IC 201P – Design Practicum
Anti-Pandora's box

B Nishritha (B20283)
Khushi Ladha (B20013)
Kirsh Kumar (B20295)
Prateek Raj (B20164)
Rahul Yadav (B20059)
Mehul Jain (B20300)

Under the supervision of

P Anil Kishan, kishan@iitmandi.ac.in

Aniruddha Chakraborty, achakraborty@iitmandi.ac.in

Indian Institute of Technology Mandi

Certificate

This is to certify that the work contained in the project report entitled "Ant-Pandora's box", submitted by Group 07 to the Indian Institute of Technology Mandi, for the course IC 201P - Design Practicum, is a record of bonafide research works carried out by them under our direct supervision and guidance.

P. Anil Kishan 18/10/2022

P Anil Kishan Signature and Date

Anie 18/10/2022

Aniruddha Chakraborty Signature and Date

Acknowledgements

We are grateful to IIT Mandi, for offering a course where we were given the freedom to explore various fields of engineering and build whatever we wanted. We would like to thank our mentors, Dr. Anil Kishan and Dr. Aniruddha Chakraborty, for guiding us throughout the whole course, all the while offering us valuable mentorship and support. We would also like to extend our gratitude to the central workshop engineers, especially Rakesh sir, who helped us through every stage in the fabrication process, and taught us a great deal about how a product is actually manufactured. Lastly, our fellow batchmate, Dharma who helped us with finalising our mechanism and deciding components and explained to us certain electrical concepts that were extremely helpful during the fabrication process.

Abstract

Medicinal non adherence is a very prevalent problem in the world. Only in the United States, over 190 million people do not take their medicines at their prescribed timings. And 70% of this non-adherence has to do with behavioural issues of the patient, that include procrastination or forgetfulness.[1] Not just behavioural issues, many patients do not take their prescribed medicines on time because they need a caretaker, or are dependent on someone else to administer their medicinal dosage. This has caused the American healthcare industry, a loss of over 125,000 deaths and 105 billion dollars each year. [2]

To solve this problem, we are building a pill box, with an automatic timer and dispenser, that will ring an alarm at the time the medicine needs to be taken and give out the exact number of pills, depending on the required dosage. The pillbox is also connected with a mobile app where the user can enter the timings, and then the doses will be administered accordingly. This makes the patients independant and less prone to forgetting to take their medicines, and is overall very beneficial to the world's healthcare industries.

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Chapter 1

Introduction

1) Background of the problem

One thing every healthcare stakeholder agrees on is that a patient's adherence to his or her drug regimen can reduce costs and improve the quality of life. But drugmakers and providers alike struggle to find the best tools, words, and technologies that will improve adherence rates among patients with chronic diseases. Hence we found a solution to the over abundantly prevalent problem of medicinal non adherence, in the form of an automatic pill dispenser box, that will give out medicines to patients at the right time, once inputted.

