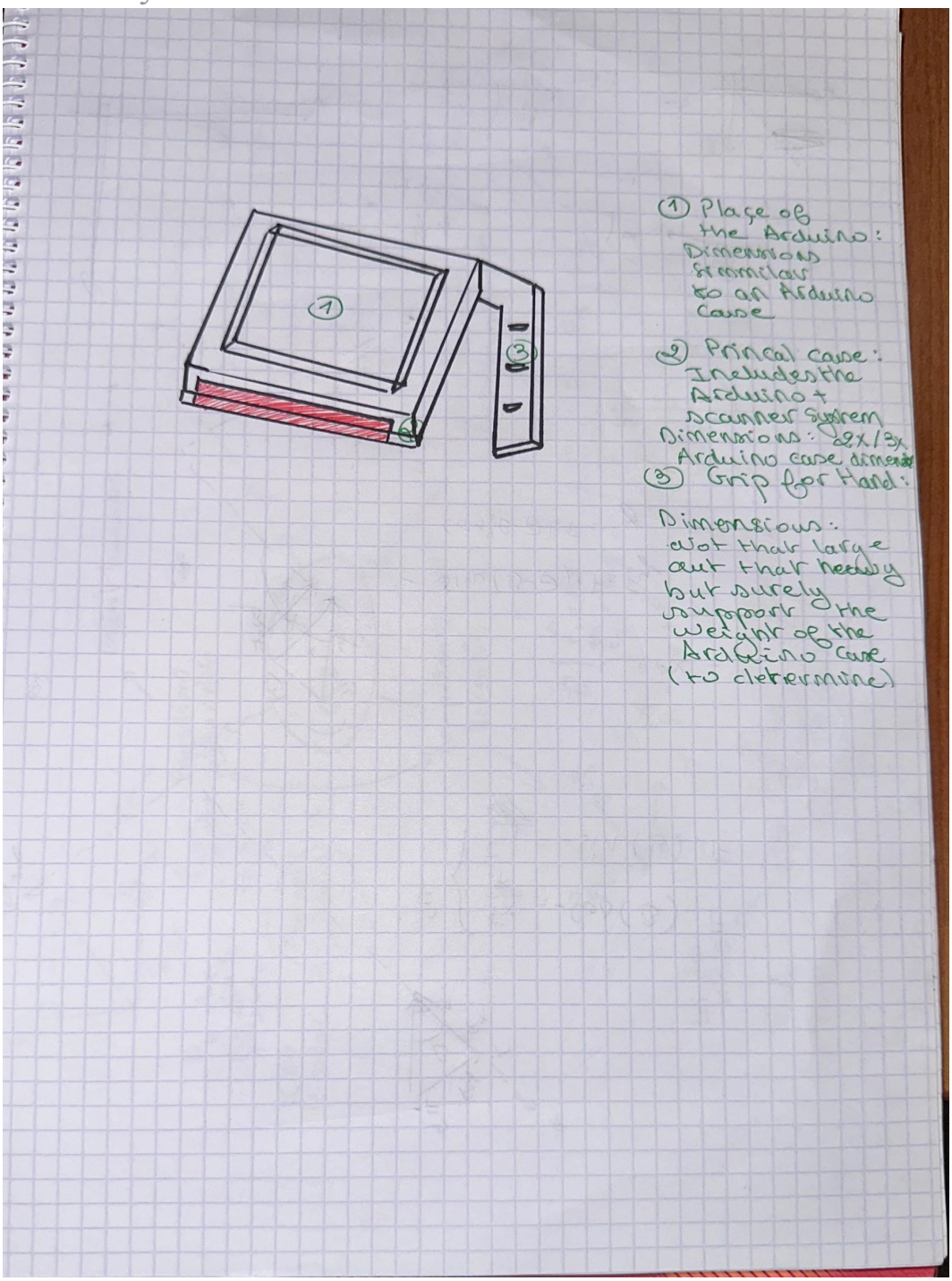
5.1.1. Software sub-system:

