AUTOMATED MEDICINE DISPENSER

A Project Report
Submitted for the course
MGT 1022 Lean Start-Up Management

Under the Guidance of

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(Deemed to be University under section 3 of UGC Act, 1956)

MARCH 2018

INTRODUCTION

A lot of people experience memory lapses. Some memory problems are serious, and others are not. People who have serious changes in their memory, personality, and behaviour may suffer from a form of brain disease called dementia. Dementia seriously affects a person's ability to carry out daily activities. Alzheimer's disease is one of many types of dementia. The term dementia describes a group of symptoms that are caused by changes in brain function. Dementia symptoms may include:

- Asking the same questions repeatedly

- Not being able to maintain daily routines

- Being unable to follow directions

- Becoming lost in familiar places

- Getting disoriented about time, people, and places

- Neglecting personal safety, hygiene, and nutrition.

People with dementia lose their abilities at different rates. The two most common forms of dementia in older people are Alzheimer's disease and multi infarct dementia (sometimes called vascular dementia). These types of dementia are irreversible, which means they cannot be cured. Symptoms of Alzheimer's disease begin slowly and become steadily worse. As the disease progresses, symptoms range from mild forgetfulness to serious impairments in thinking, judgment, and the ability to perform daily activities. Eventually, patients may need total care.

Through our product, we aim to automate a small – yet integral part – of people suffering from various degrees of dementia. Our goal is to make people of any age (especially the old people) suffering from memory lapses, remember all the medicines they have to take throughout the day for the entire week with minimal

human (manual) intervention. In this way, we look to make an impact in their lives, by trying to provide a way for them to stay on track with their medications.

NEED FOR THE PRODUCT

The product is very beneficial for the matter of fact that it is very common to see people getting confused about their daily sequential tasks (tablets in this case) and their timings to be taken. Therefore, with this product we aim to provide them the suggested medicines to be taken on the particular day without any confusion or errors.

In earlier times, for this purpose, there has to be always a person assigned to take care of the medicines for the entire week and keep on reminding the people, not only the elderly ones but also people belonging to other ages. This meant that a lot of human intervention was needed, and a lot of factors went into consideration while opting for these type of services:

- Severity of dementia
- Availability of medical personal for constant upkeep
- Location of the patient
- No guarantee that the correct medicine will be given, that too on time (very minor possibility, however there is always a chance)
- Other human factors such as if the caretaker had to go on a leave

So, to eliminate the dependency on others for remembering the particular medicine to be taken, we propose this idea of developing a prototype that will help to automate the whole process to some extent – if not fully automate it.

METHODOLOGY

- The prototype we have planned initially to work on is to use a circular plate with 8 vertical walls placed radially making 7 compartments (each compartment looking like a slice of a cake) along with the use of servo motors and development boards.

- Each compartment will be marked with a particular day and a different colour, containing the respective medicines (tablets) to be taken on that particular day.

- The prototype will be sealed from the top with a fixed plate. The circular plate with the compartments will be free to move in circular motion with a servo motor installed at the centre, to allow the circular motion of the plate.

- We plan to use a development board, which is essentially a microprocessor driven "motherboard", to initiate the periodic movement of the plate such that after every 24 hours, the plate makes a circular motion.

- The circular motion will be controlled and coded in a way that the next compartment reaches the position of the previous compartment after 24 hours. This can be achieved by fine tuning stepper motors to the exact degrees it needs to be rotated, so as to achieve the perfect position for the slot to stop.

- The above fixed plate will have an unsealed portion where the next compartment that takes the position for the particular day for medicines to be taken will be made available to the person.

- The basic prototype can further be improved and enhanced by adding new features to it. Also, because it is based on a development-board based microcontroller, it opens up the possibilities of integrating next-generation advancements such as IoT, and machine learning that'll help the doctors and family members to keep track of the health of the patient as well as proper functioning of the device.