2) Scope of the problem

The problem of medicinal non adherence is prevalent across

A. Across various age groups

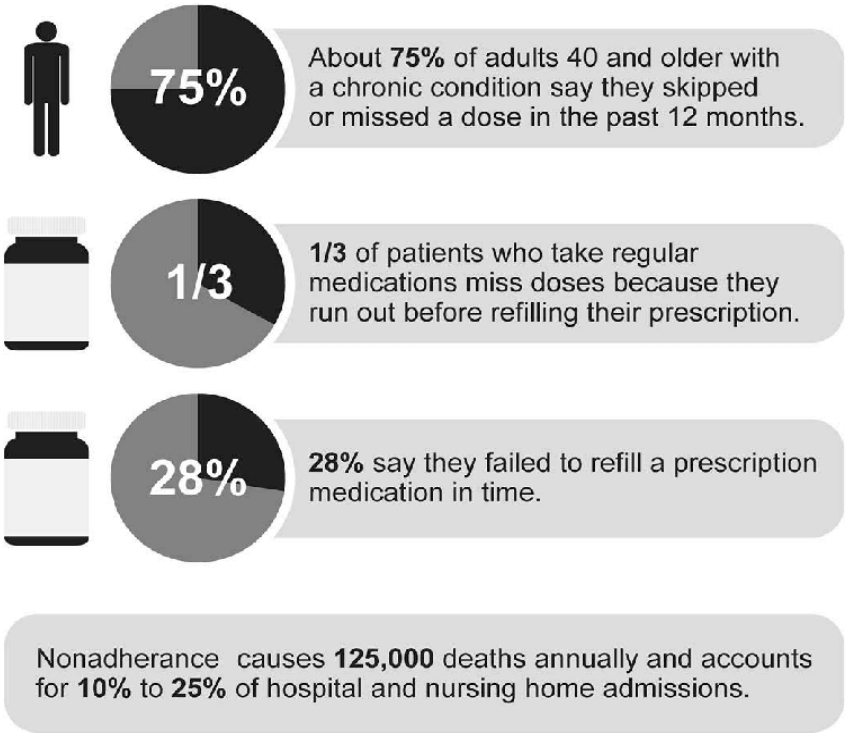


Fig. 1. Costs and consequences of medication nonadherence **[3]**

B. Multiple regions across the world

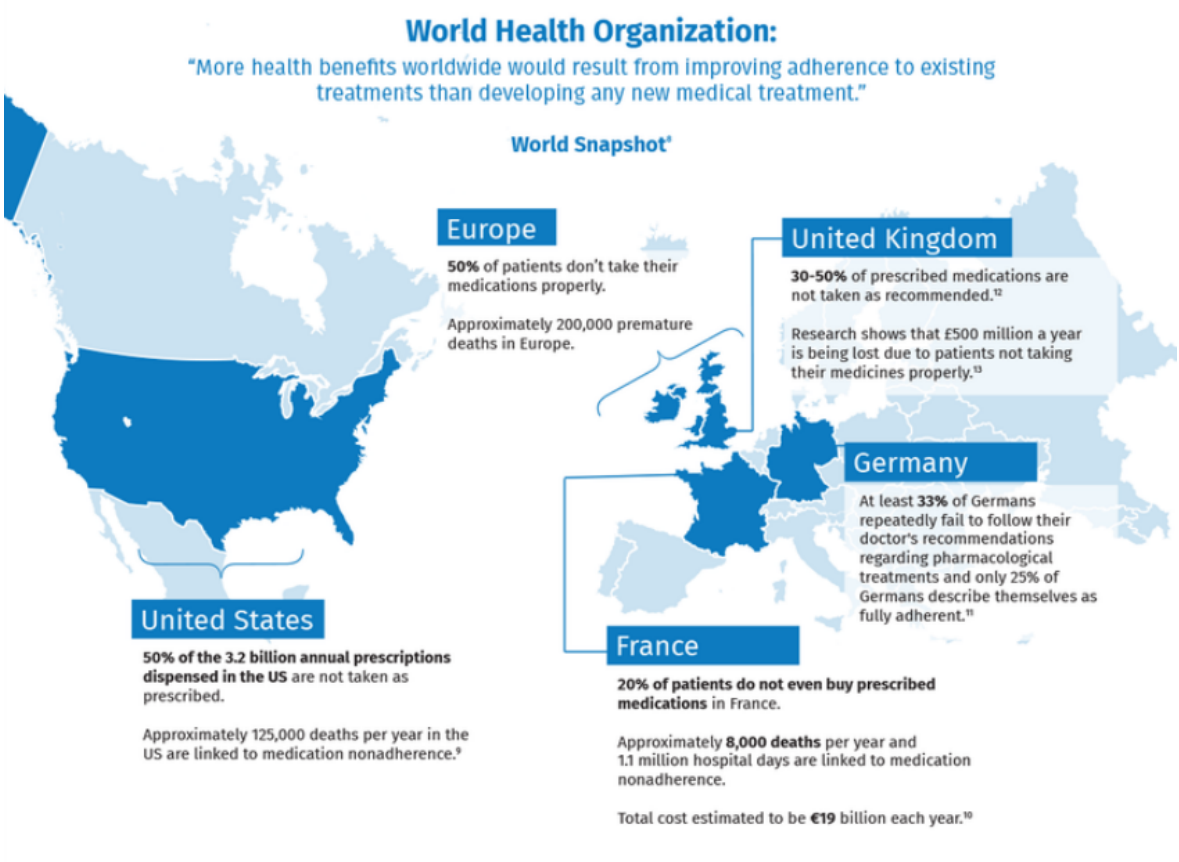


Fig.2. Medicine Non-Adherence data across multiple regions in the world[3]

C. Different types of patients

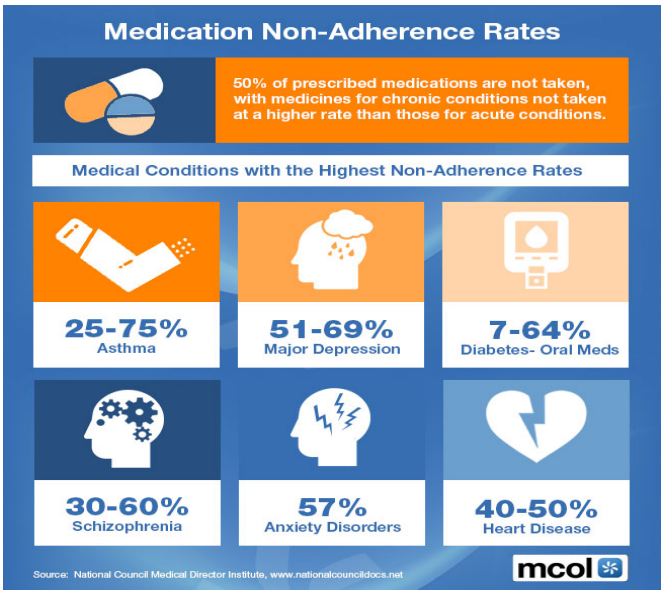


Fig. 3. Medicine Non-Adherence data in different types of patients **[4]**

3) Design philosophy used in this report

Definition: A pill dispenser box that gives off medicines at the inputted time

Users: For people who forget to take their prescriptions on time either due to behavioural issues, or the absence of a caretaker

Purpose: To help people stay healthier, and save the losses incurred by the healthcare industries

Differentiation: The available solutions in the market are basic pill containers, and the automated ones are too costly

Value: It will help in saving millions of lives annually and also save billions of dollars of losses incurred by healthcare industries

Goals: To achieve an overall healthier population

4) Problem statement

The prevalent problem of medicinal non adherence, and the absence of an automated pill dispenser in the market.

5) Beneficiaries

- People, who in general forget to take their medicines, due to personal behavioural issues.
- Old or physically incapable people who need the help of caretakers at home
- Patients in hospitals who need the help of nurses to take multiple medicines throughout the day
- Same mechanism can be extended to make a pet feeder when the pet's owners are not at home.

6) Organisation of this project

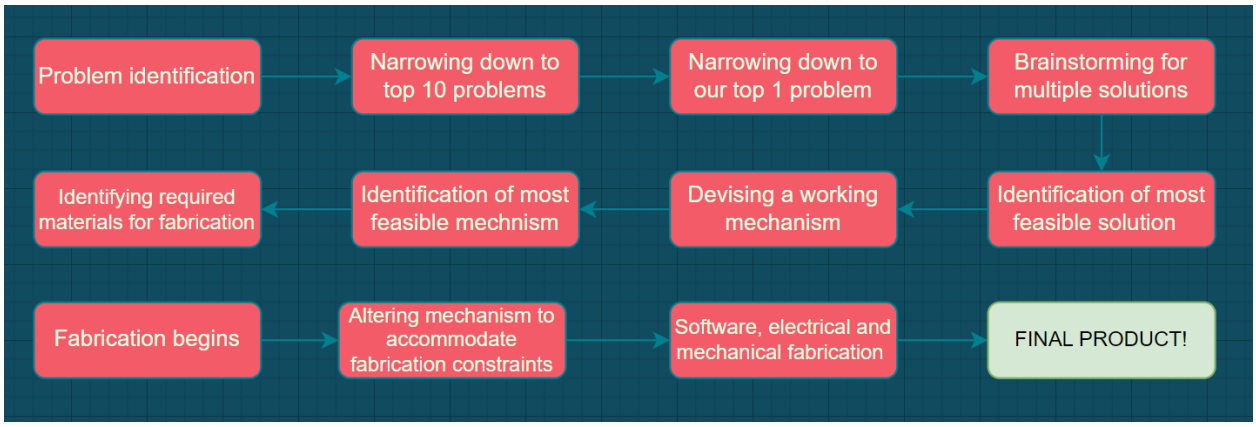


Fig. 4. Organisation of project

7) Origin of the name “Anti-Pandora’s box”

