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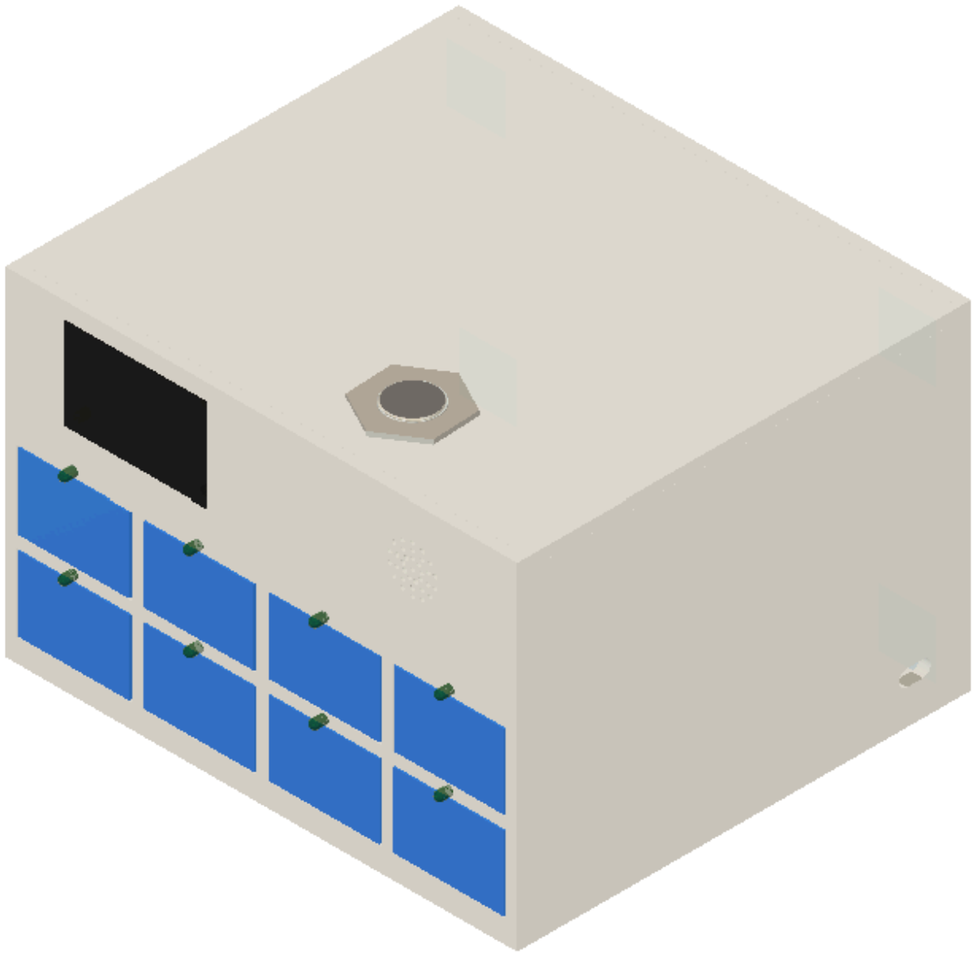
SmartMed: An Innovative Medicine Management System



Design Focus Area: Medication Management and Reminder Systems

A major challenge faced by many people is managing their daily medication schedules accurately and consistently. Individuals who take multiple medicines each day often struggle to remember the correct timing, dosage, and sequence of tablets. This issue is particularly common among elderly users, patients with chronic illnesses, and individuals with busy lifestyles.

Missing medication or taking it at the wrong time can reduce the effectiveness of treatment and may lead to serious health complications. Users may accidentally skip doses, take duplicate doses, or confuse medicines that look similar. Traditional storage methods such as pill boxes and medicine packets help organise medication but do not actively remind users when to take their medicines or help prevent mistakes.

Many people currently rely on phone alarms, written notes, or memory alone to manage their medication schedules. However, these methods are not always reliable, especially for users with hearing difficulties, memory decline, or complex medication routines. As healthcare becomes increasingly dependent on technology, there is a growing need for smarter systems that can improve medication organisation, reduce human error, and provide clear and accessible reminders.

Why Is This Area Important?

Taking medication correctly is an essential part of maintaining health and managing long-term medical conditions. Research from the NHS indicates that many people miss doses because they forget, become distracted, or do not have a reminder system that suits their lifestyle. This challenge becomes greater for older adults, who may experience memory decline, reduced hearing, or more complex prescription schedules.

A 2024 review of medication dispensing and reminder systems examined 426 studies and selected 56 for detailed analysis. The large volume of research highlights the significance of medication adherence as a global healthcare issue. The findings suggest that improving medication management remains an important opportunity for designers and engineers to develop solutions that support users in their daily lives.

Furthermore, increasing life expectancy and the growing number of people living with chronic illnesses mean that more individuals are required to manage multiple medications over long periods. This increases the need for reliable systems that can support users and reduce medication-related errors.

Consequences of Medication Non-Adherence

Medication non-adherence can have serious effects on both individuals and society.

1. **Medical Consequences**

Missing doses may cause treatments to become less effective and can lead to the worsening of chronic conditions such as diabetes, heart disease, or high blood pressure. In some cases, incorrect medication use can result in medical emergencies or hospitalisation.

2. **Economic Consequences**

Medication-related mistakes contribute to unnecessary healthcare costs through additional doctor visits, emergency treatment, hospital admissions, and wasted medication. These costs place additional pressure on healthcare systems.

3. **Social and Caregiver Consequences**

Family members and caregivers often play an important role in helping individuals manage medication schedules. Constant monitoring can create stress, anxiety, and caregiver burnout, particularly when supporting elderly patients or individuals with multiple prescriptions. Improving medication management can help reduce this burden and promote greater independence for users.

The Issue with Existing Solutions

Although traditional pill boxes are widely used, they are passive systems that only organise medication. They do not remind users when medication is due, confirm whether medication has been taken, or prevent accidental mistakes.

Similarly, phone alarms and written reminders can be ignored, forgotten, or switched off without action being taken. Users may still struggle to identify the correct medication, particularly when several tablets look similar. These limitations make current solutions less effective for individuals with complex medication schedules.

While advanced smart medication dispensers are available on the market, many of these products are expensive and may not be affordable for all users. Some systems also require subscription services, internet connectivity, or complex setup procedures, which can discourage elderly users and those with limited technical knowledge. As a result, many people continue to rely on basic reminder methods that do not adequately support medication management.

Therefore, there is a need for a medication management system that is affordable, easy to use, and capable of actively assisting users through clear reminders, medication identification, and controlled dispensing. Such a system could help improve medication adherence while remaining accessible to a wider range of users.

Initial plan :

In the following order:(record dates for any progress made to put that into the product timeline)

- Market Analysis:Analyse similar products in the market with the same purpose.
- Research
- Survey and create a summary based on the results.
- Material analysis
- Initial specification
- Idea generation - Use findings from similar products and specifications to ideate.
- Evaluation of ideas
- Mechanism Analysis
- Product development
- Manufacturing tools Research
- Design analysis
- Make a Prototype of final design
- Manufacturing process.
- Testing and evaluation
- User Feedback collection
- Evaluation against specification
- Further improvements for the product

Secondary Research

Common causes of missed medication

- Forgetting the exact time of a dose, especially when daily routines are busy or irregular.
- Confusing one medicine with another when several tablets look similar or are taken at different times.
- Taking medicine late, early, or twice because there is no clear record of whether a dose was already taken.
- Depending only on memory or a single alarm, which is often not enough for people with multiple medicines.
- Having difficulty reading labels or hearing alerts, which can affect older users and people with accessibility needs.

The NHS guidance also says that people often respond better when medicine-taking is linked to everyday activities such as meals, brushing teeth, or other regular habits. That suggests timing alone is not always enough, and reminders may work better when they connect to a routine the user already knows.

Evidence from studies

A medicine reminder system study tested a microcontroller-based device with 110 patients and found that 84% said it reminded them effectively at the correct time. The same system used an RTC, OLED display, buzzer, vibration, and phone calls, showing that multiple reminder methods can work together better than one method alone. This is useful evidence because it shows that visual, sound, and mobile alerts are practical in real use.

The NHS SPS guidance says that text or telephone reminders may be more effective when they are personal or interactive, but electronic drug monitors on their own are unlikely to improve adherence without extra support. That is important because it suggests that a reminder system should not only alert the user, but should also support behavior and follow-up. The same source also states that some programmable dispensers can help, but they may be too complex for some users and need careful suitability testing.

A 2024 study on older adults reports that around 50% of older adults struggle with medication adherence. That figure is useful because it shows the problem is not rare or minor. It also supports focusing on older users as a key group when developing a design idea.

Older adults as users

Older adults are a strong user group for this topic because they are more likely to take multiple medications and may need support remembering schedules. The research indicates that reminder systems for older adults need to be simple, clear, and not overly technical. If a system is too complex to set up or refill, it may not be used consistently.

A descriptive study on pillboxes found that 85% of older adults said the pillbox helped them manage their medicines. This is useful because it shows organized storage itself has value, even before electronics are added. However, a pillbox mainly helps with organization; it does not automatically remind users or track whether a dose was taken.

Related Studies(The information below until the references are from a research paper)

Recent studies have explored different methods to improve medication adherence among patients. One study by [6] examined the effectiveness of using customized Short Messaging Service (SMS) reminders through mobile technology. Conducted in resource-poor areas of Pakistan with 200 participants, the study found that patients who received personalized medication reminders and health-related SMS messages showed better medication adherence and lower average diastolic blood pressure compared to those who only received regular care.

Similarly, [1] carried out a systematic review to evaluate the impact of text messaging on treatment adherence among patients with arterial occlusive diseases. The

review included seven trials involving 1,310 participants. However, the researchers concluded that there was insufficient evidence to confirm the effectiveness of text-message interventions due to the very low quality of available evidence. They emphasized the need for more reliable randomized trials, especially in low- and middle-income countries.

Another study by [3] investigated the effectiveness of low-cost medication reminder devices in improving adherence. The study involved 53,480 participants who were taking one to three long-term oral medications and were not consistently following their prescribed treatment plans. Participants were divided into groups based on whether they were taking medication for cardiovascular or other chronic conditions, or antidepressants. They were then randomly assigned to use reminder tools such as pill bottle strips with toggles, digital timer caps, or standard pillboxes, while another group received no reminder device and served as the control group.

In Viet Nam, [4] conducted a formative study on the use of the Wisepill evriMED Medication Event Reminder Monitor (MERM). among patients with drug-susceptible pulmonary tuberculosis in Thanh Hoa province. Twenty patients participated in the randomized controlled trial. Half of them received daily reminder alerts and scheduled reviews of their dosing history, while the remaining participants used the device without alerts. Researchers later conducted in-depth interviews to understand the patients' experiences and opinions about the system.

The importance of mobile phone usage in supporting public health programs in low- and middle-income countries was also highlighted in a study by [8]. The researchers evaluated a two-way SMS reminder system called Zindagi SMS to determine its impact on tuberculosis treatment success in Karachi, Pakistan. The randomized controlled trial involved 2,207 participants who were assigned either to the Zindagi SMS intervention group or to a control group. The main outcome measured was the rate of successful treatment completion recorded clinically.

Another related study by [5] focused on the development of a smartphone-based medication self-management system (SMSS). The researchers designed and tested the feasibility of the system using feedback collected from interviews with 116 patients. The SMSS provided two main features through smartphones: maintaining accurate medication histories and records, and sending reminders whenever patients forgot to take their medication.

Although SMS-based reminder systems have shown effectiveness, they still present several limitations. One major challenge is the cost of sending multiple SMS reminders daily. For patients who require reminders several times a day, the monthly expense from mobile network providers can become significant. In addition, if the device runs out of credit, reminders may not be delivered. Another issue is that patients may fail to notice the alert if they are not near their phones at the time the message arrives.

To address these limitations, this project proposes the use of phone calls instead of SMS as a medication reminder method. This approach improves upon the work of [10] and is expected to be both more cost-effective and more reliable, since phone call ringing durations are generally longer and harder to ignore than SMS notifications.

The proposed system will also allow users to provide the contact details of a dedicated medical staff member who can be notified if the patient fails to respond to reminders. This feature extends the work of [2], which integrated prescription schedules into medication reminder systems. Furthermore, the system will include a vibration feature alongside audio notifications, providing an alternative alert method for physically challenged patients who may have difficulty hearing voice reminders.

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Reminder methods

1. **Audio reminders**

- Audio reminders are useful because they can get attention even when the user is not looking at a screen.
- Studies and NHS guidance suggest that audible reminders are helpful for many users, especially when combined with other cues.
- Loud or sudden alarms can be unsuitable for some users, so the tone and volume matter.

2. **Visual reminders**

- OLED or screen-based reminders can show the medicine name, time, or dose in a readable format.
- Visual alerts help users who may have hearing difficulties or who need confirmation before taking medicine.
- The NHS notes that better reminder charts and visible prompts can be practical and cost-effective.

3. **Vibrating reminders**

- Vibrating alerts are used for people with hearing impairments or for situations where sound is not ideal.
- The NHS specifically mentions that audible/vibrating alarms may benefit the hearing impaired.
- This is a good example of designing for different user needs rather than assuming one alert style fits everyone.

4. **Mobile reminders**

- Text or phone reminders can support users when they are away from the medicine storage area.
- The NHS says these are most effective when they are personal or interactive.
- Research also suggests that app-based reminders need backup features and caregiver support to be more reliable.

Storage and dispensing

The systematic review on pill and medication dispensers describes many devices that open sections at set times, often with alarms. It notes that these systems may suit patients with stable but somewhat complex medication regimens. This is especially relevant because multiple daily medicines often need both storage and timing support.

The review also shows that a major challenge is making sure the correct medicine is presented at the correct time without creating confusion. Some devices are useful but complex to fill, which can be a problem for older adults or caregivers. That means future designs should aim to be easy to load, easy to read, and difficult to misuse.

The same review highlights remote monitoring and caregiver alerts as useful directions in this area. That shows the research is moving from simple reminder tools toward systems that also support supervision and accountability. This gradual development helps build the case for a more interactive medication management product.

What users still struggle with :

- They may remember the reminder but still forget whether they actually took the dose.
- They may ignore a reminder if it is too generic, too frequent, or poorly timed.
- They may get confused if several medicines are scheduled close together.
- They may find complex dispenser systems difficult to refill or set up.
- They may need support from family or caregivers to stay consistent.

Conclusion :

The research suggests that no single method solves every medication problem. That is why systems are increasingly combining storage, reminders, and confirmation features rather than using only one function.

Additional evidence on the scale of the problem

A 2025/2026 study of 42,601 older adult records found medication non-adherence of 5.9%, and it linked the issue mainly to pharmacological factors, inappropriate use, and multiple chronic conditions with multiple medication regimens. This is useful because it gives you a very large sample size and shows that the issue is not only about memory, but also about regimen complexity and medication management systems.

Another major study, the REMIND randomized clinical trial, followed 53,480 patients taking one to three long-term oral medicines. It found that low-cost reminder devices did not significantly improve adherence overall, which is important because it shows that a simple reminder alone may not solve the problem. In the trial, the proportion achieving optimal adherence above 80% medication possession ratio was around 15.1% to 16.3% across groups, with no meaningful advantage over control.

What this means for your design research

The REMIND trial is especially useful because it shows that a medication aid needs more than just a physical reminder object. If users do not engage with the device consistently, or if the reminder is not tied to a stronger behavior system, the effect may be limited. This supports the idea that successful medication support should combine multiple functions rather than rely on a single prompt.

The study also suggests that reminder tools may work better when they are targeted to higher-risk users instead of being given to everyone in the same way. That is a strong justification for focusing on older adults and people with multiple medications, because they are more likely to need structured support.

Usability evidence you can add

A study on electronic medication adherence products examined usability and workload, showing that the user experience of these devices matters a lot in real life. This is useful for your project because a medication aid for older adults must be easy to understand, easy to refill, and not mentally tiring to operate. If a product feels too complicated, users may abandon it even if the idea is good.

Older adults have also reported positive experiences with dispensing devices when they are reliable and easy to use. One study found that older adults accepted a medication dispensing device as reliable, easy to use, and useful in coordinating personal medication management. This is valuable because it gives you evidence that the storage side of the problem can work well if the product is intuitive and supportive.

Evidence about what users need from reminder systems

Research on unobtrusive intelligent reminding found that reminders are more effective when they are delivered at an appropriate time rather than just randomly or loudly.

That matters because timing is one of the biggest issues in medication adherence, especially where doses need to fit a daily routine. It suggests that a well-designed reminder system should focus on the *right moment*, not just the existence of an alarm.

The NHS guidance also supports this by saying reminders work better when they fit the user's routine and are linked to everyday habits. Together, these sources point to the importance of scheduling logic, not just notification hardware.

Extra points for your analysis section

Summary

These extra studies help justify that the need is not just "people forget medicine." It is also that many current solutions are too simple, too generic, or too hard to use consistently. That strengthens our design direction because it shows why a more structured, user-friendly medication support system is needed for older adults and people with multiple medicines.

- Large studies show the problem affects tens of thousands of patients and is strongly linked to multiple medicines and chronic illness.
- Simple reminder devices do not always improve adherence, so a stronger design needs more than one function.
- Usability is critical because even good products may fail if users find them too difficult to set up or maintain.
- Older adults value devices that feel reliable and easy to understand.
- Reminder timing should be intelligent and routine-based rather than generic.

Primary Research

Aim : The aim of the primary research is to find out what problems users have with remembering and managing medicine, what kind of reminders they prefer, and what features would make a medication support product easier and safer to use. This will help identify real user needs before developing a design proposal.

Target audience :

A mix of users are to be surveyed ,because each group sees the problem differently.

- Elderly users who take medicine daily.
- Adults who take multiple medicines for long-term conditions.
- Family members or caregivers who help with medicine routines.
- Pharmacists or healthcare workers, if available.
- People with hearing, vision, or memory difficulties
- Teenagers and young adults

Survey questions

1. How many medicines do you take each day?
2. How often do you forget a dose?
3. What do you currently use to remember medicine?
4. Do you use alarms, reminders, or pill boxes?
5. Which reminder method works best for you: phone alarm, written note, voice reminder, or family reminder?
6. Have you ever taken the wrong medicine or dose by mistake?
7. Do you find it easy to tell different medicines apart?

8. Would a screen showing medicine name and time be useful?
9. Would sound reminders help you?
10. Would you like a caregiver to be notified if a dose is missed?
11. How important is it for you to confirm a dose before taking it?
12. What is the hardest part of managing your medicines?

Interview Questions

1. Can you describe your current medicine routine?
2. What problems do you face when taking medicine daily?
3. Have you ever missed a dose or taken one twice?
4. What usually causes mistakes in your medicine routine?
5. How do you feel about using technology for medicine reminders?
6. What kind of reminder would be easiest for you to notice?
7. Would a visual display be helpful for checking medicine details?
8. Would you prefer a simple device or a more advanced one with multiple functions?
9. Would you need help setting it up?
10. What features would make you trust the device more?
11. What would make you stop using a medicine reminder system?
12. Would you want the system to record whether the medicine was taken?

Interview Responses

Interview 1: Elderly User

Name: R. Lakshmi
Age: 72

1. Can you describe your current medicine routine?

   Ans : I take medicines three times a day for blood pressure, diabetes, and joint pain. I keep them in a weekly pill organizer and try to follow the schedule given by my doctor.

2. What problems do you face when taking medicine daily?

   Ans : Sometimes I forget whether I have already taken my tablets, especially when I am busy with household activities or if my routine changes.

3. Have you ever missed a dose or taken one twice?

   Ans : Yes. There have been occasions when I forgot a dose, and a few times I accidentally took the same medicine twice because I could not remember taking it earlier.

4. What usually causes mistakes in your medicine routine?

   Ans : The main reason is forgetfulness. Some medicines also look similar, which can cause confusion.

5. How do you feel about using technology for medicine reminders?

   Ans : I think technology can be very useful as long as it is simple and easy to understand.

6. What kind of reminder would be easiest for you to notice?

   Ans : A loud voice reminder combined with a flashing light would work best for me.

7. Would a visual display be helpful for checking medicine details?

   Ans : Yes. A display showing the medicine name and time would help me confirm I am taking the correct medication.

8. Would you prefer a simple device or a more advanced one with multiple functions?

   Ans : I would prefer a simple device with only the most important functions.

9. Would you need help setting it up?

   Ans : Yes, I would probably need assistance from a family member.

10. What features would make you trust the device more?

    Ans : Accurate reminders, clear instructions, and reliable operation every day.

11. What would make you stop using a medicine reminder system?

    Ans : If it became difficult to operate or frequently gave incorrect reminders.

12. Would you want the system to record whether the medicine was taken?

    Ans : Yes, because it would help me keep track and avoid taking medicines twice.

Interview 2: Working Adult

Name: A. Prakash
Age: 45

1. Can you describe your current medicine routine?

   Ans : I take medication for hypertension every morning and vitamin supplements at night. I mainly rely on my phone alarm.

2. What problems do you face when taking medicine daily?

   Ans : My work schedule is unpredictable, so I sometimes ignore reminders and forget to take medicine later.

3. Have you ever missed a dose or taken one twice?

   Ans : I have missed doses several times, but I have never taken one twice.

4. What usually causes mistakes in your medicine routine?

   Ans : Busy workdays, travel, and distractions.

5. How do you feel about using technology for medicine reminders?

   Ans : I am comfortable with technology and think it can improve medication management significantly.

6. What kind of reminder would be easiest for you to notice?

   Ans : A phone notification combined with an audible reminder from the device.

7. Would a visual display be helpful for checking medicine details?

   Ans : Yes, especially if it displays the medicine name and dosage information.

8. Would you prefer a simple device or a more advanced one with multiple functions?

   Ans : I would prefer an advanced device with app connectivity and tracking features.

9. Would you need help setting it up?

   Ans : No, I would be comfortable setting it up myself.

10. What features would make you trust the device more?

    Ans : AApp integration, accurate scheduling, and a record of previous doses.

11. What would make you stop using a medicine reminder system?

    Ans : Frequent technical issues or unreliable notifications.

12. Would you want the system to record whether the medicine was taken?

    Ans : Yes, it would help me monitor my medication adherence over time.

Interview 3: University Student

Name: S. Kavya
Age: 21

1. Can you describe your current medicine routine?

   Ans : I only take medication occasionally, mainly vitamins and allergy medicine when needed.

2. What problems do you face when taking medicine daily?

   Ans : When I have to take medicine regularly, I often forget because my class and study schedule changes every day.

3. Have you ever missed a dose or taken one twice?

   Ans : I have missed doses before but never taken one twice.

4. What usually causes mistakes in your medicine routine?

   Ans : Being busy with studies and forgetting to check reminders.

5. How do you feel about using technology for medicine reminders?

Ans : I think technology is the best solution because most people my age already use smartphones constantly.

6. What kind of reminder would be easiest for you to notice?

   Ans : A smartphone notification would be the most effective reminder.

7. Would a visual display be helpful for checking medicine details?

   Ans : Yes, especially if it clearly displays the medicine name and schedule.

8. Would you prefer a simple device or a more advanced one with multiple functions?

   Ans : I would prefer an advanced device with app connectivity and customization options.

9. Would you need help setting it up?

   Ans : No, I would be able to set it up independently.

10. What features would make you trust the device more?

    Ans : Reliable notifications, battery backup, and synchronization with my phone.

11. What would make you stop using a medicine reminder system?

    Ans : If it was complicated to use or required frequent maintenance.

12. Would you want the system to record whether the medicine was taken?

    Ans : Yes, especially for long-term medications where tracking is important.

Interview 4: Caregiver for his Parent

Name: M. Ravi
Age: 58

1. Can you describe your current medicine routine?

   Ans: I manage my own medicines and also help my elderly mother with her medication schedule.

2. What problems do you face when taking medicine daily?

   Ans : The biggest challenge is ensuring that my mother takes the correct medicines at the correct times.

3. Have you ever missed a dose or taken one twice?

Ans : My mother has occasionally missed doses, and there have been situations where we were unsure if a dose had already been taken.

4. What usually causes mistakes in your medicine routine?

   Ans : Multiple medications, similar-looking tablets, and changes in daily routine.

5. How do you feel about using technology for medicine reminders?

   Ans : I believe technology can greatly reduce medication errors and improve safety.

6. What kind of reminder would be easiest for you to notice?

   Ans : A combination of sound, visual indicators, and mobile phone notifications.

7. Would a visual display be helpful for checking medicine details?

   Ans : Yes, it would reduce confusion and improve confidence in taking the correct medicine.

8. Would you prefer a simple device or a more advanced one with multiple functions?

   Ans : I would prefer an advanced system if it remains easy to use.

9. Would you need help setting it up?

   Ans : Probably not, but clear instructions would be useful.

10. What features would make you trust the device more?

    Ans : Missed-dose tracking, caregiver notifications, and consistent reliability.

11. What would make you stop using a medicine reminder system?

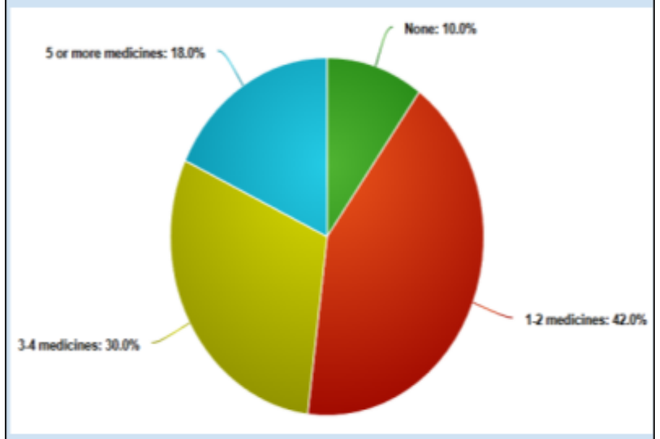
    Ans : If it failed to provide reminders accurately or became difficult to maintain.

12. Would you want the system to record whether the medicine was taken?

    Ans : Definitely. A record would help caregivers monitor medication adherence and reduce uncertainty.

Survey Responses

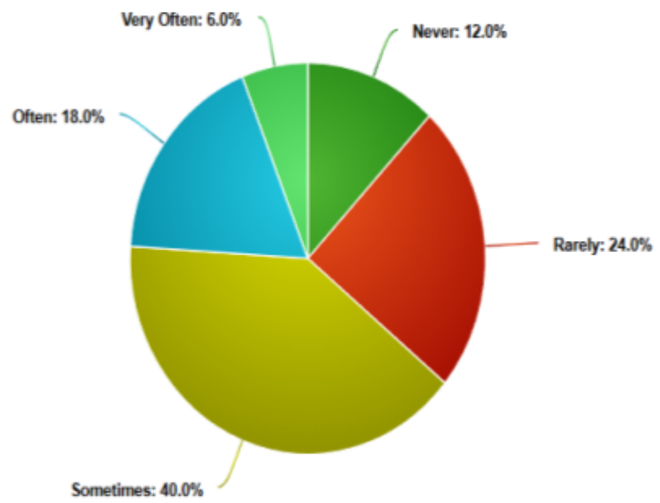
1. How many medicines do you take each day?



Finding:

48% of respondents take 3 or more medicines daily, increasing the risk of confusion and missed doses.

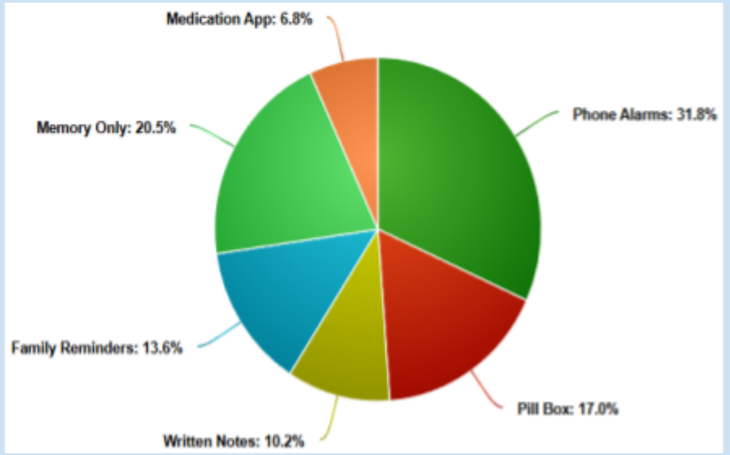
2. How often do you forget a dose?



Finding:

64% of respondents forget medication at least occasionally.

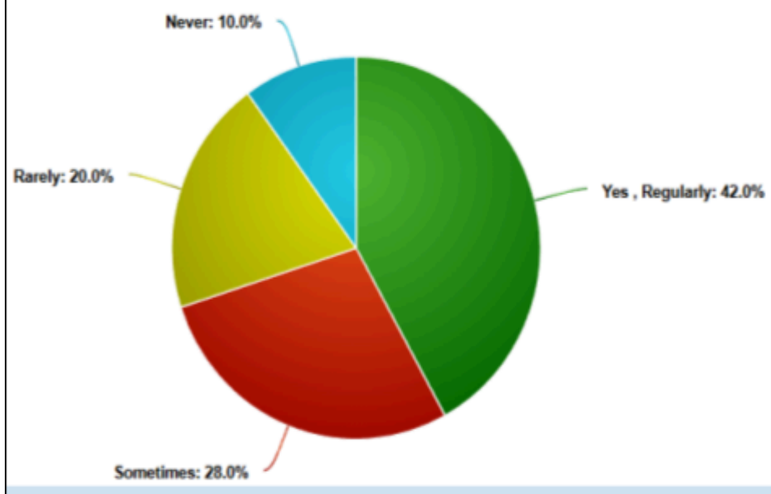
3. What do you currently use to remember medicine?



Finding:

Many respondents still depend on memory despite available reminder tools.

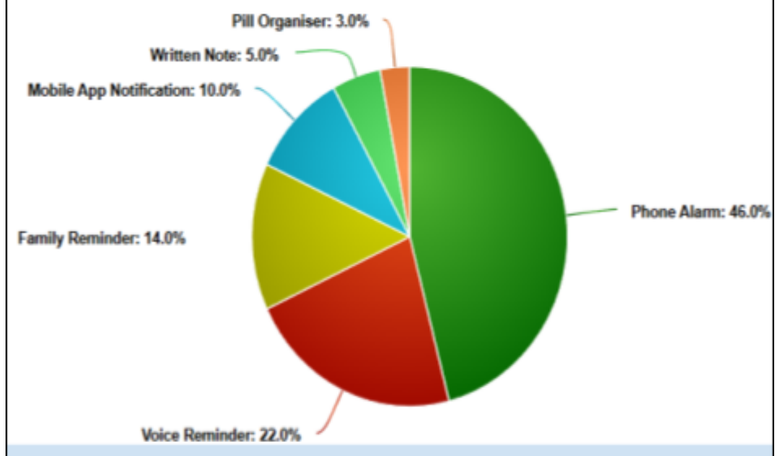
4. Do you use alarms, reminders, or pill boxes?



Finding:

58% do not consistently use reminder systems.

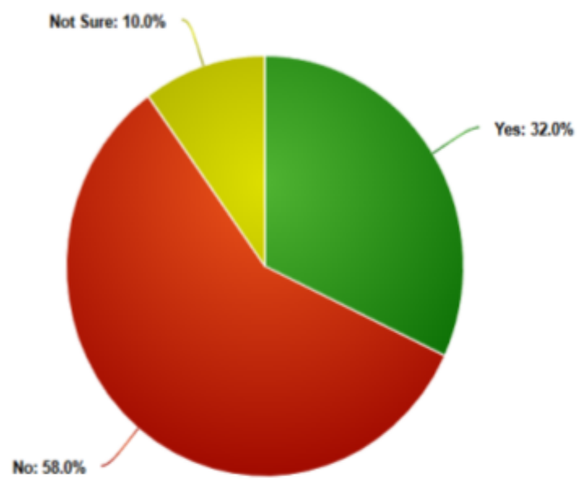
5. Which reminder method works best for you?



Finding:

Phone and voice reminders are the most preferred methods.

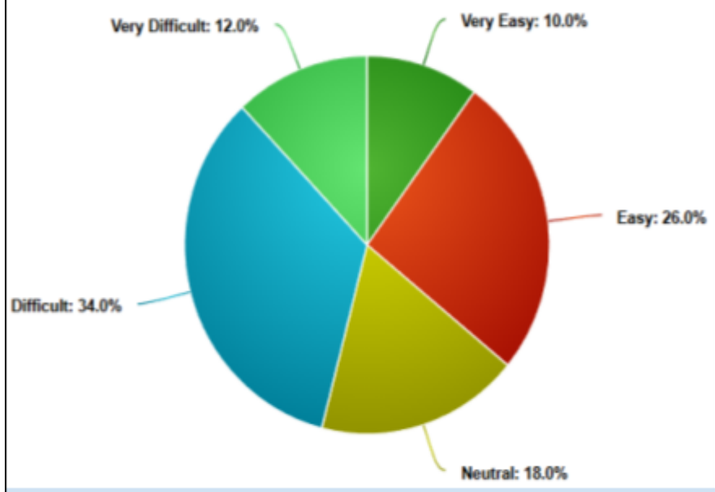
6. Have you ever taken the wrong medicine or dose by mistake?



Finding:

Nearly one-third of respondents have experienced medication errors.

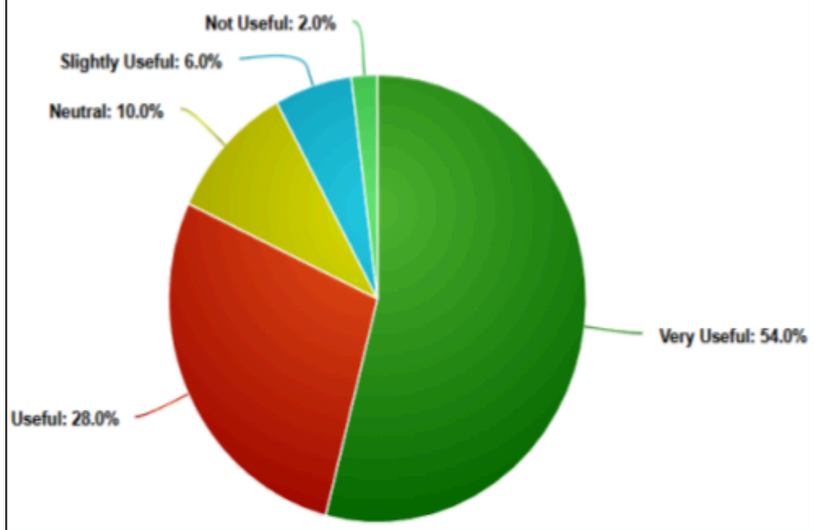
7. Do you find it easy to tell different medicines apart?



Finding:

46% find it difficult to distinguish between medications.

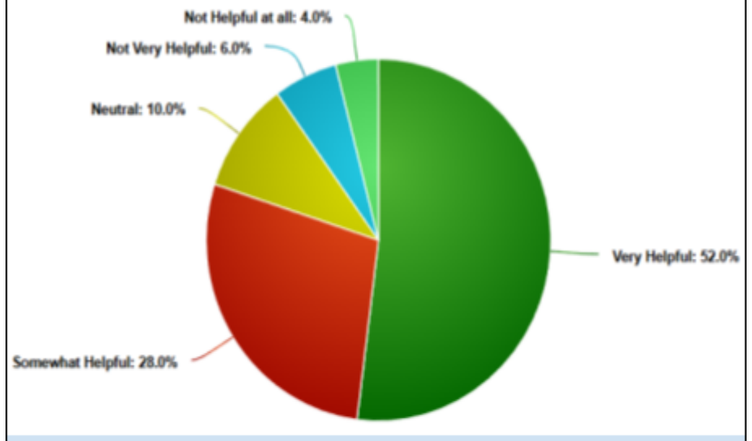
8. Would a screen showing medicine name and time be useful?



Finding:

82% believe a display showing medicine details would be useful.

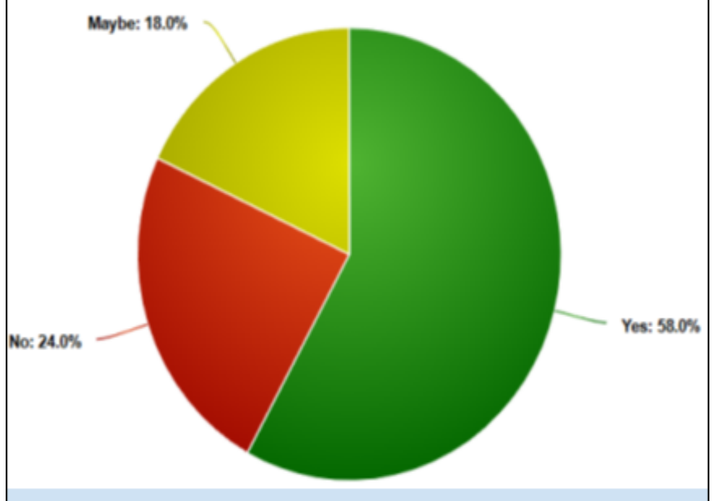
9. Would sound reminders help you?



Finding:

80% support audio reminders.

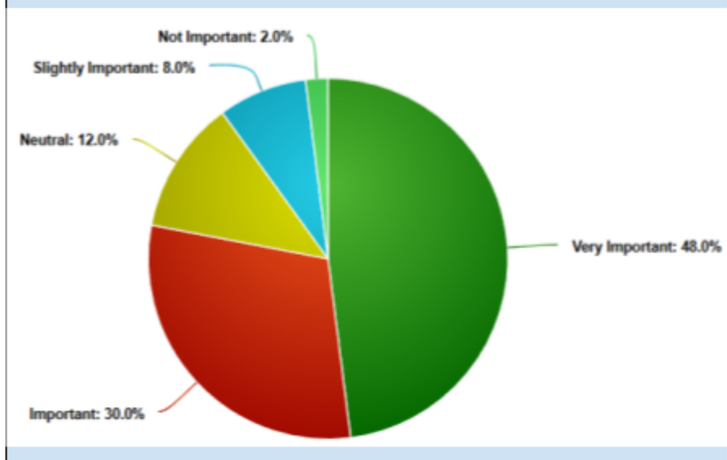
10. Would you like a caregiver to be notified if a dose is missed?



Finding:

Most respondents support caregiver involvement.

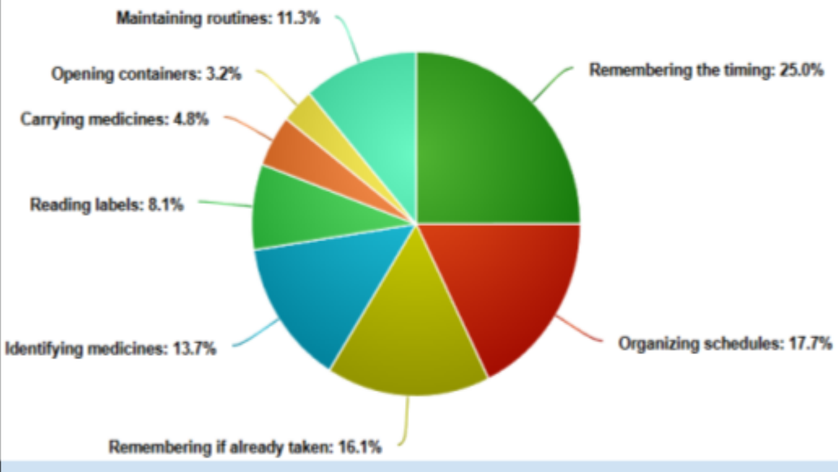
11. How important is it for you to confirm a dose before taking it?



Finding:

78% value medication confirmation before consumption.

12. What is the hardest part of managing your medicines?



Finding:

Remembering medication timing is the most common challenge.

Analysis of Research Data

The questionnaire and interviews revealed several common issues associated with medication management. The survey showed that **48% of respondents take three or more medicines daily**, increasing the likelihood of confusion and mistakes. Additionally, **64% of respondents reported forgetting medication doses at least occasionally**, indicating that medication adherence is a widespread problem.

The results also showed that while many respondents use phone alarms or other reminder methods, **36% still rely on memory alone**, making them vulnerable to missed doses. Furthermore, **32% of respondents admitted to taking the wrong medicine or dosage at least once**, highlighting the need for clearer medication identification and guidance.

A significant finding was that **46% of respondents found it difficult to distinguish between different medicines**, while **82% believed that a screen displaying medicine names and timing would be useful**. This suggests that users would benefit from a system that provides clear visual information regarding medication schedules and identification.

The survey also found strong support for reminder features. **80% of respondents considered audio reminders helpful**, demonstrating the importance of using multiple reminder methods to attract user attention. In addition, **78% stated that confirming a dose before taking it was important**, indicating that users value reassurance and verification before consuming medication.

The most common challenge identified was **remembering medication timing**, selected by **62% of respondents**. Other significant issues included organizing medication schedules, remembering whether a dose had already been taken, and identifying medicines correctly.

The interview responses further reinforced these findings. Elderly participants reported problems with forgetfulness and distinguishing between similar-looking tablets. Working adults highlighted the impact of busy schedules on medication adherence, while caregivers emphasized the importance of monitoring and tracking medication intake.

Analysis of Potential Design Opportunities

1. Improved Reminder System

Research Evidence

- **64% of respondents** reported forgetting medication doses at least occasionally.
- **62% of respondents** identified remembering medication timing as the most difficult part of managing medicines.
- **80% of respondents** stated that sound reminders would be helpful.
- **82% of respondents** believed that a system displaying medication information would be useful.

Interview Evidence

- **Lakshmi (72)** stated that she sometimes forgets whether she has taken her medication and would benefit from a voice reminder and flashing indicator.
- **Prakash (45)** reported missing doses due to work commitments and distractions.
- **Kavya (21)** explained that changing daily schedules often causes her to forget medications.