MANUFACTURING

FABRICATION

The main part of the device will consist of 3 parts: the outer shell, the inner mechanism and the base.

- **Outer Shell:** It will be made out of a lightweight material, which is durable such as balsa wood (coated with anti-corrosives on the inside), and aluminium (coated with silver for stopping bacteria growth). The main purpose of the shell is to separate the contents of the mechanism i.e. the medicines from getting exposed to air. Also, the lid of the device will be removable, so that people can fill up the medicines as and when required. There will also be a silicon lock on the rim of the lid.

- **Inner mechanism:** This part is going to be the core concept of the prototype. It will consist of a circular disc, made of light weight silver coated aluminium, which will have 7 "walls" that will end up making 7 compartments for the tablets to be stored. These will be placed in such a way that they form the shape of 7 sectors on the circular plate. Each sector will be further divided into three parts that will represent the times of the day i.e. **morning**, **afternoon**, and **night**. These three zones will be colour coded: red for morning, yellow for afternoon and blue for night time. The base of the plate will be connected to the shaft of a stepper motor, which will be placed in the base.

- **Base:** This is the part that will provide stability for the whole device. It will house the following: the stepper motor, a battery bank, and an electronic circuit for AC to DC conversion. It is responsible for storing all the wires, and miscellaneous stuff, along with that providing a sturdier support to the whole prototype. It will either be made out of Balsa Wood or some other form of hard poly-plastic which is strong and unbreakable.

ELECTRONICS

After much studying, we narrowed it down to two choices in the case of the development board: **Arduino UNO** or **MSP430**. Both offer similar kind of hardware, with only minor changes. The main reason for going with either of these boards was because they require very low power to operate, and also can be much easily interfaced with the stepper motor (**4-lead Nema17 Stepper Motor 17HS4401**). Also, the microprocessors in them can be coded with High Level Language, such as C++, which makes the task easier as well as efficient. Here, the major component is the stepper motor, with the following specifications:

- Step angle: 1.8 degree
- Number of phases: 2
- Voltage: 3.96V
- Current: 1.7A
- Resistance: 4.4 ohm
- Holding torque: 4.8kg.cm
- Operating ambient temperature: -20 ⁰C to 50 ⁰C
- Operating environment humidity: 90 percent
- Axis diameter: 5mm
- Height: 40mm

This specific motor was chosen due to two reasons: firstly, this motor is currently used in many 3D printers, which makes it suitable for robust, long lasting operations. Secondly, the operating voltage is ~4V which is well within the 5V driving output of the Arduino or MSP.

COMPUTER AIDED DESIGN (CAD) PROCESS

We designed a CAD model of our device so that we could simulate some of the test that could help us identify the type of material we should use, the shape of the plates, whether the stepper motor will be able to deliver the required torque etc. The process is as follows:

- Our 3D model is made on a software named SolidWorks 2017.

- First, a 2D sketch is drawn for the outer compartment that is going to be stable.

- Another sketch is drawn which comprises of seven different compartments; each with 3 sub-compartments

- This base plate attached to the seven compartments is to be rotated over a certain period of time with the help of the stepper motor.

- These 2D sketches are then to be extruded out to provide a 3D figure.

- The 7 compartments are separated with the help of the thin wall made by extruding the rectangles through the surfaces.

- One of the side of the fixed outer compartment is then cut-extruded to provide an open display for the tablets.

- Two concentric circles are designed which is later extruded.

- Now the servo is designed and later is attached with the above design. This is done with the help of the assembly feature provided in the software.