In Greek mythology, there was once a curious girl named Pandora, who was born with the gift of curiosity. She was gifted a box by Zeus, the Greek god of the cosmos, and was told to never open it. But her curiosity got the better of her, and she opened the box, and upon opening it, the box released all kinds of diseases, sorrows and ailments into the world. And our box, we believe, will help contain the diseases prevalent in this world, hence, the name, “Anti-Pandora’s box”.

Chapter 2

Market Research

1. Existing alternatives to current problem

Sr. no.	Product	Drawback
1	Manual pill storage container  Fig. 5. Manual Pill Storage Container **[5]**	1. Pills are not stored in a vacuum seal container and they can get oxidised and be prone to expiry sooner. 2. No alarm system 3. No dispensing system 4. Small size of container
2	Manual pill storage container with an alarm  Fig. 6. Manual Pill Storage Container with an alarm clock **[6]**	1. Pills are not stored in a vacuum sealed container 2. Small size of container 3. No dispensing system 4. Cannot differentiate between dispensed medicines

3	Manual pill dispenser with an alarm  Fig. 7. Manual Pill Dispenser with an alarm **[7]**	1. Medicines are not stored in a vacuum sealed enclosure. 2. Different medicines are in contact with each other. 3. Cost is approximately Rs.60,00

Table. 1. Existing alternatives to current problem

2. Overcoming these problems

a. In the current model, strips of the pills can be inserted, which remain closed until the alarm is hit and the pill is dispensed out.
b. The anti-pandora's box gives out the medicine at the inputted time.
c. Reduced cost (Under 7000 Rs with improved actuator)
d. Low power Consumption

Chapter 3

Conceptual Design and methodology

100 to 10 to 1

Highlighted problems signify our top 10

Serial number	Problem
1	Waiting at salon
2	Road construction takes too long
3	Mental healthcare is expensive
3	Water tables running low
4	traffic in cities
5	Bike riding in winters
6	Shortage of car parking space
7	Food spoils quickly
8	Slow charging of devices
9	Poor internet connection in hilly areas
10	leakage in underground pipes
11	Overpopulation
12	Addiction to Social Media
13	Cleanliness at public places
14	Low quality food packaging
15	Phone battery running out at public place
16	Shortage of clean water
17	Increasing prices of fuels
18	Pollution due to vehicles
19	Poor facilities at Govt. Banks
20	Personal data security
21	Cooking problems for bachelors
22	Proper house construction planning
23	Snow on roads during winter
24	Dirty rivers and lakes
25	Poor sewer system
26	Call from unknown numbers on mobile phones
27	Being on hold while calling customer care
28	Extra charge for shopping bags

29	Blisters from new shoes
30	Power socket far from bed
31	Water tank full alert/alarm
32	sometimes unable to hear alarm sound
33	delaying the work for 5 minutes
34	time doesn't match for hangout with friends and making new friends
35	concentrating on too much work and end up doing nothing
36	Leakage in water fitting
37	proper health/life insurance planning
38	hidden charges on various platforms
39	no dustbin available in trains
40	Flight tickets are expensive
41	Trains lack cleanliness
42	Original certificates can be prone to being lost/damaged
43	Water clogging on roads in monsoons
44	Long queues in public places
45	Fire accidents
46	Internet services down
47	Natural calamities being unpredictable
48	Too many ads on youtube/spotify
49	Unable to water houseplants when away from home
50	Fibre services not available
51	Items with harmful chemicals being sold by big companies
52	Crowd in public transport
53	Added preservatives in food are harmful for health
54	Clean drinking water
55	Huge quantity of sea water, but its not drinkable
56	Food has high calories
57	Hand dryer (with minimum cost) not available in hostels
58	Required contact/directories not present on mandi's website
59	Colder buildings, warmer outside
60	Online overall detailed map/tour/navigation not available
61	no notification to prof when disconnected from net in online class
62	Waste segregation is still manual
63	Resource management for basic stuff present in room android application
64	More advanced cooking machine not available
65	More flexible sockets/extensions
66	Candles are not reusable generally

67	Special Scissors for cutting food
68	IIT Mandi's wifi disconnects suddenly
69	Technology creating disparities in social and economic setup
70	Usage of plastic (including large and small usage)
71	Instant water heater
72	Food wastage at mess/restaurants
73	Food delivery while travelling
74	Uber/ola services aren't available in Hilly regions
75	Gas leakage detector
76	Forest fire detector
77	gas remaining in gas cylinder marker
78	long mess lines
79	Buses are only available in the evening to reach campus
80	Low connectivity to Mandi- only buses are available
81	one remote for multiple devices not available
82	Heavy loads on truck causes them to topple in hilly terrain
83	little things like keys etc get lost
84	Old people forget to take medicines on time
85	multiple alarms don't help in waking up
86	mirror should be there at blind turn specially for hilly areas
87	Overspeeding of vehicles in hilly regions
88	Too many ott platforms, it's hard to keep track of subscriptions
89	entry into railway station based on QR code checking
90	problem in driving in fog
91	adding a safe distance detector in car
92	unavailability of buses from North and South campus and vice versa
93	Late deliveries in college (amazon/flipkart)
94	Customised apparel recommendations
95	Fast fashion generates a lot of waste
96	Academic stress in competitive institutions
97	Miscellaneous problems in hostels
98	usage of solar power to power water filter
99	kids size outgrows clothes size
100	Meets get muted when in a call