- **Ravi (58)** highlighted that ensuring medicines are taken on time is one of the biggest challenges when caring for elderly family members.

Design Opportunity

- Develop a system that provides reminders through multiple methods, such as audio alerts, visual notifications, and smartphone notifications.
- Use reminder methods that are noticeable to users with different lifestyles and abilities.
- Reduce missed doses by making reminders more difficult to ignore.

2. Clear Medication Identification

Research Evidence

- **46% of respondents** reported difficulty distinguishing between different medicines.
- **32% of respondents** had taken the wrong medicine or dosage by mistake.
- **82% of respondents** believed a screen displaying medicine names and times would be useful.

Interview Evidence

- **Lakshmi (72)** mentioned that many tablets look similar, leading to confusion.
- **Ravi (58)** explained that multiple medications and similar-looking tablets can easily cause mistakes.
- **Prakash (45)** stated that displaying medicine names would help ensure the correct medication is taken.

Design Opportunity

- Provide clear identification of medicines before consumption.
- Display medication names and scheduled times to reduce confusion.
- Improve user confidence when taking medication.
- Reduce the likelihood of medication errors.

3. Medication Confirmation and Tracking

Research Evidence

- **78% of respondents** stated that confirming a dose before taking medication is important.
- **40% of respondents** reported difficulty remembering whether they had already taken a dose.
- **58% of respondents** wanted caregiver notifications when doses are missed.

Interview Evidence

- **Lakshmi (72)** explained that she sometimes cannot remember whether she has already taken her medicine.
- **Prakash (45)** believed medication records would help monitor adherence.
- **Kavya (21)** felt dose tracking would be useful for long-term medication management.
- **Ravi (58)** emphasized that tracking would help caregivers monitor medication compliance.

Design Opportunity

- Allow users to confirm medication before consumption.
- Record completed and missed doses.
- Provide medication history logs.
- Improve confidence and accountability for both users and caregivers.

4. User-Friendly Design for Elderly Users

Research Evidence

- The majority of respondents who take multiple medicines were from older age groups.
- **46% of respondents** experience difficulties identifying medications.
- **80% of respondents** supported audio reminders, indicating the need for accessible reminder methods.

Interview Evidence

- **Lakshmi (72)** preferred a simple device with only essential functions.
- She also indicated that she would require assistance with initial setup.
- **Ravi (58)** highlighted the importance of clear instructions and ease of use for elderly users.
- Several interviewees suggested that simple controls would improve usability.

Design Opportunity

- Design an interface that is easy to understand and operate.
- Use large buttons and clear text.
- Minimize unnecessary complexity.
- Improve accessibility for users with visual, hearing, or memory difficulties.

5. Integration of Smart Technology

Research Evidence

- **56% of respondents** already use phone alarms to remember medication.
- **46% of respondents** identified phone alarms as the most effective reminder method.
- **58% of respondents** supported caregiver notifications for missed doses.
- **82% of respondents** supported displaying medication information digitally.

Interview Evidence

- **Prakash (45)** expressed strong support for app integration and medication history tracking.
- **Kavya (21)** preferred a system that connects with smartphones and offers customization.
- **Ravi (58)** believed technology could significantly reduce medication errors.
- All interview participants expressed positive attitudes towards technology-assisted medication management.

Design Opportunity

- Integrate smartphone connectivity for scheduling and monitoring.
- Enable digital management of medication routines.
- Provide remote notifications and status updates.
- Combine storage, reminders, tracking, and communication into a single system.

Selected Design Opportunity :

The research identified that the most significant challenges faced by users are remembering medication schedules and correctly identifying medicines. Therefore, the selected design opportunity is to develop a **smart medication reminder and identification system** that provides scheduled reminders and clearly displays medication information to the user before dispensing.

Justification :

- **64% of respondents** reported forgetting medication doses at least occasionally.
- **62% of respondents** identified remembering medication timing as the most difficult aspect of medication management.
- **80% of respondents** believed sound reminders would help them remember medication.
- **82% of respondents** stated that a display showing medicine names and times would be useful.
- **46% of respondents** reported difficulty distinguishing between different medicines.
- **32% of respondents** admitted to taking the wrong medicine or dosage by mistake.

The interview findings further support this opportunity:

- **Lakshmi (72)** explained that forgetfulness and confusion between similar-looking tablets are common problems.
- **Prakash (45)** stated that work-related distractions often cause him to miss medication.
- **Ravi (58)** highlighted that multiple medications can easily lead to mistakes when managing medicines for elderly family members.

Conclusion

The chosen design opportunity focuses on creating a system that reminds users when medication is due and clearly identifies the medicine that should be taken. By combining audio reminders, visual information, and organized medication storage, the design aims to reduce missed doses and medication errors .

Design Brief

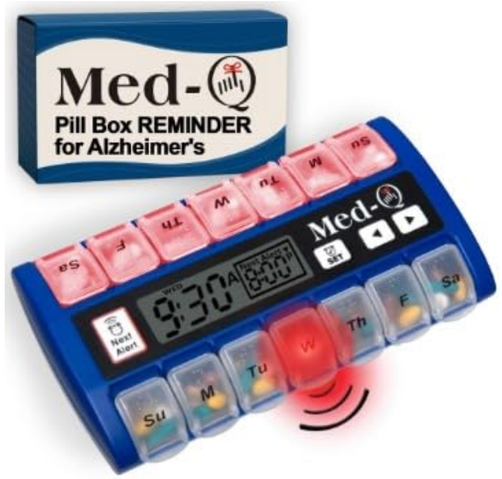
Design and manufacture a smart medication reminder and dispensing system that helps users manage their medicines safely and consistently. The product should reduce missed doses and medication confusion by providing clear audio and visual reminders, displaying medication information, and dispensing the correct medicine at the scheduled time. The device should be easy to use, particularly for elderly users, while remaining portable, rechargeable, reliable, and visually appealing.

Existing Products Analysis

No.	Product	Price(in INR)	Features	Advantages	Disadvantages
1.	 https://www.medacube.com/products/medacube-automatic-pill-dispenser	1,92,000	• Stores up to 16 medications • Up to 90-day medication supply • Audio and visual reminders • Caregiver notifications for missed doses • Wi-Fi connectivity • Touchscreen interface • Locking system for safety • Battery backup available • Tracks medication adherence automatically	• Very large medication capacity • Suitable for users taking many medications • Caregiver monitoring improves safety • Strong medication tracking features	• Very expensive Large physical size • Setup and loading process can be complicated for some users

2.	 https://herohealth.com/our-product/	Initial Cost: $459.87 Monthly Cost: $44.99	• Stores up to 10 medications • Up to 90-day supply • One-button dispensing • Audio and flashing light reminders • Mobile app integration • Missed-dose alerts • Caregiver monitoring • Medication history tracking	• Easy to use • Strong app integration • Caregiver support features • Good medication tracking	• Requires subscription for full functionality • Lower medication capacity than MedaCube • Dependence on internet services • Expensive
3.	 https://www.livefineproduct.com/products/smart-wifi-automatic-pill-dispenser?utm_source=chatgpt.com	19,200	• Wi-Fi enabled • Mobile app control • Audio and visual reminders • Large LCD display • Lockable cover • Up to 28 days capacity • Up to 9 daily dosage schedules • Remote caregiver monitoring	• More affordable than premium competitors • Mobile app integration • Easy-to-read display • Multiple reminder options	• Smaller medication capacity • Requires more frequent refilling • Limited number of compartments compared to premium systems

4.	 https://www.epill.com/me1.html	47,040	• 28 medication compartments • Up to 6 alarms per day • Loud audio reminders • Flashing light alerts • Locked medication tray • Battery backup • Simple button controls • Large LCD display	• Easy to operate • Large compartment capacity • Strong audio alerts • Suitable for elderly users	• No smartphone app • No Wi-Fi connectivity • Basic interface • Limited monitoring features • Expensive
5.	 https://www.amazon.in/Pill-Sync-Smart-Pillbox-Self-Learning/dp/B0D6ZBMGY3?utm_source=chatgpt.com	14,849	• Patented self-learning technology • No programming required • Learns the user's medication-taking routine automatically • Missed-dose alerts only when medication is forgotten • Smart compartment sensors • Built-in digital assistant • LED indicators for compartment status • Warning if the wrong compartment is opened • USB-C rechargeable battery • 7 daily compartments • Holds up to 22 aspirin-sized tablets per compartment	• Very easy to set up since no programming is required • Self-learning system reduces unnecessary alarms • Detects missed doses automatically • Rechargeable battery improves portability • Warns users if the wrong compartment is opened	• No smartphone app connectivity • No caregiver notifications • No automatic dispensing mechanism • Limited to reminder functionality • Only supports one-week medication organization

6.	 https://www.amazon.in/MedQ-Reminder-Flashing-Beeping-Keychain/dp/B076653C1D	12,900	• Audible beeping medication reminders • Flashing LED light alerts • Programmable medication schedule • 14 removable medication compartments • Can be configured for either: 1. 1 dose per day for 2 weeks 2. 2 doses per day for 1 week • Repeating alarm cycle until medication is taken • Battery-powered operation (AA batteries) • Large easy-open compartment tabs • Portable design with removable compartments • Visual guidance showing exactly which compartment should be opened	• Very simple to use and set up • Combines audio and visual reminders • Repeating alarms reduce missed doses • Portable and battery-powered • Helps prevent confusion by indicating the correct compartment to open	• No smartphone app connectivity • No Wi-Fi or Bluetooth communication • No caregiver notifications • Does not automatically dispense medication • No medication tracking or history records • Requires manual refilling and user action

Design Specification

Category	Specification	Justification
Human Factors	The product must be simple and intuitive to use.	This requirement is justified by interview responses, particularly from Lakshmi (72), who stated that she would prefer a simple device with only essential functions and would likely require assistance during setup. The product should therefore minimise complexity and provide a straightforward user experience.
	The product must provide clear audio reminders.	Survey results showed that 80% of respondents believed sound reminders would be helpful in remembering medication. Audio alerts will improve accessibility for users who may not always be looking at the device.

	The product must provide clear visual information.	82% of respondents stated that a screen displaying medicine names and timings would be useful. Therefore, the product should incorporate a display capable of presenting medication information clearly.
	The display must be easy to read.	Many users of medication management systems are elderly and may experience reduced vision. The display should therefore use clear text, adequate contrast, and an appropriate font size.
	The dispensing confirmation button must be large and easy to operate.	Elderly users and individuals with reduced dexterity may struggle with small controls. A large confirmation button will improve usability and accessibility.
	The product must minimize medication confusion.	Survey results showed that 46% of respondents found it difficult to distinguish between medicines, while 32% had previously taken the wrong medicine or dose. The system should clearly identify medication before dispensing.
	The product must support users with memory difficulties.	64% of respondents reported forgetting medication doses at least occasionally. The device should therefore actively remind users when medication is due.
Aesthetic Factors	The product should have a clean and professional appearance.	Medical devices should inspire confidence and trust. A modern appearance will encourage regular use and improve user acceptance.
	The design should appear non-intimidating.	Some users may be uncomfortable with complex technology. The product should have a friendly and approachable appearance that does not appear overly technical.
	The product should be compact and suitable for placement on a bedside table, kitchen counter, or desk.	Medication is often stored in convenient locations within the home. The product should therefore fit comfortably into common domestic environments.
	The colour scheme should improve visibility and usability.	Buttons, indicators, and display information should be clearly distinguishable from the product housing to improve usability.
	The design should conceal internal electronics.	Visible wiring and exposed components can reduce perceived quality and create safety concerns. Internal electronics should therefore be enclosed within the housing.
Technical Factors	The product must store medication securely.	The storage system must prevent tablets from falling out unintentionally while allowing controlled dispensing when required.
	The product must provide scheduled medication reminders.	The research identified remembering medication timing as the most common challenge, with 62% of respondents selecting this issue. The system must therefore provide reliable reminders at scheduled times.

	The product must display medication information before dispensing.	This will help users confirm that the correct medication is being dispensed and reduce medication errors.
	The product must dispense medication only after user confirmation.	Survey results indicated that 78% of respondents considered dose confirmation important. Requiring a confirmation button press will reduce accidental dispensing.
	The product must support app-based scheduling.	Research showed that phone alarms are currently the most widely used reminder method. Integrating a smartphone application will allow users to configure schedules conveniently.
	The product must provide both audio and visual alerts.	Using multiple reminder methods increases the likelihood that reminders will be noticed by different user groups.
	The product must operate using a rechargeable battery system.	A rechargeable system reduces the need for disposable batteries and improves portability.
	The product should provide a minimum operating time of several days between charges.	Frequent charging may discourage users from using the device consistently.
	The product must retain medication schedules during power interruptions.	Users should not need to repeatedly enter medication schedules after power loss.
	The product should incorporate an OLED display.	OLED technology provides high contrast and good readability while consuming relatively low power.
	The product should include status indicators.	Visual indicators will allow users to monitor battery level, device status, and system operation.
	The product should use a robust dispensing mechanism.	The mechanism should reliably dispense medication without jamming or damaging tablets.
	The product should be manufactured using a custom PCB.	A custom PCB improves reliability, reduces wiring complexity, and creates a more professional final product.
Environmental Factors	The product should use rechargeable batteries rather than disposable batteries.	This reduces waste generation and lowers long-term environmental impact.
	The housing should be manufactured from durable materials.	Durable materials increase product lifespan and reduce the frequency of replacement.
	The design should minimise material usage where possible.	Reducing unnecessary material use lowers manufacturing costs and environmental impact.

	The product should be repairable and maintainable.	Components such as batteries and electronic modules should be accessible for replacement, extending product lifespan.
	The product should be energy efficient.	The device will spend most of its life waiting for scheduled reminders. Efficient power management will reduce energy consumption and increase battery life.
	The product should be designed for long-term use.	Medication management is often required over many years. The product should therefore be capable of providing reliable long-term service.

Further Research

1. Structural Weight Analysis of Stored Medication Research

The average weight of common medications is relatively low.

Medication Type	Average Weight per Tablet
Small Tablet	0.15–0.30 g
Standard Tablet	0.30–0.60 g
Large Tablet	0.60–1.20 g

For design calculations, an average weight of **0.5 g per tablet** was assumed.

Assuming:

- 8 compartments
- 20 tablets per compartment

Calculation	Result
Tablets Stored	160
Average Tablet Weight	0.5 g
Total Medication Weight	80 g

Analysis

Even with all compartments filled, the total weight of medication is approximately **80 g**, which is less than the weight of a typical smartphone. Consequently, the stored medication contributes very little structural load to the product.

The housing, batteries, electronics, and dispensing mechanism will account for most of the product's mass. Therefore, structural design should focus primarily on durability, reliability, and protection of components rather than supporting the weight of medication.

Conclusion

The medication storage system is not expected to create significant structural concerns. Lightweight materials such as PLA, PETG, or acrylic are likely to provide more than sufficient strength.

2. Product Weight Analysis and Portability

Existing Product Comparison

Product	Approximate Weight
LiveFine Smart Dispenser	1.3–1.8 kg
Hero Smart Dispenser	4.5–5 kg
MedaCube	12–15 kg

Human Carrying CapabilityAnalysis

User Group	Comfortable Carrying Weight
Child (10–15 years)	1–3 kg
Young Adult	5–10 kg
Adult	5–15 kg
Elderly User (65+)	1–5 kg
Arthritis/Parkinson's Users	Preferably below 2 kg

Although most users can lift several kilograms, many medication users are elderly or may suffer from reduced grip strength, arthritis, tremors, or muscle weakness.

A very heavy device may:

- be difficult to refill
- be difficult to move for cleaning
- increase risk of dropping

However, a device that is too light may:

- move during dispensing
- feel unstable
- appear less robust

Proposed Weight Range

Weight	Assessment
< 500 g	Too light, may move during operation
500 g – 1 kg	Portable and stable
1 – 2 kg	Acceptable
> 2 kg	Reduced accessibility

Conclusion

An ideal product weight would be between **0.8 kg and 1.5 kg**, providing sufficient stability while remaining portable and inclusive for elderly users and users with reduced strength.

3. Determining the Number of Compartments Required Research

Medication requirements generally increase with age.

Age Group	Typical Number of Different Medications
Under 18	0–2
18–30	1–3
31–50	2–5
51–70	4–8
Above 70	5–10

Capacity Comparison

Compartments	Suitability
4	Insufficient for many elderly users
6	Suitable for moderate users
8	Suitable for most users
10+	Larger and more complex

Analysis

The product is primarily intended for:

- Adults
- Older adults
- Elderly users

Research indicates that many elderly users take between **4 and 8 different medications daily**.

Designing for only 4 compartments would exclude many potential users. Designing for 10 or more compartments would increase product size and complexity.

Conclusion :

A storage system containing approximately **8 compartments** would provide a balance between user needs, product size, and manufacturing complexity.

4. Determining Tablet Capacity per Compartment Research

The average user may consume:

Medication Type	Typical Daily Consumption
Prescription Medication	1–2 tablets/day
Vitamins	1 tablet/day
Chronic Disease Medication	1–3 tablets/day

Capacity Analysis

Tablets Stored	Approximate Supply
10 tablets	5–10 days
15 tablets	1–2 weeks
20 tablets	2–3 weeks
30 tablets	Approximately 1 month

Analysis by Age Group

Age Group	Suggested Capacity
Under 30	10–15 tablets
31–50	15 tablets
51–70	15–20 tablets
Above 70	20 tablets

Conclusion

A capacity of **15 to 20 tablets per compartment** would meet the needs of most intended users while keeping the product compact and reducing refill frequency.

5. Medication Packaging Analysis

Tablets can be stored in either their original packaging or could be stored individually without the packaging. In order to decide which is the most suitable method of storing the tablets, this analysis has been done.

Tablets Stored in Original Blister Packaging :

Advantages

- Protects tablets from moisture and contamination.
- Preserves manufacturer labeling and expiry information.
- Reduces risk of tablet damage.
- Maintains pharmaceutical safety standards.

Disadvantages

- Requires larger compartments.
- Difficult to automate dispensing.
- Different blister pack sizes create design challenges.
- Increases product size significantly.

Research Considerations

Many medications are supplied in blister packs because they:

- protect against moisture

Tablets Removed from Packaging and Stored Individually

Advantages

- More compact storage.
- Easier dispensing mechanism design.
- Increased storage capacity within the same volume.
- Simpler user interaction.

Disadvantages

- Tablets become exposed to humidity and dust.
- Users lose immediate access to expiry information.
- Risk of mixing medications if compartments are incorrectly filled.
- Some medicines are specifically intended to remain in blister packaging until use.

- reduce contamination
- maintain effectiveness
- improve shelf life

However, most commercially available pill organisers and smart dispensers require users to remove tablets from their original packaging before storage.

Comparison

Factor	In Packaging	Removed from Packaging
Moisture Protection	Excellent	Moderate
Ease of Dispensing	Poor	Excellent
Storage Efficiency	Poor	Excellent
Product Size	Larger	Smaller
Medication Visibility	Moderate	Excellent
Manufacturing Complexity	High	Low

Conclusion :

Based on the comparison, storing tablets individually after removing them from their original blister packaging is the more suitable option for this product. Although the original packaging provides better protection from moisture, contamination and damage, it would require larger compartments, increase the overall product size and make automated dispensing more difficult. Removing the tablets from their packaging allows more efficient use of space, easier dispensing and a smaller product size, which are important for the proposed medication management system. Therefore, the final design will use separate compartments for individual medications, while ensuring that the compartments are secure and protected from contamination.

Material Analysis

Required Material Properties :

Property	Reason
Lightweight	Elderly users should be able to move the product easily.
Sufficient Strength	Must support electronics, batteries, compartments, and daily handling.
Easy to Manufacture	Suitable for 3D printing, laser cutting, or school workshop equipment.

Good Surface Finish	Products should look professional and suitable for medical use.
Impact Resistance	Should survive accidental knocks or drops.
Moisture Resistance	Medication storage areas should not be affected by humidity.
Safe and Non-Toxic	Users may frequently handle the product.
Cost Effective	Suitable for a student project budget.
Easy Assembly	Should allow screws, adhesives, or snap-fit features.
Environmental Sustainability	Material should have reasonable environmental credentials.

Material Selection Rubric

Not all properties are equally important.

Total Score = 100

Property	Weighting (%)	Importance
Strength & Durability	20	Very High
Ease of Manufacturing	20	Very High
Lightweight	15	High
Impact Resistance	10	High
Moisture Resistance	10	High
Appearance & Surface Finish	10	Medium

Cost	5	Medium
Ease of Assembly	5	Medium
Sustainability	5	Medium
Total	**100**	

Scoring:

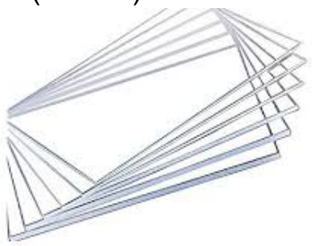
- 5 = Excellent
- 4 = Good
- 3 = Average
- 2 = Poor
- 1 = Very Poor

Weighted Score:

Score = (Rating ÷ 5) × Weighting

Material	Properties	Advantages	Disadvantages
PLA(Polylactide) 	• **Low Density:** PLA is lightweight, helping to reduce the overall weight of the product and improve portability. • **High Rigidity:** PLA is relatively stiff and maintains its shape well under normal loading conditions. • **Good Dimensional Accuracy:** PLA experiences minimal warping during 3D printing, allowing accurate and precise components to be produced. • **Biodegradable Source Material:** PLA is derived from renewable plant-based resources such as corn starch, making it more	• Very easy to 3D print • Low cost • Excellent dimensional accuracy • Good surface finish • Environmentally friendlier than many plastics	• Brittle compared to engineering plastics • Softens at relatively low temperatures • Can crack under impact

	environmentally friendly than many petroleum-based plastics. ● **Low Heat Resistance:** PLA begins to soften at relatively low temperatures compared with engineering plastics, which may limit its suitability in hot environments. ● **Brittle Behaviour:** PLA tends to fracture rather than deform when subjected to high impact forces.		
PETG (Polyethylene Terephthalate Glycol) 	● **High Impact Resistance:** PETG can absorb sudden forces and impacts without cracking easily. This makes it suitable for products that may be knocked or accidentally dropped during everyday use. ● **Moderate Weight:** PETG has a relatively low density, allowing the product to remain lightweight while still maintaining good structural strength. ● **Good Moisture Resistance:** PETG does not readily absorb moisture from the environment, helping to protect stored medication and maintain dimensional stability. ● **High Toughness:** The material can bend slightly under stress before breaking, reducing the likelihood of sudden failure. ● **Good Chemical Resistance:** PETG is resistant to many household cleaning products, allowing the device to be cleaned regularly without damaging the material. ● **Smooth Surface Finish:** PETG	● **High impact resistance:** PETG is significantly tougher than PLA and is less likely to crack or shatter if the product is accidentally dropped, making it suitable for everyday use. ● **Good moisture resistance:** PETG does not absorb moisture easily, helping to protect the medication storage compartments from environmental humidity. ● **Durable and long-lasting:** The material can withstand repeated handling and opening of compartments without showing significant wear. ● **Suitable for 3D printing:** PETG can be manufactured using common 3D printers while still producing strong and accurate components. ● **Professional appearance:** PETG provides a smooth and clean finish that is appropriate for healthcare-related products.	● **More difficult to print than PLA:** PETG requires higher printing temperatures and careful printer settings to achieve good results. ● **Higher material cost:** PETG is generally more expensive than PLA, increasing manufacturing costs. ● **Stringing during printing:** PETG can produce fine plastic strings during printing, requiring additional finishing work.

	can produce attractive surfaces after manufacturing, contributing to a professional appearance suitable for medical products.		
Acrylic (PMMA) 	• **Excellent Optical Clarity:** Acrylic can be manufactured in transparent form, allowing visibility of internal compartments and stored medication. • **Low Density:** Acrylic is lightweight and contributes little additional weight to the product. • **High Surface Hardness:** The material provides a smooth and attractive finish that is commonly used in commercial display products. • **Good Moisture Resistance:** Acrylic does not absorb significant amounts of water, helping maintain its appearance and dimensions. • **Rigid Structure:** Acrylic maintains its shape well under load and provides good dimensional stability. • **Low Impact Resistance:** Although rigid, acrylic is relatively brittle and can crack or shatter when subjected to sudden impacts.	• **Easy to manufacture:** PLA is one of the easiest materials to 3D print and produces accurate components with minimal warping. • **Cost-effective:** PLA filament is widely available and relatively inexpensive, making it suitable for student projects. • **Good surface finish:** PLA typically produces smooth and visually appealing printed parts. • **Environmentally friendlier:** PLA is derived from renewable resources such as corn starch, reducing dependence on petroleum-based plastics. • **Widely available:** PLA can be purchased from most suppliers of 3D printing materials.	• **Brittle material:** PLA can crack under impact and is less durable than engineering plastics such as PETG or ABS. • **Poor heat resistance:** PLA may deform when exposed to elevated temperatures, especially in direct sunlight or warm environments. • **Lower durability:** Repeated use may cause wear or damage to moving components.

ABS(Acrylonitrile Butadiene Styrene) 	• **High Toughness:** ABS can absorb impacts and mechanical stresses without breaking easily, making it suitable for frequently handled products. • **Good Heat Resistance:** ABS remains stable at higher temperatures than PLA, reducing the risk of deformation. • **Lightweight Construction:** The material has a relatively low density, helping maintain product portability. • **Good Fatigue Resistance:** ABS performs well under repeated loading and movement, making it suitable for moving mechanisms. • **Good Machinability:** ABS can be drilled, cut, and shaped using various manufacturing methods. • **Moderate Moisture Resistance:** ABS performs well in indoor environments and is not significantly affected by normal humidity levels.	• **Excellent toughness:** ABS can withstand impacts and rough handling better than many other plastics. • **Commonly used in commercial products:** Many consumer electronics and appliance housings are manufactured from ABS. • **Good heat resistance:** ABS remains stable at higher temperatures than PLA. • **Lightweight material:** ABS contributes to a portable final product. • **Durable for moving mechanisms:** ABS is suitable for components subjected to repeated movement.	• **Difficult to manufacture:** ABS is prone to warping during 3D printing and often requires specialised equipment. • **Produces fumes during printing:** Additional ventilation is required when manufacturing with ABS. • **Lower dimensional accuracy:** Warping may affect the precision of printed components. • **More challenging for beginners:** Manufacturing defects are more common than with PLA.
Birch Plywood 	• **High Strength-to-Weight Ratio:** Birch plywood provides good strength while remaining relatively lightweight. • **Natural Material:** Produced from renewable timber resources, making it a more sustainable option. • **Good Stiffness:** The layered construction helps resist bending and deformation. • **Easy Machining Properties:** Birch plywood can be cut, drilled, and assembled using common workshop tools. • **Moisture Sensitivity:** The	• **Sustainable material:** Birch plywood is derived from renewable resources and has a lower environmental impact than many plastics. • **Easy to machine:** The material can be cut, drilled, and assembled using common workshop tools. • **Lightweight construction:** Birch plywood offers a good strength-to-weight ratio. • **Cost-effective:** Sheets are relatively inexpensive and widely available. • **Natural appearance:** The wood grain can create a warm and	• **Poor moisture resistance:** Wood can absorb moisture, leading to swelling or warping. • **Less hygienic:** The porous surface may be more difficult to clean than plastic materials. • **Reduced precision:** Achieving complex mechanisms and tight tolerances is more difficult than with plastics. • **May splinter during machining:** Additional finishing may be required to achieve a smooth surface.

	material can absorb moisture from the environment, potentially leading to swelling or warping. • **Textured Surface:** Unlike plastics, plywood naturally has a wood grain surface that may require additional finishing to achieve a smooth appearance.	attractive aesthetic.	

Material Evaluation

Criteria	Weight	PLA	PETG	Acrylic	ABS	Plywood
Strength & Durability	20	3	5	3	5	3
Ease of Manufacturing	20	5	4	3	2	4
Lightweight	15	4	4	4	5	5
Impact Resistance	10	2	5	2	5	3
Moisture Resistance	10	3	5	5	5	2
Appearance	10	4	4	5	4	4
Cost	5	5	4	3	4	5
Ease of Assembly	5	4	4	3	4	4
Sustainability	5	5	3	2	2	5

Weighted Scores :

Material	Score (/100)
PLA	76
PETG	89
Acrylic	68

ABS	80
Birch Plywood	73

Final Material Selection

Recommended Material: PETG

Final Score: 89/100

Justification

PETG achieves the highest overall score because it provides the best balance between:

- Strength
- Impact resistance
- Moisture resistance
- Lightweight construction
- Professional appearance
- Manufacturability

For a medication management product, durability and reliability are more important than achieving the lowest possible cost. PETG is capable of withstanding daily use, accidental knocks, and exposure to varying environmental conditions while remaining suitable for 3D printing or laser cutting.

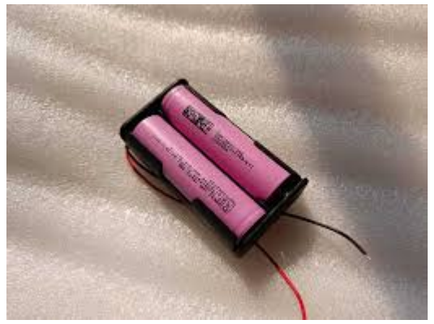
Battery Type Analysis

Required Battery Properties :

Property	Reason
Rechargeable	Reduces operating cost and waste.
Safe Operation	Products may be used by elderly users in homes.
Long Runtime	The device should operate for several days without charging.
Compact Size	Must fit within the product housing.

Sufficient Current Output	Must power ESP32, OLED, speaker, LEDs, and motor.
Easy Charging	Users should be able to recharge conveniently.
Availability	Batteries should be easy to replace or purchase.
Lightweight	Supports portability.

Battery	Properties	Advantages	Disadvantages	Evaluation
AA Alkaline Batteries	• Nominal Voltage: 1.5 V per cell • Non-rechargeable • Widely available • Low initial cost	• Easily available in most stores. • Simple to install and replace. • No charging circuit required. • Familiar to most users.	• Require frequent replacement. • Generate more waste. • Higher long-term operating cost. • Voltage gradually drops during use. • Poor suitability for motors and Wi-Fi devices.	While simple to use, disposable batteries do not align well with modern sustainable product design and would increase maintenance requirements.
AA NiMH Batteries	• Nominal Voltage: 1.2 V per cell • Rechargeable • Moderate capacity	• Rechargeable hundreds of times. • Safer than lithium batteries. • Widely available. • Lower environmental impact than disposable batteries.	• Lower energy density. • Multiple batteries required. • Bulky battery holder. • Shorter runtime compared with lithium-ion batteries.	A viable solution, but larger and heavier than lithium-based alternatives.

18650 Lithium-Ion Cell 	• Nominal Voltage: 3.7 V • Capacity: typically 2500–3500 mAh • Rechargeable	• High energy density. • Lightweight. • Compact size. • Rechargeable hundreds of times. • Widely used in portable electronics.	• Requires protection circuitry. • Requires a dedicated charging module. • May not provide sufficient runtime if the motor is used frequently.	Suitable for smaller portable devices but may offer limited runtime for a medication management system incorporating Wi-Fi, speakers, and motors.
Dual 18650 Lithium-Ion Cells 	• Nominal Voltage: 3.7 V • Capacity: 6000–7000 mAh combined (parallel configuration) • Rechargeable	• Long operating time. • Lightweight compared with equivalent battery capacities. • Capable of supplying current for motors and ESP32. • Reduced charging frequency. • Compact battery arrangement.	• Requires charging and protection circuitry. • Slightly higher cost. • Requires careful battery management.	Provides the best balance between runtime, weight, size, and performance.
Lithium Polymer (LiPo) 	• Nominal Voltage: 3.7 V • Rechargeable • Flat battery construction	• Very lightweight. • Can be manufactured in various shapes. • High energy density.	• More expensive. • More vulnerable to puncture damage. • Requires careful charging management. • Reduced durability during long-term use.	Suitable for compact commercial products but less practical for a school project.

Battery Evaluation

Criteria	AA Alkaline	NiMH	Single 18650	Dual 18650	LiPo
Runtime	2	3	4	5	4
Rechargeable	1	5	5	5	5
Safety	4	5	4	4	3
Weight	2	3	5	4	5
Availability	5	4	5	5	4
Charging Convenience	1	4	4	4	3
Suitability for Project	2	3	4	5	3

Total Score

Battery Type	Score
AA Alkaline	17
NiMH	27
Single 18650	31
Dual 18650	32
LiPo	27

Final Conclusion :

Dual 18650 Lithium-Ion Cells (Parallel Configuration)

Justification

- Provides the longest runtime.
- Lightweight and portable.
- Reduces charging frequency.
- Commonly used in portable electronic products.

Charging System

Charging Method	Advantages	Disadvantages	Evaluation
Remove Battery and Charge Externally	• Simple electronics. • No charging circuit required.	• convenient for elderly users. • Increased wear on connectors. • Product must be opened frequently.	Not ideal for the intended users.
Micro-USB Charging	• Inexpensive. • Widely available.	• Becoming outdated. • Connector less durable. • Not reversible.	Acceptable but no longer considered modern.
USB-C Charging	• Modern standard. • Reversible connector. • Easy for elderly users to connect. • Widely available chargers. • More durable connector.	• Slightly higher component cost.	Provides the most user-friendly and professional charging solution.
Wireless Charging	• Convenient. • No cable connection required.	• Expensive. • Additional electronics required. • Lower efficiency. • Increased project complexity.	Very expensive and complex to implement.

Final Conclusion :

USB-C Charging Port with TP4056 Charging and Protection Circuit

Justification

- Modern and user-friendly.
- Easy for elderly users to connect.
- Supports safe battery charging.
- Protects against overcharging, over-discharging, and short circuits.
- Creates a professional appearance consistent with modern consumer electronics.

International Standards and Regulations

Standardization code Number	Purpose	Application to project	Design Implication
ISO 14971 Medical Device Risk Management	• Identify hazards. • Assess risks. • Reduce risks to acceptable levels.	• Medication errors. • Accidental dispensing. • Battery hazards. • User misuse.	A risk assessment should be performed for all critical functions before finalising the design.
IEC 62366-1 Medical Device Usability Engineering	• Reduce user errors. • Improve accessibility. • Improve ease of use.	• Large buttons. • Clear display. • Simple navigation. • Easy medication identification.	The interface should be understandable without specialist training.
IEC 60601-1 Medical Electrical Equipment Safety	• Ensure electrical safety. • Prevent electric shock. • Prevent overheating.	• Battery charging circuit. • Internal electronics. • Power regulation.	All electronics should be enclosed and operate safely at low voltage.
ISO 9241 Ergonomics of Human-System Interaction	• Improve usability. • Improve readability. • Improve accessibility.	• OLED display. • Button size. • User interaction.	Information should be easy to read and controls easy to operate.
IEC 62133 Rechargeable Battery Safety	• Safe operation of lithium-ion batteries. • Protection against overcharging. • Protection against short circuits.	• Dual 18650 battery system.	Only protected cells and approved charging modules should be used.
RoHS Directive Restriction of Hazardous Substances	Reduce hazardous materials in electronic products. Restricted substances include: • Lead • Mercury • Cadmiu	-	Electronic components should ideally comply with RoHS requirements.
WEEE Directive Waste Electrical and Electronic Equipment	• Encourage recycling. • Reduce electronic waste.	-	The product should be designed so batteries and electronic components can be replaced or recycled separately.

Safety Analysis

Hazard	Potential Risk	Design Solution
Incorrect medication dispensing	Users may take the wrong medicine or wrong dose, potentially affecting health.	The OLED display should show the medicine name before dispensing. User confirmation button required before release.
Accidental dispensing	Tablets may be released unintentionally, causing medication errors.	Dispensing mechanism should only activate after a reminder and button confirmation.
Access by children	Children may access stored medication, creating poisoning risks.	Medication compartments should remain enclosed and require deliberate access for refilling.
Sharp edges	Users could suffer cuts or scratches during handling.	Housing should have rounded edges and smooth surfaces.
Electrical shock	Damaged wiring or exposed conductors may expose users to electricity.	All electronics should be enclosed within the casing and properly insulated.
Battery overheating	Lithium-ion batteries may overheat if damaged or improperly charged.	Use protected 18650 cells and a charging module with overcharge and short-circuit protection.
Fire hazard	Electrical faults may cause overheating or ignition.	Include appropriate voltage regulation and battery protection circuitry.
Pill contamination	Dust or moisture may affect medication quality.	Compartments should remain enclosed when not dispensing.
Mechanical injury	Moving dispensing parts could trap fingers.	Moving components should be inaccessible during normal operation.
Product instability	Devices may tip over during operation.	The base should be sufficiently wide and weighted for stability.

Mechanical Safety

The dispensing system should:

- Operate smoothly without jamming.
- Avoid crushing or breaking tablets.
- Prevent users from contacting moving parts.
- Avoid pinch points.

Medication Safety

The product should:

- Clearly identify the medication before dispensing.
- Display medication name and dispensing time.
- Require user confirmation before dispensing.
- Prevent access to other medications during dispensing.
- Minimise the possibility of double dispensing.

Justification

Survey results showed:

- 32% of respondents had taken the wrong medicine or dose.
- 46% reported difficulty distinguishing between medicines.
- 78% considered dose confirmation important.

LED Colour Analysis for Medicine Drawer Indicators

The LED indicator is a critical part of the product as it guides the user to the correct medicine drawer. The chosen colour must be clearly visible in bright daylight, comfortable to view at night, easily distinguishable from the white enclosure, and universally associated with positive actions. Several colours were analysed before selecting the most suitable option.

LED Colour	Advantages	Disadvantages	Suitability(out of 5)
Red	Highly visible in both day and night, immediately attracts attention.	Often associated with danger, errors or warnings, which may unnecessarily alarm users. Bright red can also be uncomfortable to view at night.	3

Green	Universally recognised as indicating the correct action or safe operation. Highly visible against the white enclosure and comfortable to view during both daytime and night-time. Consumes relatively low power.	Slightly less noticeable than red under very bright sunlight, but still easily visible when using high-brightness LEDs.	5
Blue	Modern appearance and highly visible in low-light conditions.	Can appear dim in bright daylight. Blue light is also harder for elderly users to perceive and may cause glare in dark environments.	3
White	Matches the clean appearance of the product and provides a professional look.	Blends into the white enclosure and is difficult to distinguish in bright environments.	2
Yellow/Amber	Soft on the eyes and visible in most lighting conditions. Frequently used for caution or reminders.	Lower contrast than green and less noticeable during daytime.	4

Selected Colour = Green

Green LEDs were selected for the drawer indicators because they provide the best balance between visibility, usability and user perception.

- Easily visible against the white acrylic enclosure in both daylight and darkness.
- Commonly associated with the correct action or safe operation, making it intuitive for users.
- Comfortable for elderly users to view without producing excessive glare at night.
- Green reduces the likelihood of confusion compared to red, which is generally reserved for warnings or fault conditions.

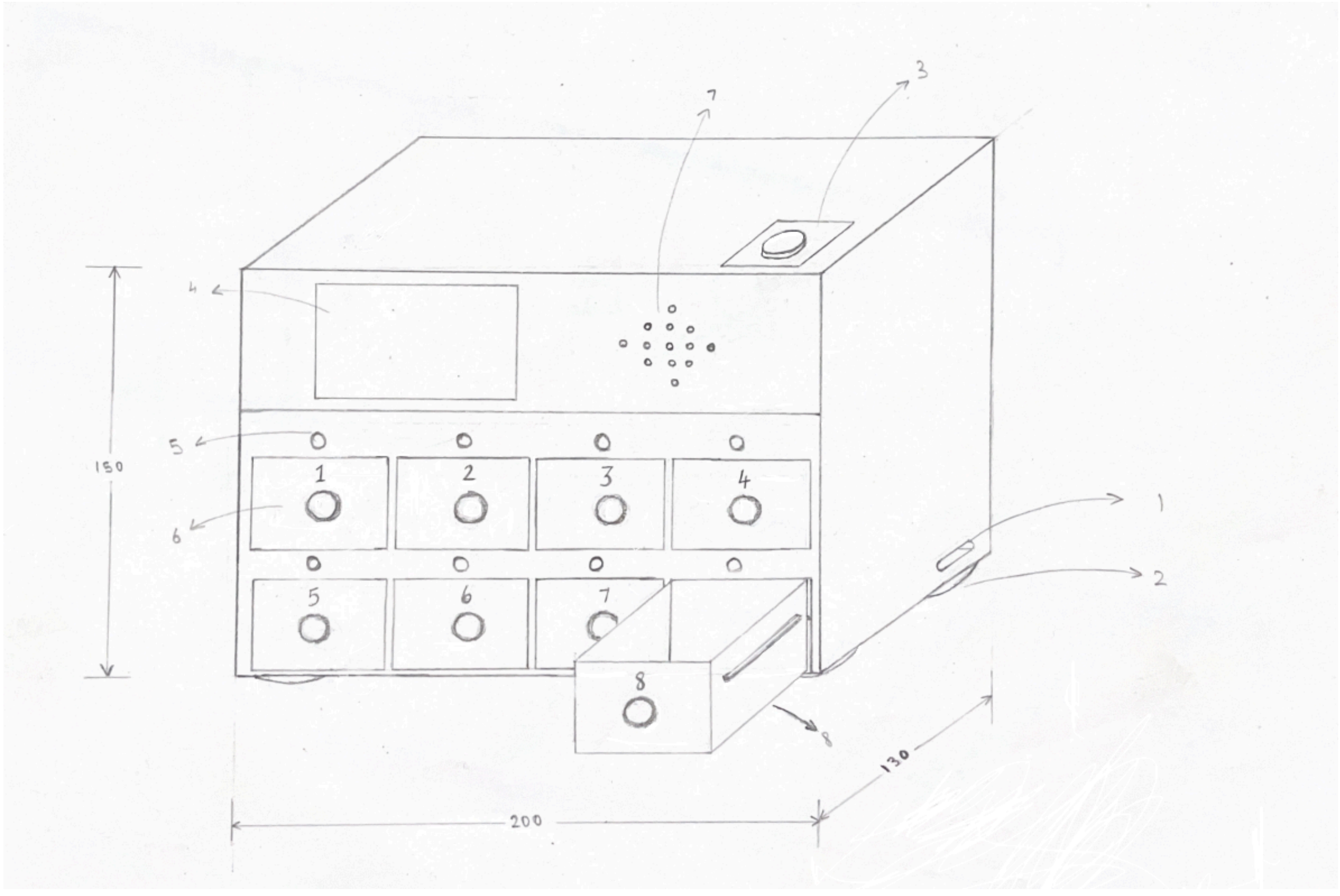
Final Specifications

Specification	Reason
Target audience – Elderly users, patients with chronic illnesses, caregivers, and individuals taking multiple medications daily	Survey results showed that medication adherence becomes more difficult with age and with increasing numbers of medications. These users would benefit most from reminder and dispensing assistance.
Price – 4,000–8,000 INR	The product should be affordable compared to commercial smart medication dispensers while still incorporating advanced features such as app connectivity, OLED display, and automated dispensing.