N/A

5.1.2. Mobile App Interface Sub-System :

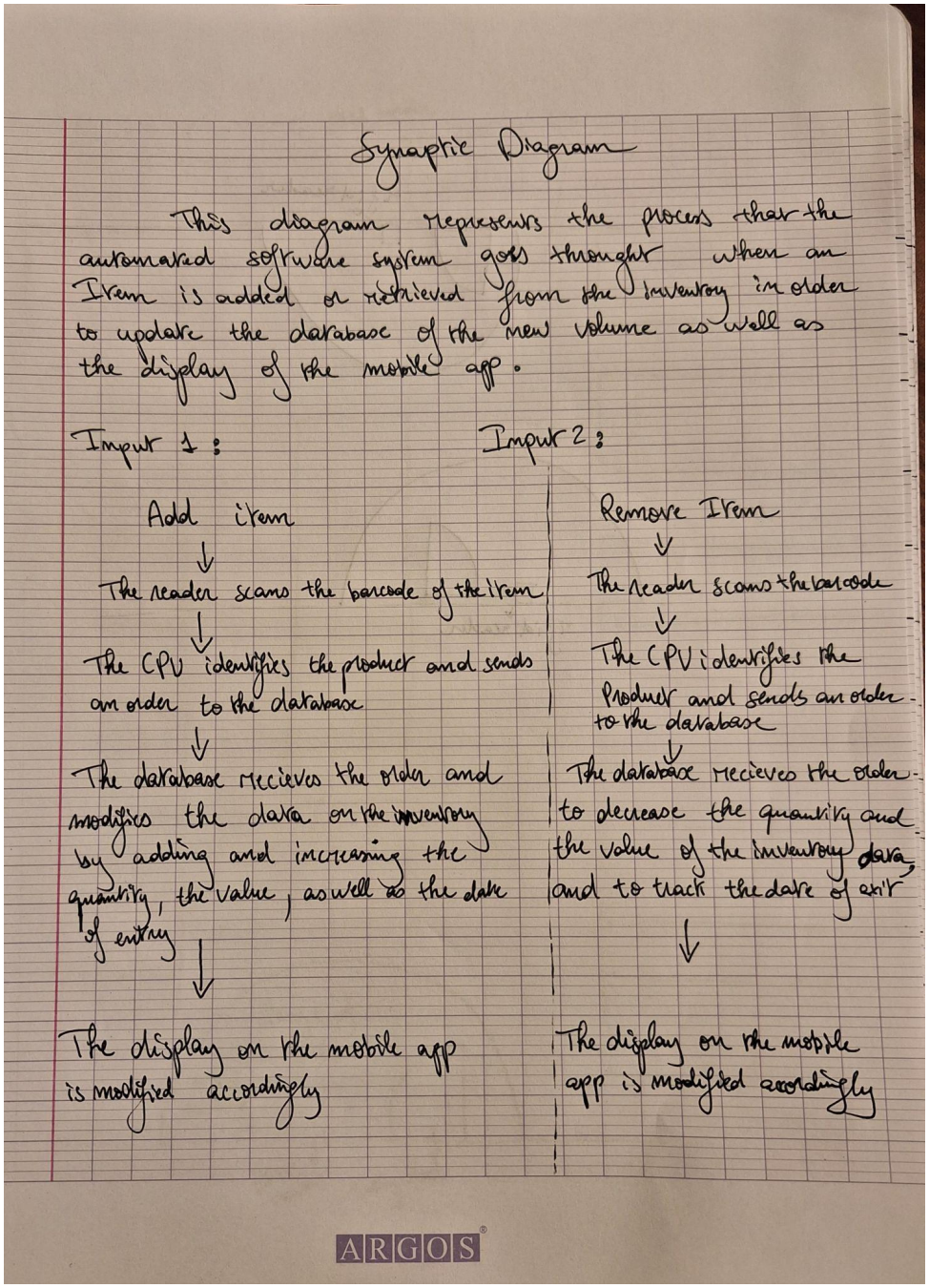


5.1.3. Scanner Sub-System :

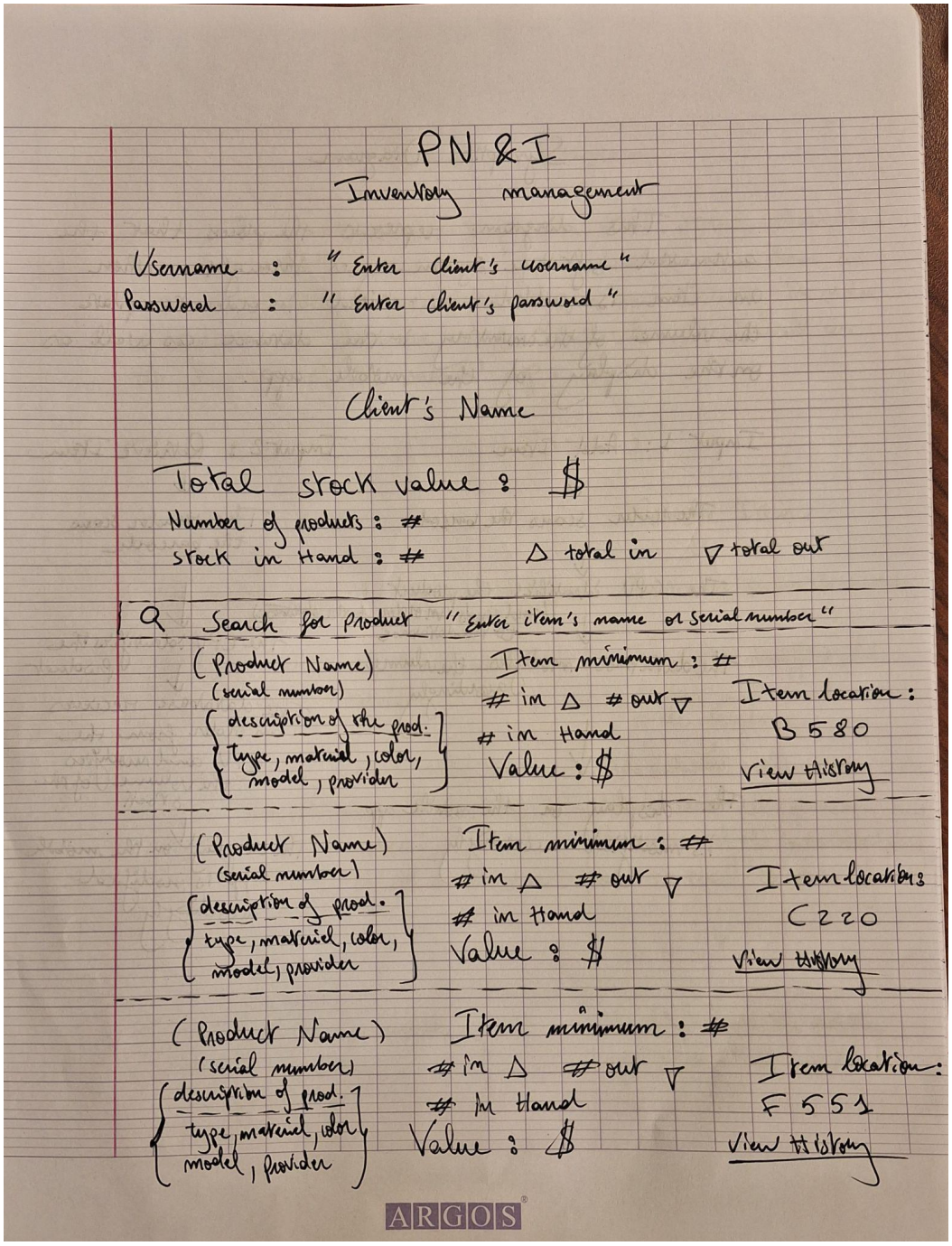


5.2. Solution 2 by (Elie Saliba)

5.2.1. Sub-system 1: software

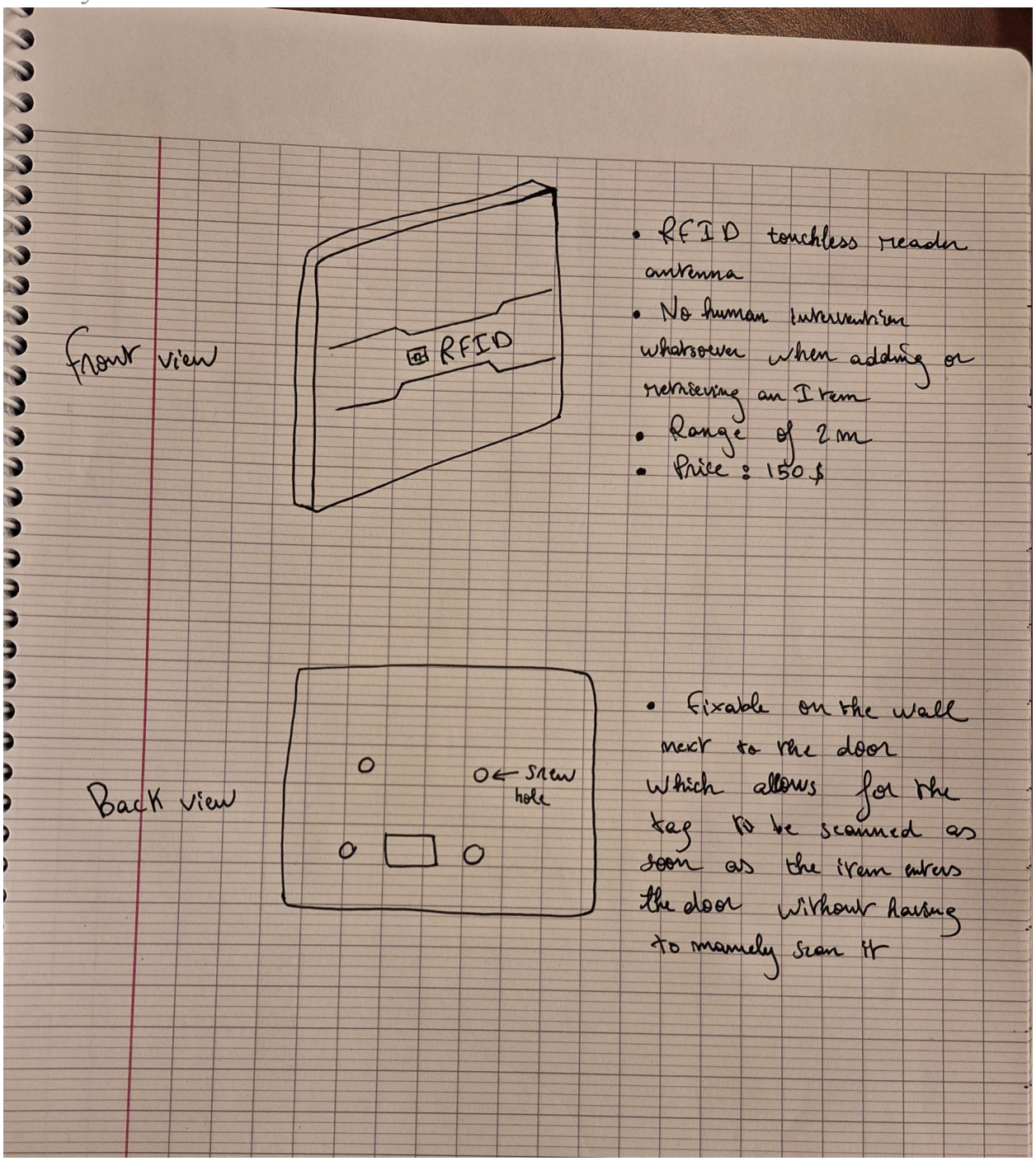


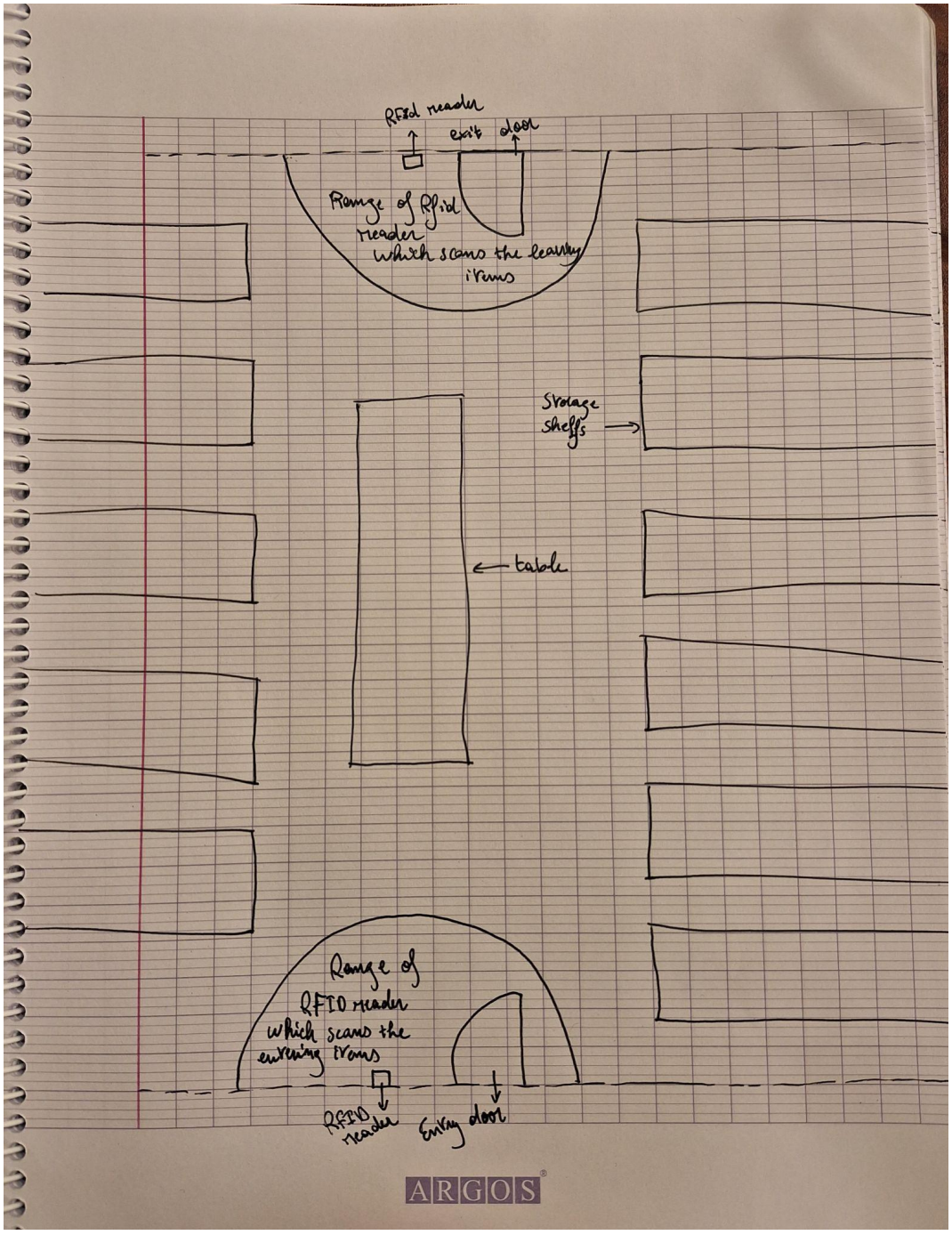
5.2.2. Sub-system 2: mobile app interface



This sketch does not represent the design of the interface. Rather, it shows a brief idea of how the structure of the mobile app would look, as well as every useful information about the inventory of the clients. The client would be able to access his inventory by entering his username and password. The app would then open another page showing an updated display of the client's stock information. The display of the list of products would only show the product name, the number of stock in hand and the Value of the product. This would maintain the simplicity of the app. Only after clicking on the desired product, the rest of the information will be shown.