Once the model is done, the code for running the motor is uploaded into the Arduino and then it is run. The syntax of a part of the Arduino code is:

```
const float resolution = xx.xx; // step resolution here
int step_degree (float desired_degree) {
    return (desired_degree/resolution);}
stepper.step(step_degree (40)); //rotate 40 degree.
```

Step resolution is 200 (i.e. 200 steps needed to cover 360º)
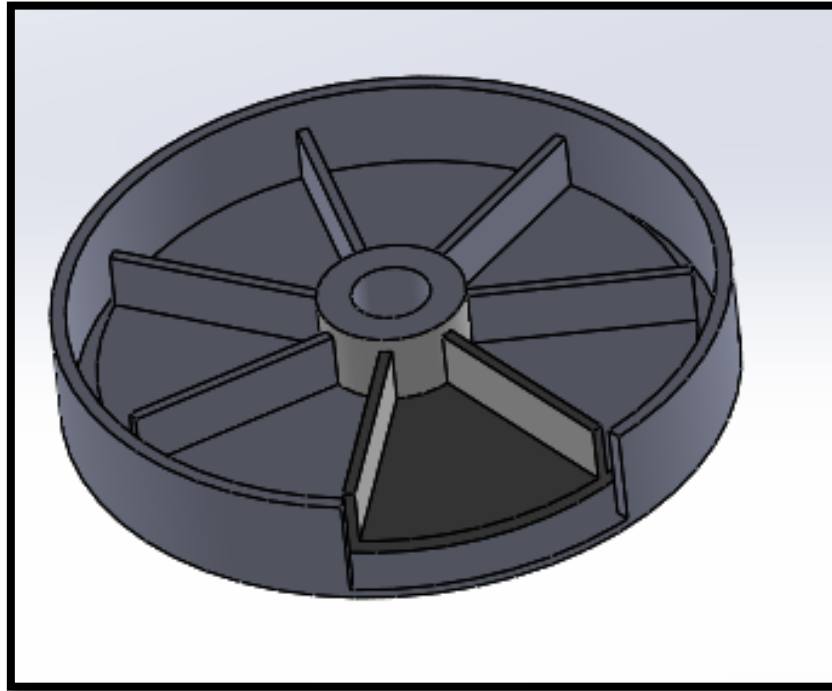
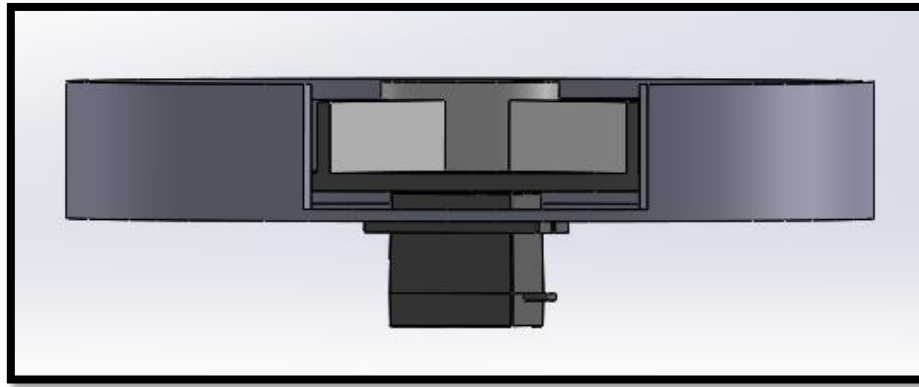*Figure 1: Perspective View*
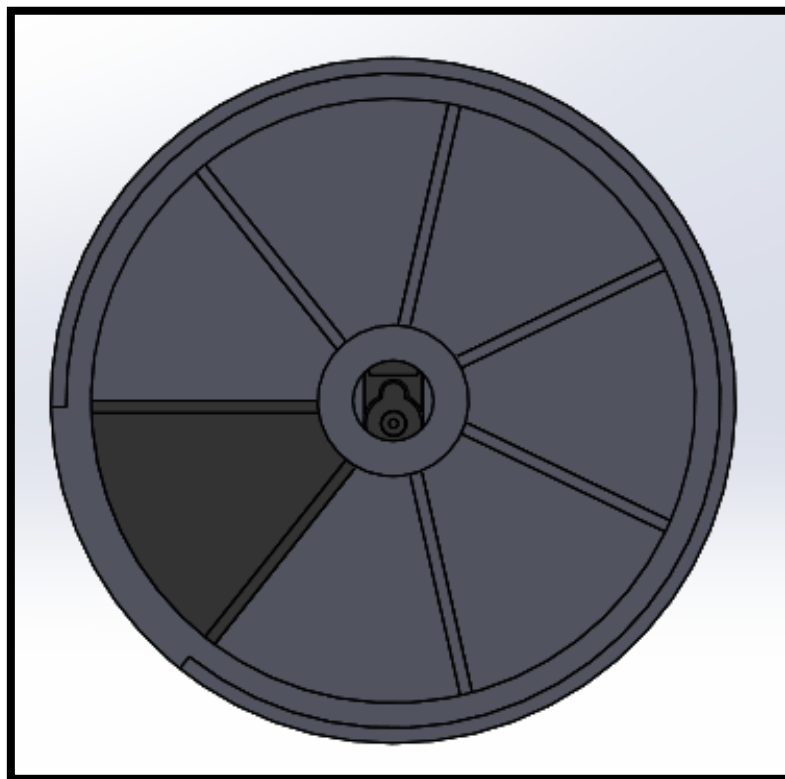
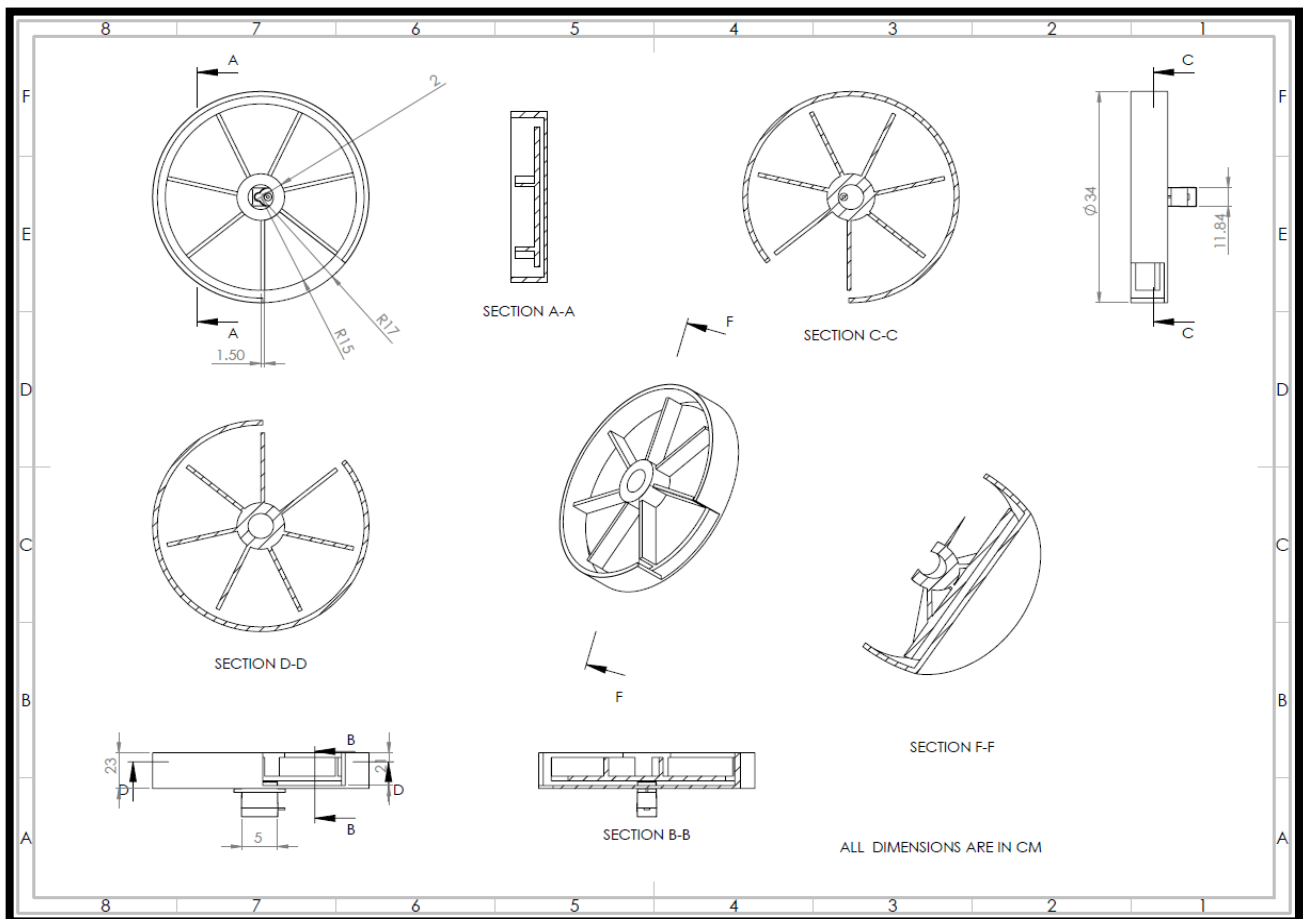*Figure 2: Top Down View*