Location – Home environments (bedside table, kitchen counter, study desk)	Most users take medication at home. The product should fit comfortably within common domestic environments and remain easily accessible.
Material – PETG	These materials are durable, lightweight, easy to manufacture, and suitable for prototyping. PETG also offers improved heat resistance compared to PLA.
Safety : • No sharp edges • Enclosed electronics • User confirmation before dispensing • Secure pill compartments	**Refer Safety analysis & International Safety analysis for more specifics** The product should be designed to ensure user safety during normal operation. It should feature smooth, rounded edges to prevent cuts or injuries, particularly for elderly users. All electrical components and wiring must be securely enclosed within the housing to protect users from accidental contact. The dispensing mechanism should only operate when intended to prevent accidental medication release, while the pill compartments should securely store medication and prevent tablets from falling out unintentionally.
Stable during operation	The dispenser should remain stable when the dispensing mechanism operates and when users press the confirmation button.
OLED Display (2.42 inch)	Research indicated that 82% of respondents found a screen displaying medication information useful.
Audio reminder system (Buzzer OR Audio)	Survey results showed that 80% of respondents considered sound reminders helpful.
Mobile App Connectivity (Wi-Fi)	Allows users to set medication schedules remotely and update reminders without interacting directly with the device.
Number of Compartments – 8	Provides sufficient storage for multiple medication types while maintaining a compact form factor.
Storage Method – One medication type per compartment	Reduces medication confusion and allows individual medicines to be scheduled separately.
Capacity per Compartment : 15–20 tablets	Supports approximately 1–2 weeks of medication for most users while keeping the device compact.
Total Capacity : 120–160 tablets	Provides adequate storage without making the dispenser excessively large.
Medication Identification : Display	The OLED screen should show the medication name and scheduled time before dispensing to reduce medication errors.

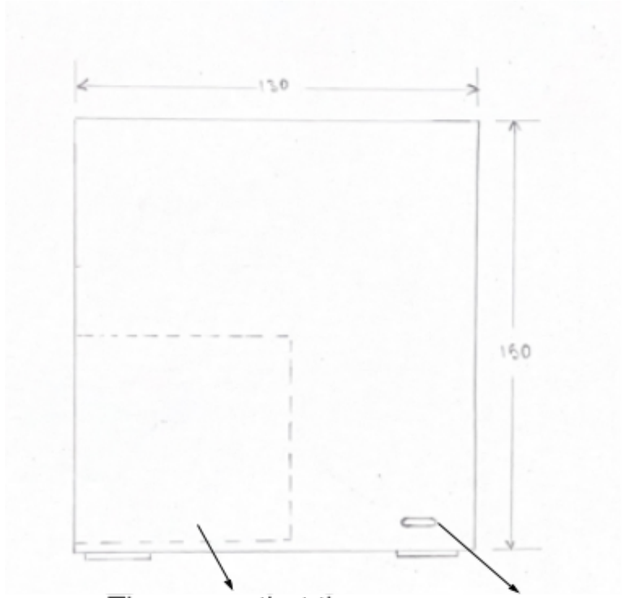
User Input – Large confirmation push button (≥20 mm diameter)	Elderly users may have reduced dexterity. Larger buttons improve usability and accessibility.
Status Indicators – Power LED, Reminder LED, Charging LED	Allows users to easily determine the current status of the device.
Weight – Less than 1.5 kg	The device should be portable while remaining stable during operation. **Refer Weight Analysis**
Dimensions – Approximately 200 mm × 200 mm × 120 mm	Provides sufficient internal volume for medication storage and electronics while remaining compact.
Battery Type – Dual 18650 Lithium-ion Cells	Provides adequate energy storage and supports rechargeable operation.
Battery Life – Minimum 5–7 days between charges(6000-7000 mah)	Reduces charging frequency and improves user convenience.
Charging Method – USB-C charging module	Modern, widely available, and easy for users to operate.
Colour Scheme – White body with blue accents	Colours commonly associated with healthcare, cleanliness, and trust.
Maintenance – Easy access refill lid or no lids	Allows users to refill medication compartments quickly and safely.
Environmental Considerations : ● Rechargeable battery system ● The housing should be made from a durable material such as PETG as discussed in the Material analysis.	Reduces the need for disposable batteries and decreases environmental waste.Increases product lifespan and reduces the need for replacement.
Expected Product Lifespan : Minimum 3–5 years	Ensures long-term usability and reduces replacement frequency.

Ideation 1

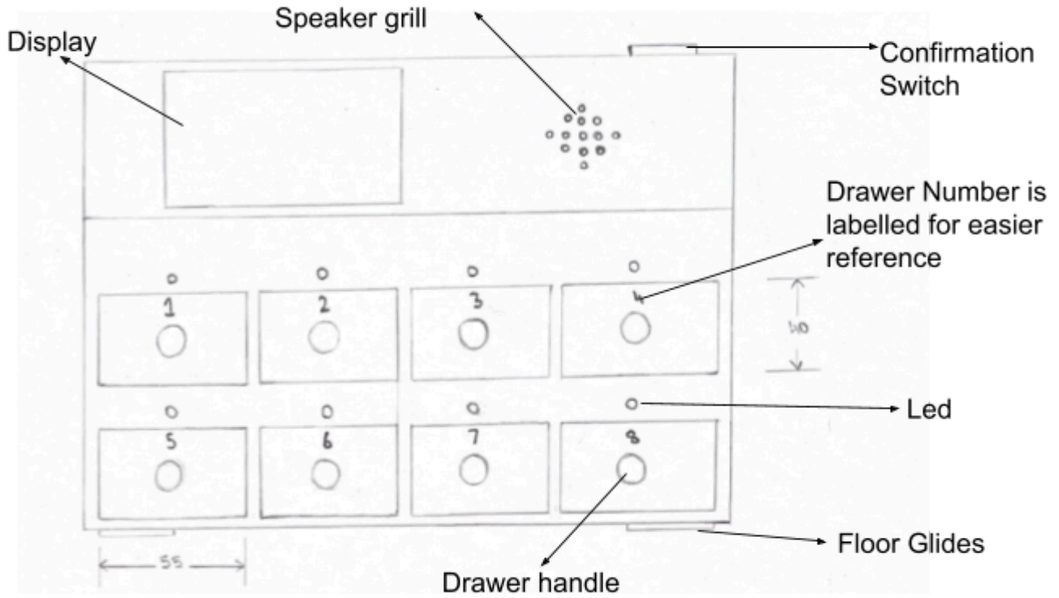


Orthographic views

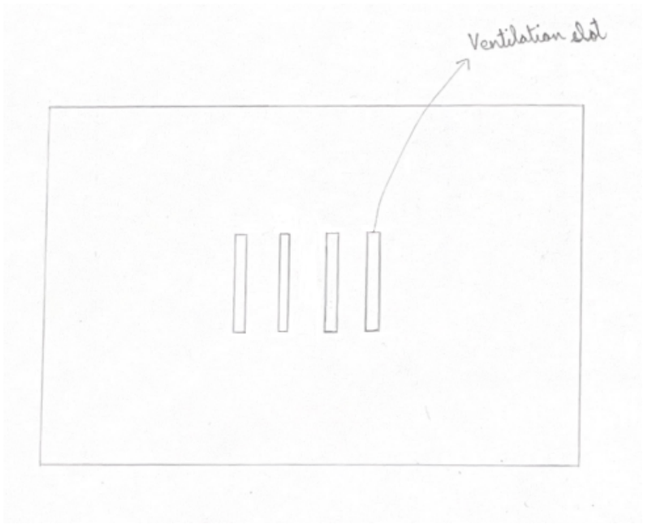
Side View



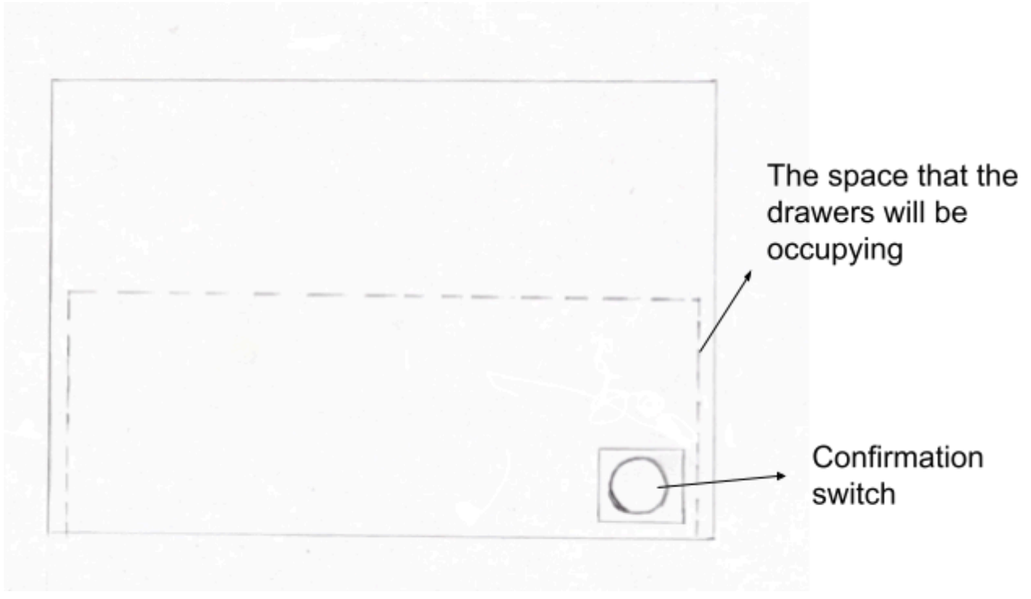
Front View



Bottom View



Top View



4. OLED Display ● Displays medicine name, compartment number, dosage and time. ● The high contrast screen remains readable in both bright daylight and low-light conditions.	**6. Drawer Handle** ● Slightly protruding front improves grip. ● Rounded edges improve comfort. ● Easy to pull using one hand. ● Large enough for elderly users.	**Power Switch** ● Allows the device to be switched off when transporting or storing. ● Prevents accidental battery drain. ● Simple slide switch for reliable operation.	**Drawer Number** ● Clearly identifies each compartment. ● Matches medication schedule stored in the system. ● Helps reduce the chance of selecting the wrong medicine.
3. Confirmation Button ● A large tactile push button confirms that medication has been taken. ● Easy to locate and press, especially for elderly users. ● Stop the reminder alarm after confirmation. ● Simple one-button interface reduces user confusion.	**8.Pull-out Drawers** ● Individual drawers store one type of medication. ● Slides smoothly using guide rails. ● Prevents medicines from mixing with other compartments. ● The drawer opens only when required, improving organisation. ● The large opening provides easy access for users with limited hand mobility.	**Internal Battery** ● A rechargeable Lithium-ion battery powers the dispenser. ● Allows cordless operation. ● Rechargeable through USB-C. ● Provides several days of operation between charges.	**1.USB-C Charging Port** ● Recharges internal battery. ● Standard USB-C connector. ● Easily accessible.
7. Speaker grill ● Protective perforated grille allows sound to pass while preventing dust from entering. ● Buzzer produces an audible reminder when medication is due. ● Alerts users even if they are not looking directly at the dispenser. ● Small openings maintain a clean appearance while protecting internal electronics.	**2.Rubber Feet** ● Prevent the dispenser from sliding. ● Protect tabletops from scratches. ● Absorb small vibrations when drawers are opened. ● Improve stability during use.	**Body Housing** **Material:** ABS Plastic ● Strong yet lightweight enclosure. ● Protects internal electronics. ● Impact resistant. ● Smooth surfaces are easy to clean. **Dimensions = 200 × 150 × 130 mm**	**5. Led** ● Indicates when medication is due. ● Lights up the required drawer. ● Helps users identify the correct compartment.

Overall Functioning

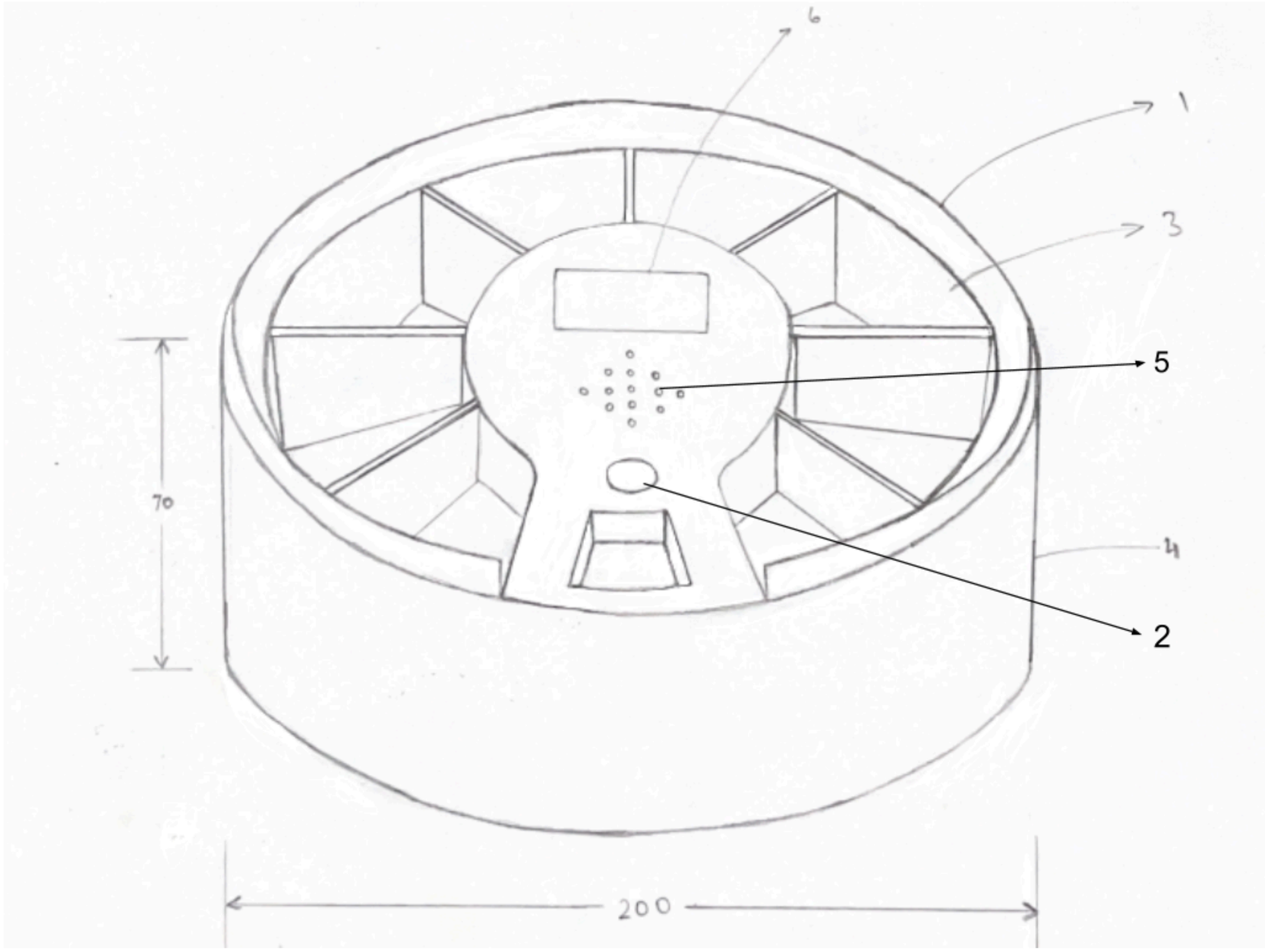
1. The user fills each drawer with a different medicine and uses the ESP32 web interface to enter:
    - Medicine name
    - Drawer number
    - Dosage
    - Reminder time
2. The schedule is stored in the ESP32, while the DS3231 RTC module keeps accurate time even if the power is turned off.
3. When the scheduled time is reached:

    - The buzzer sounds.
    - The OLED display shows the medicine name, drawer number and dosage.
    - The LED above the correct drawer lights up to indicate which drawer to open.
    - The speaker asks to open the respective drawer(Ex: “Open drawer number 1”)
4. The user pulls out the highlighted drawer, takes the required medicine and closes the drawer.
5. The user presses the Confirm Button after taking the medicine.
6. If the confirm button is pressed:
    - The reminder stops.
    - The system records the dose as Taken in the ESP32 web interface.
7. If the button is not pressed within the set reminder period:
    - The reminder continues for a preset time.
    - The dose is automatically marked as Missed in the ESP32 web interface.
8. The user or caregiver can open the ESP32 web interface from a phone or computer to:
    - View upcoming reminders
    - Check medicine information
    - View the history of taken and missed doses
    - Edit medicine schedules
9. The medication logs are stored in the ESP32's memory and displayed through the web interface.

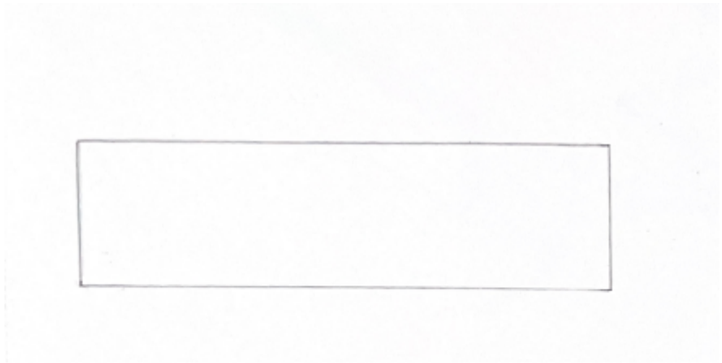
Summary of research used to inspire the design ideas

The design was inspired by Bauhaus, which emphasises geometric forms, modular construction and the principle that "form follows function." The symmetrical drawer layout and rectangular form reflect this movement. The uncluttered appearance also follows Modernism, while current consumer electronics trends towards clean, organised and compact products influenced the final styling.

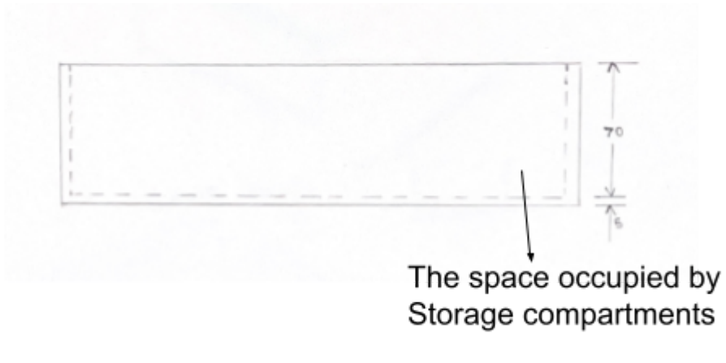
Ideation 2



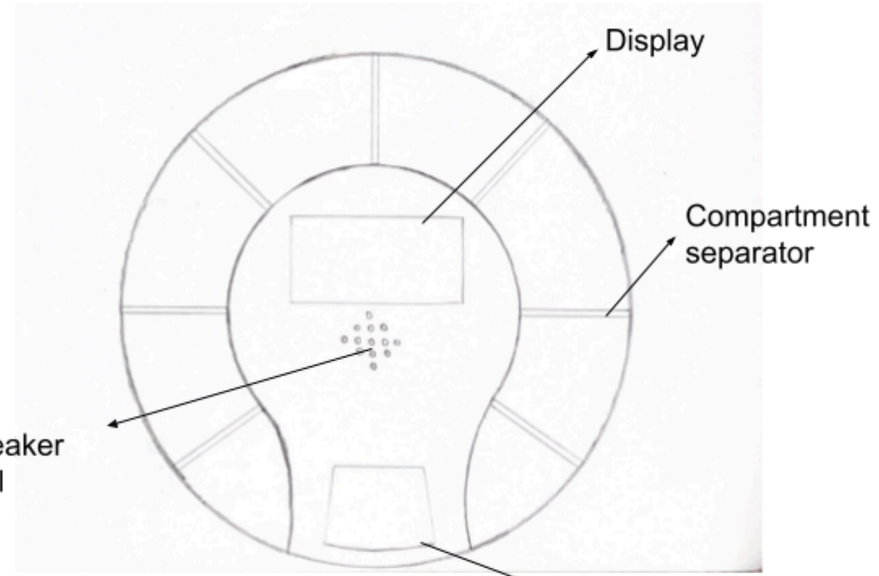
Side View



Front View



Top View



1.Transparent Acrylic Cover (3–4 mm thick) ● The transparent acrylic lid allows the user to view all medication compartments. ● Protects medicine from dust, moisture and accidental contact. ● Easily removable for refilling and cleaning. ● Smooth polished edges improve safety and appearance.	**6.OLED Display** ● Displays medication name, compartment number and current reminder time. ● Provides clear visual instructions. ● Low power consumption. ● Mounted centrally for maximum visibility.	**2. Confirm Button** ● Displays medication name, compartment number and current reminder time. ● Provides clear visual instructions. ● Low power consumption. ● Mounted centrally for maximum visibility.	**3.Carousel Tray (8 Compartments)** ● Divided into eight equal compartments. ● Stores different medicines separately. ● Prevents mixing of medication. ● Each compartment can be labelled with medicine name or dosage. ● Manufactured from food-safe ABS plastic. ● Depth: 25 mm Width at outer edge: 55 mm Capacity: approximately 25–35 tablets
5.Speaker Grill ● Protects internal buzzer while allowing sound transmission.	**Internal Battery** ● Rechargeable Li-ion battery. ● Powers system during normal operation. ● Rechargeable via USB-C.	**4.Main Body** ● ABS plastic. ● Lightweight yet durable. ● A rounded profile improves aesthetics. ● Easy to clean. ● Protects internal electronics.	**USB-C Charging Port (Placed in the back)** ● Recharges internal battery. ● Standard USB-C connector. ● Easily accessible.

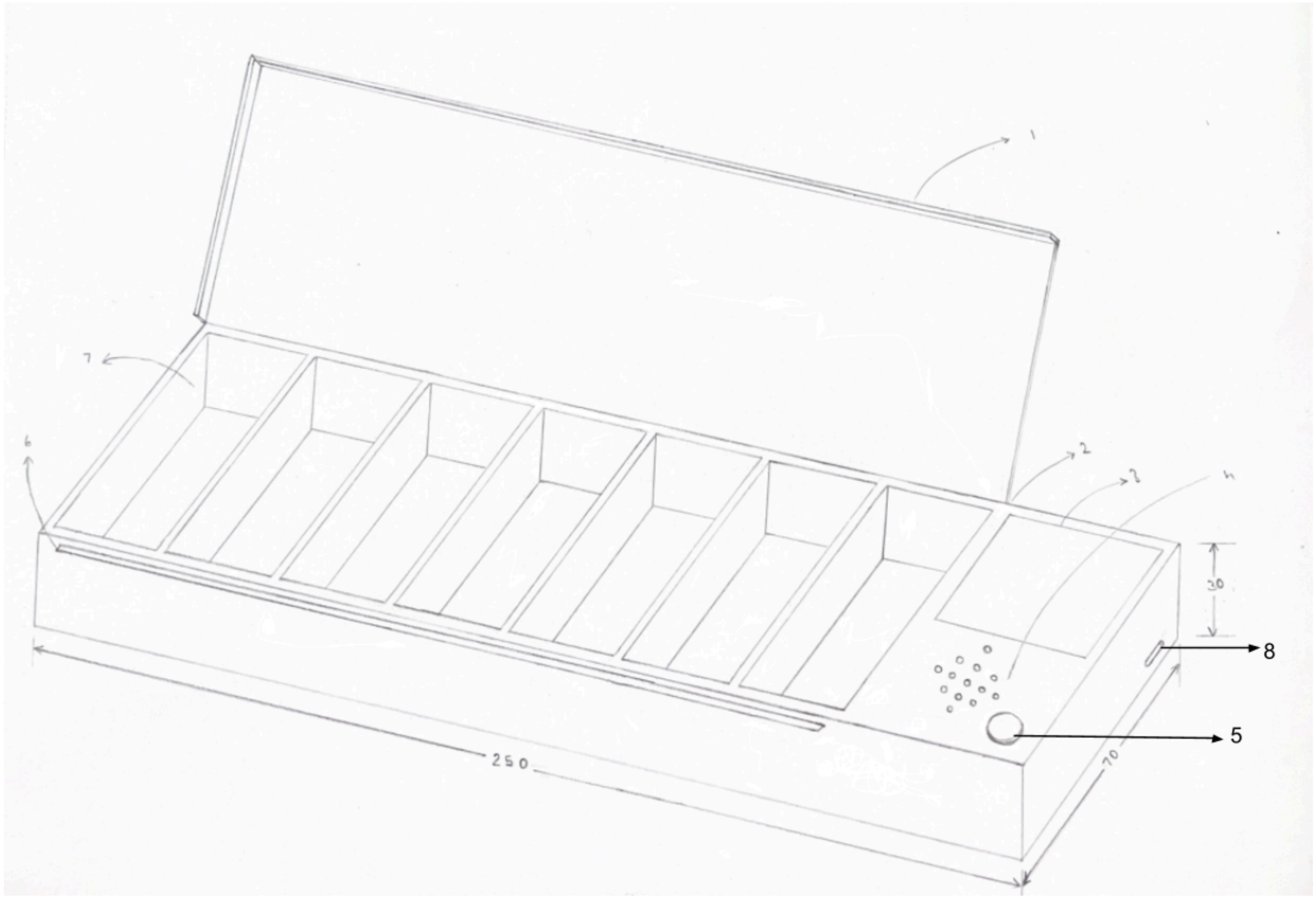
Overall Functioning

1. The user fills each of the eight compartments with the required medicines and sets the medication schedule through the ESP32 web interface.
2. The ESP32 continuously reads the current time from the DS3231 RTC module.
3. When a scheduled medication time is reached:
    - The OLED display shows the medicine name and time
    - The buzzer rings
4. The ESP32 rotates the carousel using the stepper motor until the correct compartment aligns with the dispensing opening in the acrylic lid.
5. The user removes the medicine through the opening and presses the Confirm button.
6. The ESP32 records the medication as Taken in the built-in web interface log. If the user does not confirm within the allowed time, the entry is recorded as Missed.
7. If multiple medicines are scheduled at the same time, the system automatically rotates to the next compartment after confirmation and repeats the reminder process.
8. Medication history is stored and viewed through the ESP32 web interface

Summary of research used to inspire the design ideas

The design was influenced by Modernism, where products are designed primarily for function with technology seamlessly integrated into the form. The simple circular geometry and lack of unnecessary decoration also reflect Minimalist principles. Current healthcare product trends favour clean, user-friendly devices with smooth surfaces, neutral colours and intuitive operation, all of which influenced the overall aesthetic

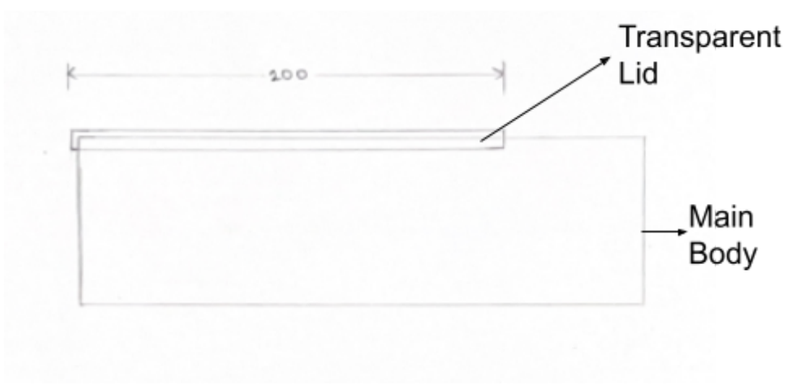
Ideation 3



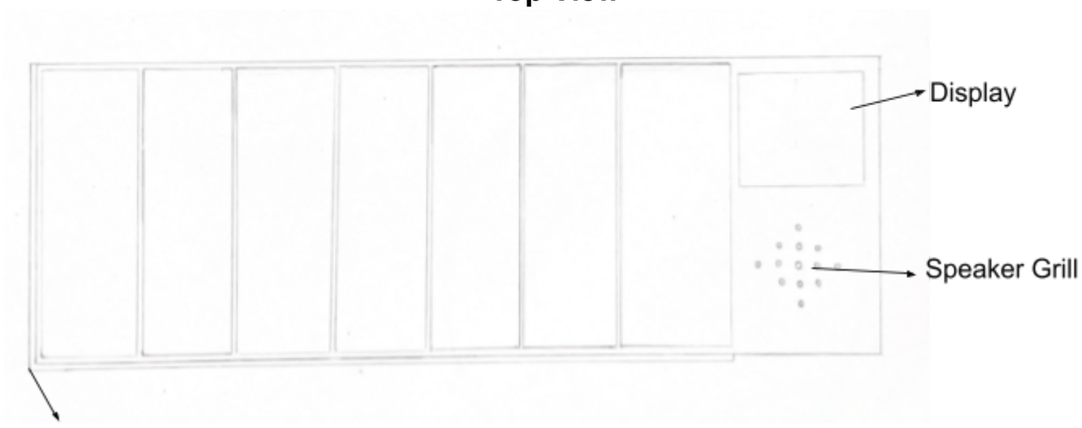
Orthographic views

Side View

Front View



Top View



1. Transparent polypropylene Lid(1mm thickness) ● Transparent acrylic allows the user to easily identify medicines without opening the dispenser. ● Protects medication from dust, dirt and accidental contamination. ● Hinged design provides quick access during refilling. ● Smooth polished edges improve user safety. ● Lightweight and easy to clean. ● Acrylic provides good impact resistance and a professional appearance.	**6.Friction Lock Tab (Front Extrusion)** ● A small moulded protrusion holds the lid securely closed using friction. ● Prevents accidental opening during transport. ● Allows one-handed opening without additional latches.	**Storage Compartments** ● Seven individual compartments store medication separately. ● Can be organised by: Monday-to- Sunday (or) Seven Different Medication ● Divider walls prevent tablets from mixing. **Dimensions = 65mm x 23 mm x 25 mm**	**3. OLED Display** ● Displays current time. ● Displays medicine reminders. ● Shows compartment number/day. ● Displays medication status. ● Easily readable under indoor lighting.
4. Speaker Grill ● Allows clear transmission of voice reminders. ● Protects internal speaker. ● The speaker announces prerecorded instructions.(ex:”Open compartment 1 ”) ● Voice recordings stored on Micro SD card.	**5. Confirmation Switch(Push Button switch)** ● Used to confirm medication has been taken. ● Stops the reminder alarm when pressed ● Records medication as Taken. ● Advances to the next scheduled reminder.	**Internal Battery** ● Powers the dispenser without external supply. ● Rechargeable Lithium polymer battery. ● Provides portable operation. ● Battery is light weight	**8. USB-C Charging Port** ● Charges internal battery. ● Modern reversible connector. ● Easily accessible. ● Fast charging capability.
7.Main Body Material: ABS Plastic ● Durable injection moulded enclosure. ● Protects internal electronics. ● Lightweight. ● Easy to manufacture. **Dimensions = 250 mm x 70 mm x 30 mm**	**2. Living Hinge** ● Thin flexible section connecting two parts.(The lid and the main body) ● Allows the lid to open and close repeatedly.	-	-

Overall Functioning of the Product

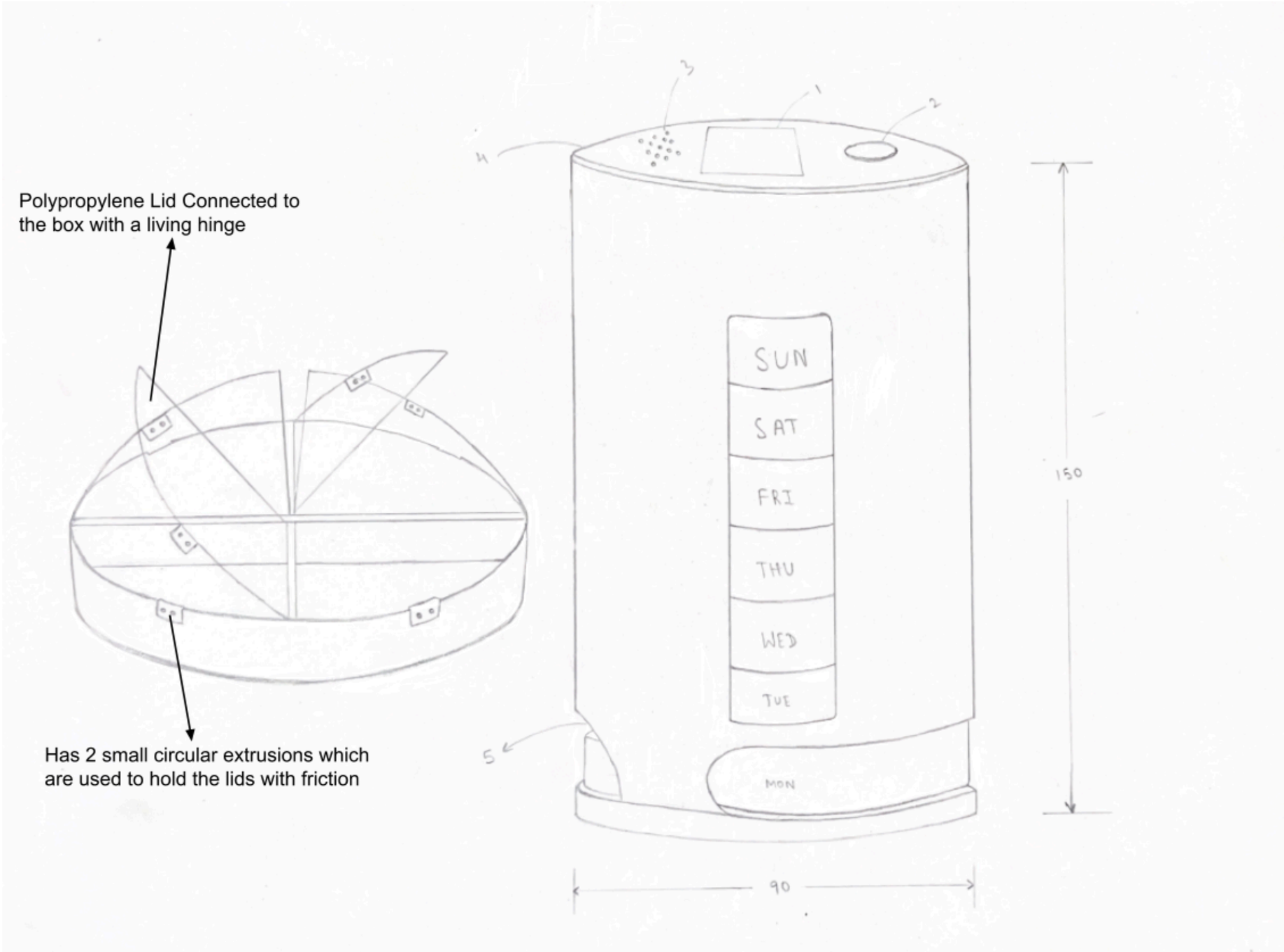
1. The user fills each of the seven compartments with the required medicines, either for each day of the week or seven different types of medicine, and sets the medication schedule through the ESP32 web interface.
2. The ESP32 continuously reads the current time from the DS3231 RTC module.
3. When a scheduled medication time is reached:
    a. The OLED display shows the medicine reminder and scheduled time.

   b. The buzzer rings
4. The user opens the transparent lid, removes the medicine from the indicated compartment, and closes the lid using the front friction lock.
5. The user presses the Confirm button after taking the medicine.
6. The ESP32 records the medication as Taken in the built-in web interface log. If the user does not confirm within the allowed time, the entry is automatically recorded as Missed.
7. Medication schedules and history can be viewed and managed through the ESP32 web interface at any time.

Summary of research used to inspire the design ideas

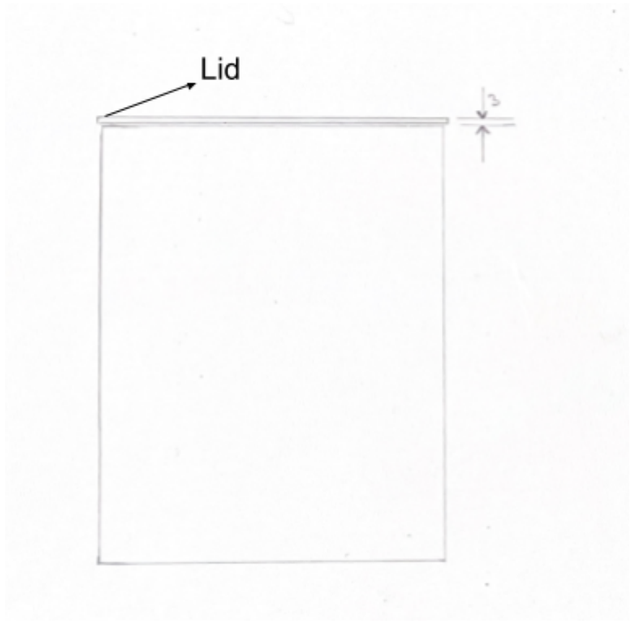
The design was inspired by Modernism, where functionality is prioritised over decoration. Its simple rectangular form, flat surfaces and practical layout reflect the idea that form follows function. The clean appearance also follows Minimalism, removing unnecessary features to create an easy-to-use product. Current healthcare product trends influenced the straightforward and organised design, making it suitable for everyday medication storage.

Ideation 4

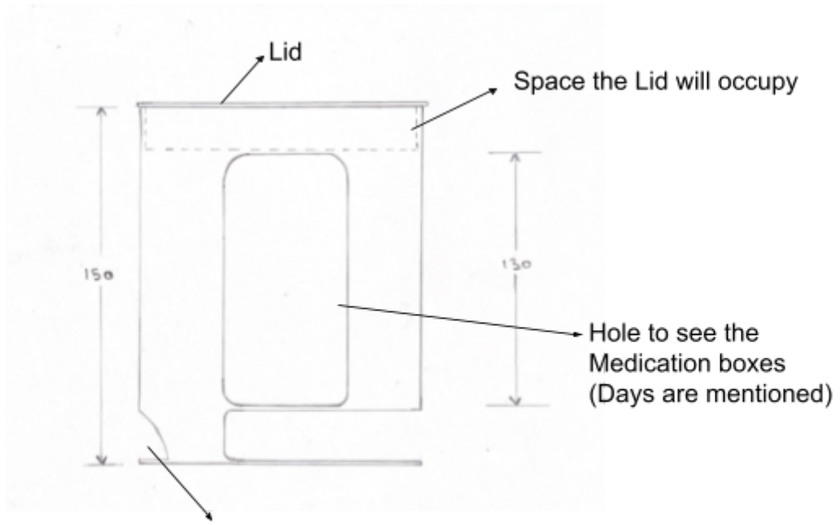

Polypropylene Lid Connected to the box with a living hinge
Has 2 small circular extrusions which are used to hold the lids with friction
1
2
3
4
5
SUN
SAT
FRI
THU
WED
TUE
MON
150
90

Orthographic View

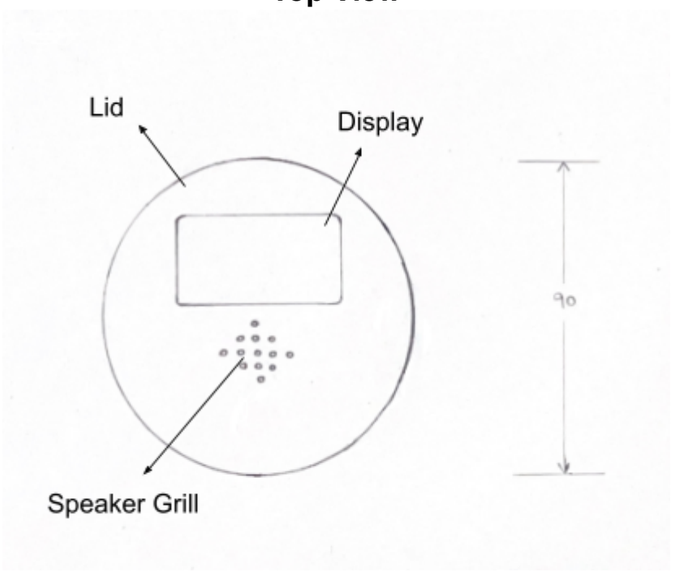
Side View



Front View



Top View



Main Body ● Cylindrical shape provides a compact footprint while maximizing internal storage. ● Smooth rounded edges improve ergonomics and user safety. ● Matte ABS finish resists scratches and fingerprints. ● Houses seven removable daily medication boxes.	**4.Removable Top Lid** ● Contains all electronic components. ● Easily lifted off to refill the medication boxes. ● Sits accurately on the housing using alignment lips. ● Protects electronics from dust and accidental contact.	**1.OLED DISPLAY** ● Displays medication reminders. ● Shows medicine name. ● Displays dosage quantity. ● Shows current time. ● Displays system status and battery level.
5.A cutout in the main structure to push the medication box out	**2.Confirmation Button** ● The user presses after taking medication. ● Stop the reminder alarm. ● Confirms medicine has been taken. ● Records successful dose in ESP32 web interface.	**Medication Boxes** ● Seven boxes ● One box for each day of the week. ● Completely removable for easy filling. ● Can alternatively store seven different medicines. ● Individual compartments prevent mixing. ● Transparent lids allow contents to be checked quickly. ● Compact enough for travel. ● Easy to clean.
Sliding Daily Box ● Slides smoothly out of the housing. ● Individual removal prevents disturbing other days. ● The day label is clearly visible through the viewing window.	**3.Speaker Grill** ● Allows clear transmission of voice reminders. ● Protects internal speaker.	-

Overall Functioning of the Product

1. The user fills each of the seven removable medication boxes with the required medicines and places them inside the main housing.
2. The ESP32 continuously reads the current time from the DS3231 RTC module and follows the medication schedule.
3. When a scheduled medication time is reached:
4. The OLED display shows the medicine name, dosage and time.
5. The speaker provides an audible reminder.
6. The user pushes the required medication box through the cutout in the main structure and slides the box out.
7. The user removes the medication and presses the Confirm button.
8. The ESP32 records the medication as Taken in the web interface. If the user does not confirm within the allowed time, the medication is recorded as Missed.
9. After taking the medication, the user slides the medication box back into the housing, ready for the next scheduled use.