5.2.3. Sub-system 3: Scanner



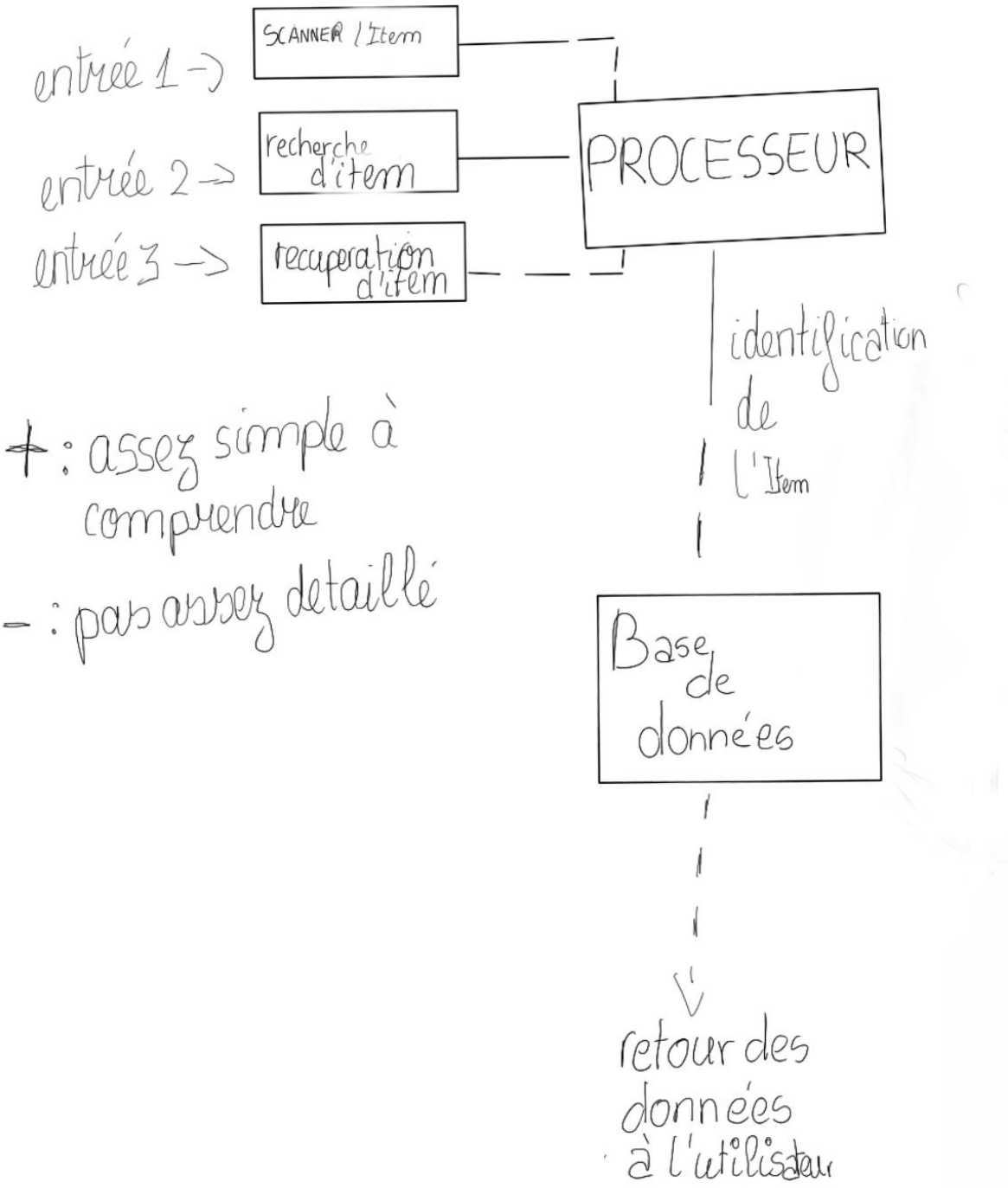


width of the door: 1 m

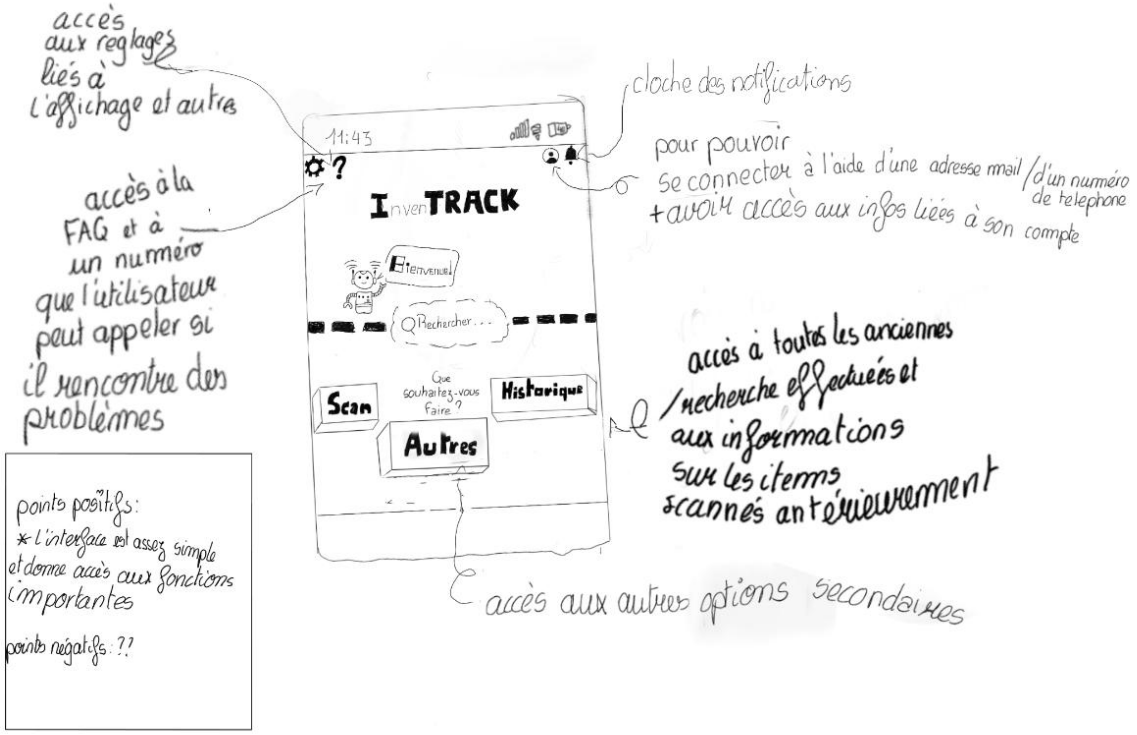
range of the scanner: 2 m

5.3. Solution 3 by (Deva Brou)

5.3.1. Software subsystem :



5.3.2. Mobile app interface subsystem:

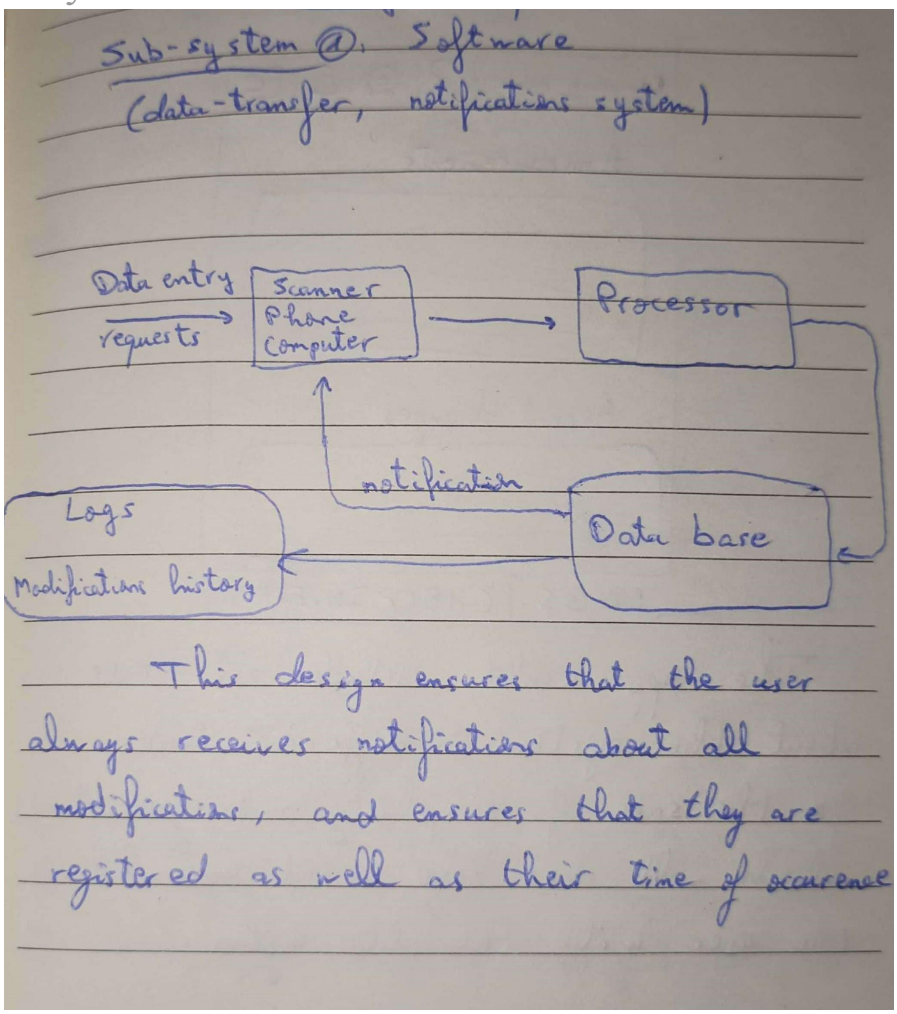


5.3.3. Scanner subsystem :


barcode scanner
* va scanner le qr code qui apparait soit sur l'application mobile soit sur n'importe quelle autre surface
insérer la carte arduino ici
* ça serait bien qu'il soit léger sans nécessairement être petit.
base plane pour qu'il tienne sur lui même

5.4. Solution 4 by (Zakariae Boulayad)

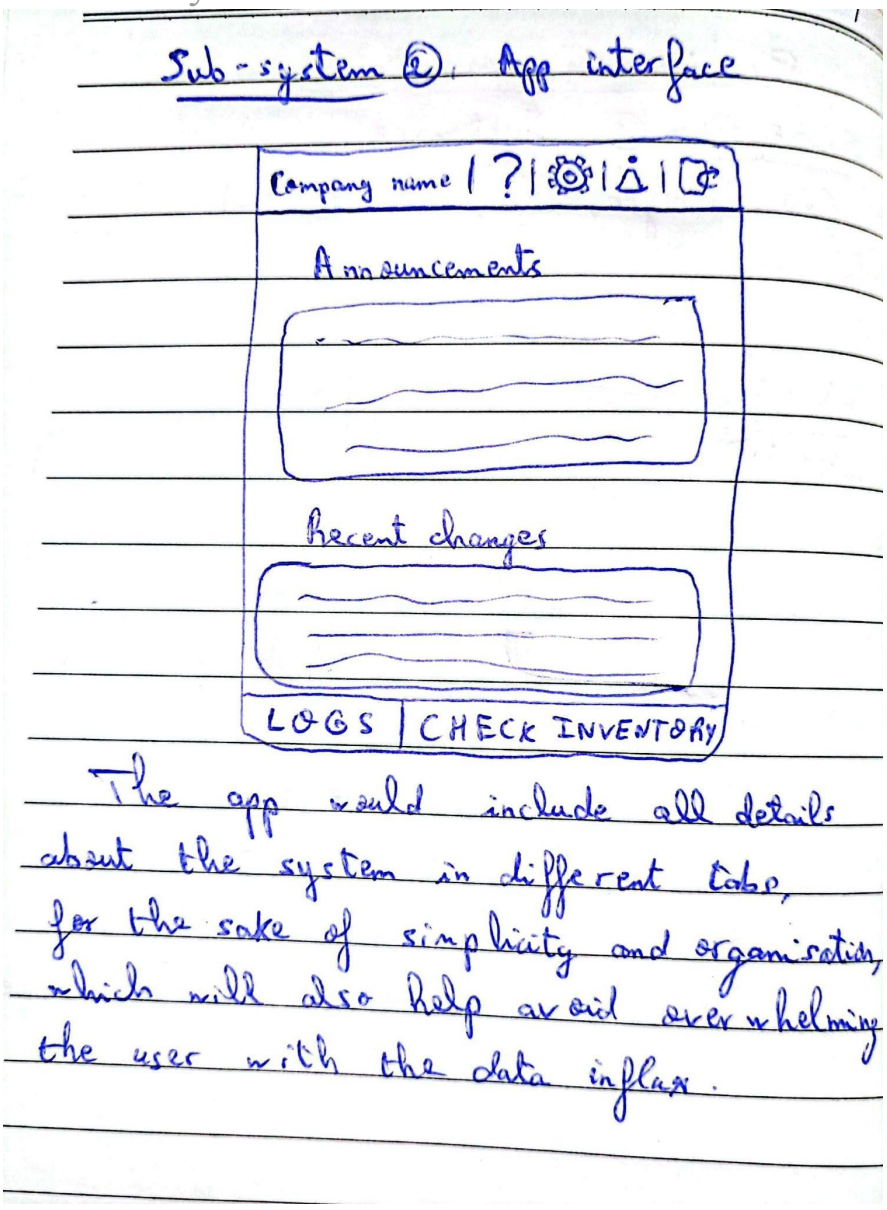
5.4.1. Software subsystem:



The system has an input which could be either an inventory recall (the user requests access to the inventory list and its categories), an item addition (the user scans an item's code with the scanner, which then adds the item to the inventory using its code as an identifier), or an item retrieval (the user scans an already existing item, which prompts the system to remove that identifier from the system). This input is sent to the processor, which in our case will most likely be an Arduino board, the request is processed and understood by the computer on the board, which then accesses the database (where all inventory items and their corresponding identifiers will be stored, the database will need a storage space, which is usually provided by the client in the form of servers, hard drives or supervisors' desktop computers), this request will then produce two identical outputs, one will be sent as a notification to selected individuals, whereas one will be displayed to the user confirming the success or the failure of the operation, it

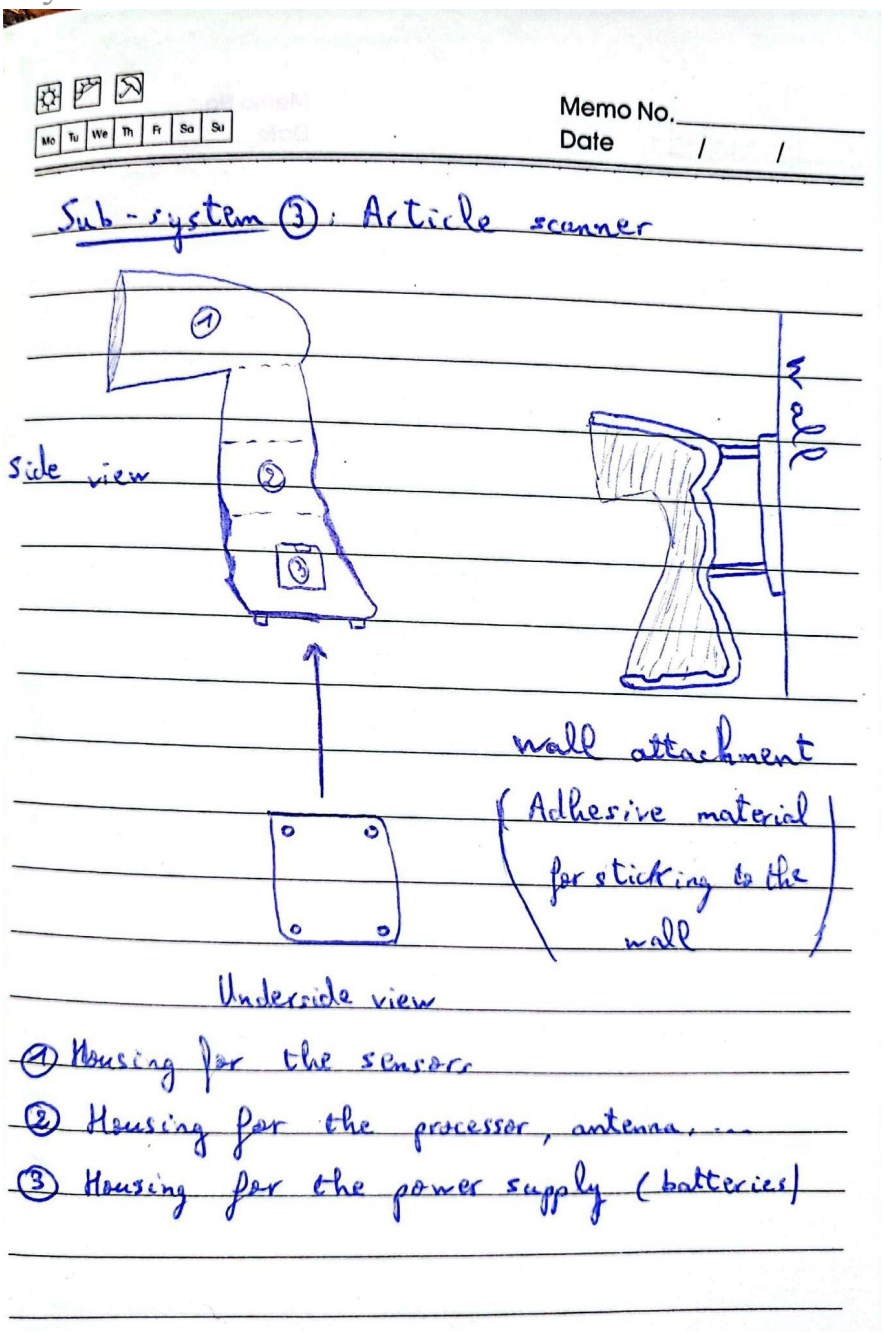
will also be “logged”, as in registered in the system by function of the time and date of the operation.

5.4.2. Mobile interface subsystem:



The purpose of the app is to allow quick and easy access to all kinds of data and details. A clear, functional and aesthetic interface is required in order to promote usability and user-friendliness (as mentioned in the interpreted needs of the client). The main interface will display general information such as the company name, an announcements window, and a “recent changes” window. It will also provide access to main functions such as logs and statistics, inventory list, settings, notifications, and a help window (to provide a guide in case any users have difficulties using the app).

5.4.3. Scanner subsystem:



The scanner is a crucial sub-system, since it aims to fulfill the client's need for modern, automated methods of article addition and deletion. It was first unclear whether the scanner should be portable or wall-mounted, but looking at how both designs have their own compelling advantages and inconveniences, we've decided on a hybrid design, which includes a handheld scanner with a long, comfortable handle for ease of handling, as well as a large casing at the top to house the sensors and optics responsible for detecting signals from RFID tags. We want the scanner to be able to stand on its own, which is why all of the heavy

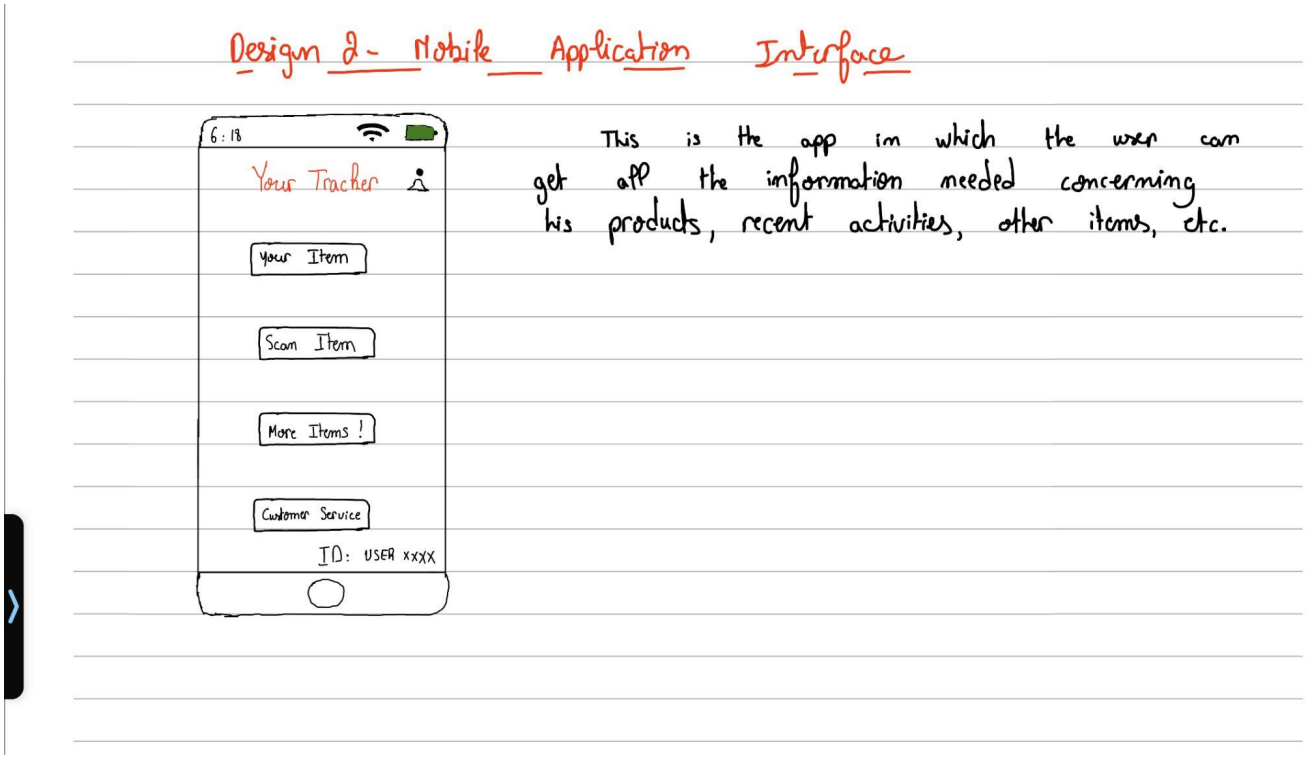
components (the processing board and power supply) are stored in the bottom casing, to keep the scanner bottom-heavy in order to prevent tipping over. The under-side of the handle features four outward dents that will serve as supports, as well as attachment points to the wall attachment (they provide extra leverage between the bottom of the handle and the corresponding surface on the wall attachment). As for the wall attachment itself, it uses strong adhesive materials to stick to the wall, this is to keep it portable as well, and to ease the attachment process.