Figure 3: Side View

Figure 4: 2D Parametric Drawing

DESIRED OUTCOMES

Through our project, we aim to tackle the issue of people forgetting to take their medicines due to varying degrees of dementia. This is just a small aspect of the patients' lives which we are looking into, because we feel that if we can somehow automate the process of their daily activities, such as taking their medications on time, we will be able to help them in their recovery and make their daily routines less of a chore. Our product:

- Aims to deliver a solution to help patients take their medicines on time
- Fully automates the process, thus reducing human intervention
- Aims to provide a low-cost solution, in an industry plagued by costly services
- Introduces a low maintenance device, which is user-friendly

FUTURE SCOPE

The world is advancing in producing technologies by the minute. A manufacturer never knows when their product will become obsolete. Hence, keeping this in mind, we have tried to future-proof our device, by allowing people in the future, to modify the device by implementing services such as IoT, which will help to keep track of whether the patient is taking their medicines regularly or not, whether the slots need refilling, and also users can hook up fitness bands to the device, which can alert the patient at the time of taking their medicine. Also, with the added benefit of machine learning, doctors can have daily updates on their patients' health, and either modify the dosage or change the medications completely. All these can be done with the help of advancements in existing technologies.

THE BUSINESS MODEL CANVAS

Business Model Canvas is a strategic management and lean start-up template for developing new or documenting existing business models. It is a visual chart with elements describing a firm's or product's value proposition, infrastructure, customers, and finances. It assists firms in aligning their activities by illustrating potential trade-offs. The general template of a Business Model Canvas looks as follows:

Key Partners:

- Hospitals dealing with Alzheimer disorders such as Fortis, Apollo Clinics etc
- Insurance companies that are willing to promote start ups
- Other companies to provide us with equipment for manufacturing purposes
- Companies providing raw materials to our start up

Key Activities:

- Local medical clinics are to be partnered with

- Filing patents

- Providing an online platform for purchasing of the product

- Develop manufacturing capabilities

Key Resources:

- Lab/manufacturing facilities

- Technical managers and process engineers

- Online presence with another company

Value Propositions:

- Environmentally friendly

- Have an expansive view in mind

- Proper sites to be used for picking up of the raw materials

Customer Relationships:

- Act as a supplier and helps in control of the production

- Low rates for the special customer and various other discount policies

- Providing easy user experience to the customer

Channels:

- Through print and online media

- Advertisement boards and banners

- Tie-up with selected hospital and clinics

Customers Segments:

- Customers having memory disorders
- Old people taking medicines on a daily basis