10. The medication schedule and Taken/Missed history can be viewed through the ESP32 web interface.

Summary of research used to inspire the design ideas

The design was inspired by Scandinavian Design, using a simple cylindrical form, rounded edges and neutral colours to create a clean and welcoming appearance. The lack of decorative details reflects Minimalism, while integrating all electronics into the removable lid follows Modernist principles, where technology is incorporated without compromising the simple exterior. Current smart healthcare trends also influenced the discreet integration of technology and clean aesthetic.

Evaluation

Criteria	Excellent (4 pts)	Good (3 pts)	Fair (2 pts)	Poor (1 pt)
1. Functionality	Performs all intended functions effectively, including accurate medication reminders, clear notifications and reliable operation.	Performs most functions effectively with only minor limitations.	Basic functionality is achieved but some important features are limited.	Fails to perform several essential functions or is unreliable.
2. Ease of Use (Human Factors)	Extremely intuitive to operate, suitable for elderly users, with clear access to medication and simple controls.	Generally easy to use with only minor difficulties.	Operation requires additional effort or may confuse some users.	Difficult to operate and unsuitable for the target users.
3. Medication Organisation	Medicines are clearly separated, easy to identify and organised to minimise user error.	Medicines are well organised with only minor limitations.	Basic organisation provided but medicines may be less accessible or more confusing.	Poor organisation with high potential for medication errors.
4. Ease of Refilling	Compartments are easily removable or accessible, allowing quick and convenient refilling.	Refilling is straightforward with only minor inconvenience.	Refilling is possible but time-consuming or awkward.	Refilling is difficult and impractical.
5. Electronic Integration	Sufficient internal space for all electronic components with neat wiring and easy maintenance.	Most electronics fit well with only minor space constraints.	Limited space results in crowded components or difficult assembly.	Electronics cannot be accommodated effectively without major compromises.

6. Manufacturability	Can be manufactured accurately using common school workshop equipment and simple manufacturing processes.	Mostly easy to manufacture with only a few complex operations.	Requires several difficult manufacturing processes or high precision.	Very difficult or impractical to manufacture in a school workshop.
7. Reliability	Robust design with very few moving parts, ensuring long-term dependable operation.	Generally reliable with only minor concerns regarding wear or failure.	Moderate reliability due to several moving parts or complex mechanisms.	Poor reliability with high risk of mechanical or electrical failure.
8. Maintenance & Cleaning	Easy to clean, refill and maintain, with components that can be accessed or replaced easily.	Maintenance is generally simple with only minor difficulties.	Some components are difficult to access or clean.	Difficult to maintain, repair or clean.
9. Portability	Compact, lightweight and convenient to transport or place in different locations.	Fairly portable but slightly bulky or heavy.	Moderately portable with noticeable inconvenience.	Large, heavy or unsuitable for transport.
10. Aesthetics	Modern, attractive and professional appearance with good proportions and clean lines.	Visually appealing with only minor design weaknesses.	Functional appearance but lacks refinement.	Unattractive or poorly proportioned design.
11. Cost Effectiveness	Low manufacturing cost while maintaining excellent functionality and quality.	Reasonable cost with good value for money.	Higher manufacturing cost due to materials or complexity.	Very expensive or economically impractical to manufacture.
12. Safety	Protects medicines and electronics, prevents accidental access or injury, with no hazardous features.	Generally safe with only minor safety concerns.	Some safety issues that require improvement.	Significant safety risks or poor protection of users and components.

13. Size	Compact while still providing sufficient storage and space for electronics.	Slightly larger but remains practical for everyday use.	Bulky or inefficient use of space.	Excessively large or too small for its intended purpose.
14. Weight	Lightweight yet sturdy, making it easy to move while remaining stable.	Acceptable weight for normal use.	Slightly heavy or unnecessarily light.	Too heavy or too light, affecting usability.

Ideation 1

Criteria	Score (4)	Reasoning
Functionality	**4**	Provides clear medication reminders, labelled drawers and spoken instructions, ensuring reliable operation.
Ease of Use	**4**	Sliding drawers are intuitive and easy to access, making the product suitable for elderly users.
Medication Organisation	**4**	Each drawer is clearly labelled and completely separates medicines, reducing confusion and medication errors.
Ease of Refilling	**4**	Individual drawers can be removed and refilled separately without disturbing the remaining compartments.
Electronic Integration	**4**	The large internal volume provides sufficient space for the ESP32, RTC, OLED display, battery, speaker and wiring without overcrowding.
Manufacturability	**4**	Straightforward construction using acrylic panels, guide rails and butt joints makes it suitable for manufacture in a school workshop.
Reliability	**4**	The simple sliding mechanism has very few moving parts, reducing the likelihood of mechanical failure.

Maintenance	**4**	Drawers and electronics can be accessed easily for cleaning, repairs or replacement.
Size	**4**	Although larger than other concepts, the additional size improves accessibility and comfortably accommodates all electronic components.
Weight	**3**	Slightly heavier due to the larger housing and integrated electronics, but still suitable for normal household use.
Aesthetics	**4**	Clean rectangular form with organised drawer layout gives a professional and modern appearance.
Cost Effectiveness	**3**	Slightly higher material usage than smaller concepts but avoids expensive motors and complex mechanisms.
Safety	**4**	Fully enclosed electronics, smooth edges and secure drawers minimise the risk of injury or accidental medicine spillage.

Ideation 2

Criteria	**Score (4)**	**Reasoning**
Functionality	**4**	Automatically rotates to the correct compartment, providing accurate medication dispensing and reminders.
Ease of Use	**3**	Simple one-button operation, but users must wait for the carousel to rotate before accessing medication.
Medication Organisation	**4**	Individual compartments keep medicines separated and reduce medication errors.
Ease of Refilling	**3**	The entire carousel must be opened and rotated manually during refilling, making the process slower.

Electronic Integration	**4**	Large central space easily accommodates the ESP32, battery, RTC, OLED display and buzzer.
Manufacturability	**2**	Requires a precise rotating mechanism, stepper motor and accurate alignment, making manufacture difficult in a school workshop.
Reliability	**2**	The motor and rotating mechanism introduce more moving parts, increasing the risk of mechanical failure.
Maintenance	**3**	Electronics are accessible, but servicing the rotating mechanism is more difficult.
Size	**3**	Compact overall, but additional internal space is required for the rotating mechanism.
Weight	**3**	Motor and rotating components increase the overall weight.
Aesthetics	**4**	Modern circular design with clean lines creates an attractive appearance.
Cost Effectiveness	**2**	Additional motor, driver and mechanical components significantly increase manufacturing cost.
Safety	**4**	Medication remains enclosed and users are protected from the electronics and moving components.

Ideation 3

Criteria	**Score (4)**	**Reasoning**
Functionality	**3**	Provides reminders but requires users to manually identify and open the correct compartment.

Ease of Use	**3**	The familiar layout is simple, but opening the entire lid is slightly less convenient than individual drawers.
Medication Organisation	**3**	Medicines are separated by day but all compartments are accessed through a single lid.
Ease of Refilling	**4**	The large opening allows all compartments to be refilled quickly.
Electronic Integration	**2**	Limited internal space makes installation of the ESP32, battery and display more difficult.
Manufacturability	**4**	Simple box construction is easy to manufacture using common school workshop equipment.
Reliability	**4**	Very few moving parts provide dependable long-term operation.
Maintenance	**4**	The simple construction allows easy cleaning and maintenance.
Size	**4**	Compact design occupies little storage space.
Weight	**4**	Lightweight due to the simple structure and absence of complex mechanisms.
Aesthetics	**3**	Simple appearance but less visually distinctive than the other concepts.
Cost Effectiveness	**4**	Low manufacturing cost because of the simple construction and minimal number of components.
Safety	**4**	Smooth edges and enclosed compartments provide good user safety.

Ideation 4

Criteria	Score (4)	Reasoning
Functionality	**4**	Smart reminders and removable compartments provide effective medication management.
Ease of Use	**4**	Removable compartments are easy to access and refill, making the product convenient for daily use.
Medication Organisation	**4**	Individual removable compartments keep medicines clearly separated.
Ease of Refilling	**4**	Removing the lid provides unrestricted access to every compartment during refilling.
Electronic Integration	**3**	Housing all electronics inside the lid improves storage space but requires careful component arrangement due to limited thickness.
Manufacturability	**3**	The body is simple to manufacture, but accurately fitting all electronics within the lid increases manufacturing difficulty.
Reliability	**4**	Simple construction with few moving parts improves long-term reliability.
Maintenance	**3**	Electronics are concentrated inside the lid, making repairs slightly more difficult than the drawer design.
Size	**4**	Compact while still providing adequate storage capacity.
Weight	**4**	Weight is distributed evenly and remains suitable for everyday use despite the heavier lid.

Aesthetics	**4**	Modern appearance with clean lines and concealed electronics.
Cost Effectiveness	**3**	Moderate manufacturing cost due to the electronic lid assembly.
Safety	**4**	Enclosed electronics and secure compartments minimise safety risks.Curved edges.

Final Scores :

Design	**Score**
Ideation 1	50 / 52
Ideation 2	41 / 52
Ideation 3	46 / 52
Ideation 4	48 / 52

Final Chosen Design :

Ideation Number	Positive features
Ideation 1	● Individually labelled drawers allow medicines to be clearly organised and easily identified. ● Sliding drawers provide direct access to medication without opening the entire unit. ● Drawers can be removed individually, making weekly refilling quick and convenient. ● Large housing provides ample space for the ESP32, RTC module, battery, OLED display, speaker and wiring. ● Front-mounted OLED display and button are positioned within the user's normal line of sight, improving visibility and accessibility. ● The speaker provides spoken instructions, making the product suitable for visually impaired and elderly users. ● A large button requires minimal force to operate, improving usability for users with reduced hand strength. ● A stable rectangular base prevents movement while drawers are opened. ● Modular construction simplifies assembly, maintenance and replacement of components. ● Straight panels and simple joints make the product suitable for manufacture in a school workshop.
Ideation 2	● Circular arrangement makes efficient use of internal space while keeping medicines organised. ● Individual compartments reduce the likelihood of taking the wrong medication. ● Automatic rotation presents only the required medicine, reducing user error. ● Large central area provides sufficient space for electronic components. ● Single-button operation is simple and suitable for elderly users. ● Compact footprint occupies less table space. ● Enclosed design protects medication from dust and accidental contact. ● Modern appearance with a transparent lid allows users to monitor medicine levels. ● Stable circular base reduces the risk of tipping during operation.
	● Familiar layout reduces the learning curve for users. ● Large transparent lid allows medicines to be viewed without opening the organiser.

Ideation 3	● Compact and lightweight design makes the product easy to carry and store. ● Seven compartments provide clear organisation for daily medication. ● Wide opening allows easy refilling of all compartments. ● Simple construction improves reliability due to fewer moving parts. ● Smooth edges improve user safety and comfort during handling. ● Suitable for users with limited hand strength because minimal force is required to access medication. ● Low material usage reduces manufacturing cost.
Ideation 4	● Electronics housed separately from the medication compartments prevent contamination and maximise storage space. ● Modular lid allows electronic components to be serviced without disturbing stored medication. ● Removable daily compartments improve portability and convenience. ● Transparent lid allows users to check medicine levels quickly. ● Compact vertical arrangement reduces the overall footprint while maintaining storage capacity. ● OLED display positioned on the lid is easy to read during use. ● The large confirmation button is ergonomically positioned for comfortable operation. ● Lightweight medication compartments are easier for elderly users to handle. ● Smooth rounded edges improve comfort and reduce the risk of injury. ● Simple body construction makes manufacturing easier while maintaining a modern appearance.

Further Analysis

No.	Potential Refinement	Inspired by Idea	Reason for Refinement
1	Add a transparent lid over the drawers.	Ideation 3	Allows the user to check the medication stored inside without opening the drawers and provides additional protection from dust.
2	Separate the electronics from the medication compartments using an internal partition.	Ideation 4	Prevents the electronics and wiring from interfering with the medication storage area and makes the internal layout more organised.

3	Make the electronics section removable.	Ideation 4	Allows electronic components to be accessed easily for maintenance, repair or replacement without disturbing the medication drawers.
4	Angle the OLED display towards the user.	Ideation 4	Improves visibility and makes the information easier to read from the user's normal position.
5	Reduce unnecessary internal space around the drawers.	Ideation 3	Makes the product more compact and reduces the amount of material required while maintaining the required storage capacity.
6	Reduce the thickness of unnecessary structural components.	Ideation 3	Reduces the overall weight of the product, making it easier to move and more suitable for elderly users.
7	Use chamfered or smoothed edges on exposed panels.	Ideation 3	Improves safety and comfort by reducing sharp edges that could cause discomfort during handling.
8	Use a compact vertical arrangement for the drawer section.	Ideation 4	Reduces the footprint of the product while maintaining the required number of medication compartments.
9	Improve the transparency of the lid to allow medication levels to be checked.	Ideation 3	Allows users or caregivers to identify when medication needs to be refilled without opening the product.

Further Market Research of Potential End-Users

Following the development of the four initial concepts, further market research was carried out to determine which design would best meet the needs of the target users. The aim was to identify the most suitable concept and gather suggestions for refinement before producing the final design proposal.

Method

A concept evaluation questionnaire was conducted with 20 potential end-users.

Participants

- 12 elderly users (aged 60–78)
- 5 adults (aged 35–59) who take daily medication
- 3 caregivers responsible for helping family members manage medication

Each participant was shown printed sketches of the four design concepts and a brief explanation of how each product operated. Participants were then asked to complete a questionnaire and discuss the strengths and weaknesses of each concept.

Questionnaire

1. Which design would you find easiest to use?

Design	**Responses**
Idea 1 – Rotating Carousel	3
Idea 2 – Drawer Design	11
Idea 3 – Weekly Pill Organiser	4
Idea 4 – Electronic Lid Design	2

Conclusion :

Most users preferred the drawer design because the medication could be accessed directly without waiting for a rotating mechanism.

Design decision :

The drawer mechanism was selected for the final proposal.

2. Which reminder method would you prefer?

Reminder Type	Responses
Flashing LED only	1
Buzzer	4
Speaker with voice instructions	15

Conclusion :

Most participants preferred spoken reminders because they clearly identified which compartment should be opened.

Design decision :

A speaker was selected instead of a buzzer.

3. Which method of refilling medication would you prefer?

Method	Responses
Rotating carousel refill	**3**
Opening entire organiser	**5**
Individual removable drawers	**12**

Conclusion :

Participants preferred removable drawers because they could refill one day at a time.

Design decision

Each medication drawer remains removable.

5. Which button size would you find easiest to press?

Button Size	Responses
Small (10 mm)	2
Medium (18 mm)	5

Conclusion

Most elderly users preferred a larger confirmation button.

Design decision

A large push button was selected.

Large (25 mm)	13

6. Where should the display be positioned?

Position	**Responses**
Side	3
Top	5
Front	12

Conclusion :

A front-mounted display was considered easier to read while sitting or standing.

Design decision :

The OLED display will be positioned on the front face.

7. Which shape do you prefer?

Shape	**Responses**
Circular	6
Rectangular	14

Conclusion :

Participants believed the rectangular design looked more organised and was easier to place on a bedside table.

Design decision

The rectangular drawer layout was retained.

8. Which overall size would you prefer?

Size	**Responses**
Small and compact	4

Conclusion :

Participants preferred a medium-sized product if it provided easier access and enough room for the electronics.

Design decision

The overall dimensions were increased slightly to improve usability and electronic integration.

Medium size with larger storage	15
Large	1

Additional Comments from Participants

Several participants also provided suggestions:

- Rounded corners would make the product feel safer.
- A transparent cover would allow medicines to be checked quickly.
- The product should remain stable when drawers are opened.
- The display should show both the medicine name and the current time.
- The medication log should be available on a mobile phone or computer.

Summary of Market Research Findings

Finding	Modification to Final Design
Drawer mechanism preferred by most users.	Drawer design selected as the final concept.
Voice reminders preferred over a buzzer.	Speaker incorporated into the design.
Large buttons are easier for elderly users.	25 mm confirmation button selected.
Front display preferred.	OLED display positioned on the front of the enclosure.
Medium-sized product is preferred.	Overall dimensions increased slightly to improve accessibility and accommodate electronics.

Stable product required.	Wide base retained to improve stability when drawers are opened.

Conclusion

The additional market research confirmed that users valued simplicity, accessibility and reliability more than complex mechanisms. The drawer-based concept received the highest level of user acceptance (11 out of 20 participants) due to its ease of use, simple refilling process and clear medication organisation. Feedback also highlighted the importance of spoken reminders, a large confirmation button, a front-mounted display and a stable enclosure. These findings directly informed the refinement of the final design proposal, ensuring that it better satisfies the needs of elderly users, patients managing long-term medication and caregivers.

Removal of Drawer Numbering

The permanent numbering of the drawers was removed because it is not necessary for the user to identify the correct compartment. The product already incorporates multiple guidance features that clearly indicate which drawer needs to be opened. When medication is due, the OLED display shows the medication information and the required drawer, while the green LED positioned above the correct drawer illuminates to provide a clear visual indication. In addition, the audio reminder system provides an audible instruction identifying the required drawer.

Therefore, adding numbers to every drawer would provide duplicated information and could make the front of the product appear more cluttered. Removing the numbers creates a simpler, cleaner and more modern appearance, while still maintaining clear guidance for the user.

This is particularly beneficial for the intended elderly users because they do not need to remember which number corresponds to each medication. Instead, the product directly shows, lights and audibly identifies the required compartment.

Floor glide analysis

Option	Floor protection	Slip resistance	Durability	Replaceability	Cost	Ease of install	Avg. score
Bonded TPR ring	9	9	8	7	7	6	**7.9**
Adhesive TPR pads	7	6	5	9	9	9	**7.5**
Screw-in rubber feet	9	9	9	9	5	5	**7.9**
Slip-on caps (tube legs)	6	6	6	9	8	10	**7.3**

Over-moulded rubber	10	10	10	4	3	8	**8.1**
Riveted rubber strip	8	7	8	6	6	6	**6.9**
Felt + rubber hybrid	8	5	6	8	8	9	**7.25**
Nylon glide w/ rubber tread	8	8	8	8	6	8	**7.6**

Chosen floor glide type : Over- moulded rubber

Design Proposal Checked Against the Design Specification

Specification	Does the Final Design Meet the Specification?	Reason
Target Audience – Elderly users, patients with chronic illnesses, caregivers and individuals taking multiple medications daily	Yes	The product includes a large confirmation button, OLED display, speaker reminders and, making it suitable for elderly users and those managing multiple medications.
Price – ₹4,000–₹8,000	Yes	The design uses commonly available electronic components (ESP32, OLED display, RTC, speaker) and a PETG enclosure, keeping manufacturing costs within the target price range.
Location – Home environments	Yes	The compact drawer design is intended to be placed on a bedside table, kitchen counter or study desk without occupying excessive space.

Material – PETG	Yes	The enclosure and drawers will be manufactured from PETG, providing durability, impact resistance and ease of manufacture.
No sharp edges	Yes	All external edges will be rounded or chamfered to reduce the risk of injury during normal use.
Enclosed electronics	Yes	The ESP32, battery, RTC, OLED display and speaker are housed inside a dedicated electronics compartment to prevent accidental contact.
User confirmation before dispensing	Yes	Medication is only recorded as taken after the user presses the confirmation button, reducing accidental logging.
Secure pill compartments	Yes	Individual sliding drawers securely store medication and reduce the likelihood of tablets falling out unintentionally.
Stable during operation	Yes	The wide rectangular base provides stability when drawers are opened or when the confirmation button is pressed.
0.96" OLED Display	Yes	A front-mounted OLED display shows the medication name, scheduled time and system status.
Audio reminder system	Yes	A speaker provides spoken reminders indicating which drawer should be opened, improving accessibility compared with a buzzer alone.
Mobile App Connectivity (ESP32 Wi-Fi)	Yes	The ESP32 hosts a web interface allowing users to set medication schedules and view medication history.

Eight compartments	Yes	The design incorporates eight individual drawers, each capable of storing one medication type.
One medication type per compartment	Yes	Each labelled drawer is intended to store only one medication, reducing medication errors.
15–20 tablets per compartment	Yes	Drawer dimensions are sufficient to accommodate approximately 15–20 tablets while remaining compact.
Total capacity – 120–160 tablets	Yes	The combined capacity of all eight drawers meets the required overall storage capacity.
Medication identification display	Yes	The OLED display identifies the medication name and scheduled dispensing time before the drawer is opened.
Large confirmation button (≥20 mm)	Yes	A large push button is positioned on the front panel for comfortable operation by elderly users.
Status indicators	Yes	Power, charging and reminder LEDs provide clear visual feedback regarding the device status.
Weight – Less than 1.5 kg	Yes	The PETG enclosure and lightweight electronic components are estimated to keep the overall weight below the specified limit.
Dimensions – Approximately 200 mm × 200 mm × 120 mm	Yes	The proposed dimensions provide sufficient space for eight drawers and all electronic components while remaining compact.

Dual 18650 Lithium-ion batteries	Yes	Two rechargeable 18650 cells provide adequate capacity for extended operation between charges.
Battery life – 5–7 days	Yes	The selected battery capacity (approximately 6000–7000 mAh combined) is expected to achieve the specified operating time.
USB-C charging	Yes	A USB-C charging module allows convenient and widely compatible charging.
White body with blue accents	Yes	The proposed colour scheme creates a clean, professional healthcare appearance while improving product visibility.
Easy-access refill system	Yes	Individual drawers can be removed independently, allowing medication to be refilled quickly without disturbing the remaining compartments.
Rechargeable battery system	Yes	Rechargeable lithium-ion batteries reduce disposable battery waste and improve sustainability.
Durable PETG housing	Yes	PETG offers good durability and impact resistance, extending the product lifespan.
Expected lifespan – 3–5 years	Yes	Durable materials, modular construction and replaceable electronic components are expected to provide a service life of at least 3–5 years with normal household use.

Constraints Considered During the Development of the Design Proposal

1. Time Constraint

The product was designed to be manufactured within the time available for the coursework project while maintaining a high standard of quality.

Time Constraint	How it was Considered
Limited time available for designing and manufacturing.	A simple drawer mechanism was selected instead of a rotating carousel to reduce the number of moving parts and simplify construction.
Complex mechanisms require longer assembly and testing.	Standard electronic modules (ESP32, OLED display, RTC module and speaker) were used instead of designing custom electronic circuits, reducing development and programming time.
Limited workshop sessions.	The enclosure was designed using flat PETG panels joined with simple butt joints, allowing quicker cutting and assembly than complex curved constructions.
Limited time for maintenance and testing.	The electronics were housed in a removable lid so components could be accessed easily without dismantling the entire product, reducing repair and testing time.

Overall consideration:
The design was intentionally kept simple to ensure it could be completed within the available coursework period while maintaining reliability and functionality.

2. Cost Constraint

The design needed to remain affordable while incorporating all of the required smart features.

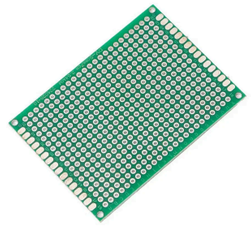
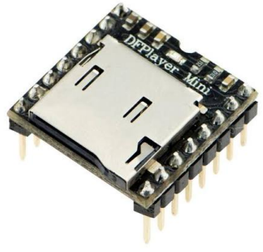
Cost Constraint	How it was Considered
Target manufacturing cost between ₹4,000 and ₹8,000.	Commonly available electronic modules were selected because they are inexpensive and easy to source.

Expensive mechanisms increase manufacturing costs.	The drawer mechanism was chosen instead of a motorised carousel, eliminating the need for a stepper motor, gears and motor driver.
Material costs.	PETG was selected because it provides a good balance between strength, durability and price while being suitable for laser cutting or CNC machining.
Replacement and maintenance costs.	Modular construction allows individual electronic components to be replaced instead of replacing the entire product, reducing long-term maintenance costs.
Manufacturing costs.	The enclosure consists mainly of flat panels that minimise machining time and material waste.

Estimated Cost Breakdown

Item	Quantity	Image	Approximate Cost (INR)	Item	Quantity	Image	Approximate Cost (INR)
ESP32 Development Board	1		500	SD Card (4 GB)	1		330
OLED Display 2.42 inch	1		1100	Wires(Red & Black)	1 metre each		50

DS3231 RTC Module	1		200	JST connectors (Male and Femal 1 pair)	1		≈5(Can only purchase as a pack of 5)
Speaker(8 Ω, 3 W)	1		150	(Male to male) & (Male to Female) & (Female to Female) Jumper cables	10 each		110
18650 Batteries	2		250 x 2 = 500	Heat Shrink(3 mm)	1 metre		15
Battery Holder	1		30	PETG Sheets	5 feet x 3 feet		2600

TP-4056 USB-C Charging Module	1		15	Adhesives(HV Glue)	1		250
Blank PCB Board	1		30	Push Button	1		200
LEDs(green)(3mm)	8		≈20	Power Switch (SPST Toggle Switch)	1		30
DFPlayer Mini	1		300	Floor glide	4(pieces)		250(Could only get as a pack of 40) ≈32
Estimated Total	≈ ₹6437						

3. Resource Constraints

The product was designed using materials, components, tools and equipment that are readily available within a typical school workshop.

Materials

Material	Reason for Selection
PETG Sheet	Durable, lightweight, impact resistant and easy to machine. **Refer Material Analysis for more information**
Cyanoacrylate Instant Glue	Produces strong permanent joints during assembly.

Electronic Components

Component	Purpose
ESP32	Controls the complete system and hosts the web interface.
OLED Display 2.42 inch	Displays medication information and reminders.
DS3231 RTC Module	Maintains accurate time even during power loss.
DFPlayer Mini	Play the audio from the SD card through the speaker
Speaker(8 Ω, 3 W)	Provides spoken medication reminders.

Dual 18650 Batteries	Rechargeable power supply.
USB-C Charging Module	Recharges the batteries safely.
LEDs	Indicates power, charging and reminder status.
Push Button	Allows users to confirm medication has been taken.
Power Switch (SPST Toggle Switch)	Used for turning the device On and Off
Wires(Red & Black)	Connecting Components
(Male to male) & (Male to Female) & (Female to Female) Jumper cables	Connecting Components

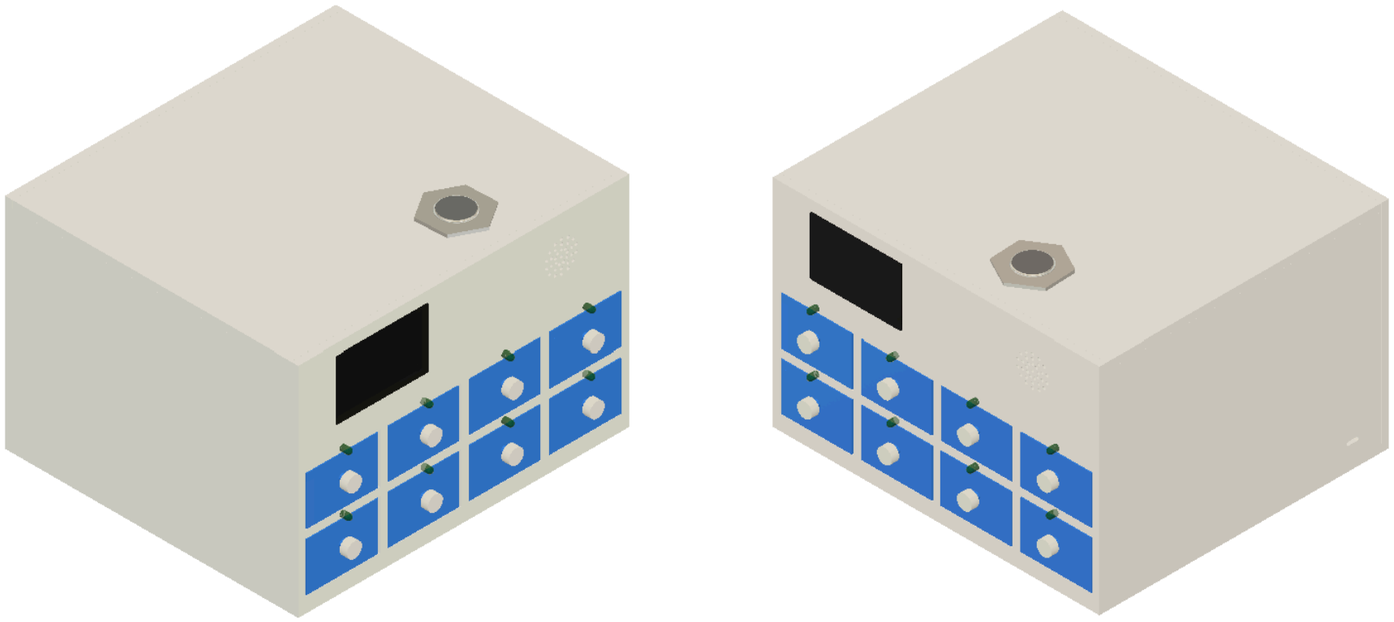
Tools

Tool	Purpose	Image	Equipment	Purpose	Image
Steel Rule	Accurate measurement and marking.		Laser Cutter	Cutting PETG and acrylic panels accurately.	

Precision Screwdrivers set	Assembly of electronic components.		Disc/Belt Sander	Finishing edges and improving accuracy.	
Soldering Iron	Electrical connections.		Hot Glue Gun	Temporary positioning of wires during assembly and when fixing the electronic components to the main structure.	
Wire Stripper	Preparing wires for soldering.				
Clamps	Holding components during Soldering				

Final refined product design

Isometric View

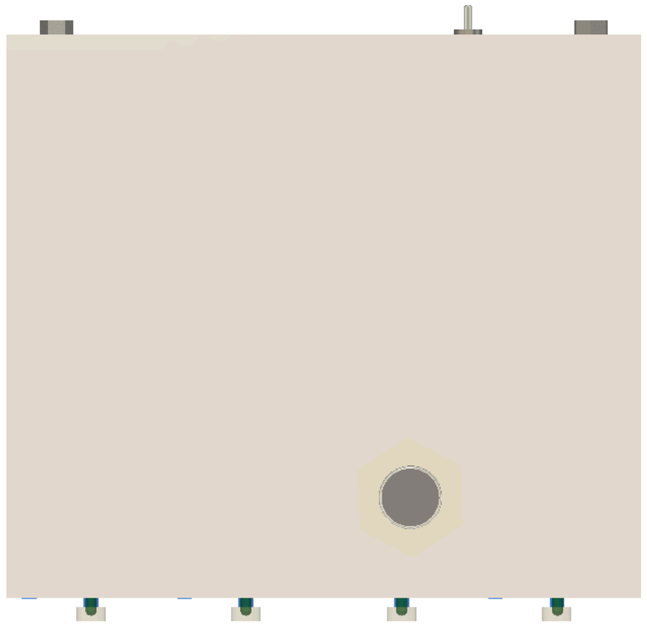


Right Side

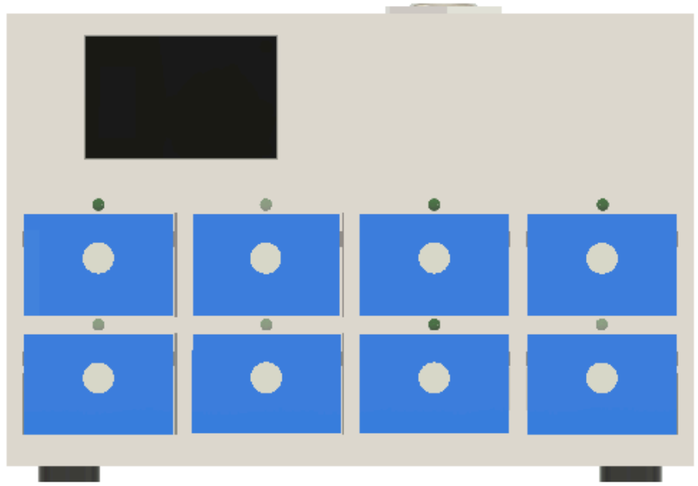
Left Side View

Back View

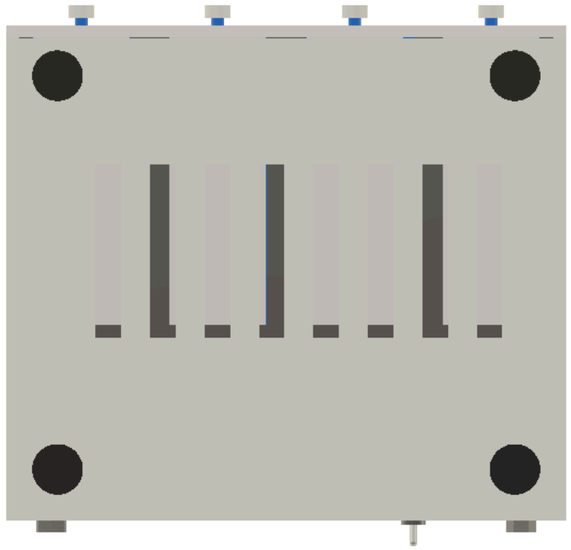
Top View



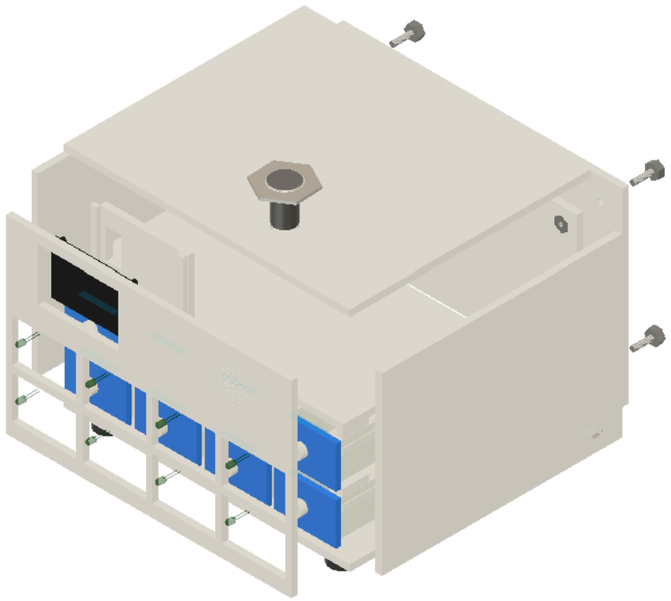
Front View

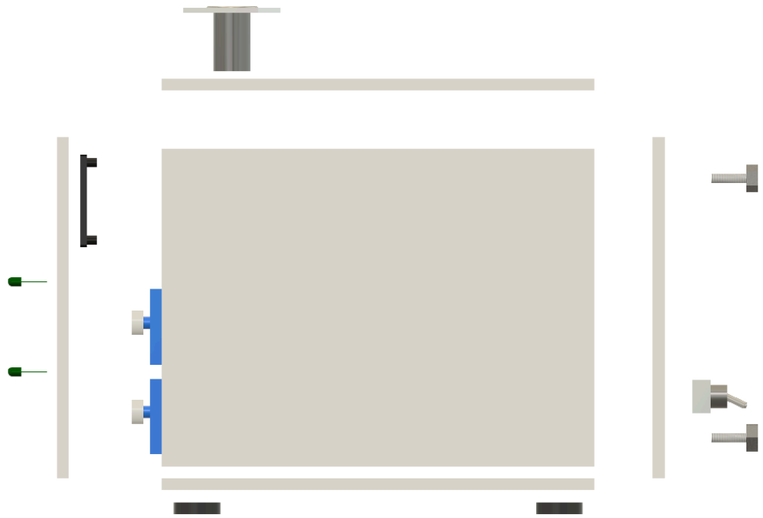


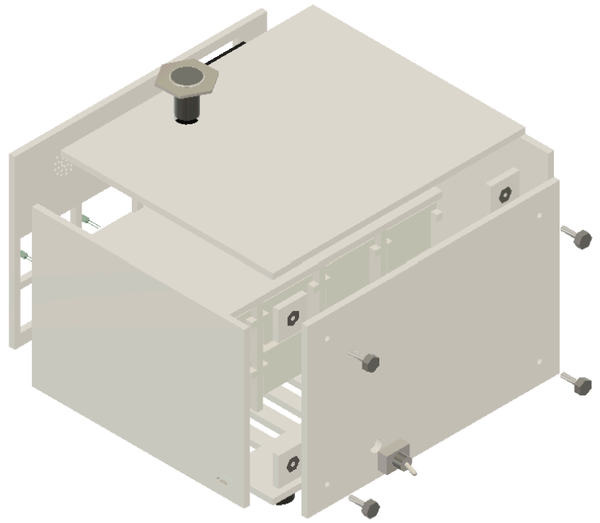
Bottom View



Exploded View

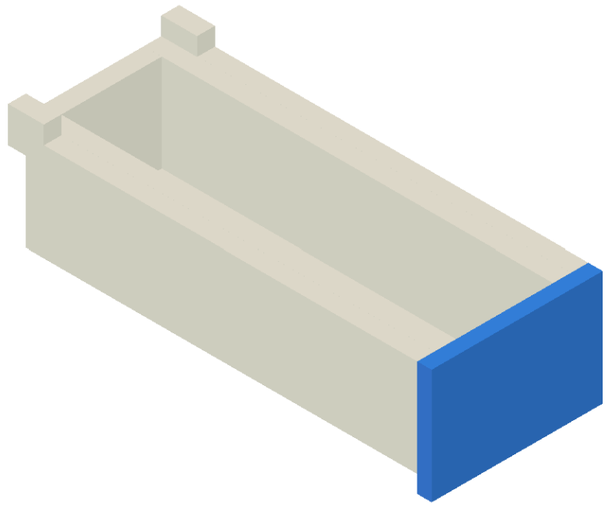




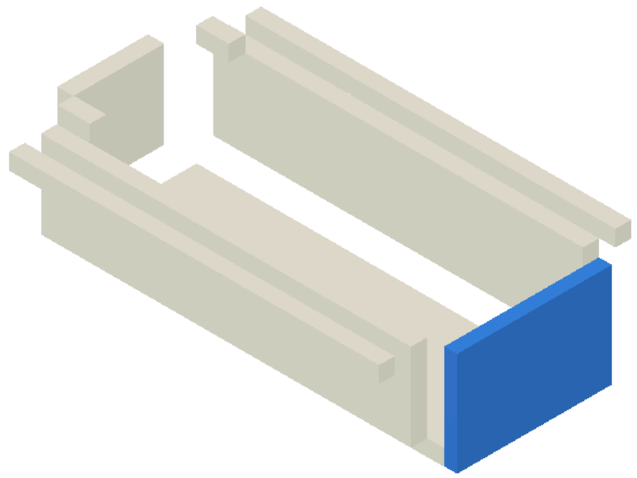


Drawer

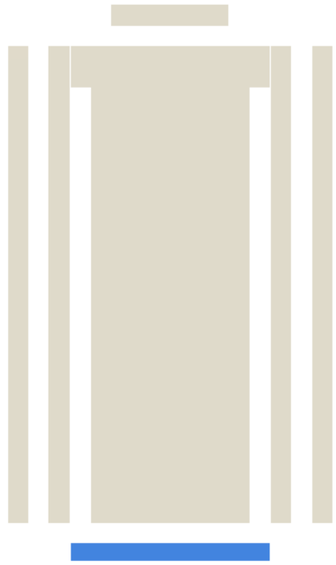
Isometric View



Exploded (Isometric)