Table. 2. 100 problems

Identifying the TOP 10

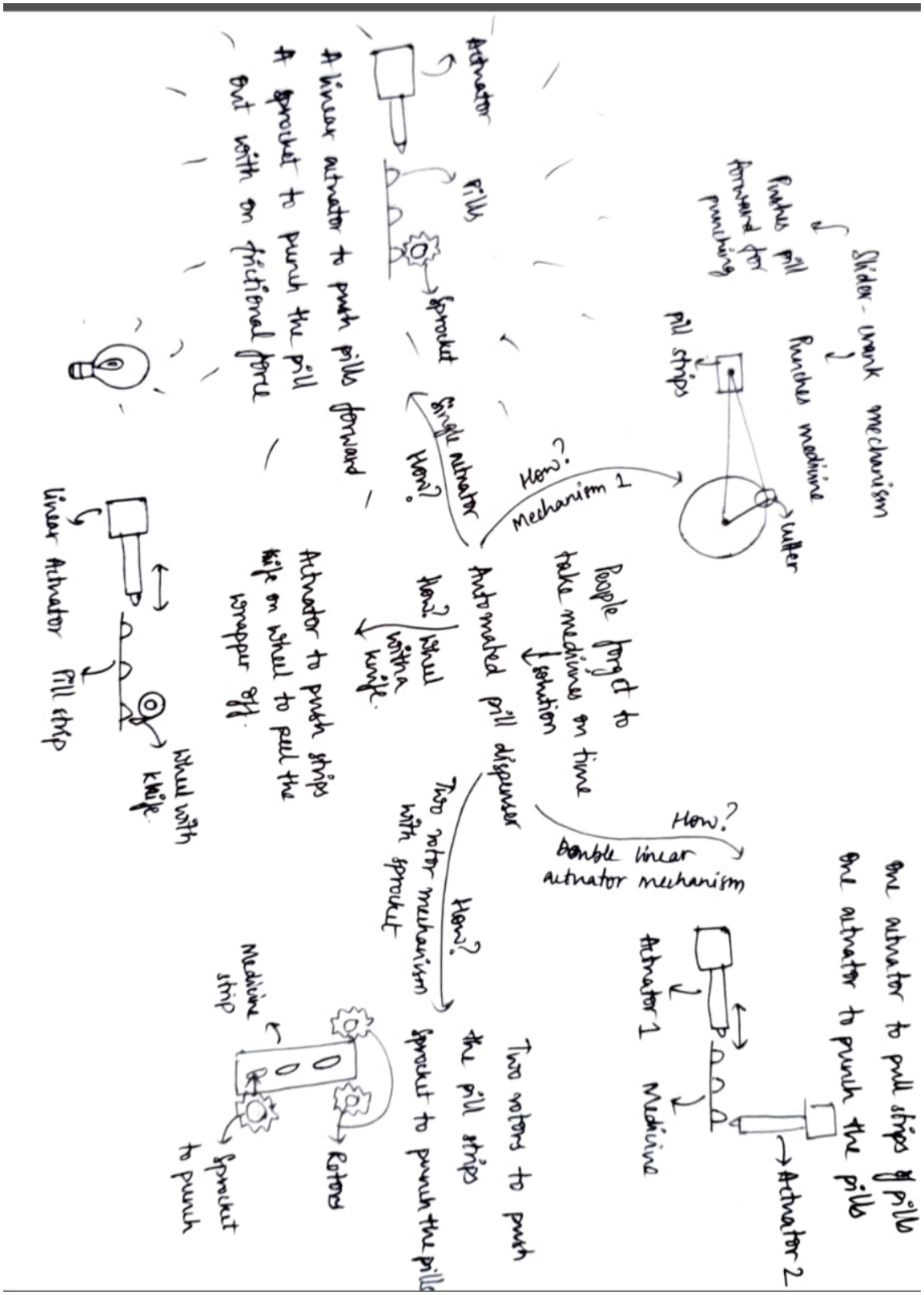
Serial number	Problem identified
1	Special Scissors for cutting food
2	Old people forget to take medicines on time
3	Mirror should be there at blind turn specially for hilly areas
4	Problem in driving in fog
5	Customised apparel recommendations
6	Usage of solar power to power water filter
7	Kids size outgrows clothes size
8	Phone battery running out at public place
9	Addiction to Social Media
10	Mental healthcare is expensive

Table. 3. Top 10 problems

Our ~~MILLION $~~ 13K IDEA

People forget to take their medicines on time

1. Brainstorming and Idea generation for solution mechanism



2. Selection of the most viable ideas proposed.

It was concluded after intensive brainstorming sessions that we would finalise the mechanism with one linear actuator and one sprocket to dispense the medicine. The function of the linear actuator would be to push the pill moulds towards the sprocket, where it would be unwrapped with frictional force applied from the spokes of the sprocket.

3. Decision matrix

Points were given from 0-10, with 0 being least viable and 10 being most viable

Solution ideas	Cost	Feasi -bility	Availa -bility	Total	Remarks
Slider crank mechanism	7	6	6	19	Hard to make a system stable with too many moving parts
Double linear actuator	3	9	9	21	Was getting too costly due to non availability of a small actuator
Two rotor mechanism with sprocket	10	4	9	23	Two rotors may not be able to push the medicine strips for ward, and it may get stuck due to friction
Wheel with a knife mechanism	10	4	10	24	Low clearance for the cutting action of wrapper to take place, so there were chances for
Single linear actuator with sprocket	8	9	9	26	Most viable fabrication option identified