Cost Structures:

- Labour cost (assembly line workers, engineer, management)
- Raw material cost (servo, aluminium or wood etc.)
- Online subscription charges

Revenue Streams:

- A type of luxury provided so as to not worry about the medicine routine throughout the day
- These expensive models have been brought up to a low selling cost
- Usage fee per patient/client (with possible reimbursement from insurance)
- For end users, premium subscription to be provided

The final Business Canvas (after many iterations) looks somewhat as follows:

The Business Model Canvas

Designed for: *Automated Medicine Dispenser* Designed by: Date: Version:

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STP ANALYSIS

SEGMENTATION

Segmentation is the process of dividing the target audience into different groups with common characteristics, so that there is some clarity about how the product will cater to these specific groups.

For our product, the consumer target base has been segmented according to two approaches: **Demographic** and **Behavioural**.

Demographic: Demographic factors generally include gender, age, sexuality, marital status and ethnicity. The major factor we will be focusing here is **age**. The main categories that the target audience is divided into is: **young people** and **old people**.

Younger people generally do not face much severity in the symptoms of dementia. Hence a basic model will help the young people to keep track of their daily medications. Also, a more passive system can be employed, such as an alarm beeping when it's the time to take their medications. This will help them to start learning their daily regime and over time, build up their memory for the different activities. With the old people, however, a more advanced model may be required, which will keep track of their medicine doses and also alert them in a more active way when reminding them to take their medicines, say vibrating their FitBits (fitness bands) until they have taken their required dosage.

Behavioural: Behavioural factors generally include how people use the product, the benefits that they are looking for, or how loyal they are towards a product. For our product, the consumer base can be divided based on whether or not they face from memory lapse problems, such as dementia, and if yes to what extent they suffer from it. People who suffer from memory lapses will benefit the most

from our product. They can be divided into two groups (based on age): **young** patients and **old** patients.

Younger patients generally tent to easily learn day-to-day tasks fairly easily, hence as explained earlier, they will need very little to no guidance in helping them remember to take their daily medications. Also, even though the rates at with the health of young and old people deteriorate are fairly the same, the recovery process is far different, with younger patients having the capability to recuperate much faster than elderly people. With old patients, they will need to be actively kept reminded about the series of events they'll need to follow so that their health doesn't deteriorate beyond control.

TARGETING

Targeting involves selecting which segmented group will be the best option to target as a probable audience. For our product, **we will majorly target the elderly people**, as in this way we can focus on a more complete product, rather than having to produce a basic one for the young and the old, and then having to redesign both differently, over time.

Almost 47 million people are living with dementia around the world on, with 4.1 million of them in India, according to a new report which also found that nearly half of all people with dementia globally will live in Asia by 2050 – according to a 2015 report by King's College London. Researchers also found that there are more than 9.9 million new cases of dementia each year worldwide, implying one new case every 3.2 seconds. At the country level, ten countries are home to over a million people with dementia in 2015: China (9.5 million), US (4.2 million), India (4.1 million), Japan (3.1 million), Brazil (1.6 million), Germany (1.6 million), Russia (1.3 million), Italy (1.2 million), Indonesia (1.2 million) and France (1.2 million).

In elderly people, a sever format of dementia is seen. It is known as **Alzheimer's disease** and is a common form of dementia. It is characterized by a gradual decline in brain function. Symptoms include memory loss, decline in cognitive functions, and personality changes. There is no cure for Alzheimer's dementia. Treatment plans can be made to address symptoms and improve quality of life. Although the cause is not completely understood, age is the largest contributing factor to the development of the disease. Its prevalence is very common in elderly people, with high costs of rehabilitation and no guarantee of a cure.