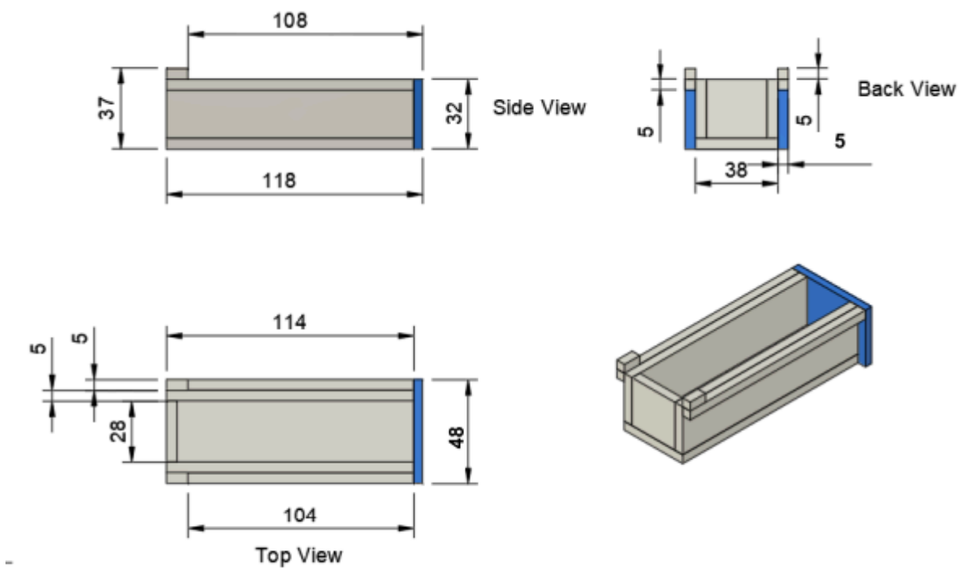


Exploded (Top)



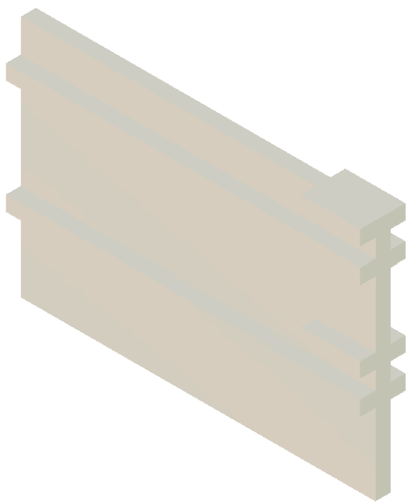
Exploded (Side)

Overall Dimension

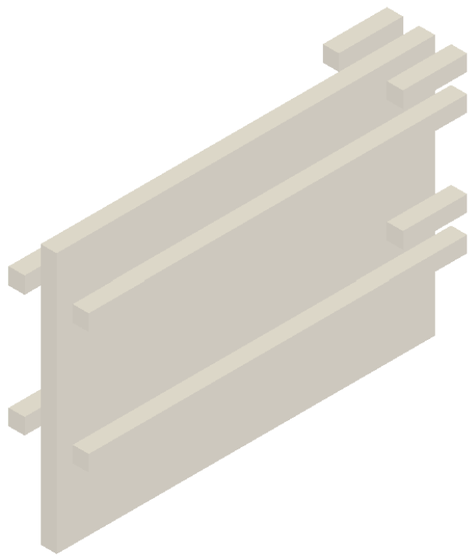


Interguide (Composite part)- Holds the drawers

Isometric View

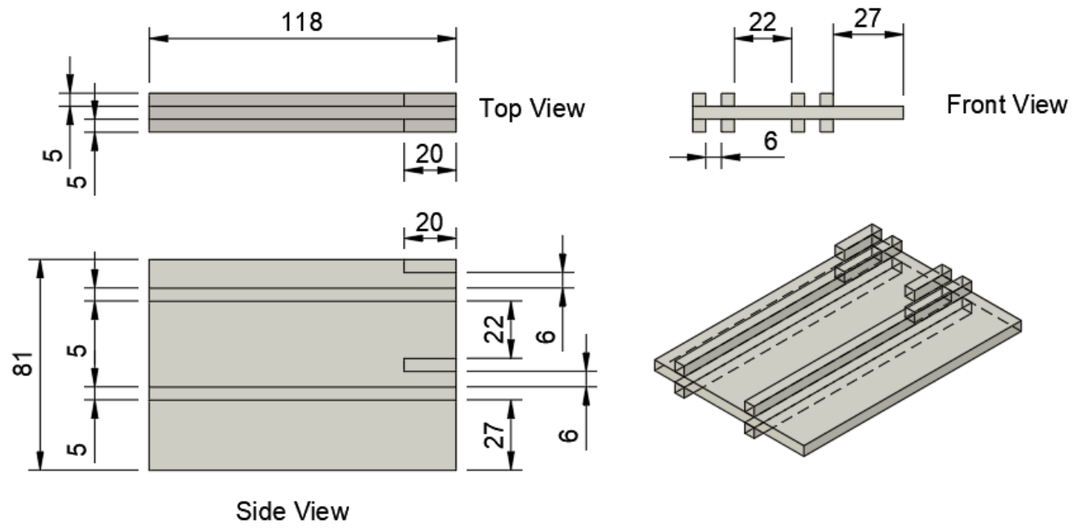


Exploded (Isometric)

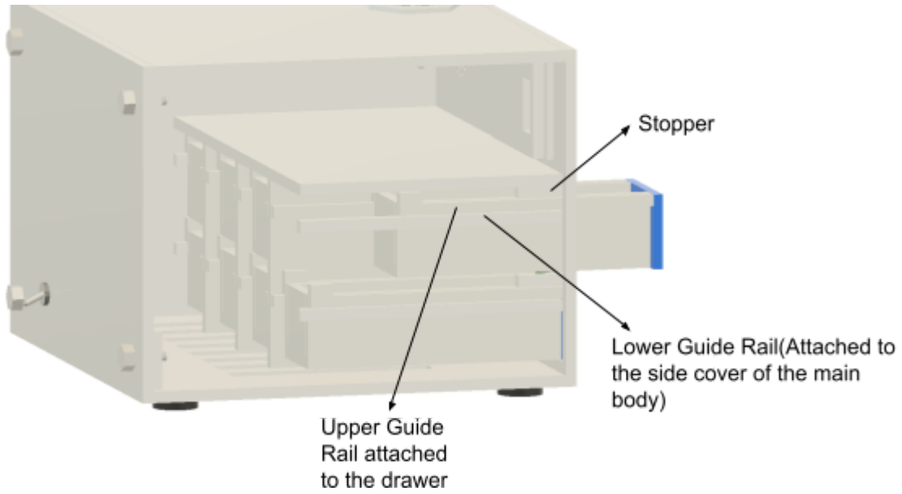


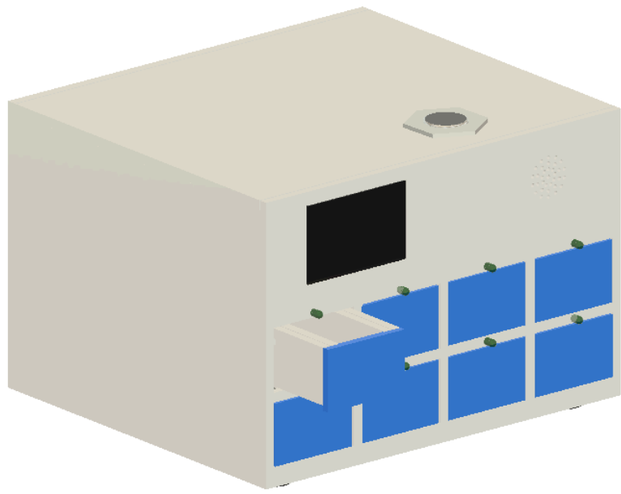
Exploded(Front)

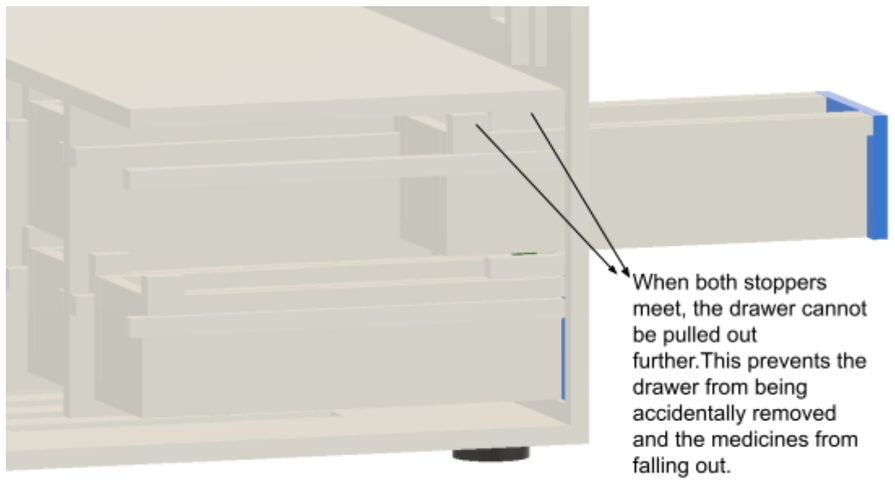
Overall Dimension

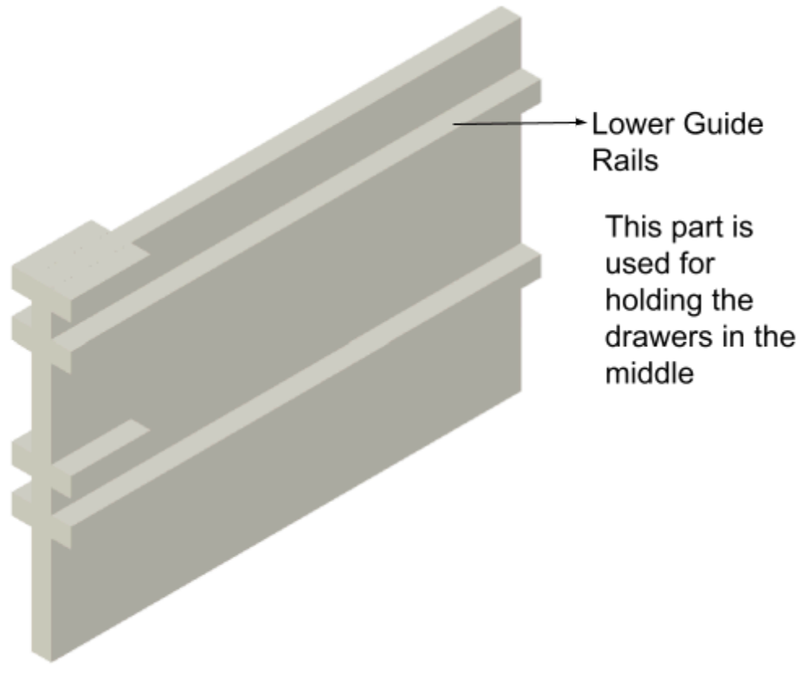


Drawer Mechanism

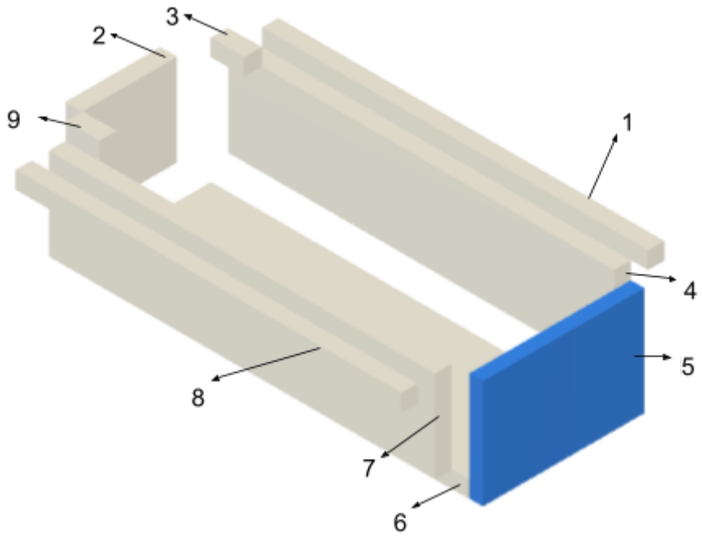


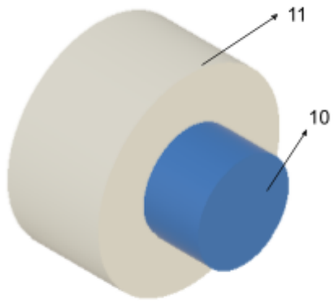


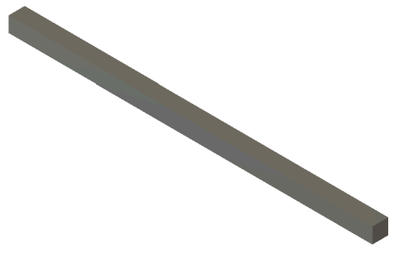
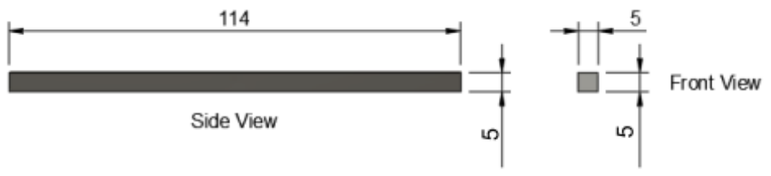
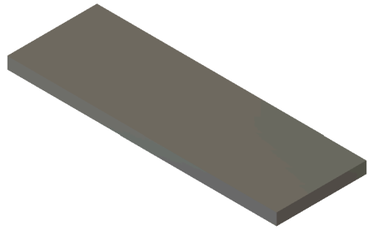
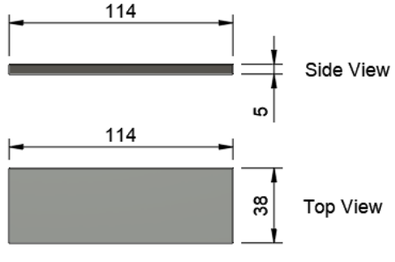


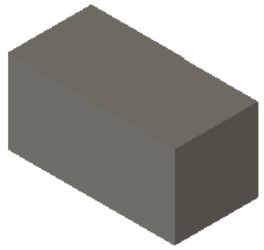
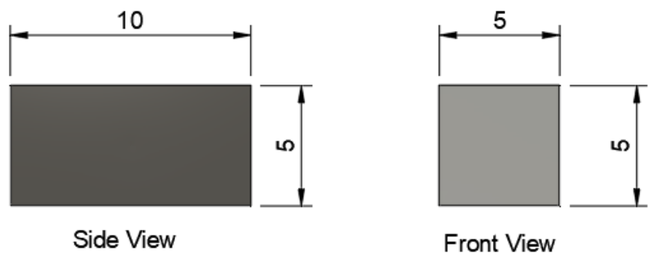
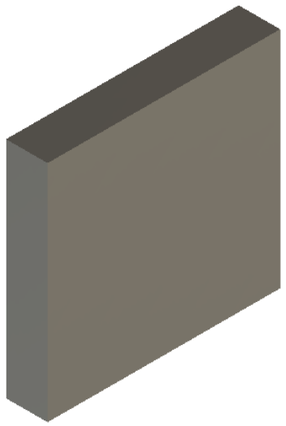
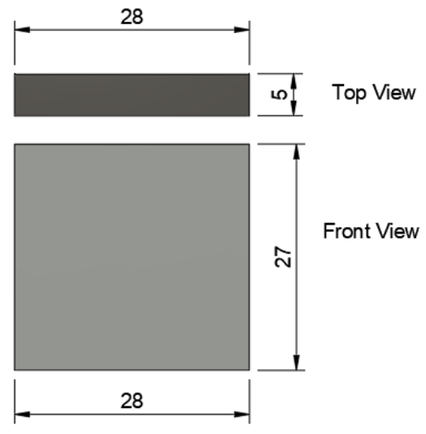
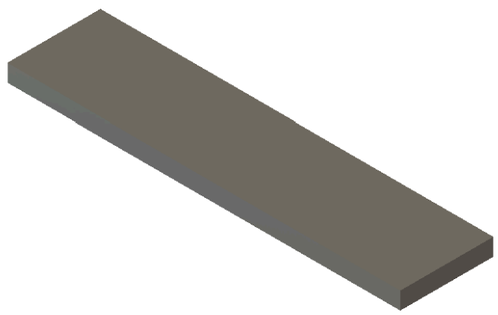
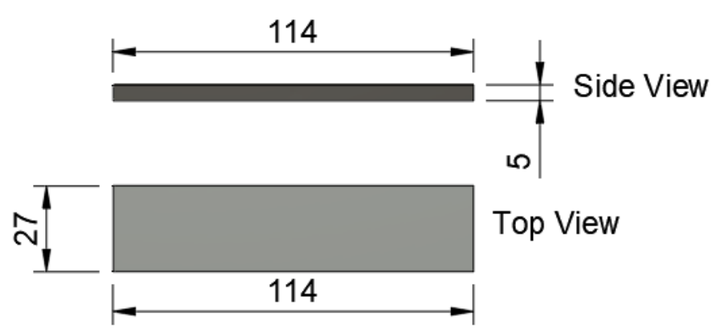


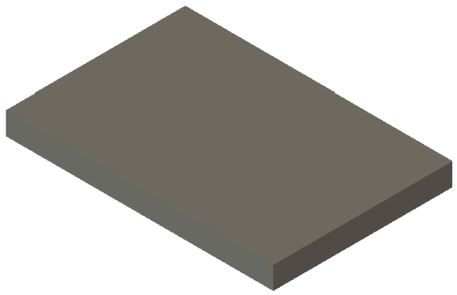
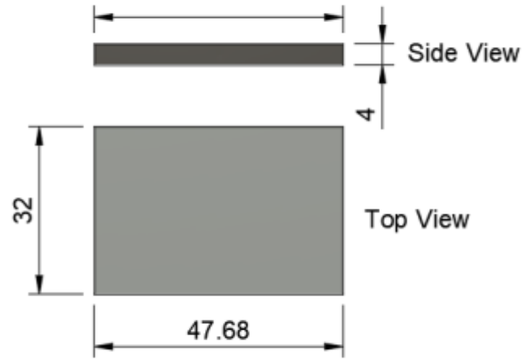
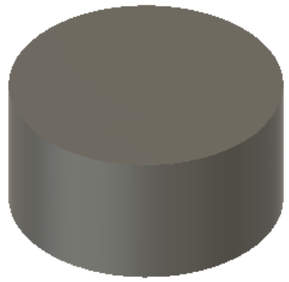
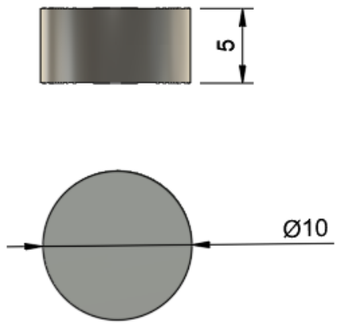
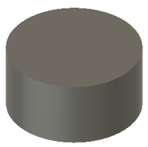
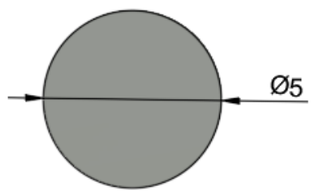
Drawer Assembly(DR)



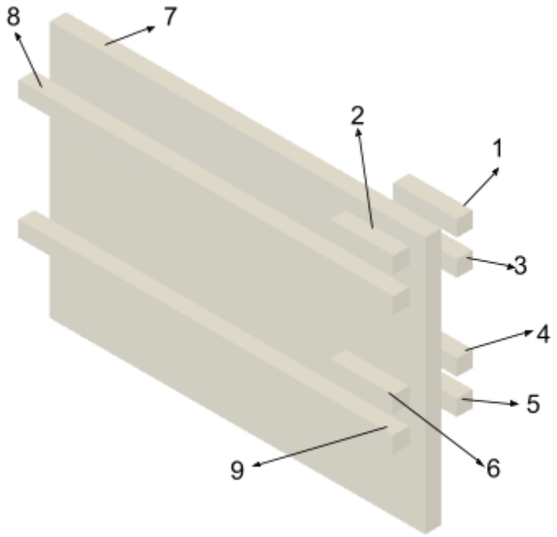


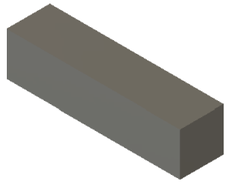
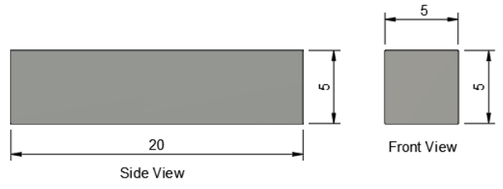
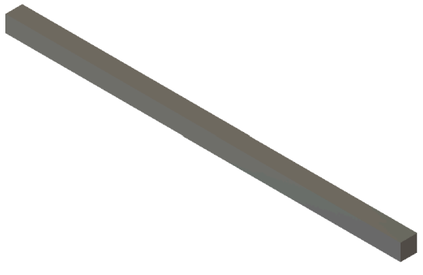
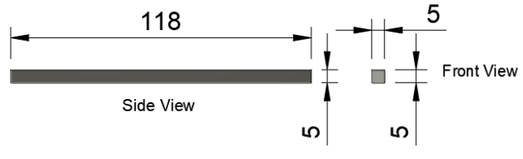
Part Number	Image	Dimension	Description
1 & 8			**Guide Rail** – A piece used to position and guide the drawer correctly within the outer guide mechanism.
6			Base of the drawer

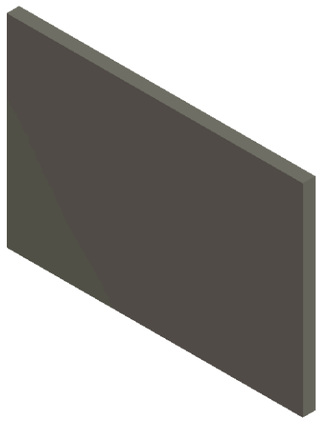
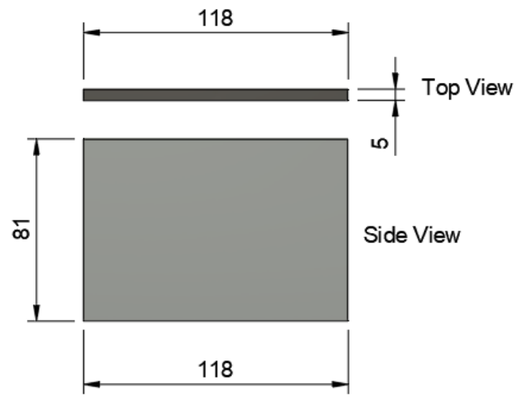
3 & 9			Stopper - Stops the drawer from completely being removed
2			Back cover of the drawer
7 & 4			Side cover of the Drawer

5			Front Cover of the drawer
11			Bigger Circle of the Handle.Made of the 5 mm Acrylic
10			Smaller Circle of the Handle.Made of the 2 mm Acrylic

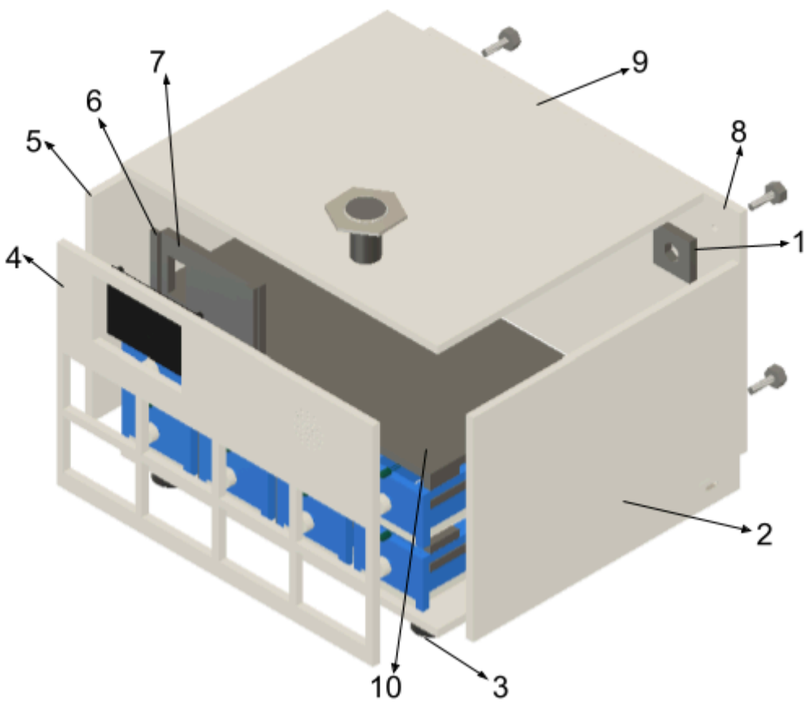
Interguide Assembly(IA)

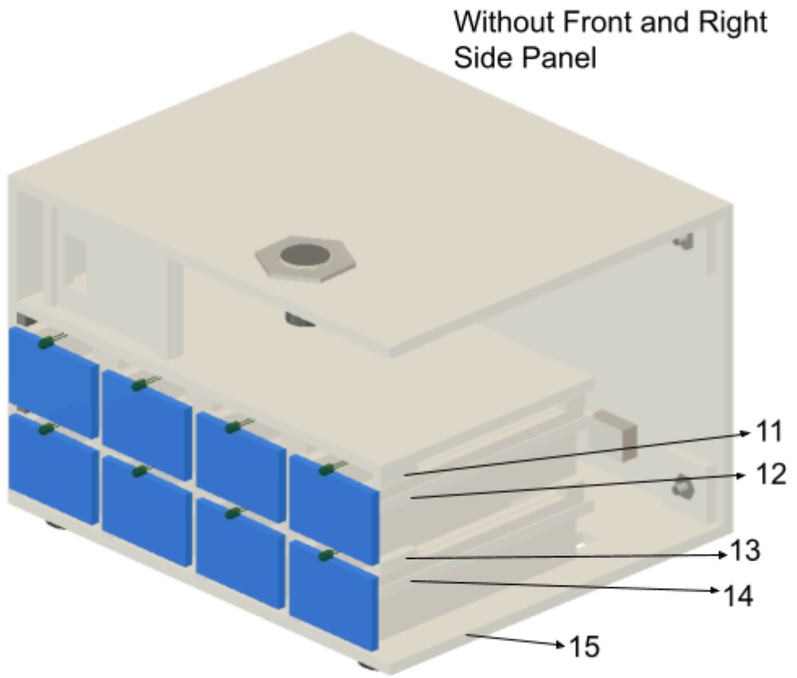


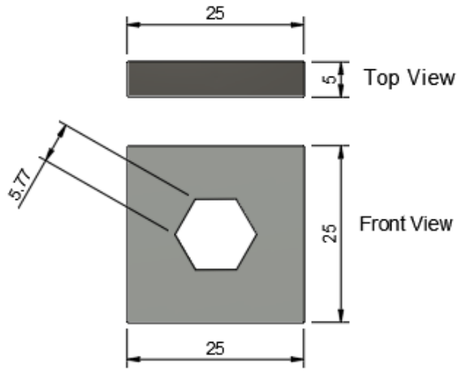
Part Number	Image	Dimension	Description
1 & 2 & 4 & 6			**Upper Guide Rail** – A shorter guide rail that acts as a stopper, preventing the drawer from being pulled completely out of the structure.
3 & 8 & 5 & 9			**Lower Guide Rail** – This rail supports the drawer rail, allowing the drawer to slide smoothly in and out.

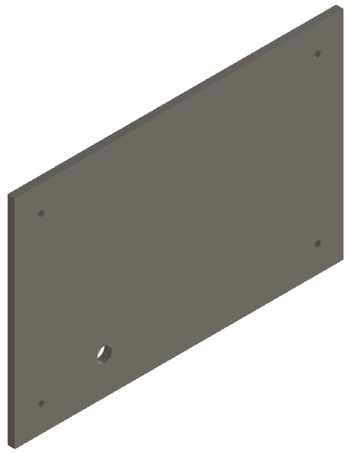
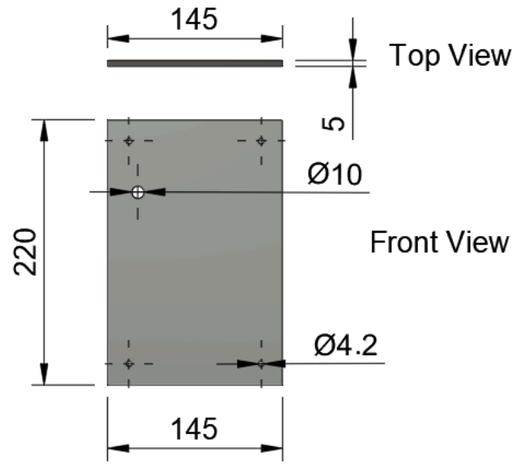
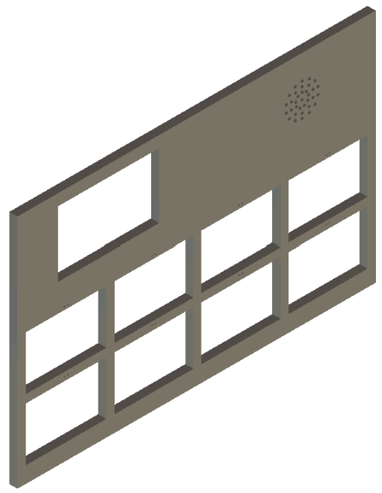
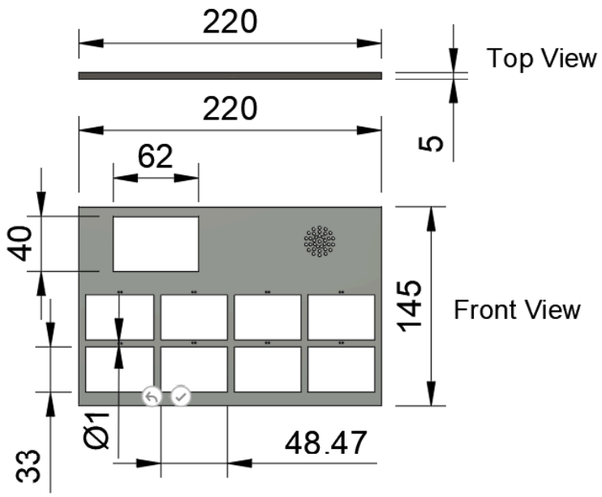
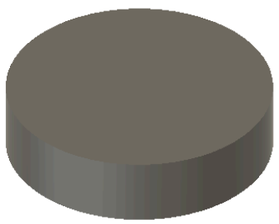
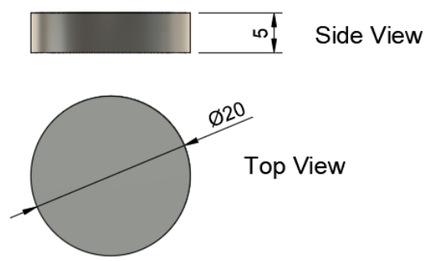
7			**Main Body of the Interguide Assembly** – Provides the main structural framework, allowing the guide rails to be positioned accurately and securely in the correct locations.

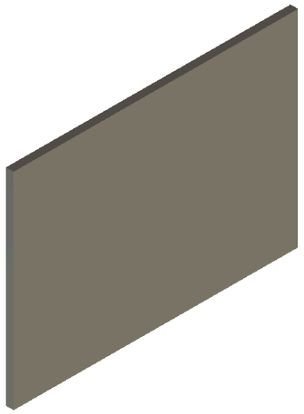
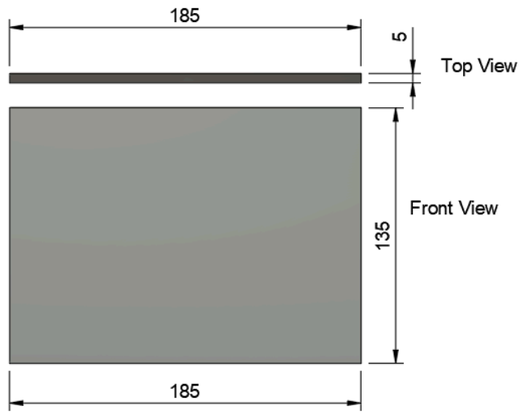
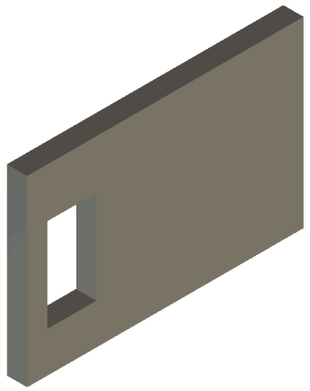
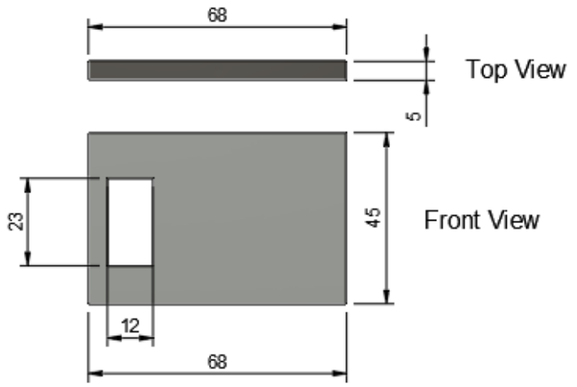
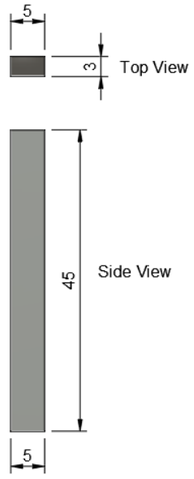
Outer Structure(OS)

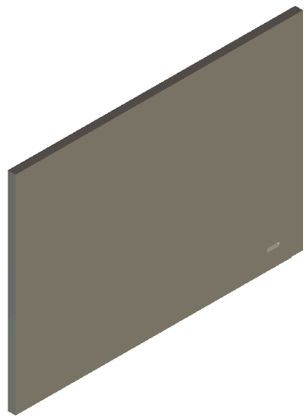
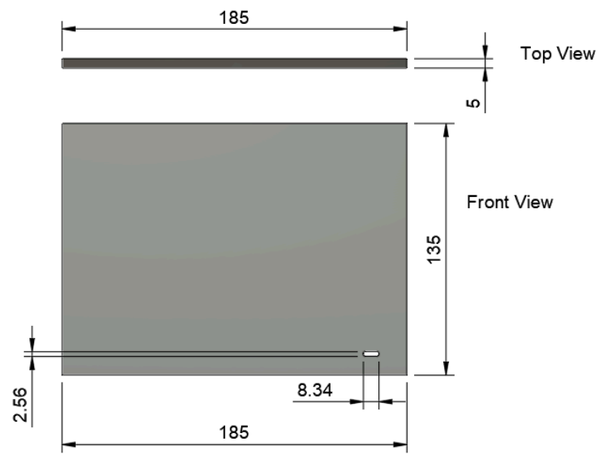
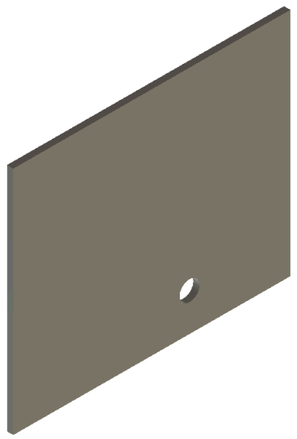
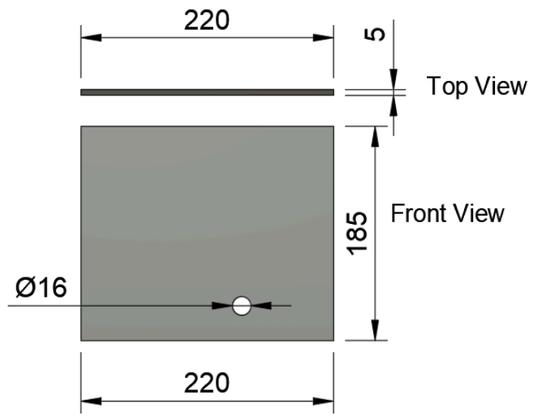
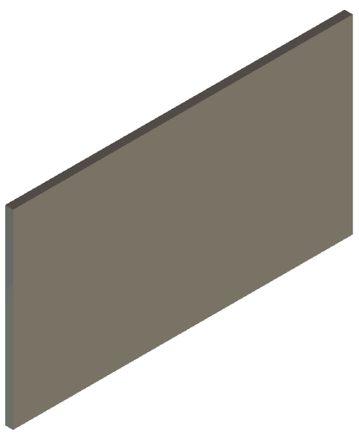
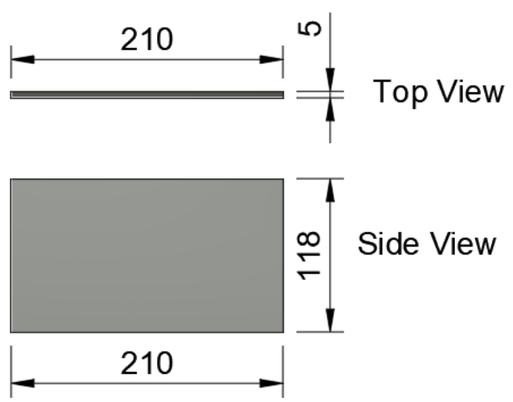


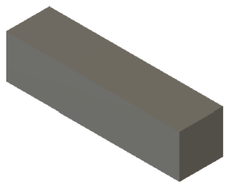
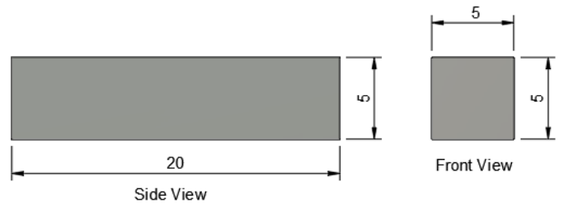
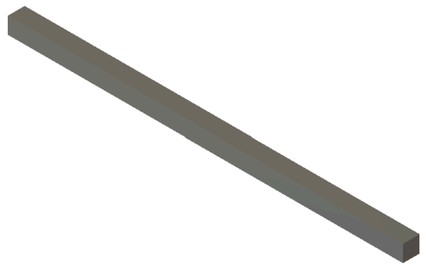
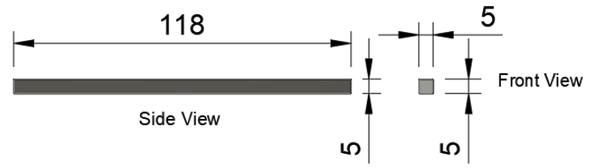
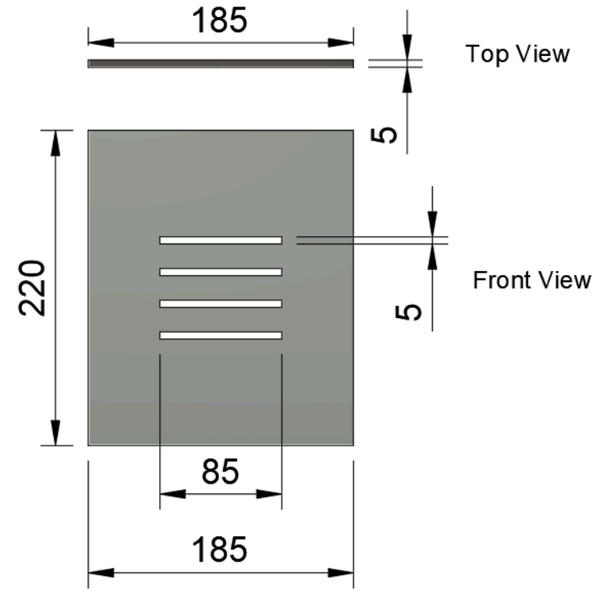


Part Number	Image	Dimension	Description
1			**Hold a Hexagonal Nut -** Allows the back panel to be removed if required

2			**Back Panel -** Has holes in the 4 corners for the bolts and 1 hole for the power switch
4			**Front Panel -** Has cutouts for the display , speaker, the drawers and the LED .
3			**Floor Glide** – Prevents the product from sliding or moving while it is in use, improving overall stability.

5			**Left Side Panel**
7			**Display Mount -** The display will be attached to this piece.The hole is to route the wires from the display.
6			**Display Mount Spacer -** Creates Space between the Display Mount (7) and the Front Panel(4).This allows the display screen to sit flush with the front panel.

8			**Right Side Panel-** Has a hole for the charging port
9			**Top Panel -** Has a hole for the confirmation switch
10			**Top Drawer Cover –** Separates and protects the top drawers from the electronics housed above, preventing contact between the medication compartments and electronic components.

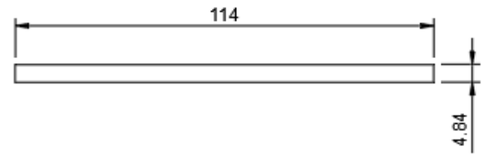
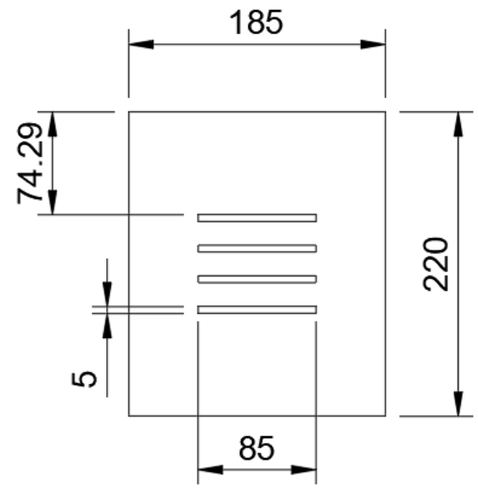
11 & 13			**Stopper -** Stops the drawer from completely being removed This piece is attached to the LeftSidePanel(5) and the RightSide Panel(8)
12 & 14			**Lower Guide Rail** – This rail supports the drawer rail, allowing the drawer to slide smoothly in and out. This piece is attached to the LeftSidePanel(5) and the RightSide Panel(8)
15			**Base Panel** – Forms the base of the entire structure and includes rectangular ventilation holes that allow airflow, helping to dissipate heat and keep the electronic components cool.