Table. 4. Decision Matrix

Chapter 4

Embodiment and Detailed Design

1. Product architecture

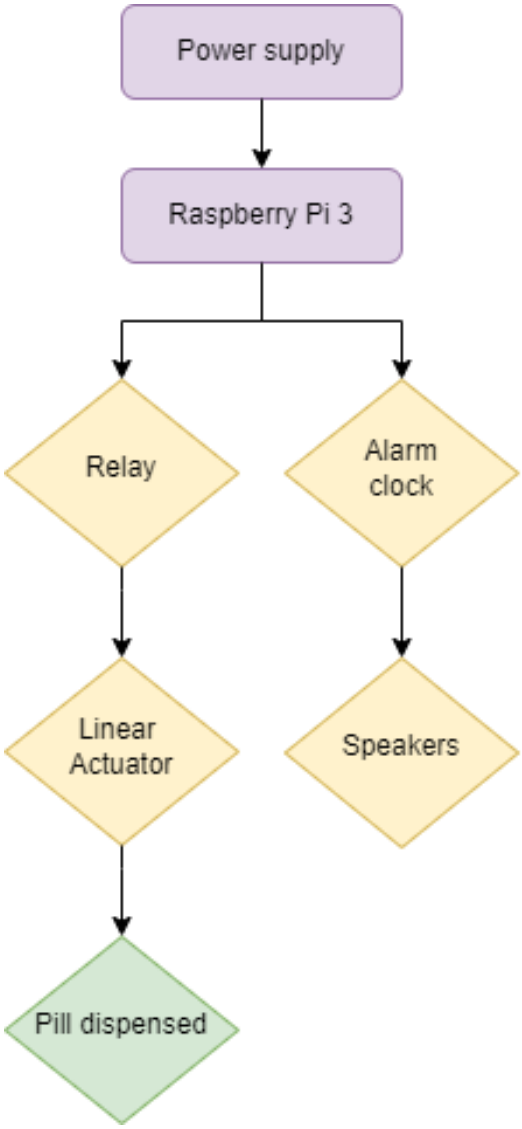


Fig. 8. Flow chart of working prototype

2. System-level design -

- The power supply is given to the raspberry pi through a 300V adapter.
- The Raspberry Pi is connected to the relay and alarm clock with jumper wires.
- The relay helps in activating the back and forth movement of the linear actuator.
- The linear actuator moves along the guideways, and into the pill mould housing, pushing the bottom most pill mould forward under the sprocket.
- The sprocket is fixed into place on a shaft that is held by the shaft holders.
- The sprocket and shaft holders are all placed with the help of nut and bolt fastening.
- When the pill mould moves under the sprocket, the medicine is dispensed just by the frictional force from the sprocket, and pops out into the collecting tray.

3. Design configuration

Part	Dimensions (in mm)	Material	Manufacturing process
Linear actuator	350*60*60 when unexpanded	Aluminium	NA-Outsourced
Raspberry pi3	63.5*55.88*20.32	Electrical components	NA-Outsourced
Relay		Electrical components	NA-Outsourced
Sprocket	⌀46, Thickness=10	Plastic	
Shaft	⌀6.4, Length=100	Stainless steel	Metal cutting
Shaft holders	Complex, Dimensions given in Table 6	Acrylic sheet	Laser machining
Actuator guideway	700*80*30	Aluminium	Metal cutting

Speakers	70*60*50	Electrical component	NA-Outsourced
Jumper wires	NA	Electrical component	NA- Outsourced
Pill mould	Complex, dimensions given in Table 6	Wood	Wood cutting
Pill mould casing	150*200*35	Acrylic sheet	Laser machining
Collecting tray	Complex, dimensions given in Table 6	Aluminium	Metal cutting and shaping

Table. 5. Design Configuration

4. Detailed design

- **Electrical/Electronics aspect:**

  Raspberry Pi 3: It is used as a microcontroller in this project. It is powered with a 5V, 2.5A AC-to-DC adapter.

  Alarm clock: Speakers (5V 2A) are synchronised with a switch and are powered directly from Rpi with an USB cable. OX cable is used for Input output control and it is also connected directly With Rpi.

  Linear Actuator: Rated voltage and current that our actuator consumes are 24vdc and 5.5A respectively that's why it is being powered with an 230v ac to 24v DC adapter with external supply. Actuator uses a DC motor inside it so to reverse the motion of actuator we need to reverse the power terminals that's why Relay is used.

  Relay: It contains 4 modules out of which only 2 are being used one with forward motion and other with reverse motion according to the program that is their inside Rpi.

- **Software part:**
  We have used the below code in the RPi to run the linear actuator

```python
# Importing the required libraries.
import RPi.GPIO as GPIO
from time import sleep
import vlc
import multiprocessing

# Set warnings as False.
GPIO.setwarnings(False)
GPIO.setmode(GPIO.BCM)

# Reading the alarm clock audio.
vlc_instance = vlc.Instance("--input-repeat=999")
player = vlc_instance.media_player_new()
song = vlc_instance.media_new("/home/pi/Music/audio.mp3")

player.set_media(song)
player.audio_set_volume(100)
player.play()

# GPIO pins for actuator positive and negative terminals
r2 = 40
r1 = 38

# Defining functions for setting up and working of the GPIO pins for the actuator
def set_input_pin(pin):
    GPIO.setup(pin, GPIO.IN)
def set_output_pin(pin):
    GPIO.setup(pin, GPIO.OUT)
    GPIO.output(pin, GPIO.LOW)
```

```
def high(pin):
    GPIO.output(pin, GPIO.HIGH)
def low(pin):
    GPIO.output(pin, GPIO.LOW)

# Function for the forward movement of the linear actuator.
def fwd(t):
    low(r2)
    low(r1)
    high(r2)
    sleep(t)
    low(r1)
    low(r2)

# Function for the backward movement of the linear actuator.
def rev(t):
    low(r2)
    low(r1)
    high(r1)
    sleep(t)
    low(r1)
    low(r2)

# Testing function
# for i in [r1,r2]:
#     GPIO.setup(i, GPIO.OUT)
#     GPIO.output(i, GPIO.LOW)

```

```
# GPIO setup for the alarm clock pin with Rpi
GPIO.setup(17,GPIO.IN, pull_up_down=GPIO.PUD_UP)
# GPIO.setup(17,GPIO.HIGH)

# Main Function for the complete working of the prototype.
while True:
    inpt=GPIO.input(17)
    if inpt== False:
        player.pause()
        #sleep(10)
        player.stop()
        GPIO.cleanup()
        GPIO.setmode(GPIO.BOARD)
        for i in [r1,r2]:
            GPIO.setup(i, GPIO.OUT)
            GPIO.output(i, GPIO.LOW)
        fwd(26)
        sleep(8)
        fwd(6)
        sleep(8)
        fwd(8)
        sleep(8)
        rev(41)
        break
```