The following infographic shows the mortality rate due to Alzheimer's and Other Mental Diseases' Impact on Different Age Groups Over Time:
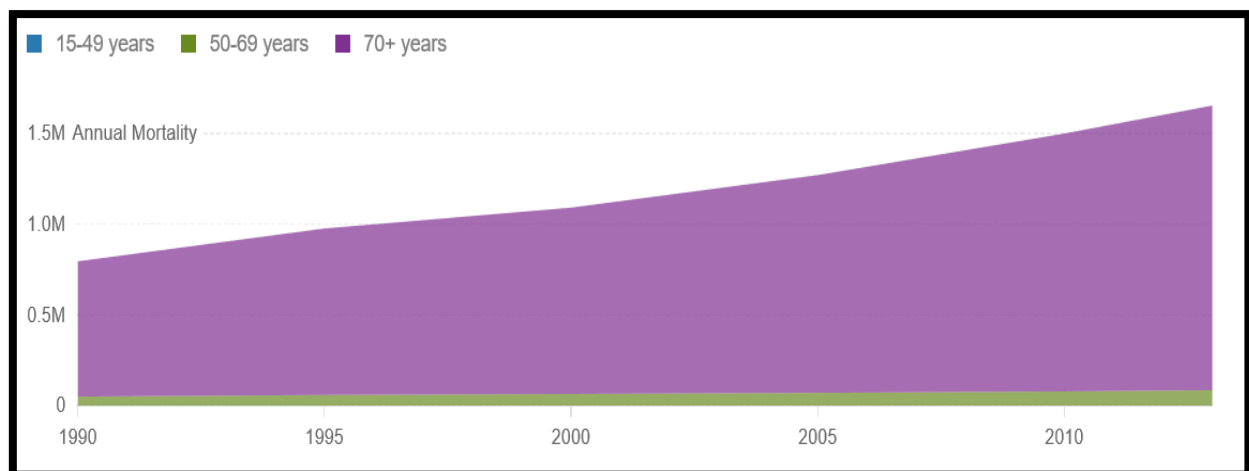
Based on this available data, we have concluded that the majority of our demographic consists of people over the age of 70 years. Parallelly, we are trying to develop a product that will help even the younger people to keep track of their daily activities, such as taking medicines on time, which most of the time they may forget due to a lot of rush in their life.

POSITIONING

Let us consider a positioning map, where we compare how our product stands up to other alternatives in the market:

Our unique selling point, or USP, is that we offer a device that works on a simple concept, however it can help the patients suffering from dementia, a great deal in remembering to do their day to day activities – some of which may be necessary for them, to lead a better life, such as taking their medications on time.

MIT's Deep Brain Stimulation Program and an Israeli start-up called Neuronix are currently working on products to curb (if not cure) diseases such as

Alzheimer's and Dementia. These two start-up companies aim to solve these problems by targeting the brain electrically rather than chemically. They're both using technologies that have proven successful for other brain disorders. One company plans to use deep brain stimulation, which has been used to treat tens of thousands of Parkinson's patients. The other (Neuronix) hopes to find success with transcranial magnetic stimulation, a non-invasive approach used to treat depression and as a research tool to stimulate or inhibit specific parts of the brain.

On top of that, there always will exist home-made remedies and Mind Training sessions, which necessarily do not achieve overly good results, however they do just enough to reach the acceptable level. Also, most of the times, the patients get feel like they're getting scammed as they do not find any feasible results over long periods of time.

In the end, the value proposition we are putting forward, is the ability to have the best product in the market, at a price that doesn't burn a hole in the consumer's pockets, and at the same time providing affordable medical care to everyone.

MARKETING MIX FOR AUTOMATED MEDICINE DISPENSER (4P)

Here, we will analyse our product, as well as the market we are about to enter. We will also present, how we plan to approach the current medical equipment manufacturing market.

PRODUCT

Product can be often categorized into three categories: **Core Product, Actual Product** and **Augmented Product**. For a **specialty** product such as an Automated Medicine Dispenser, these can be described as:

- **Core Product:** The core product we are trying to sell, is basically a medical equipment, which provides a solution to the problems that people suffering from memory disorders face i.e. it will allow patients of Alzheimer's and Dementia to keep their day-to-day medicine taking activity in mind and take the medications timely.