5.5. Solution 5 by (Elmahdi Barroug)

5.5.1. Software subsystem:

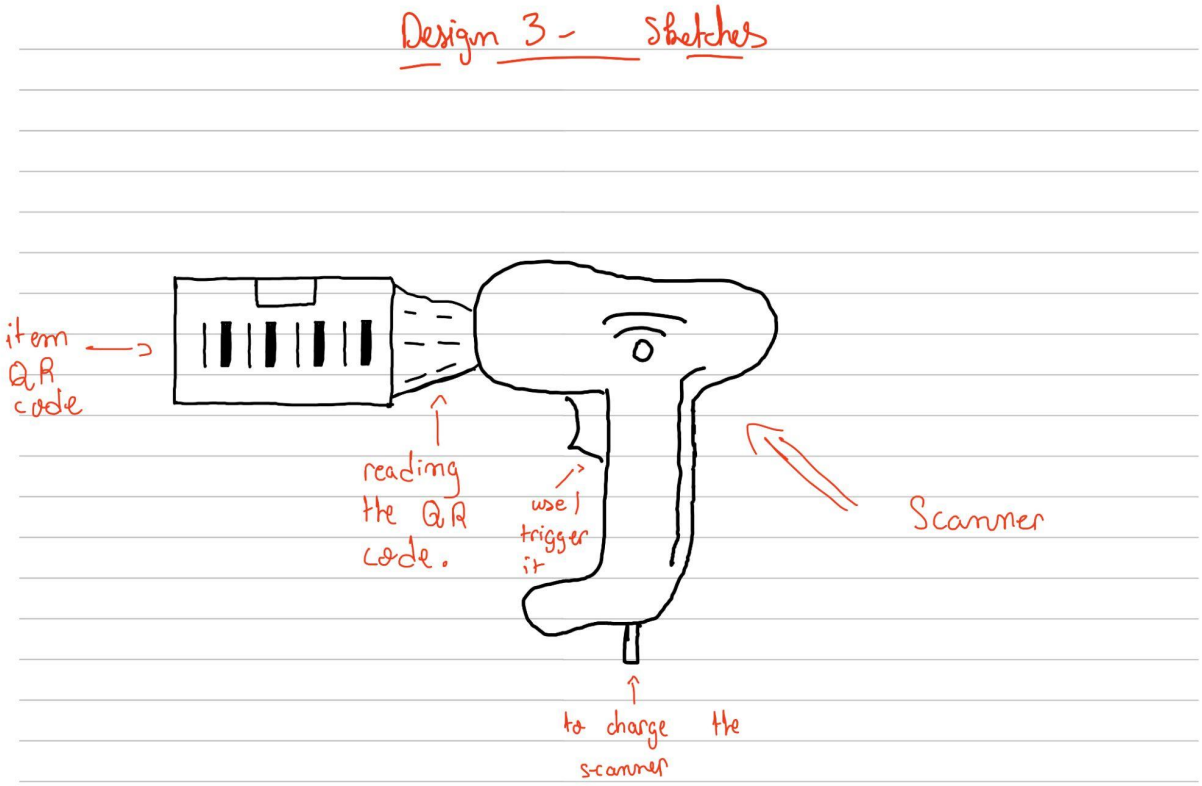
N/A

5.5.2. Mobile Application Interface:



This app allows the user to stay updated about his products/items in simple steps. It consists of mainly 4 tabs, the first is where the customer can check his items' recent activity, price, and location. The second tab is where a customer/user can scan a new item they are interested in with the possibility of adding it to the items basket, or just neglecting the item and not using it. The third tab is where the costumer can find out about different areas of items that will broaden his interests, hence discovering new interests. The last tab, called "customer service," is where the user can contact one of our employees and inquire about his item or complain about a certain inconvenience.

5.5.3. Scanner Subsystem:



This barcode scanner reads and decodes information encoded in a barcode. It uses a light source and a sensor to capture the patterns of dark and light bars in the barcode, converting them into a digital signal. This data is then processed and can be used to retrieve product information, track inventory, entries and exits of an item, or perform various tasks, such as pricing, in a fast and accurate manner.

6. Evaluation and selection based on design criteria

Decision Matrix

Priority number	Design Criteria	Ziyad's Concept	Elie's Concept	Deva's Concept	Zakariae's Concept	Mahdi's Concept
4	Interface	2	2	3	1	1
5	Autonomy	2	3	2	2	2
5	Reliability	1	3	1	2	1
5	Access Tracking	3	3	3	3	3
5	Spatial Localisation	3	3	3	3	3
5	Digital Manipulation	3	3	3	3	3
5	Data Approval Efficiency	1	3	3	3	1
5	Alert	3	3	3	3	3
1	Video Recognition	1	1	1	1	1
3	Longevity	2	3	2	2	2
4	Cost	3	1	3	3	3
4	Detection range	2	3	2	2	2
4	Adaptability	3	1	3	2	2
2	Weight	2	3	2	2	2
Total		127	147	130	138	123

NB: Priority scale : 5(High priority)→1(Low priority)

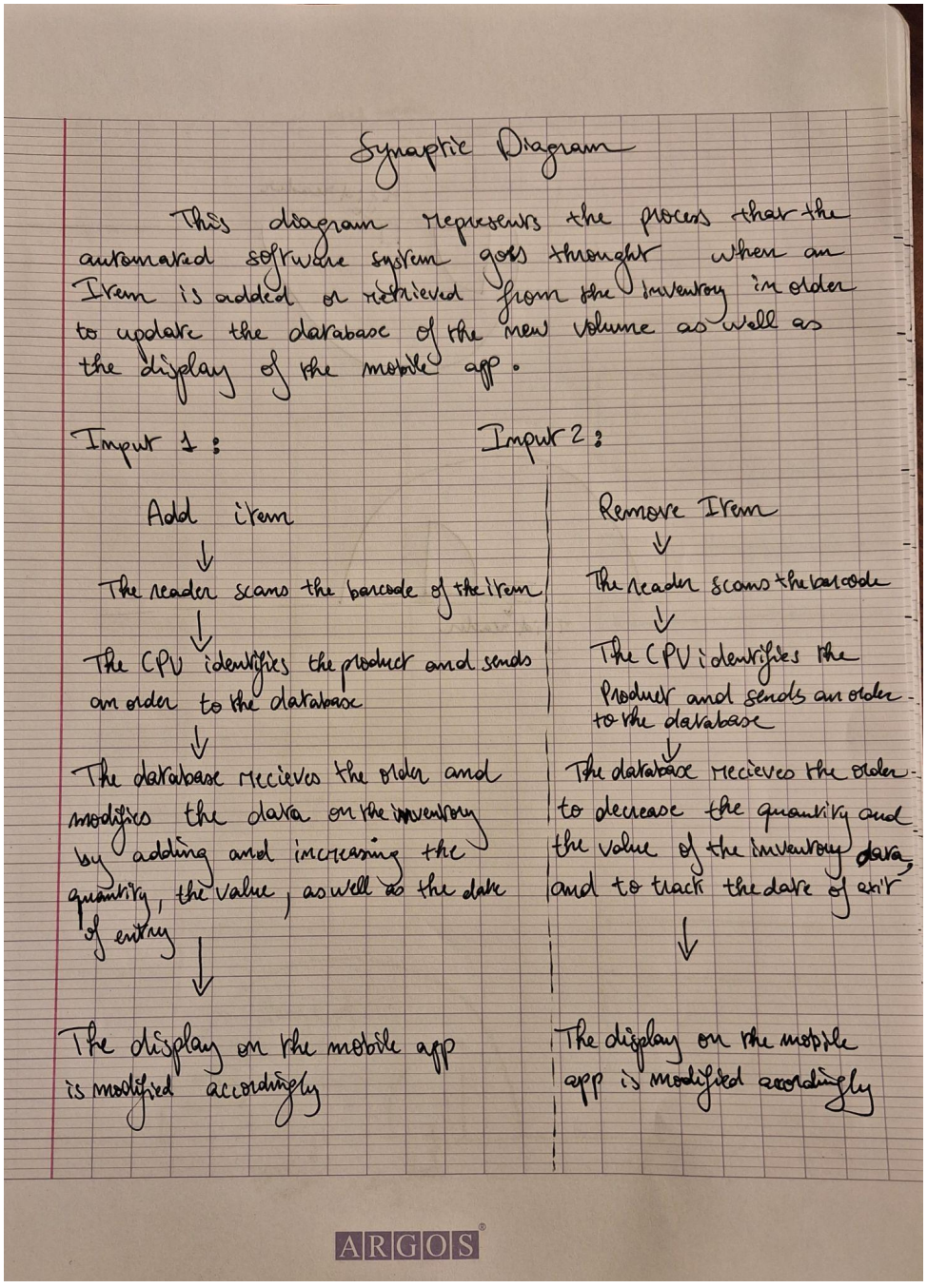
Based on the decision matrix above, we've determined that the best option would be solution N°2. However, it is apparent that this solution has its flaws, particularly in the criteria related to