- **Mechanical Aspects:**

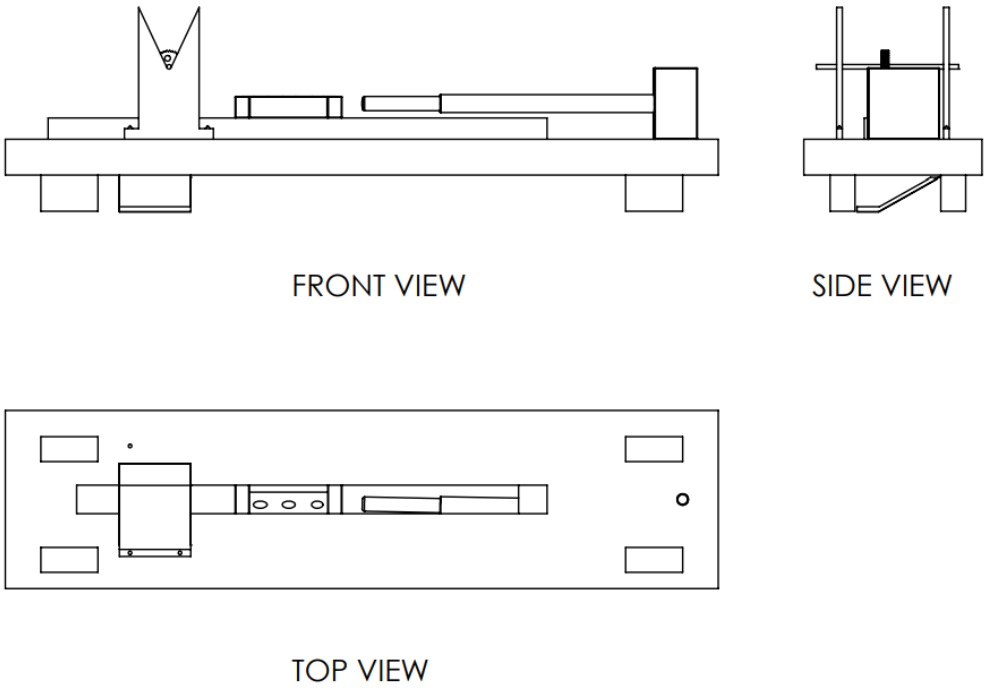


Fig. 9. Isometric Projection of the prototype

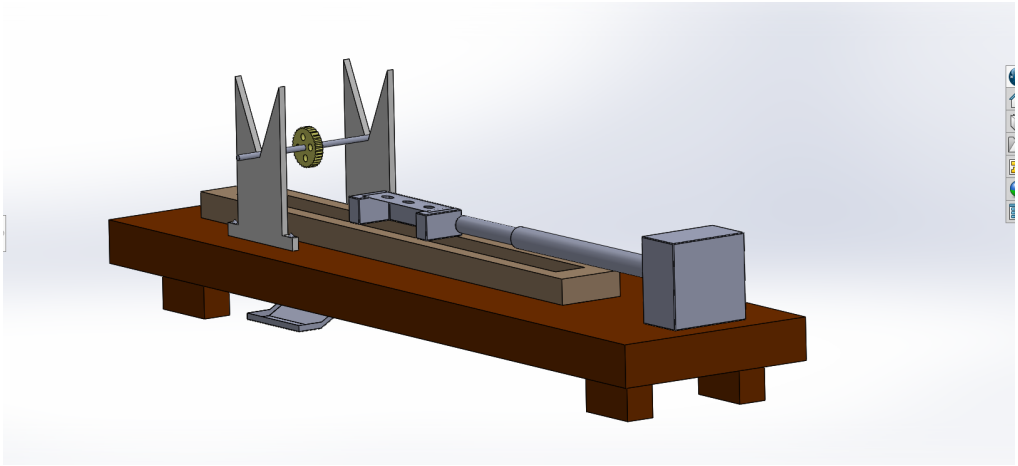


Fig. 10. 3-dimensional view of the prototype

5. Results and Discussion

The electrical aspects of the project were fulfilled using the minimum resources, i.e, a Raspberry Pi, relay, Linear actuator and alarm clock. For the software component, we had run a code to activate the back and forth motion of the linear actuator in sync with the alarm clock. For the mechanical structure we used easily available components in the central workshop, like wood, aluminium and acrylic sheets. This helped in greatly reducing the weight of our model, as we didn't use a lot of heavy metals in fabrication.

Chapter 5

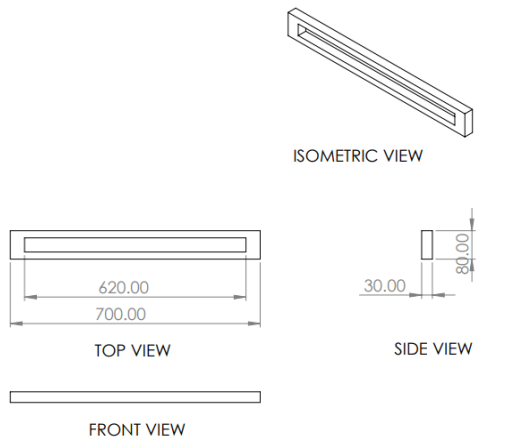
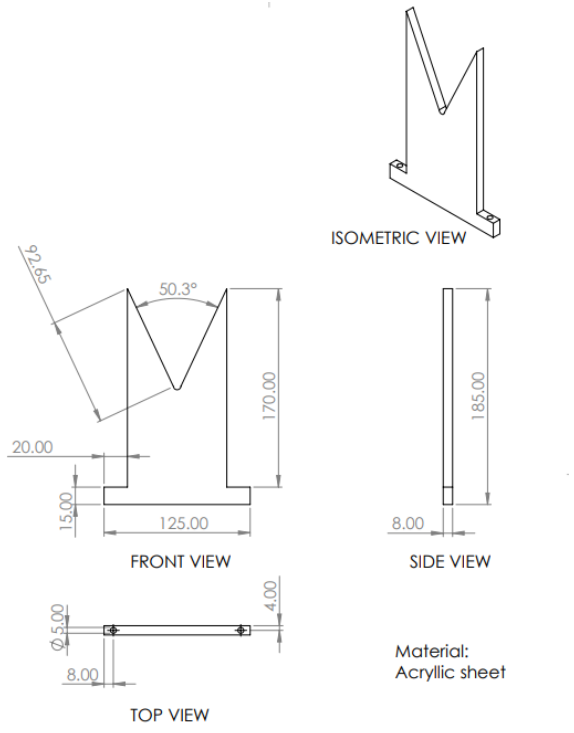
Fabrication and Assembly