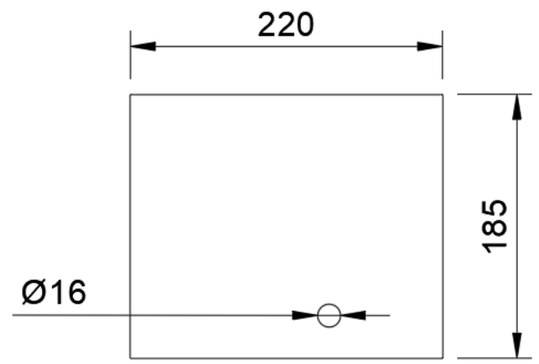
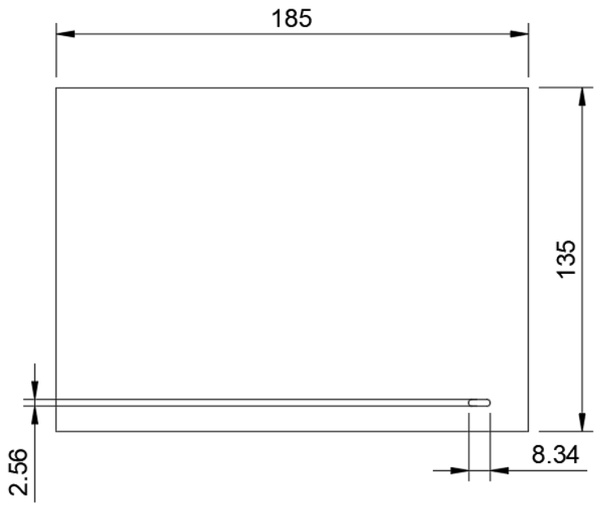
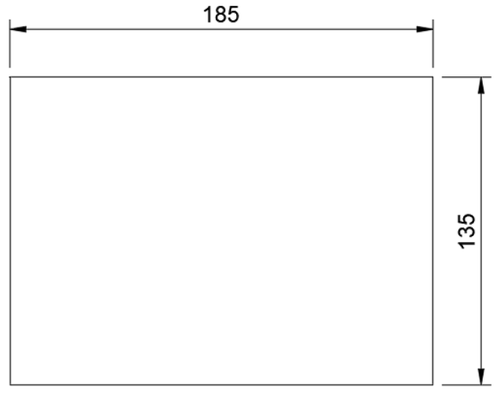
Cutting List

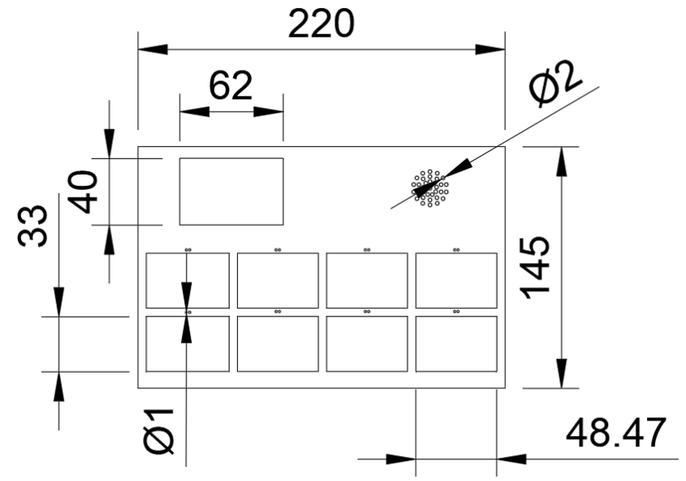
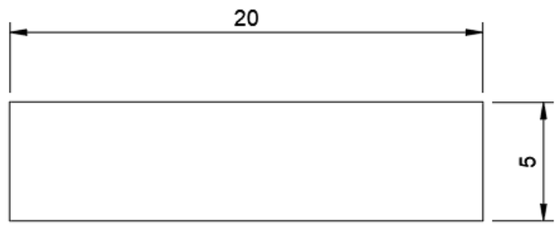
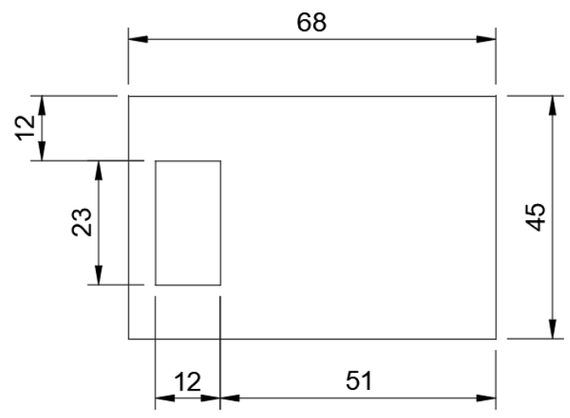
OS = Outer Structure

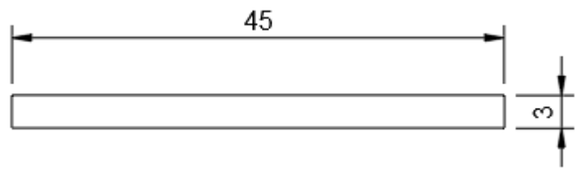
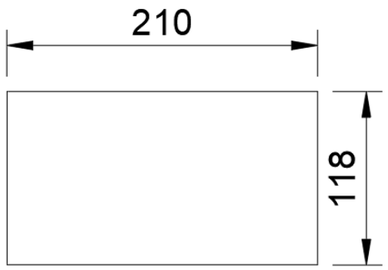
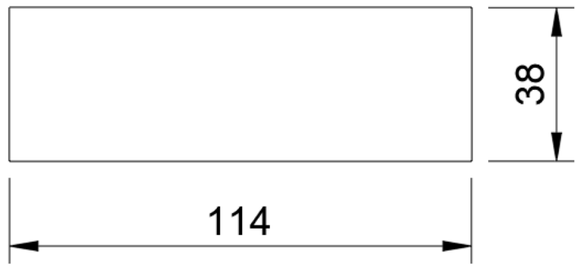
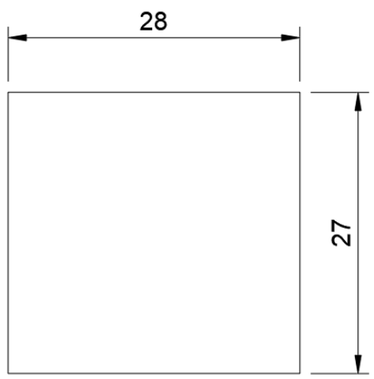
DG = Interguide Assembly

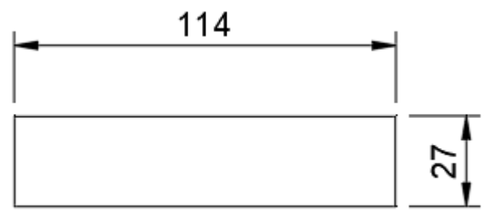
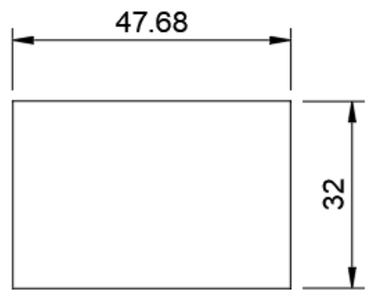
DR = Drawer Component

Part No.	Part Name	Material	Quantity	Dimensions
DR-1 DR-8 IA -3 IA -8 IA -5 IA -9 OS -12 OS -14	Lower Guide Rail	Acrylic	32	
OS - 15	Base Panel	Acrylic	1	

OS - 9	Top Panel	Acrylci	1	
OS-2	Right Panel	Acrylic	1	
OS -5	Left Panel	Acrylic	1	

OS-4	Front Panel	Acrylic	1	
OS-11 OS-13 IA - 1 IA - 2 IA - 4 IA - 6	Upper Guide Rail	Acrylic	16	
OS - 7	Display Mount	Acrylic	1	

OS-6	Display Mount Spacer	Acrylic	2	
OS -10	Top Drawer Cover	Acrylic	1	
DR - 6	Drawer Base	Acrylic	8	
DR - 2	Drawer Back Cover	Acrylic	8	

DR - 7 DR - 4	Drawer Side	Acrylic	16	
DR - 5	Drawer Front	Acrylic(2mm)	16	

Fabrications Process

1. Design the parts mentioned in CAD(Fusion 360)
2. Convert the CAD designs to DXF format.
3. Open the CNC Machine's Cutting software and open the DXF file in that software
4. Prepare the CNC Laser cutter and place the Acrylic sheet in the machine.

   Note : The Acrylic sheet, if obtained as a big sheet , should be cut into a size in which the laser cutter can accommodate.

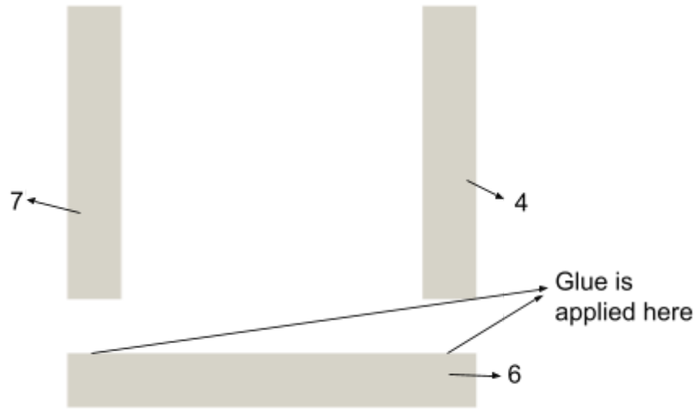
5. Laser-Cut the parts

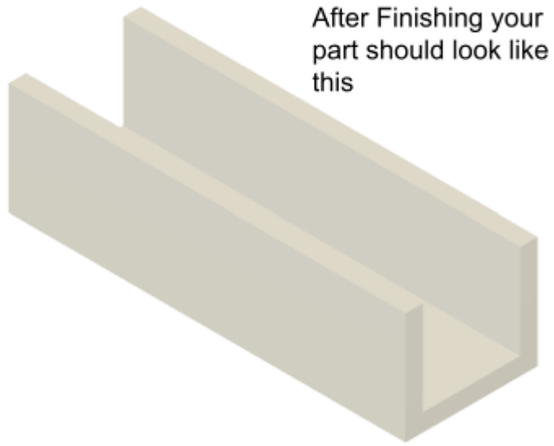
   Note : Try to fit as many parts as possible in a single sheet

6. Assemble the pieces and segregate cut pieces according to the final assembly parts they will be glued to
7. Peel the protective layer from the acrylic sheet.

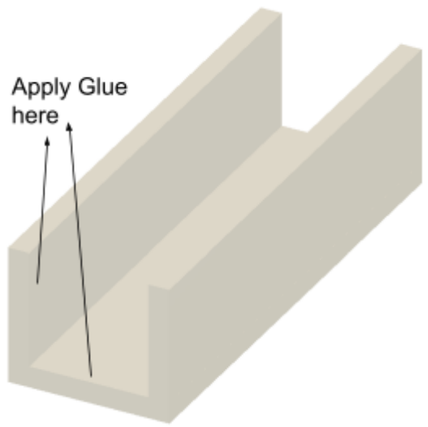
8. Start by assembling the Drawers

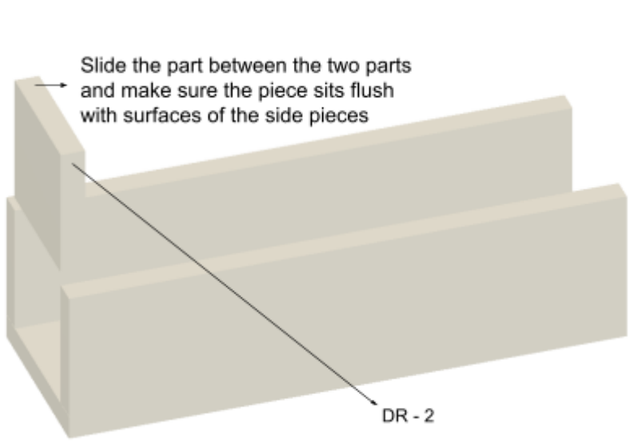
Required Parts : DR - 6 ,DR -7, DR - 4



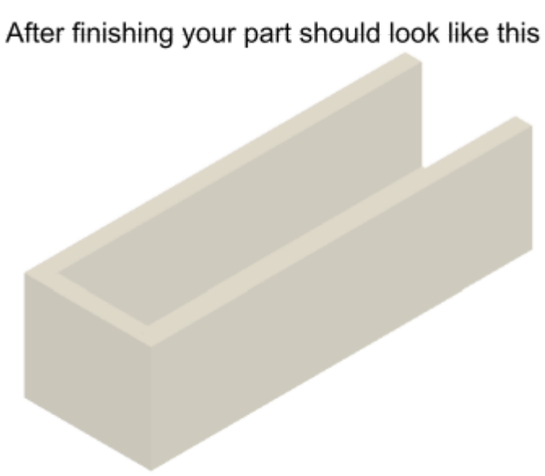


9. Required Parts : DR -2

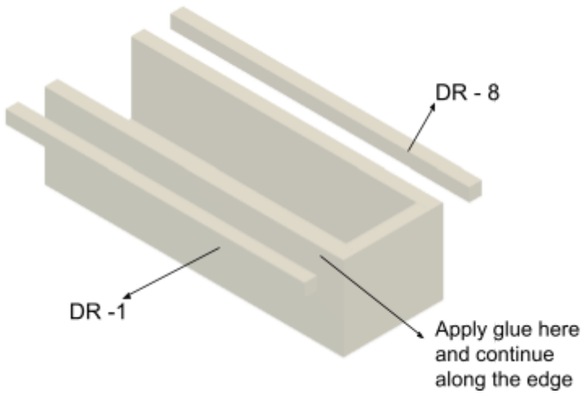




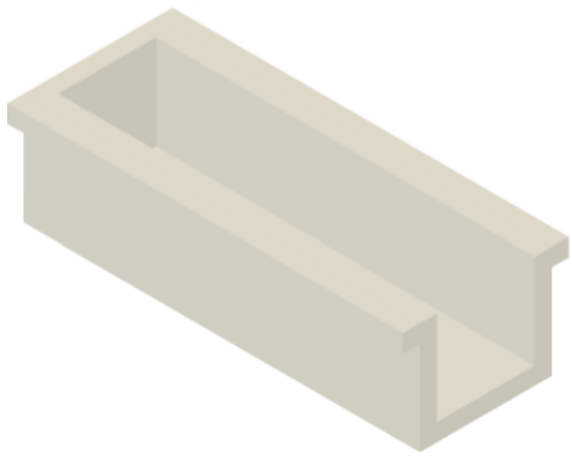
After finishing your part should look like this



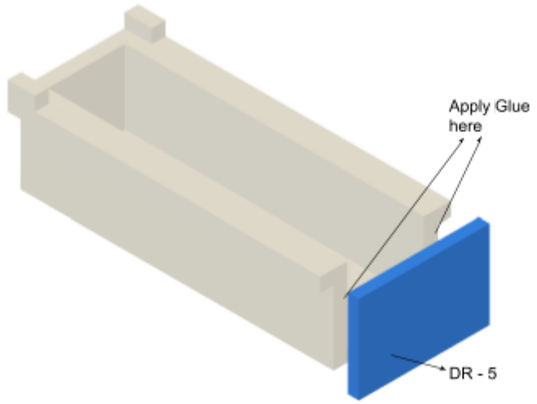
10. Required Parts : DR - 8 ,DR - 1

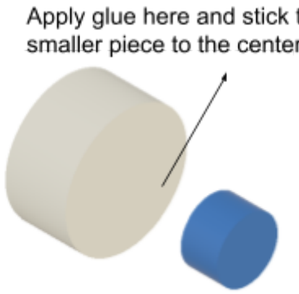


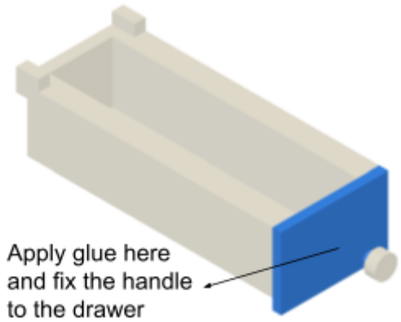
After finishing your part should look like this

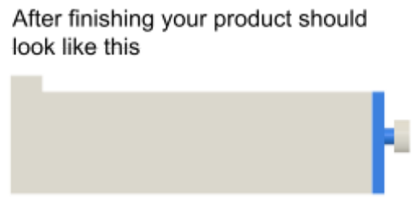


11. Required Parts : DR - 5 , DR-10 , DR -11



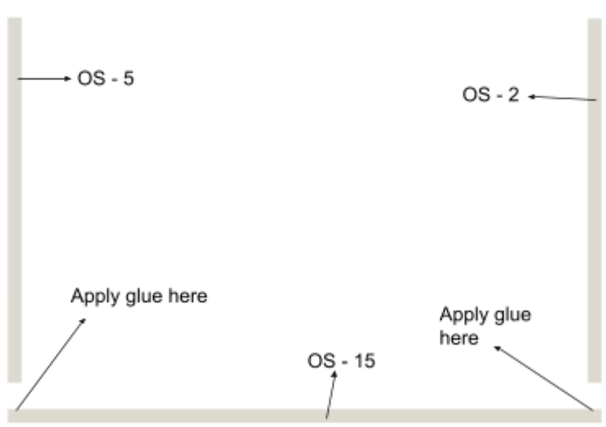


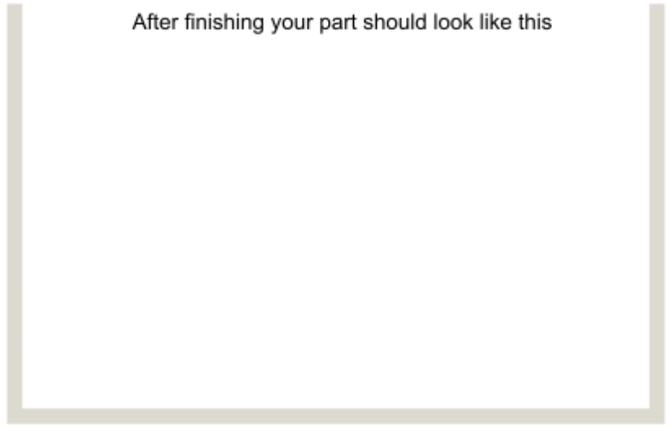




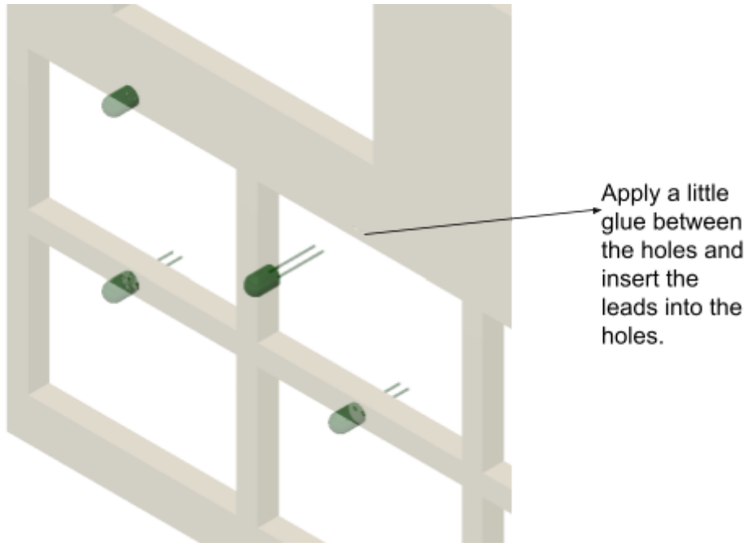
12. Assemble the main structure

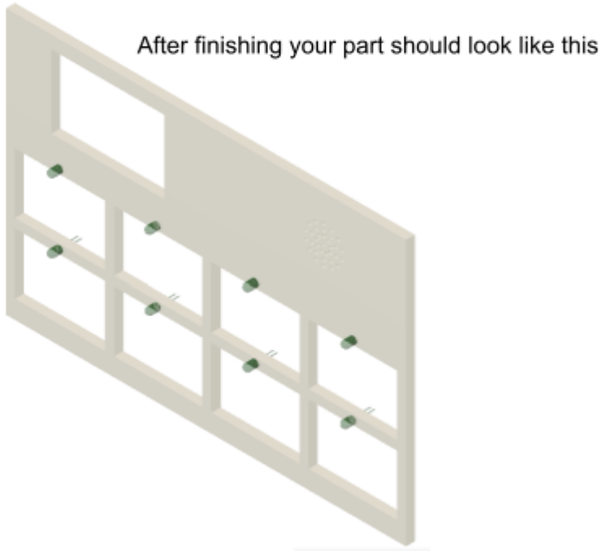
Required Parts : OS -2 , OS - 5



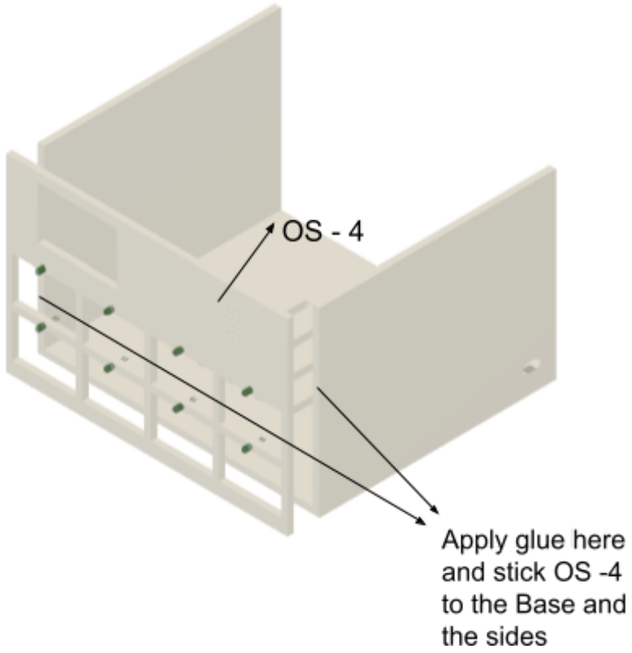


13. Required Parts : OS - 5 and LEDs



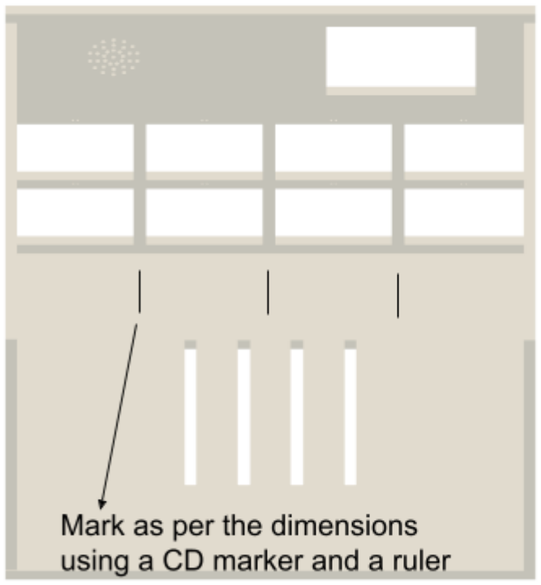


14. Required Parts : OS - 4



After finishing your part should look like this

15. Required Parts : Nil

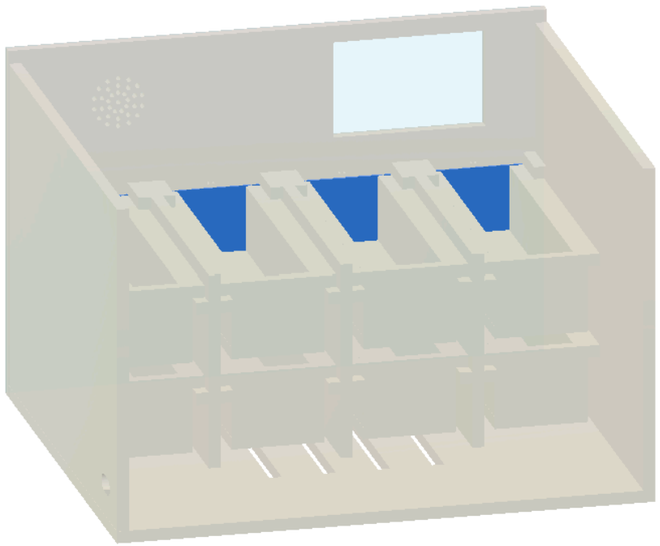


16. Required Parts : Interguide(Composite part)

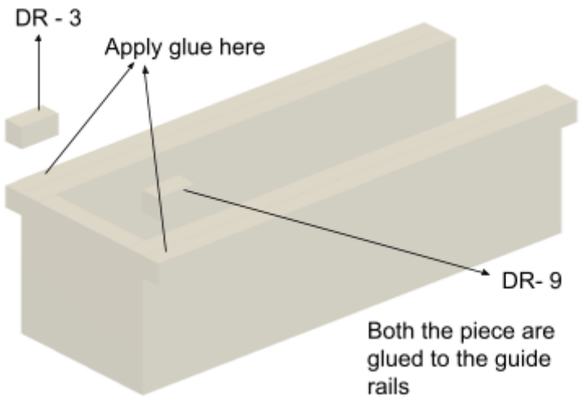
Apply glue along the lines marked one at a time and place the Interguide pieces on the lines

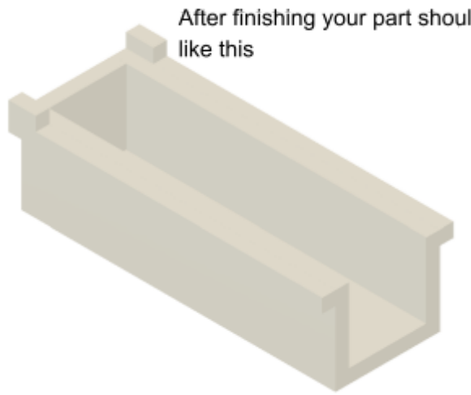
After finishing your part should look like this

17. Insert the Drawer from the front

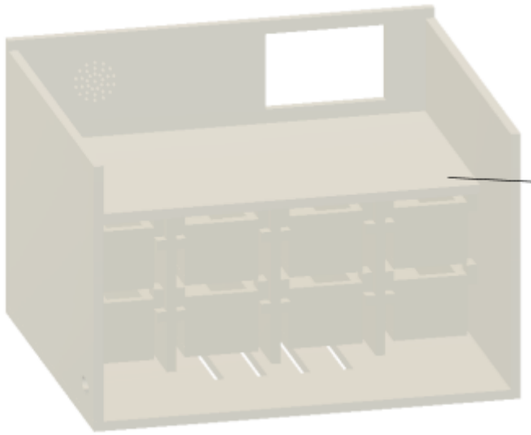


18. Required Parts : DR - 3 , DR - 9

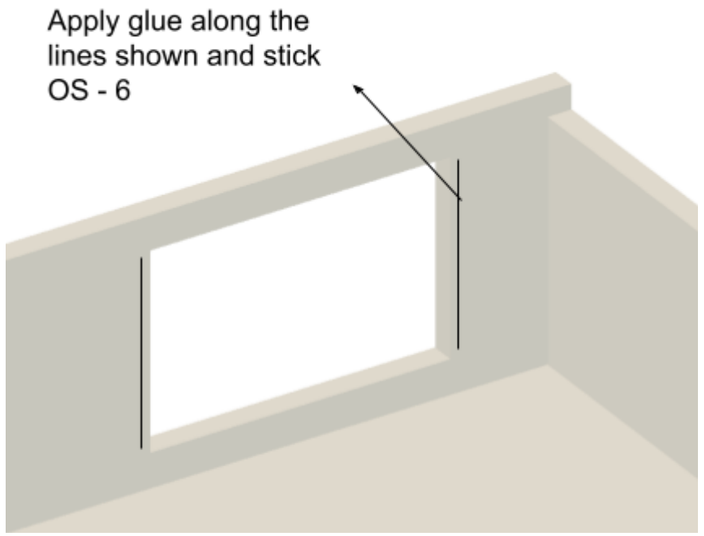


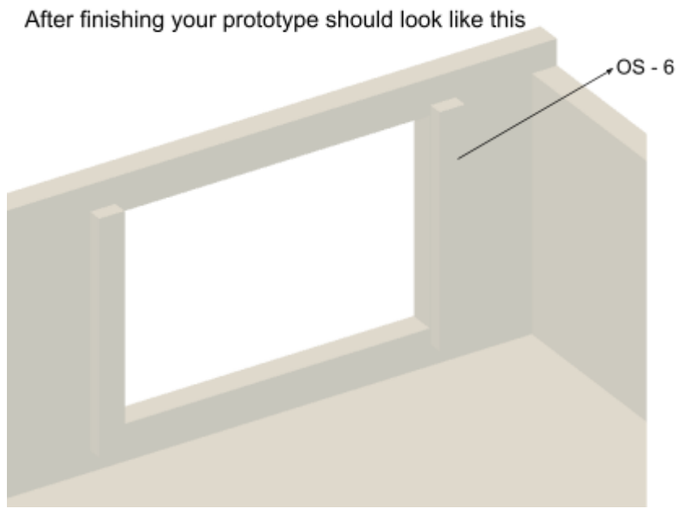


19. Required Parts : OS -10

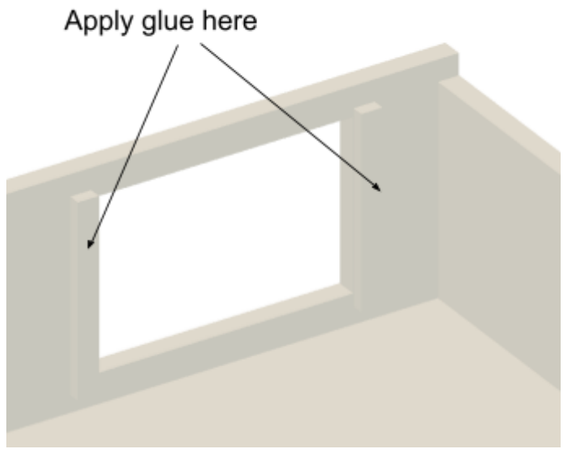


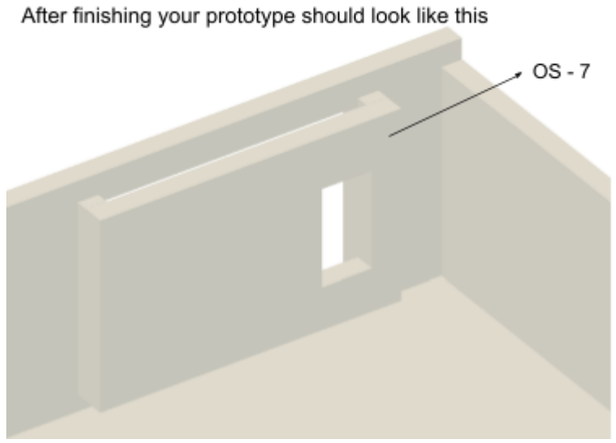
20. Required Parts : OS -6



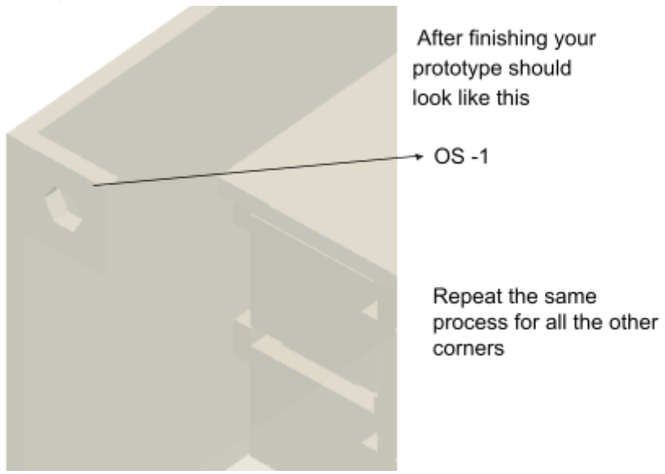


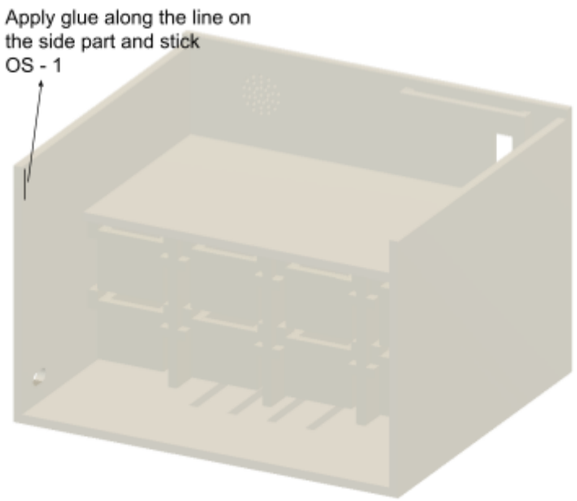
21. Required Parts : OS - 7



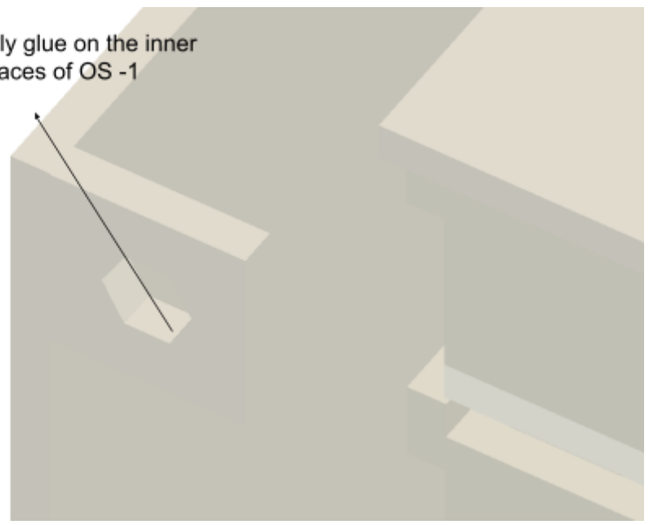


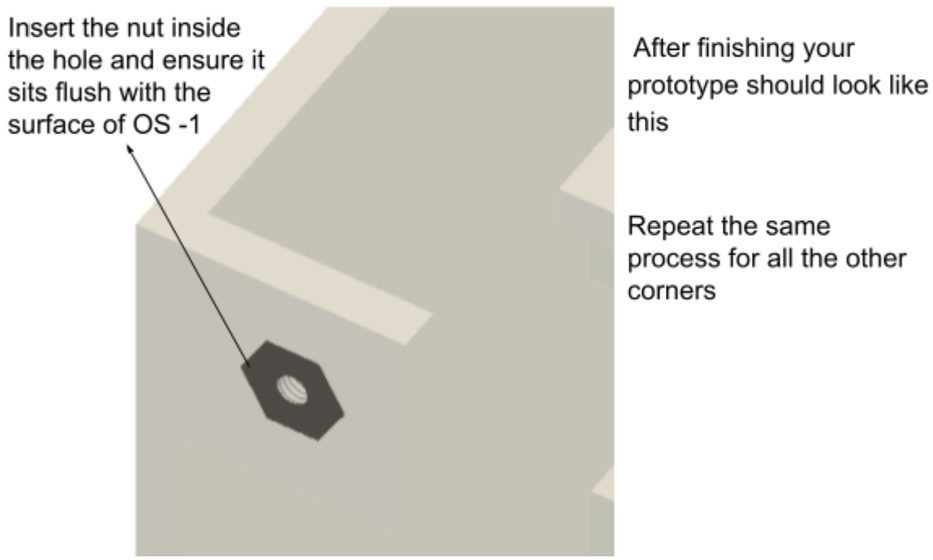
22. Required Parts : OS - 1



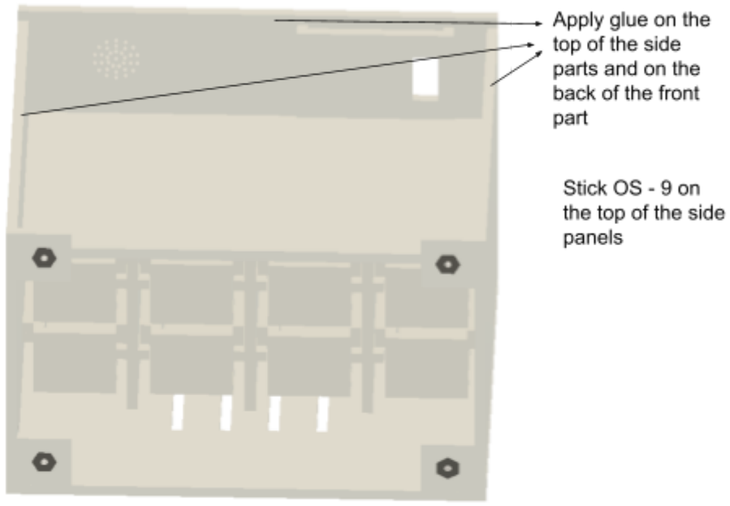


23. Required Parts : Hexagonal Nut(6 mm)

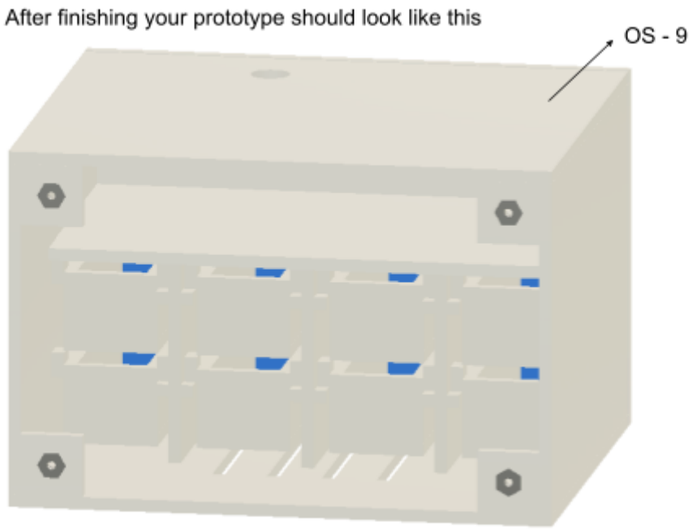




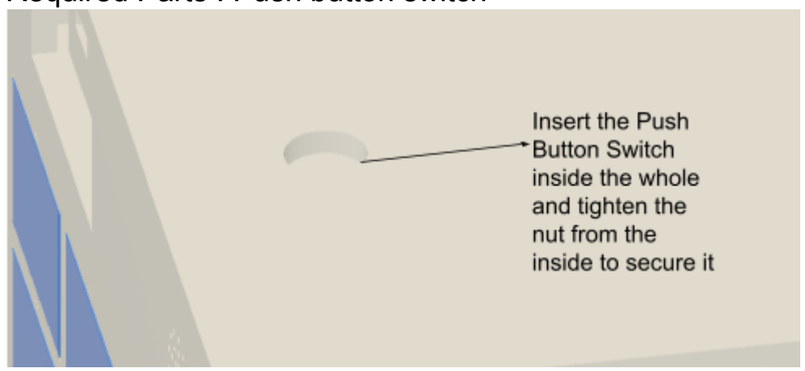
24. Required Parts : OS - 9



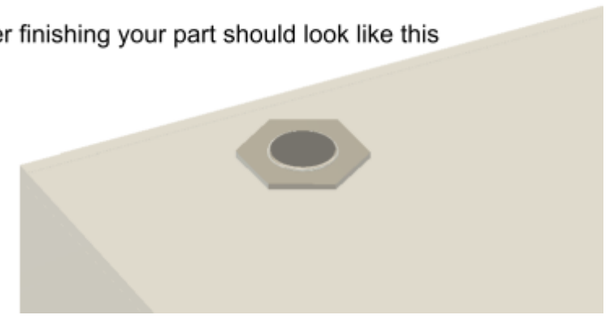
After finishing your prototype should look like this



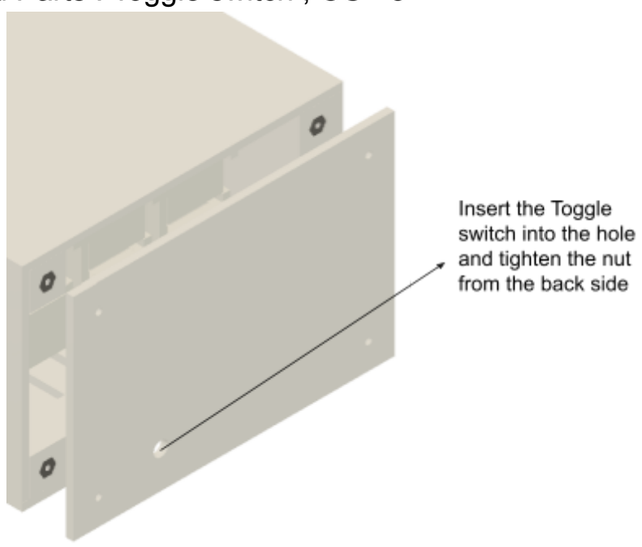
25. Required Parts : Push button switch

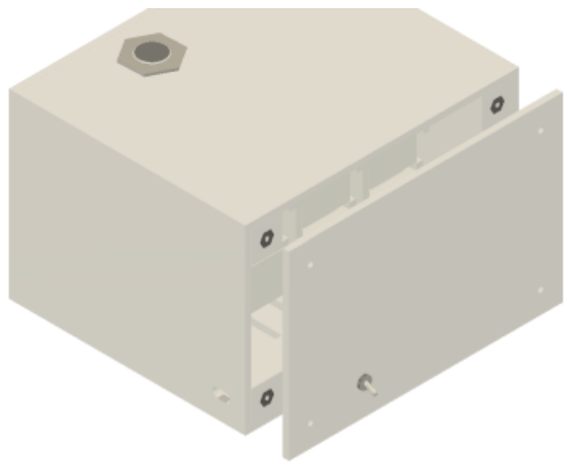


After finishing your part should look like this



26. Required Parts : Toggle switch , OS - 8





After finishing your part should look like this

27. Connect all the electronics

ESP32 to OLED display

OLED pin	ESP32 pin	Purpose
VCC	3.3V	Power
GND	GND	Ground
DIN	D23	SPI data
CLK	D18	SPI clock
CS	D5	Chip select
DC	D15	Data/command
RST	D14	Reset