the scanner/reader and interface sub-systems , which will be addressed and refined in order to perfect the final solution in relation to the design criteria, as shown in the decision matrix. After refining the lacking sub-systems, either by merging them with existing sub-systems from other concepts, or by creating entirely new ones, the resulting concept will represent the final solution.

For this, we chose to modify Elie's reader by making it detachable from the wall, and in order to reduce the cost of the scanner, we'd have to reduce its range greatly, from ~4 meters to ~10 centimeters. We will however preserve its shape and physical design due to how it is now easier to hold and transport (fits in your pocket). For the interface, we chose to interchange Elie's original interface with Deva's which was more detailed and user-friendly.

7. Final solution

7.1. Software sub-system:



Synaptic Diagram

This diagram represents the process that the automated software system goes through when an Item is added or retrieved from the inventory in order to update the database of the new volume as well as the display of the mobile app.

Input 1 :

Add item

↓

The reader scans the barcode of the item

↓

The CPU identifies the product and sends an order to the database

↓

The database recieves the order and modifies the data on the inventory by adding and increasing the quantity, the value, as well as the date of entry

↓

The display on the mobile app is modified accordingly

Input 2 :

Remove Item

↓

The reader scans the barcode

↓

The CPU identifies the product and sends an order to the database

↓

The database recieves the order to decrease the quantity and the value of the inventory data, and to track the date of exit

↓

The display on the mobile app is modified accordingly

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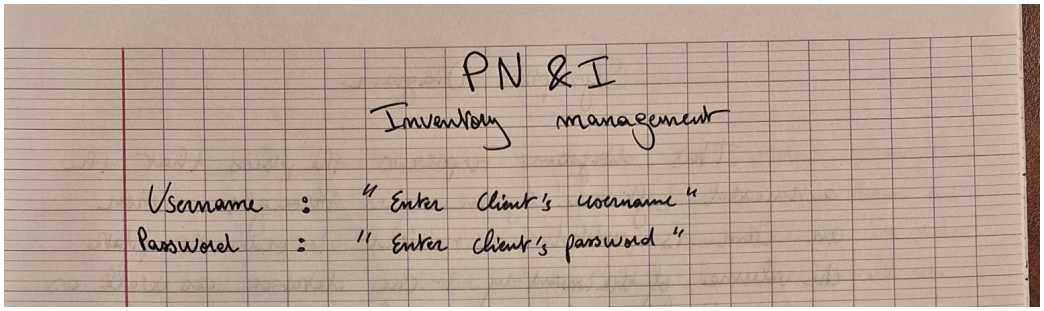
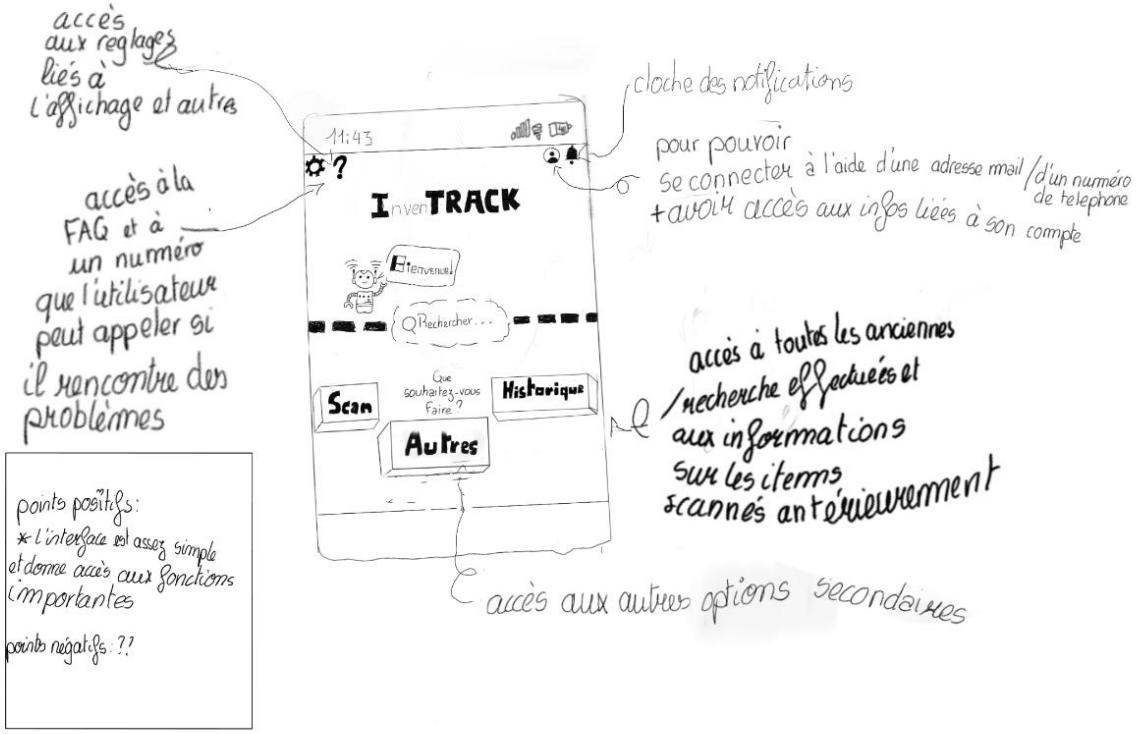
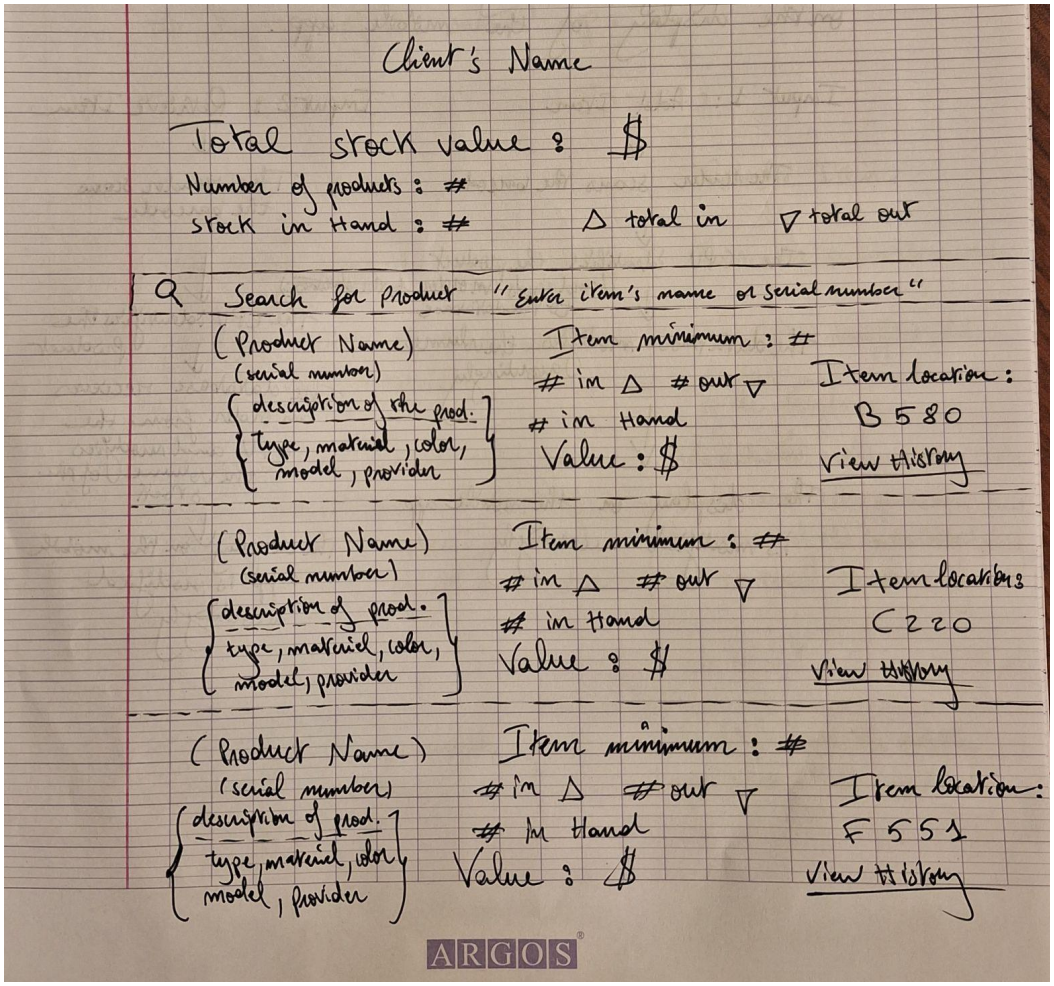
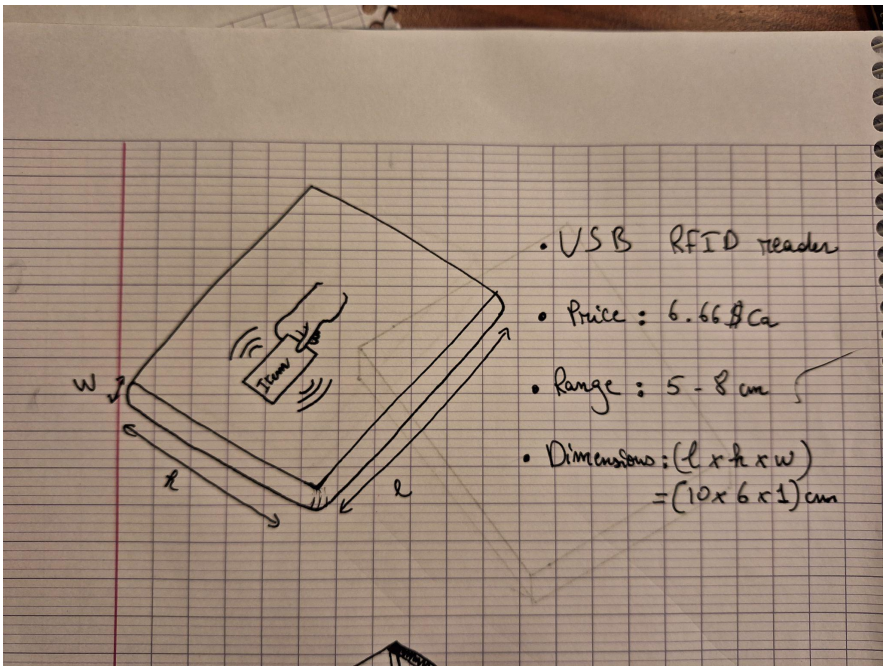
7.2. Interface sub-system:

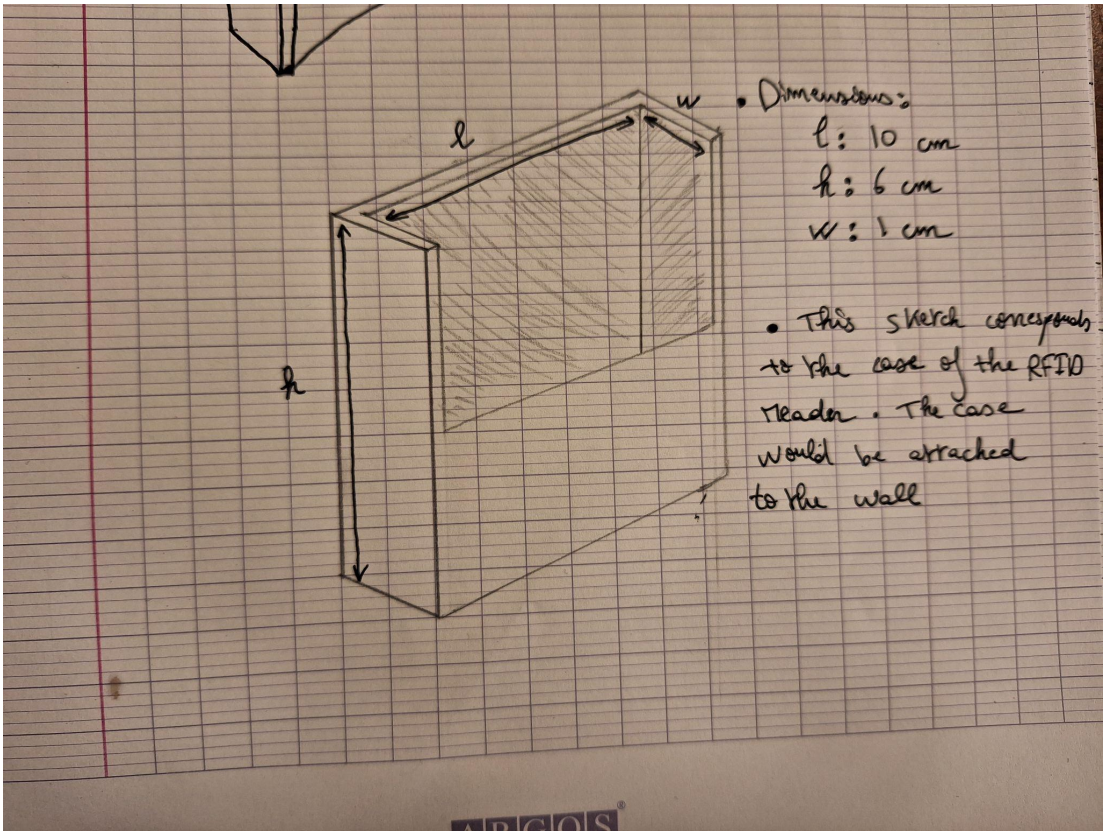





Client's Name
Total stock value : $
Number of products : #
stock in Hand : #
△ total in
▽ total out
Q Search for product "Enter item's name or serial number"
(Product Name)
(serial number)
{description of the prod.
type, material, color, model, provider}
Item minimum : #
in △ # out ▽
in Hand
Value : $
Item location :
B580
View history
(Product Name)
(serial number)
{description of prod.
type, material, color, model, provider}
Item minimum : #
in △ # out ▽
in Hand
Value : $
Item location:
C220
View history
(Product Name)
(serial number)
{description of prod.
type, material, color, model, provider}
Item minimum : #
in △ # out ▽
in Hand
Value : $
Item location:
F551
View history
ARGOS

7.3. Scanner sub-system:





8. Conclusion and recommendations

To conclude, the ideation process is a process that requires a lot of brainstorming so that we can provide the best solution to the problem at hand. Regarding our work, we finally chose solution #2, to which we made some modifications, addressing its disadvantages such as cost, adaptability, and the interface to better meet the problem statement. So, we have a hybrid solution. As future work, we will focus on selecting the materials to build the scanner housing, programming our Arduino, developing the user interface, and searching for an RFID chip that meets the requirements of our solution.

9. References

1. Unknown author - www.pcmag.com
2. Xiaowei Zhu, Samar K. Mukhopadhyay, Hisashi Kurata,

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