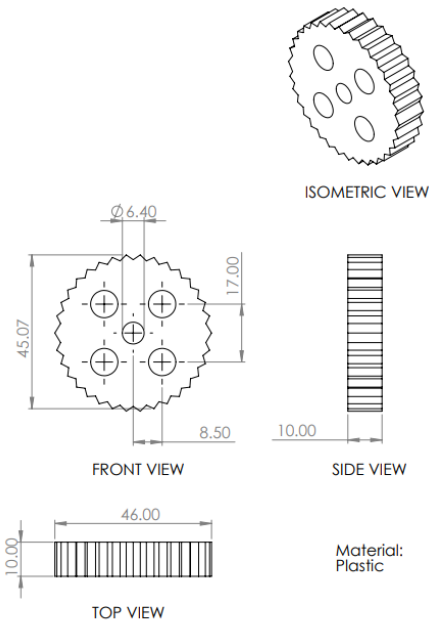
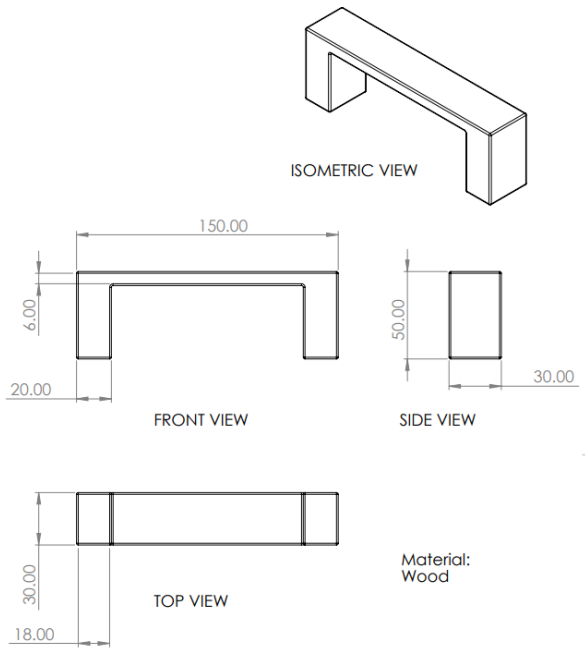
1.Bill Of Materials

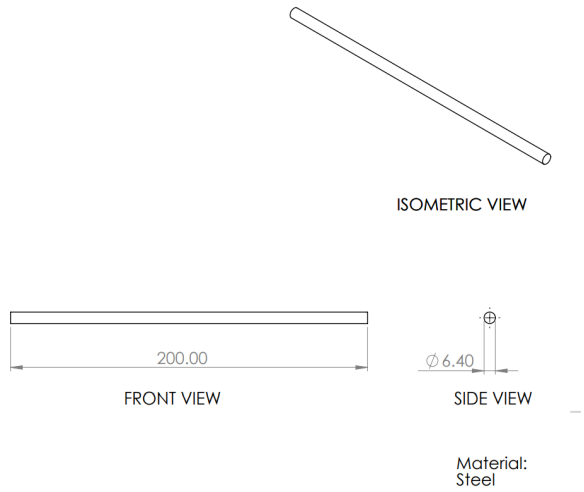
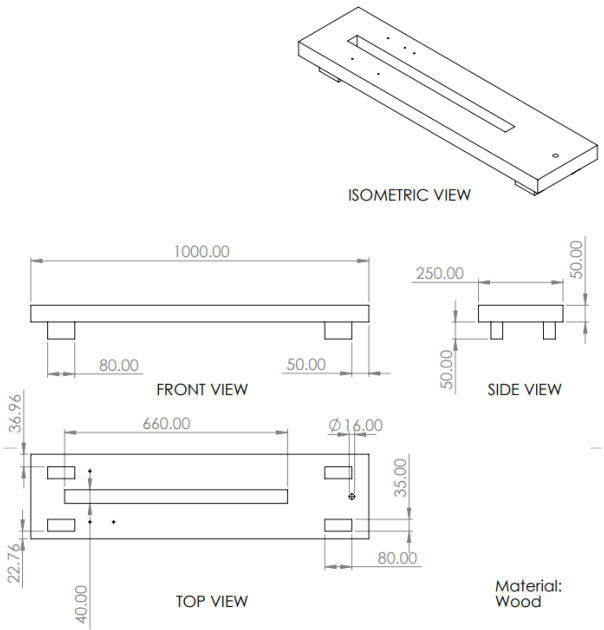
Sr. no.	Part name	Quantity	Cost (In INR)
1	Linear actuator	1	6000
2	Raspberry pi3	1	3850
3	Relay	1	260
4	Sprocket	1	150
5	Shaft	1	20
6	Shaft holders	2	500
7	Actuator guideway	1	350
8	Speakers	2	299
9	Jumper wires	6	150
10	Pill mould	3	300
11	Pill mould casing	1	750
12	Collecting tray	1	100
13	Closing lid	2	600
		Total	13,329 Rs