ESP32 to DS3231 RTC

DS3231 pin	ESP32 pin	Purpose
VCC	3.3V	Power
GND	GND	Ground
SDA	D25	I²C data
SCL	D27	I²C clock

ESP32 to DFPlayer Mini

DFPlayer pin	ESP32 pin	Purpose
VCC	5V power rail	Power
GND	GND	Ground
RX	D12	ESP32 → DFPlayer
TX	D13	DFPlayer → ESP32

DFPlayer Mini to speaker

DFPlayer pin	Speaker
SPK1	Speaker +
SPK2	Speaker −

LED to ESP32

LED	ESP32 GPIO
LED 1	D2
LED 2	D4
LED 3	D19
LED 4	D21
LED 5	D22
LED 6	D32
LED 7	D33
LED 8	D26

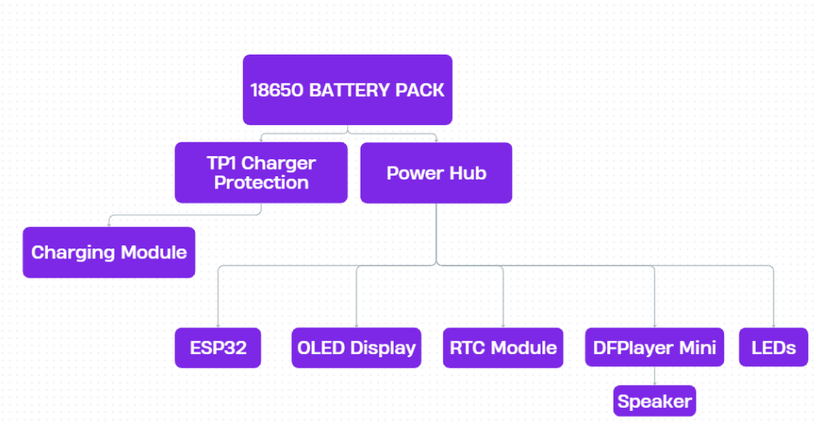
Component	Connection
LED anode (+)	To ESP32 through 220–330 Ω resistor
LED cathode (−)	GND

ESP32 to Confirmation push button (Using 5-pin SPDT PushButton)

Button pin	Connection To
C	GND
NO	D34
NC	Not connected
D34 to10 kΩ resistor (Because GPIO34 does not have an internal pull-up, hence the external 10 kΩ resistor is used.)	3.3V

Power Architecture

Component	Power	Ground
ESP32	Vin pin (5v) Vin pin has an inbuilt voltage regulator	Common GND
OLED	3.3V	GND
DS3231	3.3V	GND
DFPlayer Mini	5V	GND
LED 1	ESP32 GPIO through resistor	GND



LED 2	ESP32 GPIO through resistor	GND
LED 3	ESP32 GPIO through resistor	GND
LED 4	ESP32 GPIO through resistor	GND
LED 5	ESP32 GPIO through resistor	GND
LED 6	ESP32 GPIO through resistor	GND
LED 7	ESP32 GPIO through resistor	GND
LED 8	ESP32 GPIO through resistor	GND
Push button	GPIO + 10KΩ Resistor (3.3V pull-up)	GND

Final ESP32 Pin Allocation

Component	ESP32 pin	Function
LED 1	D2	Drawer 1 indicator
LED 2	D4	Drawer 2 indicator
OLED CS	D5	OLED SPI
DFPlayer RX	D12	ESP32 → DFPlayer
DFPlayer TX	D13	DFPlayer → ESP32
OLED RST	D14	OLED reset

Power

Component	Power
OLED	3.3 V
DS3231	3.3 V
DFPlayer	5 V
LEDs	From ESP32 GPIO through 220–330 Ω resistors
Button pull-up	10 kΩ to 3.3 V
All components	Common GND

OLED DC	D15	OLED data/command
OLED CLK	D18	OLED SPI clock
LED 3	D19	Drawer 3 indicator
LED 4	D21	Drawer 4 indicator
LED 5	D22	Drawer 5 indicator
OLED DIN	D23	OLED SPI data
RTC SDA	D25	I²C data
LED 8	D26	Drawer 8 indicator
RTC SCL	D27	I²C clock
LED 6	D32	Drawer 6 indicator
LED 7	D33	Drawer 7 indicator
Confirmation button	D34	User confirmation

Blynk data arrangement(App setup)

Blynk Virtual Pin	Data	Example
V0	Medicine 1 name	Paracetamol
V1	Medicine 1 time	08:00
V2	Medicine 2 name	Vitamin D

V3	Medicine 2 time	13:00
V4	Medicine 3 name	Medicine C
V5	Medicine 3 time	20:00
V6	Medicine 4 name	Medicine D
V7	Medicine 4 time	08:00
V8	Medicine 5 name	Medicine E
V9	Medicine 5 time	13:00
V10	Medicine 6 name	Medicine F
V11	Medicine 6 time	20:00
V12	Medicine 7 name	Medicine G
V13	Medicine 7 time	08:00
V14	Medicine 8 name	Medicine H
V15	Medicine 8 time	20:00
V16	History/status	Taken / Missed
V17	Current drawer	1–8
V18	Reset	Button

Final Code

Read code from left section until the end and then start reading the right section from the start of the table

```
// SMART MEDICATION REMINDER SYSTEM
#define BLYNK_TEMPLATE_ID "TMPL3tw5JGhCh"
#define BLYNK_TEMPLATE_NAME "Automatic Medicine Reminder"
#define BLYNK_AUTH_TOKEN "YOUR_BLYNK_AUTH_TOKEN"
#define BLYNK_PRINT Serial
#include <WiFi.h>
#include <BlynkSimpleEsp32.h>
char ssid[] = "YOUR_WIFI_NAME";
char pass[] = "YOUR_WIFI_PASSWORD";
#include <Wire.h>
#include "RTClib.h"
RTC_DS3231 rtc;
#define RTC_SDA 25
#define RTC_SCL 27
#include <U8g2lib.h>
U8G2_SSD1309_128X64_NONAME0_F_4W_SW_SPI
oled(U8G2_R0,18,23,5,15,14);
#include "SoftwareSerial.h"
#include "DFRobotDFPlayerMini.h"
static const uint8_t PIN_MP3_TX=12;
static const uint8_t PIN_MP3_RX=13;
SoftwareSerial softwareSerial(PIN_MP3_RX,PIN_MP3_TX);
DFRobotDFPlayerMini player;
const int ledPins[8]={2,4,19,21,22,32,33,26};
#define BUTTON_PIN 34
bool buttonPreviouslyPressed=false;
String medicineName[8];
String medicineTime[8];
int activeDrawer=-1;
bool alarmActive=false;
bool reminderHandled[8]={false,false,false,false,false,false,false,false};
int lastMinute=-1;

// BLYNK INPUTS
BLYNK_WRITE(V0){medicineName[0]=param.asString();}
BLYNK_WRITE(V1){medicineTime[0]=param.asString();}
BLYNK_WRITE(V2){medicineName[1]=param.asString();}
BLYNK_WRITE(V3){medicineTime[1]=param.asString();}
```

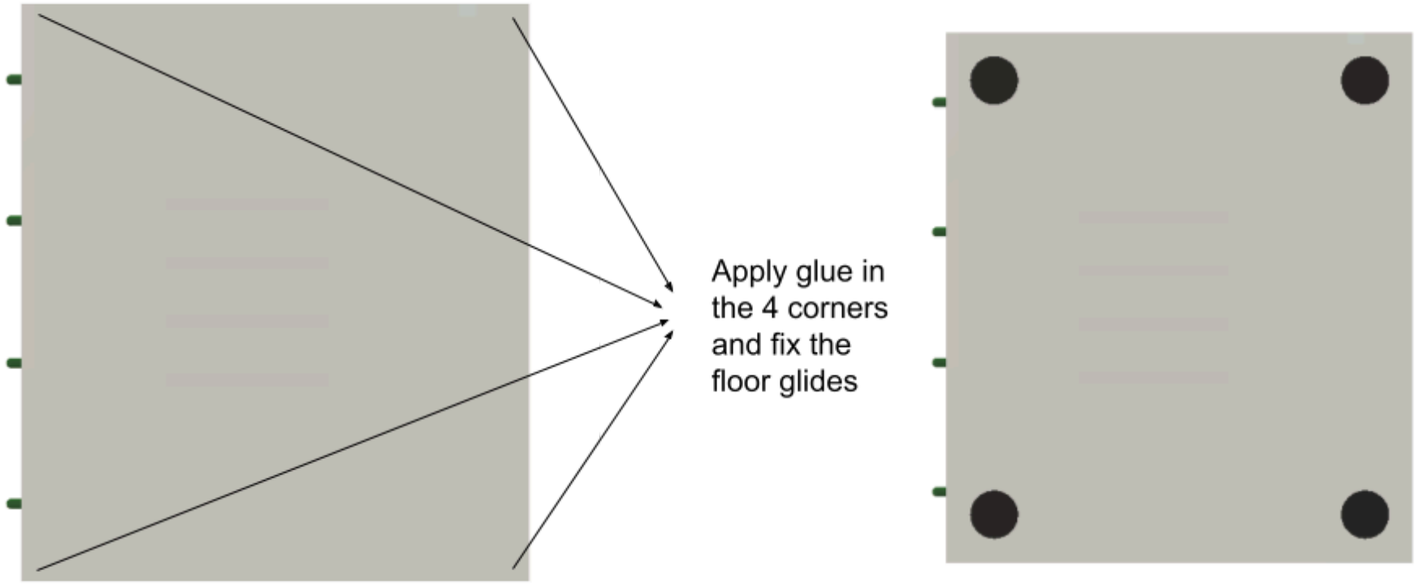
```
void turnOffAllLEDs(){
  for(int i=0;i<8;i++) digitalWrite(ledPins[i],LOW);
}
//ACTIVATE DRAWER
void activateDrawer(int drawer){
  activeDrawer=drawer;
  alarmActive=true;
  turnOffAllLEDs();
  digitalWrite(ledPins[drawer],HIGH);
  showMedicine(drawer);
  playMedicineAudio(drawer);
  Blynk.virtualWrite(V17,drawer+1);
  Blynk.virtualWrite(V16,"REMINDER ACTIVE");
}
//CONFIRM MEDICINE
void confirmMedicine(){
  if(!alarmActive)return;
  digitalWrite(ledPins[activeDrawer],LOW);
  oled.clearBuffer();
  oled.setFont(u8g2_font_6x10_tf);
  oled.drawStr(0,20,"MEDICINE CONFIRMED");
  oled.drawUTF8(0,40,medicineName[activeDrawer].c_str());
  oled.sendBuffer();
  Blynk.virtualWrite(V16,"TAKEN");
  alarmActive=false;
  activeDrawer=-1;
}

void checkButton(){
  bool buttonPressed=digitalRead(BUTTON_PIN)==LOW;
                        if(buttonPressed&&!buttonPreviouslyPressed)
confirmMedicine();
  buttonPreviouslyPressed=buttonPressed;
}
//CHECK MEDICATION TIMES
void checkMedicationTimes(){
  DateTime now=rtc.now();
  if(now.minute()!=lastMinute){
```

```
BLYNK_WRITE(V4){medicineName[2]=param.asString();}
BLYNK_WRITE(V5){medicineTime[2]=param.asString();}
BLYNK_WRITE(V6){medicineName[3]=param.asString();}
BLYNK_WRITE(V7){medicineTime[3]=param.asString();}
BLYNK_WRITE(V8){medicineName[4]=param.asString();}
BLYNK_WRITE(V9){medicineTime[4]=param.asString();}
BLYNK_WRITE(V10){medicineName[5]=param.asString();}
BLYNK_WRITE(V11){medicineTime[5]=param.asString();}
BLYNK_WRITE(V12){medicineName[6]=param.asString();}
BLYNK_WRITE(V13){medicineTime[6]=param.asString();}
BLYNK_WRITE(V14){medicineName[7]=param.asString();}
BLYNK_WRITE(V15){medicineTime[7]=param.asString();}

BLYNK_WRITE(V18){
  if(param.asInt()==1){
    alarmActive=false;
    activeDrawer=-1;
    turnOffAllLEDs();
    Blynk.virtualWrite(V16,"SYSTEM RESET");
    Blynk.virtualWrite(V17,0);
    oled.clearBuffer();
    oled.setFont(u8g2_font_6x10_tf);
    oled.drawStr(0,25,"SYSTEM RESET");
    oled.sendBuffer();
    delay(1000);
  }
}

void showMedicine(int drawer){
  oled.clearBuffer();
  oled.setFont(u8g2_font_6x10_tf);
  oled.drawStr(0,12,"MEDICATION REMINDER");
  oled.drawStr(0,28,"Medicine:");
  oled.drawUTF8(0,40,medicineName[drawer].c_str());
  oled.drawStr(0,55,"Time:");
  oled.drawUTF8(35,55,medicineTime[drawer].c_str());
  oled.sendBuffer();
}

void playMedicineAudio(int drawer){
  player.play(drawer+1);
}
```

```
    for(int i=0;i<8;i++) reminderHandled[i]=false;
    lastMinute=now.minute();
  }
  if(alarmActive)return;
  char currentTime[6];
  sprintf(currentTime,"%02d:%02d",now.hour(),now.minute());
  String currentTimeString=String(currentTime);
  for(int i=0;i<8;i++){

if(medicineTime[i]!=""&&medicineTime[i]==currentTimeString&
&!reminderHandled[i]){
      reminderHandled[i]=true;
      activateDrawer(i);
      break;
    }
  }
}

void setup(){
  Serial.begin(9600);
  for(int i=0;i<8;i++){
    pinMode(ledPins[i],OUTPUT);
    digitalWrite(ledPins[i],LOW);
  }
  pinMode(BUTTON_PIN,INPUT);
  Wire.begin(RTC_SDA,RTC_SCL);
  if(!rtc.begin()) Serial.println("RTC NOT FOUND!");
  else Serial.println("RTC connected.");
  oled.begin();
  oled.clearBuffer();
  oled.setFont(u8g2_font_6x10_tf);
  oled.drawStr(0,20,"SMART MEDICATION");
  oled.drawStr(0,40,"SYSTEM STARTING...");
  oled.sendBuffer();
  softwareSerial.begin(9600);
  Serial.println("Starting DFPlayer...");
  if(player.begin(softwareSerial)){
    Serial.println("DFPlayer connected!");
    player.volume(30);
  }else{
    Serial.println("DFPlayer connection FAILED!");
  }
```

```
  Serial.println("Connecting to Blynk...");
  Blynk.begin(BLYNK_AUTH_TOKEN,ssid,pass);
  oled.clearBuffer();
  oled.setFont(u8g2_font_6x10_tf);
  oled.drawStr(0,20,"SMART MEDICATION");
  oled.drawStr(0,40,"SYSTEM READY");
  oled.sendBuffer();
  Serial.println("SYSTEM READY");
}

void loop(){
  Blynk.run();
  checkButton();
  checkMedicationTimes();
  DateTime now=rtc.now();
  char currentTime[6];
  sprintf(currentTime,"%02d:%02d",now.hour(),now.minute());
  Blynk.virtualWrite(V19,currentTime);
  delay(100);
}
```

28.

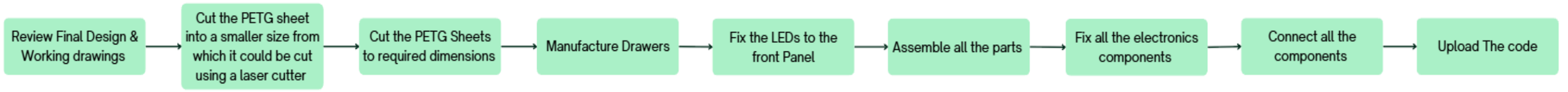


Gantt Chart

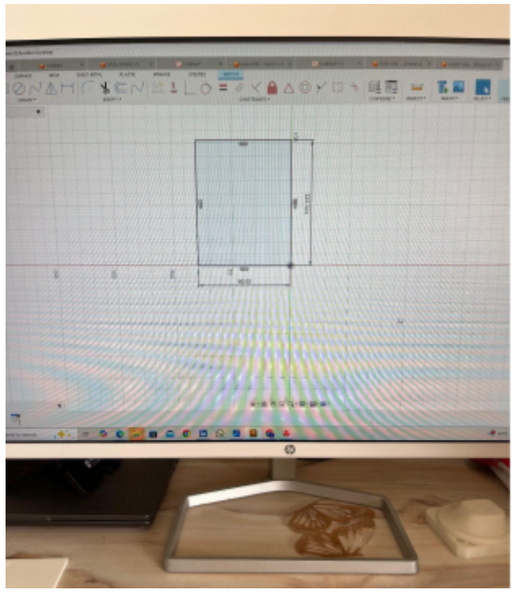
Activity	W1 (May1)	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16
Research & Investigation																
Target user & existing product research																
Materials & electronics research																
Specification & Ideas																
Design specification																
Ideation																
Select and develop final design																

Design Development																
CAD & working drawings																
Manufacturing plan																
Electronics & Programming																
Electronics testing & programming																
Product Manufacture																
Testing																
Final QC & evaluation																
Planning for Production in Quantity																

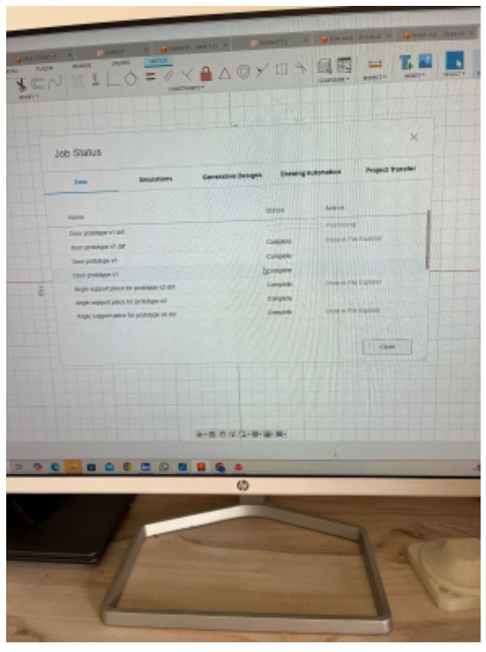
Flow chart



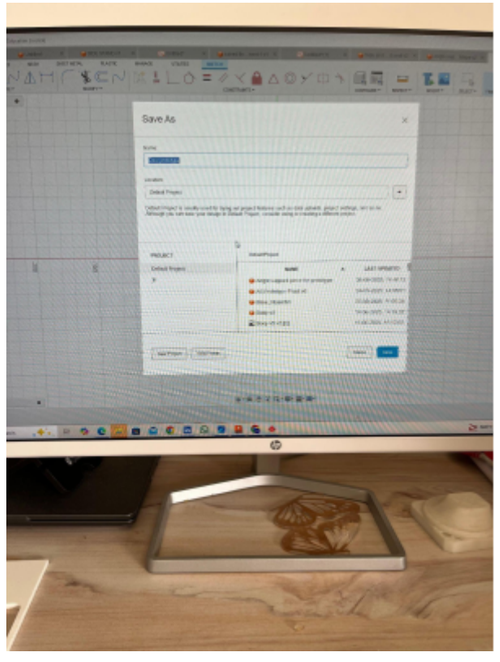
Manufacturing process

1. 

All parts are designed in fusion 360

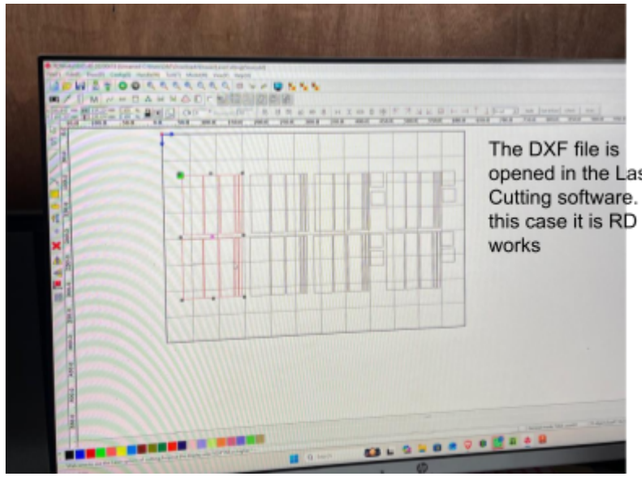
2. 

Exporting the file in DXF format



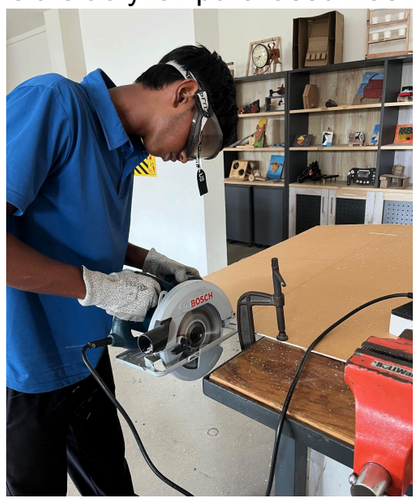
Save the file in a separate folder so that when printing its easier to identify and open.

3.



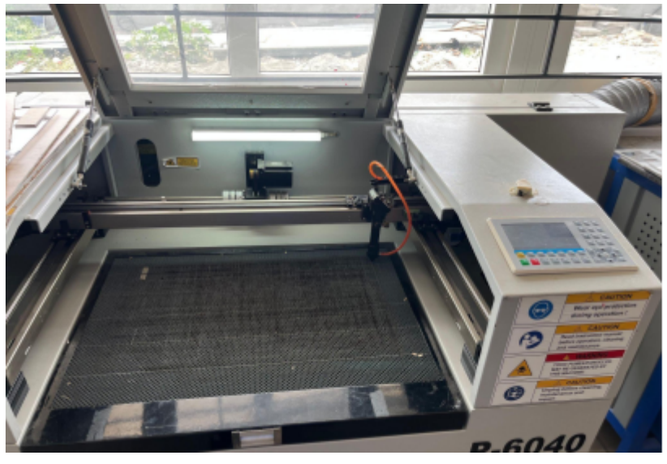
The DXF file is opened in the Laser Cutting software. In this case it is RD works

4. As the acrylic I purchased was very big , I had to cut it into smaller pieces using a circular saw.

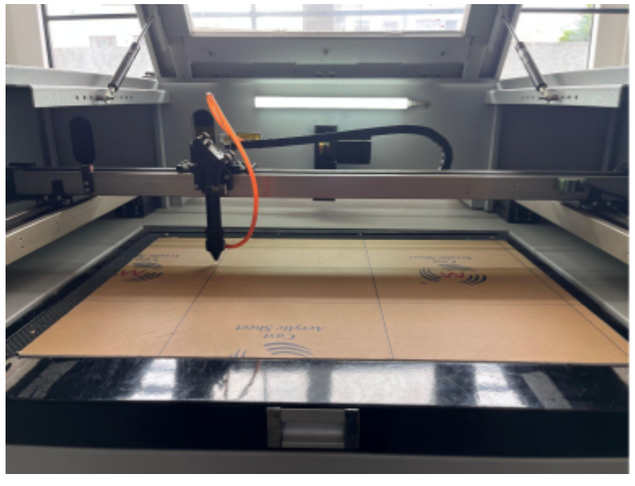


The big acrylic sheet was cut into 120 x 60 cm panels.

5.

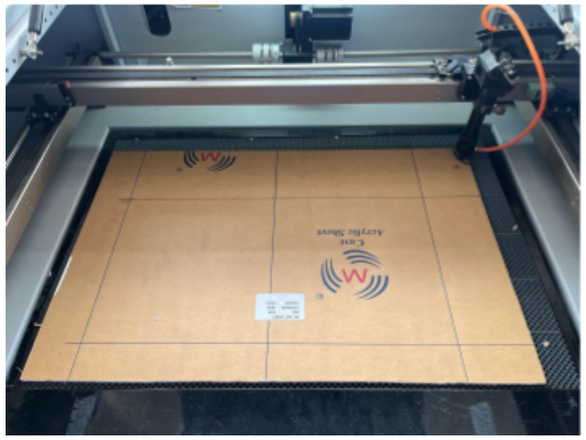


Turn the machine On and open the hood.



The CNC Laser cutter is cutting is cutting part by part.

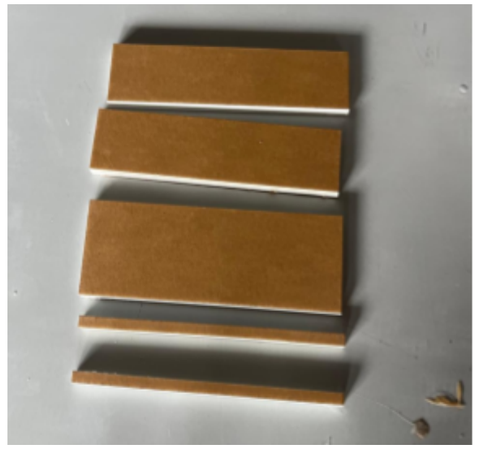
Speed used is 8 m/s
Intensity min 40% and max 65 %



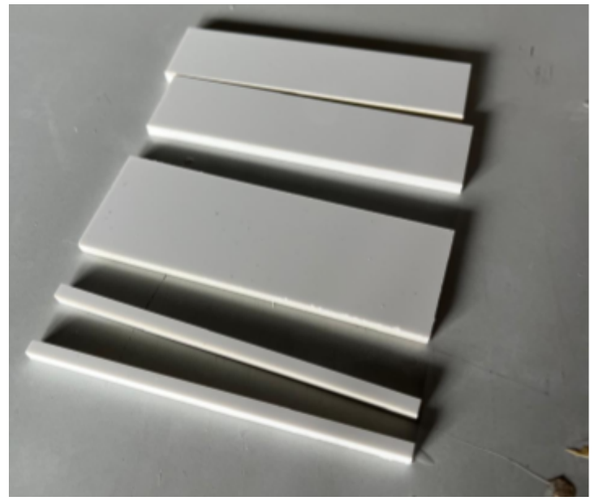
The acrylic sheet has been placed inside the machine and aligned to match the frame it is intended to cover.

6.

As there are many parts , I decided to cut the parts in batches.
Firstly I cut the parts for the 8 drawers

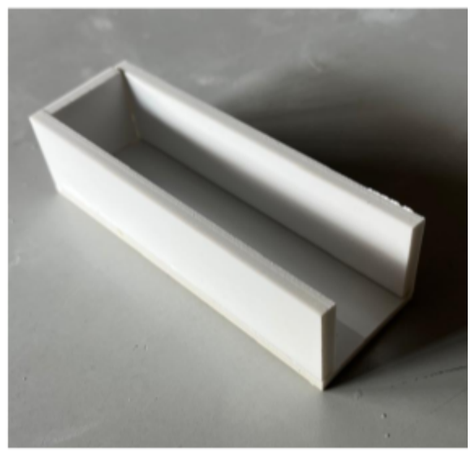


Parts for each drawer has been grouped together.



The outer layer is peeled before assembling

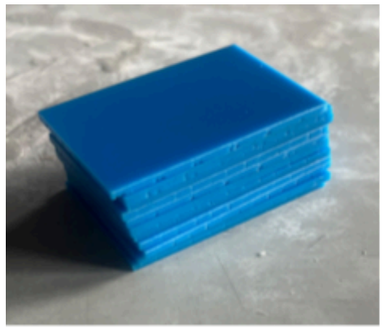
9.



After gluing all the 5mm acrylic parts, The drawer will look like this

10.

I cut the 2 mm Blue acrylic parts



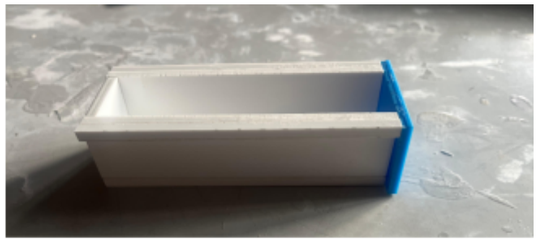
I peeled the outer layer of the acrylic parts

Applied Super glue

Stacked 2 pieces on each other.

I couldn't source 5mm Blue colour acrylic so i am using 2 mm acrylic.

12.



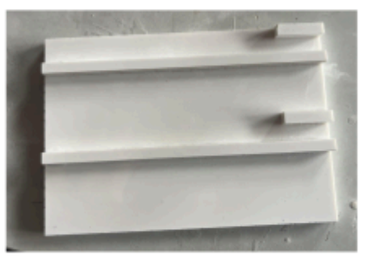
Applied glue on the front of the drawer and glued the blue acrylic piece

13.

I cut the rest of the parts

I started assembling Interguide parts

Used a CD marker to mark the line where the pieces have to be glued and then fixed all the small pieces

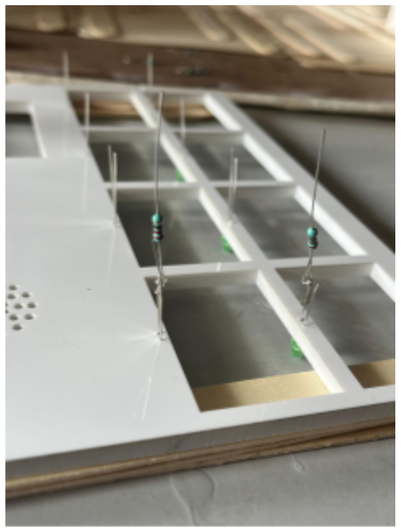


14.

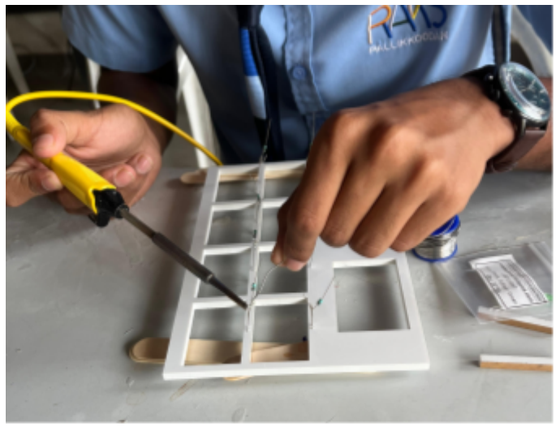
Repeated the same process of marking and gluing the guide rails on the side panels

15. Fixing the led s in the front panel

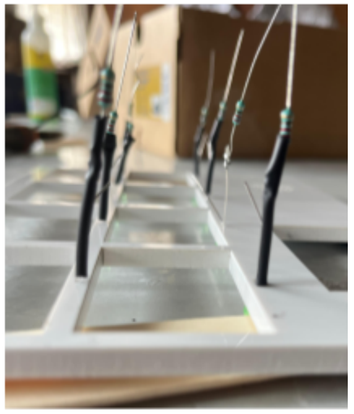
Inserted the Led leads into the holes and fixed them using a little drop of glue



Attaching the 220 ohm resistors to the cathode.



Soldering the resistor and the LED

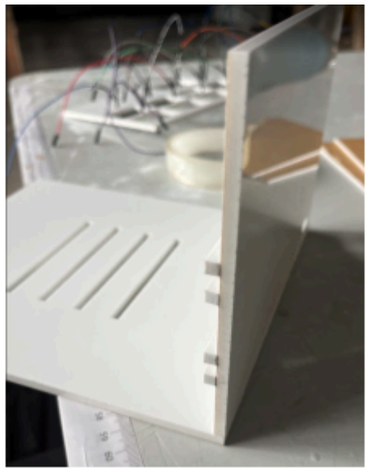


Used a heat shrink to prevent both the leads from coming in contact with each other

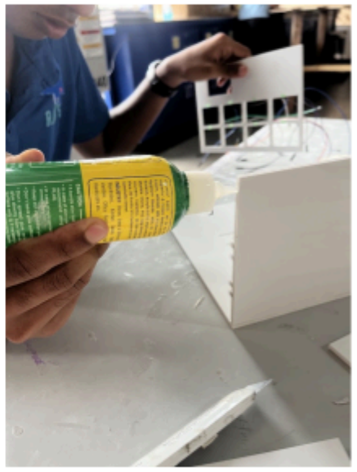
Soldered a wire to both the leads from the led s.

16. Assembling the main structure

Applied glue on the base

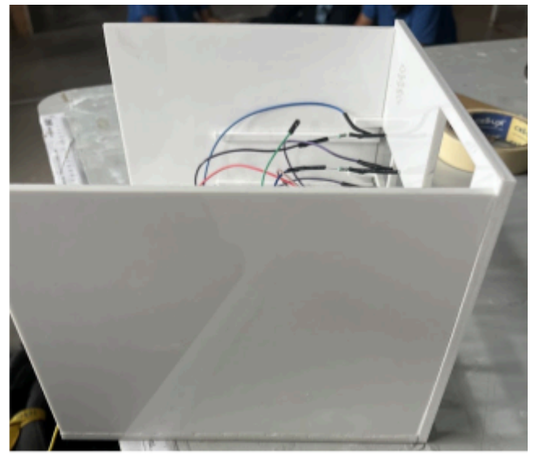


Fixed the right side panel



Applied glue on the front of the base and the right side panel

Fixed the Front Panel

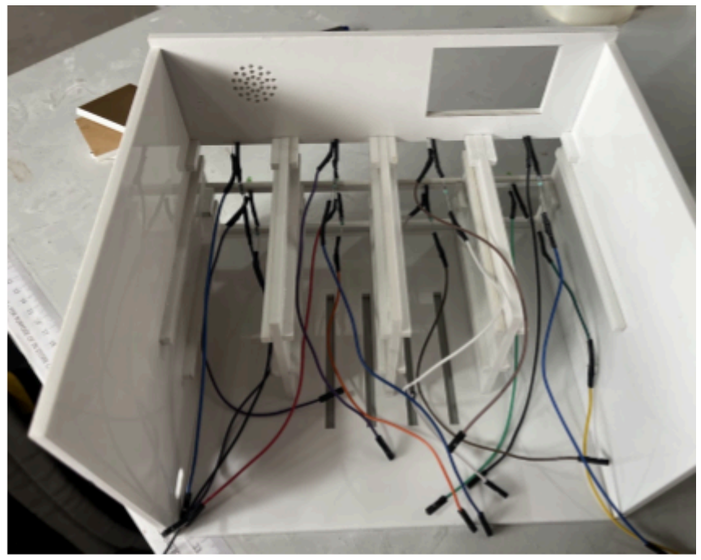


Repeated the same process on the other side

17. Fixing the Interguide part to the main structure

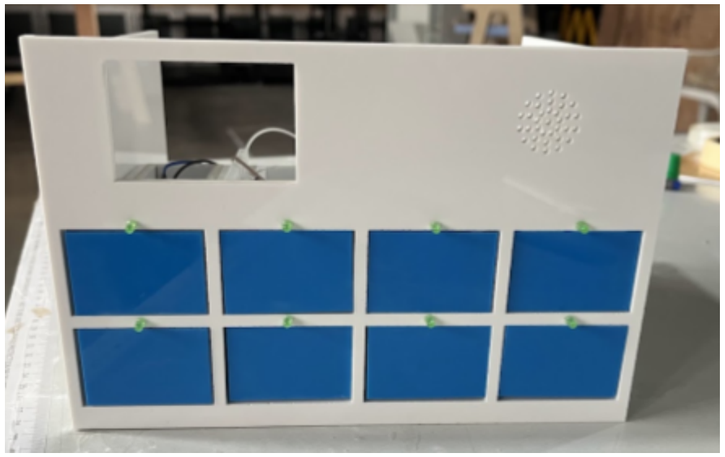
Drew a line to know exactly where the interguide part has to be placed.

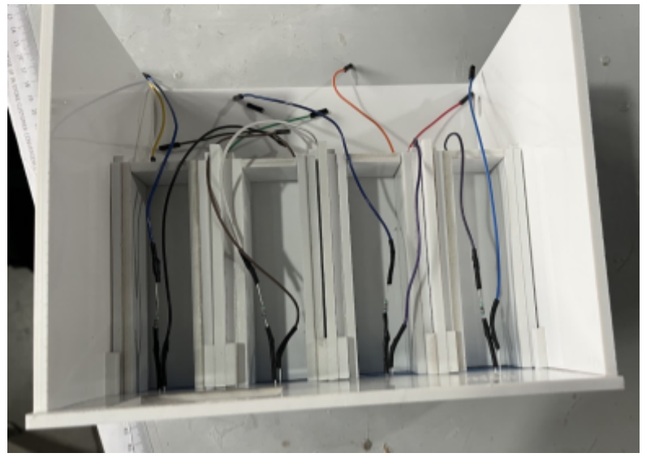
Applied glue and fixed one of the interguide part



Repeated the same process for all the interguide parts

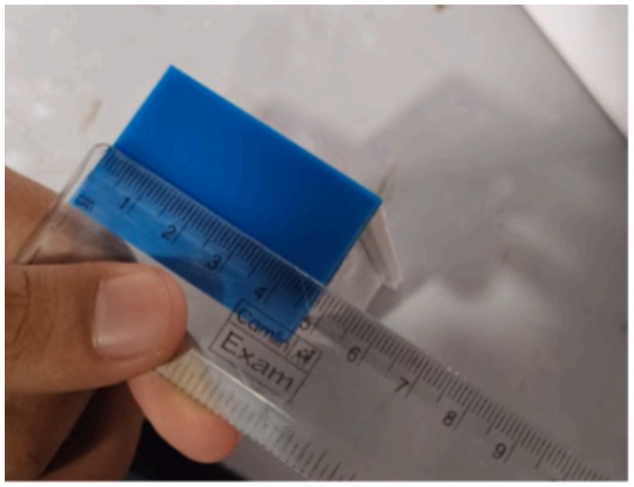
18. Insert the drawers



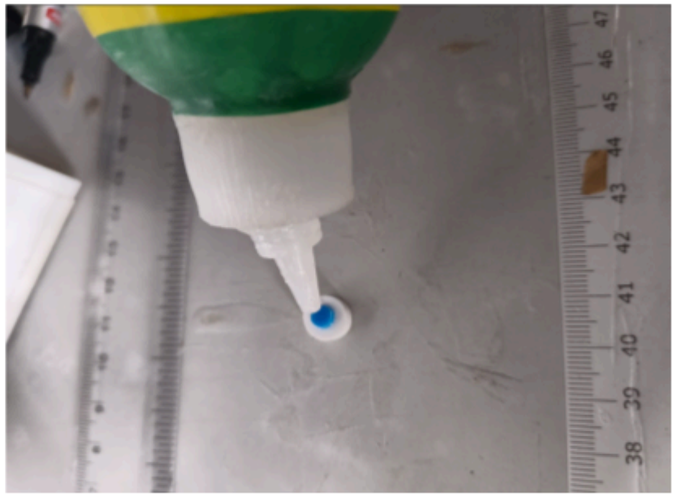


19.

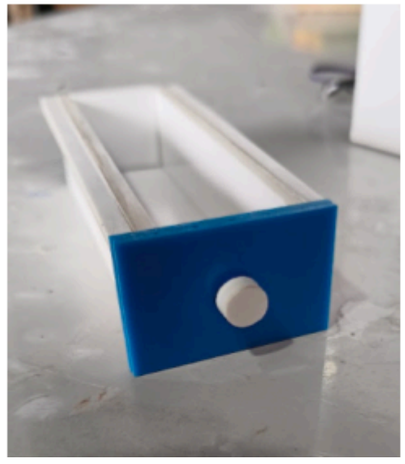
Marking the center on the drawer's front using a CD marker and ruler



Applying glue on the handle



The small blue circle is of 2mm acrylic and was glued to the white 5mm accrylic

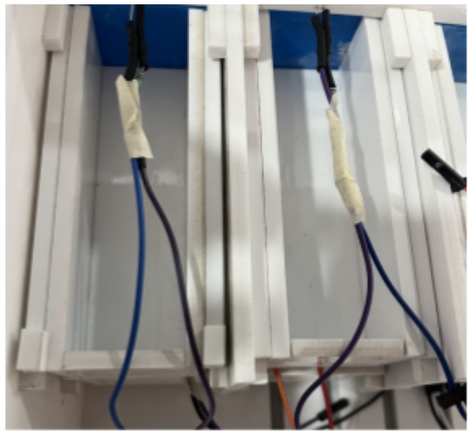


After fixing the handle

20.

Used masking tape to tape both the wires coming from the led s together to prevent them from getting stuck in the corners or in rails.

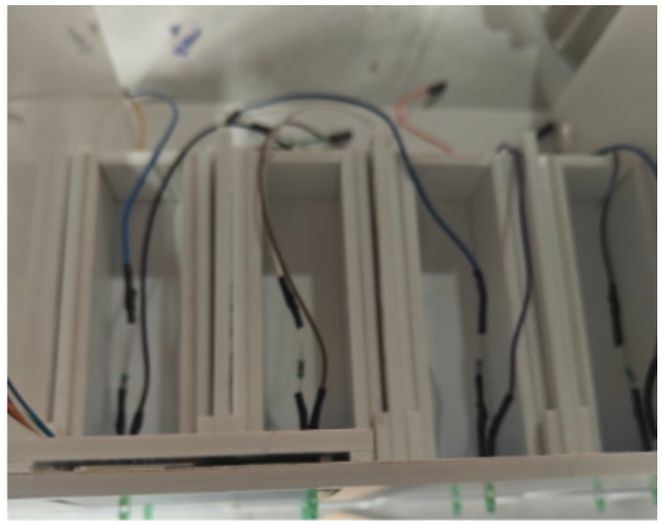
Cut the drawer Stoppers



Applied glue and stuck the stoppers on the side rails on the drawers

21.

Fixed the two smaller pieces on the side and applied glue on the side pieces to fix it to the main structure.



Fixed the part to the front panel

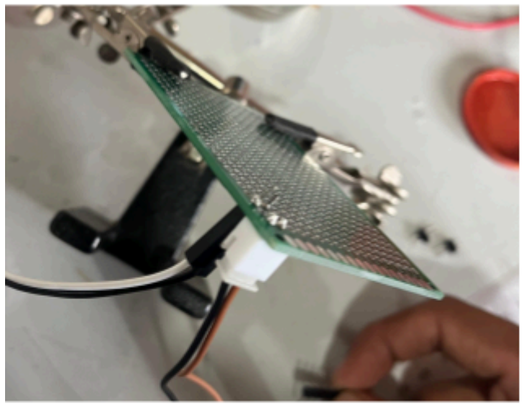
Fixed the Display

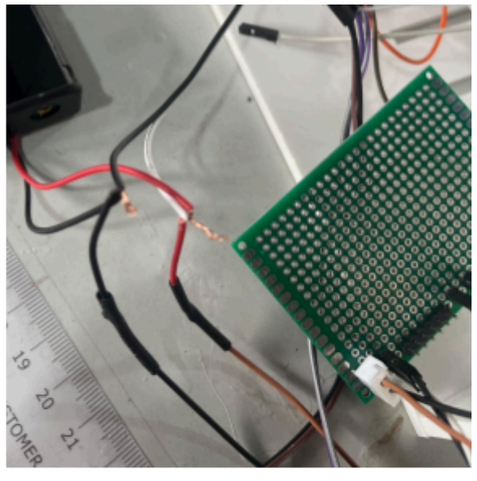
22. Fixing Charging module

Used a small acrylic piece to increase the height were the charging module should be placed

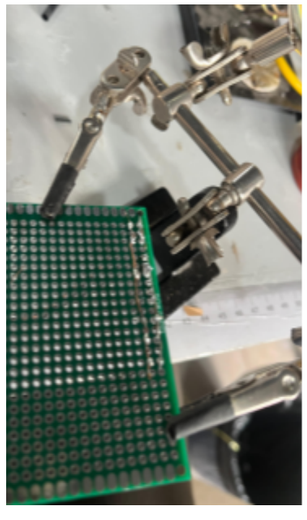
Used hot glue to fix the charging module to the acrylic base

23. Power supply hub





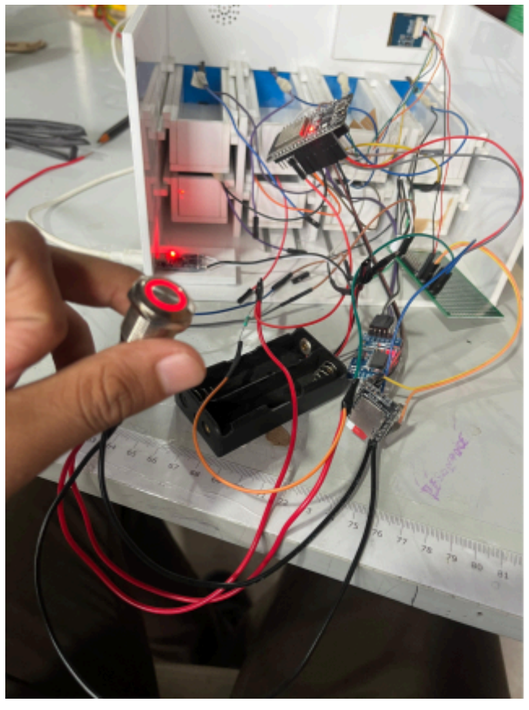
Used a blank PCB board to create a power hub by soldering male header pins to the board. The Board receives the power through the jst connector from the battery and hence can be removed if needed



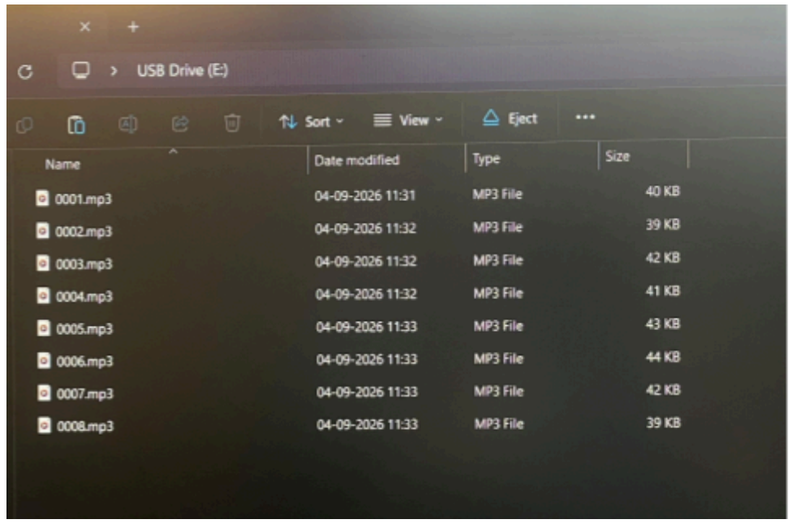
I connected all the header pins to the corresponding header pins and repeated the same process for the VCC pins using copper wires.

Connected a toggle switch between the battery and the power supply hub.

24.



Connected all the electronic components as per the initial plan



Added all the sound files in order of the drawers in the Micro sd card

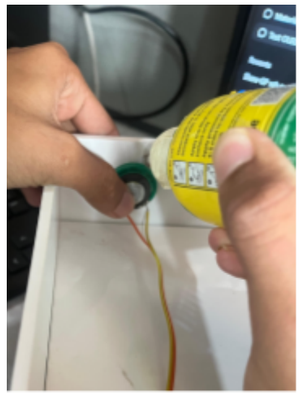
25.

I inserted the nuts inside the holes and applied glue on the sides to ensure it doesn't move

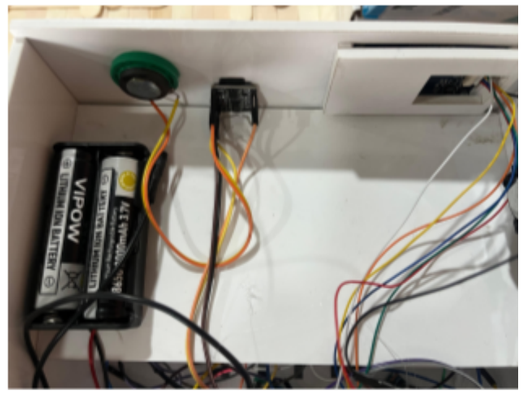
Applied glue on the side of the acrylic piece and fixed it to the main structure.

26.

Used hot glue to fix the battery holder to the drawer cover panel

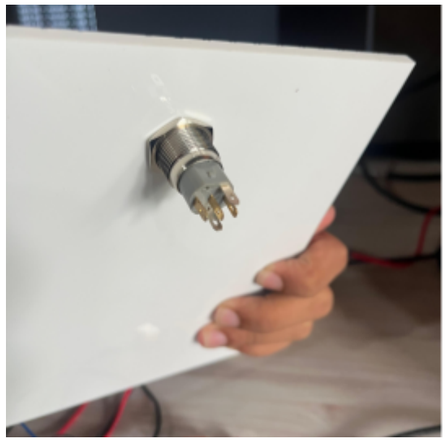


Fixed the speaker to the front panel using glue



Attached all the components to the drawer cover panel using hot glue

27.

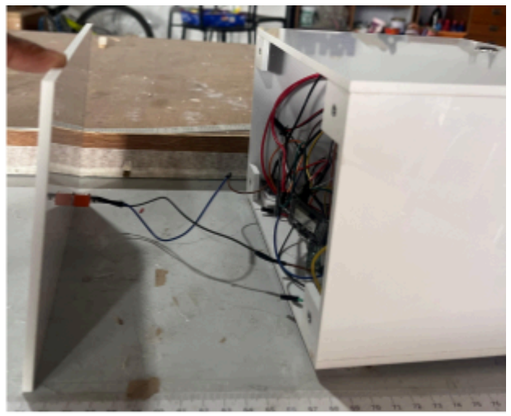


Fixed the push button switch to the top panel using the nut that came with the switch.

Connected all the wires that needed to be connected to the switch

28.

Applied glue on the top of the side panels and fixed the top panel



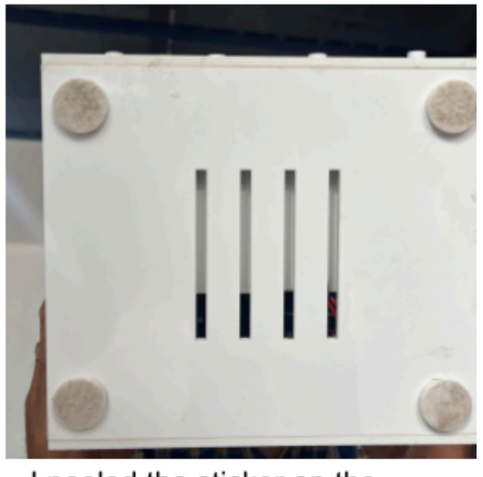
The wire between the switch and the battery has adequate length so that the user can comfortably remove the back panel when required

Used a screwdriver to fix the back panel

29.

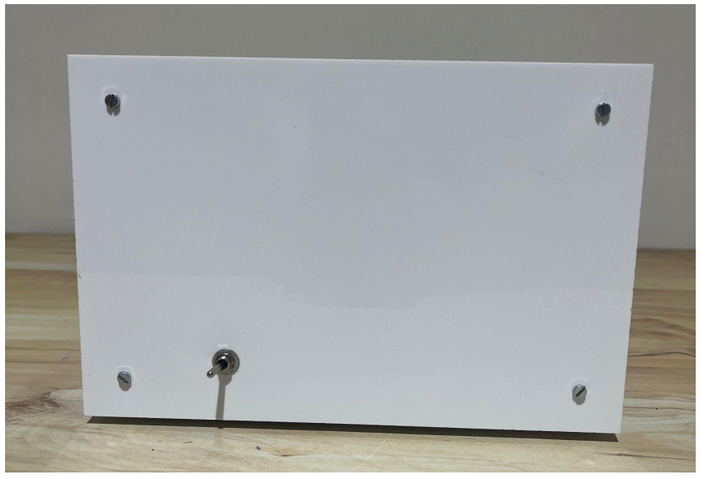
Flipped the product and made it lie on its back

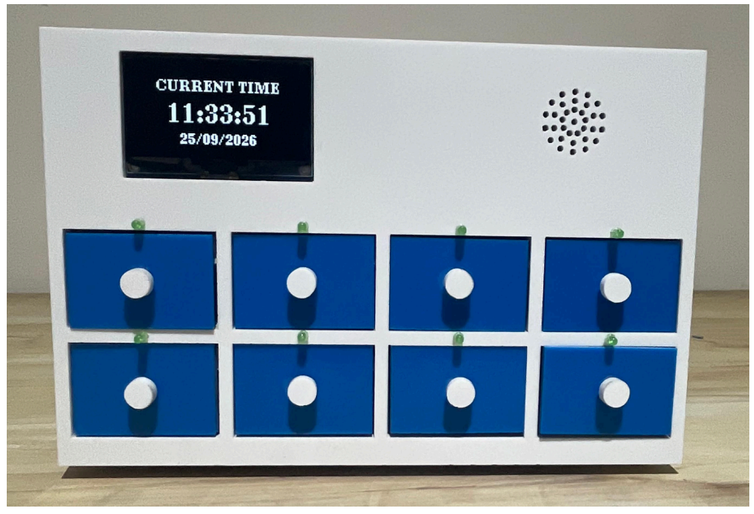
Overmolded rubber glide wasn't available and hence I used this eco-friendly floor glide



I peeled the sticker on the floor glide and stuck it to the product

Finished product Images

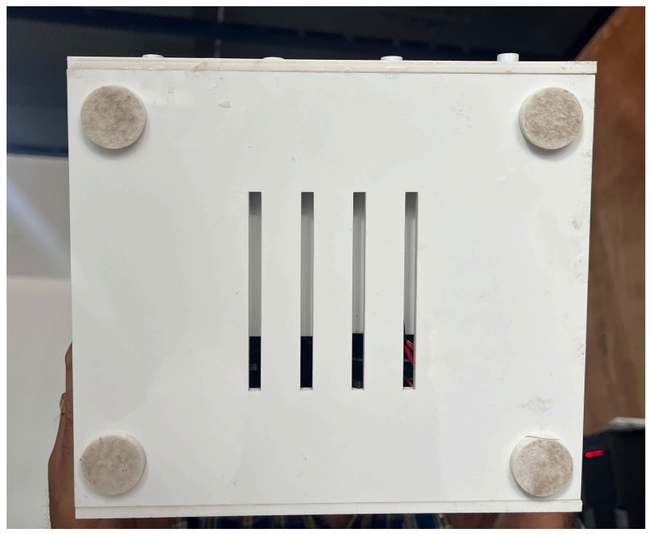




CURRENT TIME
11:31:08

CURRENT TIME
11:31:38

25/09/2026



Plan for Testing

No.	Test	What is being tested?	How the test will be carried out	What will be checked
1	Overall dimensional test	Size of the finished product	Measure the overall length, width and height using a ruler.	Dimensions should be recorded accurately so they can later be compared with the Stage 2 specification.(For Evaluation against Specification)
2	Weight test	Overall mass of the product	Place the fully assembled product on digital weighing scales.	Record the actual weight of the complete product.
3	Drawer capacity test	Amount each drawer can hold	Place the intended quantity of test tablets/objects into each of the 8 drawers. Open and close the drawers after filling them.	Each drawer should hold the required amount without overflowing, jamming or preventing the drawer from closing.
4	Drawer sliding test	Smoothness of drawer mechanism	Open and close every drawer repeatedly, using normal hand force.	Drawers should move smoothly without excessive friction, sticking, wobbling or becoming detached.
5	Drawer stopper test	Effectiveness of upper guide rail	Pull each drawer forwards until it reaches its maximum travel.	The upper guide rail should stop the drawer from being accidentally pulled completely out of the product.
8	Structural strength test	Strength of main PETG structure	Apply a controlled load representative of normal use to the top and base of the product.	The main body should remain rigid without cracking or excessive bending
9	Stability test	Whether the product moves or tips during use	Place the product on a normal flat table and operate different drawers from different positions.	Products should remain stable and should not tip or slide excessively.

10	Joint test	Strength of butt joints	Visually inspect joints and apply light manual force around the assembled sections.	Joints should remain secure with no visible separation.
12	OLED display test	Function of the display	Power the product and trigger different programmed medication reminders.	OLED should turn on and clearly display the correct medication information and time.
13	RTC accuracy test	Accuracy of the DS3231 clock	Set the RTC correctly and compare its displayed time with a reliable reference clock at regular intervals.	RTC should maintain accurate time so medication reminders occur at the correct time.
14	Medication scheduling test	Whether reminders occur at the programmed time	Set a medication for a specific test time and wait for the RTC to reach that time. Repeat several different times.	Reminders should activate at the programmed time rather than early or late.
15	Individual LED test	Correct operation of the 8 drawer LEDs	Activate each medication reminder separately. Observe which LED illuminates.	The LED corresponding to the required drawer should illuminate, while unrelated LEDs remain off.
16	Audio reminder test	Speaker functionality	Trigger each of the programmed audio reminders individually.	Correct audio instruction should play clearly and identify the required drawer.
17	Confirmation button test	Button and confirmation system	Activate a medication reminder and press the confirmation button after taking the test medication.	ESP32 should detect the button press and record the medication as Taken.
18	Missed-dose test	Ability to identify an unconfirmed medication	Activate a medication reminder but deliberately do not press the confirmation button within the allowed time.	The system should identify and record the medication as Missed.

22	Wi-Fi connection test	ESP32 wireless communication	Connect a phone to the ESP32's Wi-Fi interface and access the medication-management webpage or app.	The phone should connect reliably and communicate with the ESP32.
24	Log test	Recording of medication activity	Complete some medication reminders and deliberately miss others. Check the stored history.	History should correctly identify which medications were taken and which were missed.
26	Battery operation test	Operation without USB power	Disconnect external USB power and operate the dispenser using its rechargeable battery.	Product should continue operating normally without unexpected resets or shutdowns.
27	Charging test	Rechargeable power system	Charge the battery using the intended protected charging system under appropriate supervision and observe the charging process.	Charging should operate normally, with no abnormal heating, smell or other unsafe behaviour.
28	Long-duration reliability test	Reliability during extended operation	Leave the product powered for several hours with multiple medication reminders programmed.	Product should continue operating without crashes, resets or missed scheduled reminders.
29	Restart test	Behaviour after the ESP32 is restarted	Restart the system and check the RTC, programmed settings and basic operation.	RTC should retain the correct time and the system should restart normally. Any settings that are intended to persist should remain available.
30	User operation test	Ease of using the finished product	Give the prototype to a test user and ask them to respond to a medication reminder without detailed instructions beyond normal use.	User should be able to identify the correct drawer, open it and confirm the medication successfully.

Testing Images:

Medicine 1 Name
Paracetamol
Medicine 1 Time
22:50
Reset
OFF
Medicine 2 Name
Medicine 2 Name
Medicine 2 Time
Type in this format HH:MM
Current Drawer
0
Medicine 3 Name
Medicine 3 Name
Medicine 3 Time
Type in this format HH:MM
History
–
Medicine 4 Name
Medicine 4 Name
Medicine 4 Time
Type in this format HH:MM

Medicine 1 Name
Paracetamol
Medicine 1 Time
22:50
Reset
OFF
Medicine 2 Name
Medicine 2 Name
Medicine 2 Time
Type in this format HH:MM
Current Drawer
1
Medicine 3 Name
Medicine 3 Name
Medicine 3 Time
Type in this format HH:MM
History
Paracetamol : Taken
Medicine 4 Name
Medicine 4 Name
Medicine 4 Time
Type in this format HH:MM

Medicine 1 Name
Paracetamol
Medicine 1 Time
22:50
Reset
OFF
Medicine 2 Name
Medicine 2 Name
Medicine 2 Time
Type in this format HH:MM
Current Drawer
1
Medicine 3 Name
Medicine 3 Name
Medicine 3 Time
Type in this format HH:MM
History
Paracetamol : Missed
Medicine 4 Name
Medicine 4 Name
Medicine 4 Time
Type in this format HH:MM

Test Results

No.	Test	Results
1	Overall dimensional test	The dimensions are +- 2mm different from the actual dimensions
2	Weight test	Weighs more than 1.5 KG
3	Drawer capacity test	Filled the Drawer with 34 tablet sized chocolates and the drawer still had much more space which can be used for more additional tablets.
4	Drawer sliding test	The drawers slid smoothly without sticking or getting jammed.
5	Drawer stopper test	The drawers were not removable
8	Structural strength test	Kept some heavy books on the product ,but no signs of cracking or bending.
9	Stability test	Due to its mass and wide base, the product was very stable.
10	Joint test	Applied force on the joints and placed some heavy books on it , but no indication of any cracks.
12	OLED display test	Display works
13	RTC accuracy test	The time was accurate as it was initially set according to the global IST (Indian Standard Time).

14	Medication scheduling test	Images of the test have been pasted above the table.Paracetamol was placed in Drawer 1 and is supposed to be consumed at 10:50 pm and the details mentioned were entered in the app(Details entered in the app are automatically updated in the website).The green light for drawer 1 lit and the speaker intimated to open drawer 1 and the display showed what medicine was to be consumed.
15	Individual LED test	All leds worked
16	Audio reminder test	The audio for each drawer were played correctly
17	Confirmation button test	When the button was pressed within the set time , the medicine was considered taken(Image pasted above the table).
18	Missed-dose test	When the switch wasn’t pressed within the set time after the intimation , the medicine was considered as missed.
22	Wi-Fi connection test	The details updated in the app were identified by the ESP32
24	Log test	The result was shown whether the last recent medication was taken or missed.However it doesn't show as a history for all previous tablets on whether they were missed or taken.
26	Battery operation test	The product functioned without the charger being plugged in during use.
27	Charging test	The battery did get charged , I used a voltmeter to check the voltage stored in both batteries before and after charging.

Evaluation Against Specification

Specification	Does the product satisfy it
Target audience – Elderly users, patients with chronic illnesses, caregivers, and individuals taking multiple medications daily	Yes
Price – 4,000–8,000 INR	Yes ,the final prototype was produced within the specified price range based on the total cost of the materials, electronics and components used.
Location – Home environments (bedside table, kitchen counter, study desk)	The design allows it to be placed on a table, desk or any leveled surface. However, it should be kept away from water because of the electronic components.
Material – PETG	No, Acrylic was used instead of PETG because PETG could not be sourced.
Safety : • No sharp edges • Enclosed electronics • User confirmation before dispensing • Secure pill compartments	No,the product had sharp edges,but however all the other criteria for safety were satisfied.
Stable during operation	Yes,The wide base and overall structure keep the product stable while drawers are opened and closed.
OLED Display (2.42 inch)	Yes,The OLED provides information such as the medication name, scheduled time and reminder information to the user.
Audio reminder system (Buzzer OR Audio)	Yes,The audio reminder system was incorporated to provide an audible reminder when medication is due and which drawer the medication is in.
Mobile App Connectivity (ESP32 Wi-Fi)	Yes,The ESP32 provides Wi-Fi connectivity and allows medication information and scheduling to be managed through the interface.
Number of Compartments – 8	Yes,The final product contains 8 separate drawers.

Storage Method – One medication type per compartment	Yes,Each drawer is separated from the others, allowing one type of medication to be stored in each compartment(Prevents medicines from getting mixed)
Capacity per Compartment 15 to 20 tablets	Yes,Each compartment provides sufficient space for approximately 15 to 20 tablets, depending on the size of the medication.
Total Capacity 120 to160 tablets	Yes,With 8 compartments and approximately 15 to 20 tablets per compartment, the total intended capacity is approximately 120 to 160 tablets.
Medication Identification Display	Yes,The OLED displays the relevant medication information when a reminder is activated, helping the user identify what is required.
User Input – Large confirmation push button (≥20 mm diameter)	Yes,A large push button is provided so that the user can easily confirm that the medication has been taken.
Status Indicators – Power LED, Reminder LED, Charging LED	No, Reminder LEDs are provided to identify the relevant compartment. However, the final prototype does not include all three separate power, reminder and charging indicators specified originally.The back panel can be removed to check if the battery is getting charged or not.(A blue LED will be glowing on the TP4056 module)
Weight – Less than 1.5 kg	No, the completed product weighed more than 1.5 kg(This could have been avoided if PETG was used)
Dimensions – Approximately 200 mm × 200 mm × 120 mm	Yes,the final dimensions are within the specified size, making the product compact enough for use on a table or desk.
Battery Type – Dual 18650 Lithium-ion Cells	Yes, the product uses a dual 18650 rechargeable battery arrangement.
Battery Life – Minimum 5–7 days between charges(6000-7000 mah)	No, the battery capacity was designed around the specified 6000 to 7000 mAh range, but the full 5 to 7 day operating period would require longer duration testing to confirm
Charging Method – USB-C charging module	Yes, USB-C charging is incorporated.
Colour Scheme – White body with blue accents	Yes,the finished product follows the planned white body with blue accent areas.
Maintenance – Easy access refill lid	Yes,the individual drawers can be pulled out directly, providing easy access for refilling the medication compartments.

Environmental Considerations : ● Rechargeable battery system ● The housing should be made from a durable material such as PETG as discussed in the Material analysis.	● Yes, The rechargeable battery reduces the need for disposable batteries and allows the product to be used repeatedly. ● Acrylic was used instead of PETG as I couldn't source the PETG
Expected Product Lifespan – Minimum 3–5 years	Yes,the product uses durable structural materials and replaceable electronic components, but a 3 to 5 year lifespan cannot be fully verified through short-term testing. Long-term durability testing would be required.

Summary of Findings and Conclusions

The testing showed that the final medication management system successfully performed most of its intended functions. The eight drawers moved smoothly without sticking, and the drawer guides and stoppers worked correctly to keep the drawers aligned and prevent them from being removed accidentally. The main structure remained stable during use, and the joints were sufficiently strong for the intended application. The edges were also smoothed, reducing the risk of injury during normal operation.

The electronic system also performed successfully. The OLED displayed the current time and date accurately, while the DS3231 RTC maintained the time after being set. The individual drawer LEDs operated correctly, allowing the required drawer to be identified during a reminder. The confirmation button responded correctly, and the ESP32 was able to control the reminder sequence. The DFPlayer and speaker were also tested successfully for playing the required audio reminders.The medication scheduling and reminder system demonstrated that the product could identify the required medication and indicate the appropriate drawer at the scheduled time. The Blynk interface was able to communicate with the ESP32 and provide medication information.

Some limitations were identified during testing. The product was heavier than the expected 1.5 Kgs but however this could have been avoided if PETG was used.PETG was specified as the main material, but acrylic was used for the final prototype because PETG was unavailable. The final prototype also did not include separate power and charging indicator LEDs, so this part of the specification was only partially achieved. The battery capacity was within the intended range, but the full 5 to 7 day operating period would require longer-duration testing to confirm. Similarly, the expected 3 to 5 year lifespan could not be fully verified within the available testing period.

Overall, the testing demonstrated that the final product is functional, stable, safe to operate and suitable for its intended medication management purpose. The main functions, including medication reminders, drawer identification, time display, confirmation and electronic control, were successfully achieved. The remaining limitations mainly relate to material availability and long-term performance rather than the basic operation of the product. Therefore, the testing provides evidence that the final design is a practical working prototype, while further long-term testing and minor modifications could improve the finished product.

Further Improvements to the Product

Based on the testing and evaluation, the following improvements could be made:

Improvements to the individual one-off product

- Reduce the overall weight: The finished product was relatively heavy. The structure could be made lighter by reducing unnecessary material thickness and using lighter materials where strength is not critical.(May have been avoided if PETG was used)

- Use PETG instead of acrylic: PETG was specified for the final product but could not be sourced for the prototype. It would reduce weight while providing good durability and impact resistance.
- Improve battery life: Use a more efficient power-management system and optimize the electronics to reduce power consumption.
- Add separate status indicators: Add Power, Reminder and Charging LEDs to fully meet the original specification.
- Improve the speaker: Use a slightly clearer speaker or improve the speaker enclosure so that audio reminders are easier to hear.
- Reduce Material thickness : this will reduce the weight of the product.

Modifications for manufacturing in quantity

For producing 10 or more units, the design would need to be adapted for batch production:

- Reduce the number of different parts: Combine or redesign some components where possible to simplify assembly.
    1. Drawer front + drawer body
    2. Drawer guide + stopper
- Use PETG sheets: Purchase PETG in bulk to reduce material cost and ensure consistent material properties.
- Design a custom PCB: Replace loose wires and individually connected components with a PCB containing the ESP32 connections, LED resistors and power connections.
- Use connectors: Use standard connectors for the OLED, RTC, LEDs, speaker and other replaceable components to make assembly and maintenance easier.
- Create assembly jigs: Use simple jigs to position the drawer guides, LEDs and panels consistently on every unit.
- Batch-produce the drawers: Manufacture all drawers using the same dimensions and cutting process to ensure they slide correctly in every unit.
- Quality control: Check dimensions, drawer movement, electronics, display, LEDs, audio, battery operation and software at each production stage.
- Modular electronics: Make the electronics easy to replace so individual faulty components do not require the whole product to be replaced.

Evaluation of Materials, Tools and Equipment

Materials :

- Acrylic: Acrylic was used for the one-off prototype because PETG was unavailable. It was easy to cut and assemble, but the finished product was relatively heavy. For batch production, PETG would be more suitable because it is lighter and durable.
- Adhesive: Adhesive was suitable for permanently joining the acrylic components and was easy to use for the one-off product. For batch production, a suitable adhesive and controlled application method would be used to ensure that every joint has a consistent amount of adhesive.
- Electronic components: The ESP32, OLED, RTC, LEDs, button and DFPlayer worked effectively in the prototype. For 10 or more products, these components could be purchased in bulk to reduce cost and ensure consistency.
- Wiring: Individual wires and jumper wires were suitable for testing and making the one-off prototype, but they create a less organised assembly for quantity production. A custom PCB with connectors would be used instead to make wiring faster, neater and more reliable.

Tools and Equipment

- Laser cutter: Suitable for accurately producing the acrylic panels in the one-off product. For a batch of 10, the same CAD files could be reused to cut identical panels, improving consistency and reducing production time.

- Hand tools: Tools such as drills and screwdrivers were useful for finishing and assembling the prototype. For quantity production, jigs(for assembling) and more specialised equipment could be used to improve accuracy and speed.
- Soldering equipment: A soldering iron was suitable for connecting the electronics in the one-off product. For 10 products, a standardised PCB would reduce the amount of individual soldering required and make assembly more consistent.
- Measuring equipment: Rulers and measuring tools were suitable for checking the dimensions of the prototype. For batch production, more accurate measuring equipment could be used during quality control to ensure that all products meet the same dimensions.
- CAD/CAM: CAD drawings would be reused to manufacture identical components for all 10 products. This would reduce errors and ensure consistency between products.

Changes required for batch production

For a batch of at least 10 products, the manufacturing process would be changed by:

1. Purchasing PETG and electronic components in bulk.
2. Using the same CAD files to manufacture all components.
3. Using jigs to position the drawer guides and electronic components accurately.
4. Replacing loose wiring with a custom PCB and connectors.
5. Using a batch laser cutting process to produce identical components.
6. Introducing quality control checks after cutting, assembly and electronics installation.
7. Producing components in batches rather than completing one product at a time.

Plan for manufacturing the product in quantity

1. Proposed batch quantity

I would manufacture a batch of 10 medication dispensers. The product is relatively complex because it contains both a PETG structure and electronic components. Therefore, a batch production system would be most suitable.

Batch production allows the same component to be manufactured several times before moving to the next component. This is more efficient than making each complete product individually.

Production system selected: Batch production

Factor	Decision	Reason
Quantity	10 products	Meets the minimum batch requirement
Production	Batch production	Suitable for a small batch

system		of identical products
Main material	PETG	Durable, lightweight and suitable for fabrication
Manufacturing	CNC/laser cutting where suitable, drilling,bending,gluing and assembly	Gives consistent dimensions
Electronics	Batch assembly and testing	Allows all 10 electronic systems to be checked systematically
Final assembly	One product at a time	Makes it easier to test each complete system
Quality control	Checks at every stage	Prevents faulty parts reaching final assembly

Manufacturing plan

Stage 1 — Prepare materials

1. Purchase enough PETG sheets for 10 products plus approximately 10% extra for wastage.
2. Purchase the required electronic components in batches of 10.
3. Check that all components have been received.
4. Check PETG sheets for scratches, cracks or warping.
5. Sort materials and components into labelled storage areas.

Quality assurance check:

- Confirm material thickness.
- Check electronic components against the component list.
- Reject damaged materials before manufacturing begins.

Stage 2 — Manufacture the main body

The PETG panels for the main structure would be produced in batches.

1. Prepare CAD drawings for the main body.
2. Cut the PETG panels accurately.

3. Remove burrs and sharp edges.
4. Check dimensions against the working drawings.

Quality control:

Check	**Requirement**
Overall dimensions	Within drawing tolerance
Panel thickness	Correct PETG thickness
Edges	Smooth and safe
Ventilation holes	Correct size and position

Any component outside the acceptable tolerance would be remade rather than being used.

Stage 3 – Manufacture the eight drawers

Because each product requires eight drawers, manufacturing these in batches will save time.

For 10 products:

10 × 8 = 80 drawers

The same cutting and drilling setup can therefore be used repeatedly.

Process

1. Cut all drawer components.
2. Assemble each drawer.
3. Glue the required joints.
4. Allow adhesive to cure.

Quality control

Each drawer should be checked for:

- correct dimensions

- square construction
- smooth edges
- secure joints
- correct alignment

A drawer that sticks should be remade.

Stage 4 – Manufacture and assemble the guide system

The upper and lower guide rails are important because they control the movement of the drawers.

Process

1. Cut the guide-rail components.
2. Check their length.
3. Position the lower guide rail.
4. Position the shorter upper guide rail.
5. Check that both rails are parallel.
6. Secure the guide system.
7. Test each drawer individually.
8. Check that the upper rail prevents the drawer from being completely removed.

Quality assurance

A simple test jig could be made to ensure that the guide rails are positioned at the same distance on all 10 products.

This would improve consistency between products.

Stage 5 – Electronics manufacturing
PCB manufacturing for the batch

The PCB is an important improvement when moving from one-off production to quantity production.

For each product, the PCB will provide connections for:

PCB connection	Component
ESP32 socket/header	ESP32 DevKit

OLED connector	SSD1309 OLED
RTC connector	DS3231
DFPlayer connector	DFPlayer Mini
Speaker connector	Speaker
LED 1 connector	Drawer 1 LED
LED 2 connector	Drawer 2 LED
LED 3 connector	Drawer 3 LED
LED 4 connector	Drawer 4 LED
LED 5 connector	Drawer 5 LED
LED 6 connector	Drawer 6 LED
LED 7 connector	Drawer 7 LED
LED 8 connector	Drawer 8 LED
Button connector	Confirmation button
Power connector	Power hub

The 220–330 Ω resistors for the LEDs and the 10 kΩ pull-up resistor for the confirmation button can be mounted directly onto the PCB.

Using a PCB means that the same tested circuit can be reproduced ten times rather than manually wiring each product.

Connect all the electronic components to the PCB as per the schematic diagram into their designated connectors.

Electronic checks

- PCB checked for incorrect connections.

- Solder joints checked visually.
- Continuity checked before applying power.
- ESP32 checked for correct operation.
- OLED checked for correct display.
- RTC checked for accurate time.
- DFPlayer checked for correct audio files.
- The speaker checked for clear output.
- All eight LEDs checked.
- Confirmation button checked.
- Blynk connection checked.
- Battery and charging system checked using the appropriate protected charging arrangement.

Stage 6 – Custom App Development

Instead of using Blynk, I would develop a custom application specifically for the smart medication dispenser. The app would be developed once as a master version and then distributed to all 10 dispensers. This makes the software suitable for batch production because the same tested application can be used with multiple products.

The app will allow the user or caregiver to:

- Add up to 8 different medicines.
- Enter the medicine name for each drawer.
- Set the required medication time.
- View the current medication schedule.
- Receive notifications when medication is due.
- View whether medication was Taken or Missed.
- View previous medication history.
- Connect to the ESP32 through Wi-Fi.
- Update medication schedules without physically changing the dispenser.

The app will communicate with the ESP32 in each dispenser through a local Wi-Fi connection.

App Development Process

Stage	Process	QA Check
1	Design the app layout and user interface	Check that buttons and text are clear and easy to understand
2	Create the main app screens	Check that all required functions are included

3	Program communication between the app and ESP32	Check that data is sent and received correctly
4	Add medicine names and time-setting functions	Check that the correct medicine and time are stored
5	Add medication history	Check that Taken/Missed records are displayed correctly
6	Connect the app to a test dispenser	Check that the app controls the correct ESP32
7	Test all 8 medication compartments	Check that the correct drawer is identified
8	Test error handling and Wi-Fi connection	Check what happens if the connection is lost
9	Finalise and package the master application	Check the final version before distribution
10	Install the same tested version on all 10 products	Check each installation and device connection

Quality Control of the App

Before distributing the app, the master version would be tested using a prototype dispenser.

QC checklist:

- The app installs correctly.
- App connects to ESP32.
- All 8 drawers can be configured.
- Medicine names are displayed correctly.
- Medication times are stored correctly.
- ESP32 receives updated schedules.
- OLED displays the correct information.
- Correct drawer LED activates.
- Audio reminder operates correctly.
- The confirmation button records medication as Taken.
- Missed medication is recorded correctly.
- Medication history is displayed correctly.
- App reconnects after temporary Wi-Fi loss.
- The same application works with all 10 dispensers.

Stage 7 – Final assembly

After the structural and electronic components have passed their individual checks:

1. Assemble the main PETG structure.
2. Install the guide system.
3. Insert the eight drawers.
4. Install the OLED.
5. Install the LEDs above their respective drawers.
6. Install the confirmation button.
7. Install the electronics inside the protected electronics section.
8. Connect the power system.
9. Secure and organise the wiring.
10. Perform a complete functional test.

Stage 7 – Final quality control

Every completed product would undergo the same final inspection checklist.

Test	Pass requirement
Overall dimensions	Approximately 200 × 200 × 120 mm
Weight	Below 1.5 kg
Drawer operation	All 8 drawers slide smoothly
Drawer retention	Drawers cannot accidentally fall out
Edges	No sharp or dangerous edges
Structure	No loose joints
Stability	Product remains stable during use

OLED	Displays correct information
RTC	Correct time
Audio	Correct reminder plays
LEDs	Correct drawer LED activates
Button	Confirmation works
Blynk	Data can be entered and received
Wi-Fi	ESP32 connects reliably
Battery	System operates correctly from battery
Charging	Charging system operates safely
Electronics	Fully enclosed/protected
Appearance	Consistent finish between products

A product that fails a check will be reworked and tested again before being accepted into the finished batch.

Evaluation of Wider Issues of Quantity Manufacturing

Moving from one-off production to a batch production would have cultural, social, economic and environmental impacts. Although producing in quantity would make the product more consistent and affordable, it would also increase the use of materials, energy and resources.

1. Cultural and Social Factors

Factor	Positive impact	Negative impact

Independence	The dispenser could help elderly users and people who take several medicines manage their medication without constantly relying on a caregiver.	Some elderly users may find the electronic system or custom app difficult to understand, especially if they are not familiar with smartphones.
Caregivers	Producing more units would allow the product to be used by more families and could reduce the amount of time caregivers spend reminding users about medication.	Caregivers may still need to set up the app and medication schedules, creating an additional responsibility.
Accessibility	Batch production could make the product available to a larger number of people instead of being limited to one prototype.	The product may not suit every user's medication routine because the standardised design has a fixed number of compartments.
Consistency	Producing 10 identical products means users receive the same layout, controls and operating system.	Mass-produced products have less opportunity for individual customisation compared with a one-off product.
Technology	The custom app and ESP32 system make the product more modern and could encourage users to use technology to manage their medication.	Users who do not own or regularly use a smartphone could find the system less convenient.

Evaluation: Overall, quantity production would have a positive social impact because the product could help more users manage their medication independently. However, the interface must remain simple, with clear instructions and large controls so that technology does not become a barrier for elderly users.

2. Economic Factors

Batch production would change the economics of the product significantly.

Advantages:

- Buying PETG, electronic components and fasteners in larger quantities could reduce the cost per unit.
- Producing 10 products using the same CAD files reduces design and preparation time for each product.
- Using a **custom PCB** instead of individually connecting loose wires would reduce assembly time and improve consistency.
- The same custom app can be digitally distributed to all 10 products, so it does not need to be developed separately for each dispenser.
- Standardised parts make repairs and replacement easier.

- A lower production cost could allow the product to be sold within the target price range of **₹4,000 to ₹8,000**.

Disadvantages:

- There would be a higher initial cost for purchasing materials and electronic components for 10 products.(Could be avoided by using Just in Time manufacturing)
- Manufacturing equipment, electricity, PCB production and labour would increase the initial investment.
- If demand is lower than expected, some finished products could remain unsold.
- Developing the custom app requires additional programming and testing before the products can be sold.
- Batteries and electronic components can increase the cost compared with a simple mechanical pillbox.

Evaluation: Batch production is economically more suitable than making each product individually because repeated manufacturing reduces the average production cost. However, the manufacturer would need to make sure there is enough demand to justify the initial investment.

3. Environmental Factors

Environmental issue	Impact of quantity production	Possible improvement
PETG waste	Producing 10 units creates more plastic waste from cutting and manufacturing.	Nest parts closely on sheets and reuse suitable offcuts.
Electronic waste	Ten products require more ESP32 boards, PCBs, LEDs, displays and other electronic components.	Use replaceable modules and design the electronics so faulty parts can be repaired rather than replacing the whole product.
Batteries	Each product requires rechargeable lithium-ion batteries, increasing the number of batteries eventually requiring responsible disposal.	Use rechargeable batteries with appropriate protection and make them replaceable.
Energy use	CAD/CAM equipment, cutting, 3D printing/fabrication and electronics production use additional energy when producing 10 units.	Manufacture parts in batches to reduce repeated machine setup and minimise unnecessary production time.
Packaging	Ten products require more packaging materials.	Use recyclable cardboard packaging and minimise unnecessary plastic packaging.

Product lifespan	A durable PETG body and replaceable electronics could allow the product to last several years.	Design for repair and replacement of individual components.
Transport	Selling and transporting 10 products increases emissions compared with producing only one local prototype.	Batch transport and use local suppliers where possible.

Evaluation: The biggest environmental disadvantage is that quantity production increases the amount of PETG, electronics, batteries, packaging and energy used. However, designing the product for repair, reusing PETG offcuts, reducing packaging and manufacturing parts efficiently can reduce its environmental impact.

Overall Evaluation

Moving from a one-off production to batch production of 10 units would make the smart medication dispenser more commercially realistic. The main social benefit is that more elderly users and caregivers could benefit from a system that supports medication management. Economically, batch production would reduce the average cost through bulk purchasing, standardised parts and repeated manufacturing. However, the initial investment would be higher.

The main environmental concern is the increased consumption of PETG, electronic components, batteries and energy. This can be reduced through efficient material nesting, repairable electronics, recyclable packaging and responsible battery disposal.

Overall, batch production is appropriate for this product because the social and economic benefits can outweigh the disadvantages, provided that manufacturing is carefully planned to control cost, waste and environmental impact.