Table. 6. Bill of Materials

2. Mechanical components

Sr. no.	Mechanical component	Diagram
1	Actuator guideway	
2	Shaft holders	

3	Sprocket	
4	Pill mould	

5	Shaft	
6	Base	

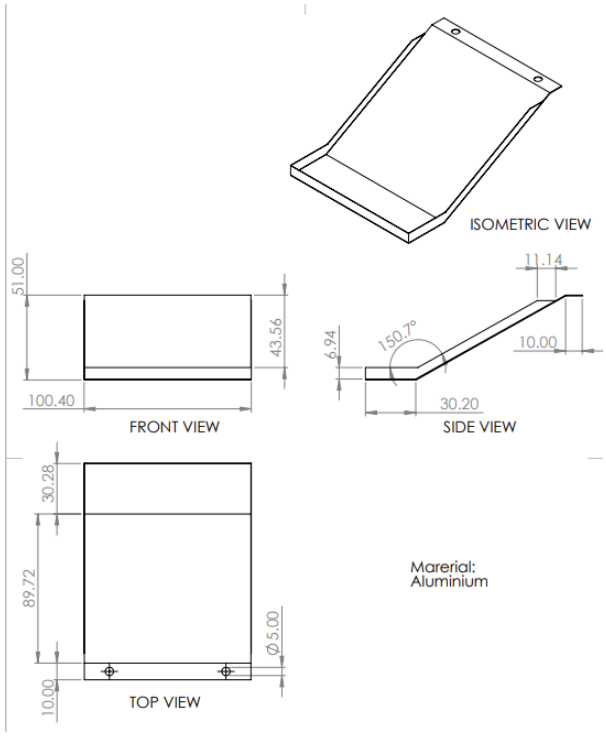
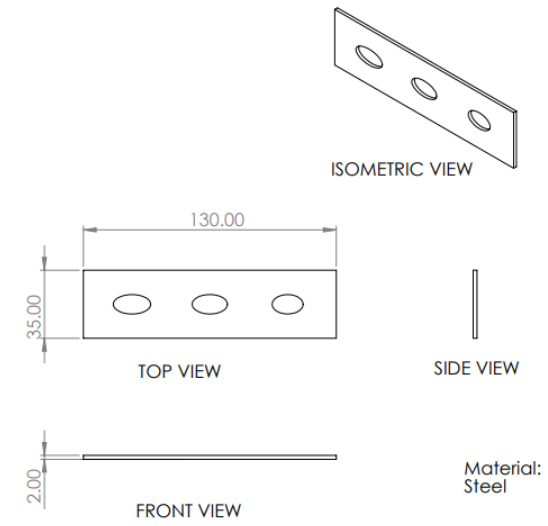
7	Collecting tray	
8	Metal layer of pill mould	

Table. 7. Mechanical Components in the prototype

3. Manufacturing Process description:

Sr. no.	Part name	Manufacturing process description
1	Shaft	1. Metal cutting to obtain shaft of required length
2	Shaft holders	1. Laser machining to obtain desired shape 2. Drilling in the drilling machine to drill holes at the base for the screws
3	Actuator guideway	1. Metal cutting for obtaining the guideway of required length and cutting the hole at the centre for the medicine to pop out
4	Pill mould	1. Wood cutting, to give the desired shape 2. Hand drilling to insert screws to attach it to the metal base layer. 3. Adhesive bonding to acrylic sheet using super glue.
5	Pill mould casing	1. Laser machining to obtain sheets of desired dimensions. 2. Drilling using the drill machine to insert screws, for it to rest on the base of the pill dispenser.
6	Collecting tray	1. Metal cutting and shaping to obtain the desired shape. 2. Hand drilled holes for inserting nuts and bolts for fastening onto the base of the box.

Table. 8. Manufacturing Process Description

4. Assembly

- The aluminium guideway, shaft holding acrylic sheets, and linear actuator are all fastened onto the base with nuts and bolts.
- The shaft is fitted onto the shaft holders using circular support bearings.
- The pill mould housing and pill moulds rest freely atop the aluminium guideway.
- The parts of the pill mould housing are attached using adhesive bonding using super glue.

Chapter 6

Concluding remarks

1. Limitations and Challenges:

- Cost: The cost of the linear actuator was very high. We could have worked with an actuator of 150 mm stroke length and one that provides 13N force. But due to non availability of such actuators in India, the cost of our model had significantly increased.
- Large size: Due to the large size of the linear actuator, we had to size the rest of the model accordingly, making bigger pill moulds, and consequently bigger pill mould casings and sprockets. The size of the whole model could be reduced by 1.5x if we had a smaller actuator.

2. Schedule plan:

Task name	Assigned	Status
Milestone 1 Problem identification		
Making a list of 100 problems	All	Done
Finalising top 10 problems	All	Done
Finalising our top 1 problem	All	Done
Milestone 2 Solution identification		
Devising solutions to the problem through brainstorming sessions	All	Done
Modification of all proposed solutions	All	Done
Identifying most viable solution	All	Done
Milestone 3 Building over the solution		
Building basic CAD design	Nishritha	Done
Submission of proposal report	Khushi, Nishritha, Prateek	Done
Finalising mechanism	All	
Milestone 4 Fabrication		
Material Selection	Mehul, Kirsh	
Mechanical fabrication	Kirsh, Mehul, Rahul	Done
Electrical fabrication	Rahul, Prateek	Done
Software fabrication	Prateek, Rahul	Done
Improvising existing mechanism, to accommodate fabrication constraints		
Milestone 5 Presentations and reports		
Pre open house poster	Nishritha, Khushi	Done
Open house poster	Nishritha, Khushi	Done
Final report	Nishritha, Khushi	Done

Table. 9. Schedule Plan

Full report can be accessed at:
DP Group 7- Grantt chart

Contribution:

Sr. no.	Member name	Roll number	Contribution
1	Nishritha Boligarla	B20283	Idea generation, CAD models, making of report, documentation
2	Prateek Raj	B20164	Idea generation, RPi coding, electrical fabrication
3	Khushi Ladha	B20013	Idea generation, making of report, documentation,
4	Kirsh Kumar	B20295	Idea generation, RPi coding, mechanical fabrication
5	Rahul Yadav	B20095	Idea generation, electrical component fabrication
6	Mehul Jain	B20300	Idea generation, overall fabrication, material selection

Table. 10. Contribution of team members

Overall, all the group members had worked together with good harmony and without any disputes in each stage of product development. Every member provided fruitful contribution and properly executed their task, to the best of their abilities.

Conclusions:

It is in plain sight of the common man of how detrimental the effects of medicinal nonadherence can be. The loss of lives and money in the healthcare industries is massive, and it can all be solved with just a simple pill dispenser. All the components used in our project are easily available, and the manufacturing processes involved are also feasible. It has a very non complex design and is easy to use too. It could be of great help to any patient and the healthcare industries overall.

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