- **Actual:** The physical device that will be shipped to the buyers is our actual product. It is a prototype that will help people suffering from various levels of dementia, especially Alzheimer's patients and elderly people, to take their daily medicines on time, without much human intervention – with scope for future enhancements in IoT and machine learning.

- **Augmented:** The added services, obtained with our product ranges from major things, such as one-year warranty, 24/7 customer service, and personalized healthcare benefits – such as personalized reports, direct link to their preferred doctors, and monthly analysis of the patient's activities.

Another thing to be looked at here, are the individual product decisions. These can be generally categorized as **Product Attributes, Branding and Packaging,** and **Product Support Services.**

PRODUCT ATTRIBUTES

- **Quality:** The Automated Medicine Dispenser is basically a device made with the best quality materials available, which is built to last – at the same time we aim to not burn a hole in our buyer's pockets.

- **Features:** The device has a simple functioning when it comes down to the basics. However, it categorizes the medicines to be taken on a "Day Wise" basis i.e. 7 slots can be filled with 7 days of medications. Also, each slot is further **sub-divided** into three smaller slots: one for morning, one for afternoon and one for night time medications.

- **Style:** The styling of the product is very clean and futuristic. It draws inspiration from science fiction movies and space-age technology. This is mainly aimed to attract attention which will remind the patient about their medications, every time they look at the device.

- **Design:** Out of the gate, our goal in design was to make it easy to handle, easy accessibility and also a low maintenance profile. Along with that, the plan was to future-proof some of that parts so that when technology advances even further, we are ready to upgrade the model without any hassles. This eliminates the threat of fading into oblivion, as technology advances.

PRICE

There are two forms of pricing decisions:

- **Value based pricing:** Assess customer needs and set product price according to it as well as potential costs incurred

- **Cost based pricing:** Design the product, determine the costs and then set the price of the product.

The model our start-up is following for setting the price of the device is a hybrid one. It means that the **price ceiling** will be decided based on the total costs incurred to design one unit as well as the profit margin we are looking at, whereas the **price floor** will be determined based on the market and our potential customer base's income and other monetary factors.

About the market we are about to enter used to be called a version of **pure monopoly**. In the past, the medical equipment manufacturers were not that many, and only a few of them were able to produce good quality products. And the direct result was that the market was in the hands of few manufacturers such as Alembic Pharmaceuticals. As years passed by, and new technologies emerged, new companies started popping up. Nowadays, the medical equipment manufacturing market has turned into an **Oligopolistic competition** filled market. Oligopolistic means that the market is dominated by few large firms. They do not compete via price wars but compete in other ways such as ads, publicity, tenders etc. Companies such as Johnson & Johnson, General Electric Co., Siemens AG, Medtronic Inc., Baxter International Inc., Fresenius Medical Care AG & Co. KGAA etc. have started taking over the medical equipment industry, and now the industry has become one of the many multi-billion-dollar industries in the world.

PLACE

Here, we focus on the major marketing channel we will be using to propagate our product. There are generally two types of markets: **Consumer** and **Industrial**. Here, we are targeting the consumer market with a **0-Level Scheme**.

According to the 0-Level scheme, the flowchart of product distribution is:

What our start-up plans to do is have a major online presence, such as a portal, through which patients can get into contact with us. Then we personally take up the case and manufacture the device and set it up for the people personally (so that each customer has a custom experience). Also, the manufacturing will be done 50% in-house (the main apparatus and electronics) and we will collaborate with some other start-up/company for the basic outer shell.

The channel integration scheme will be **Corporate Vertical Marketing System**. In Corporate VMS, one member of the distribution channel be it a producer, a wholesaler or a retailer owns all the other Members of the Channel, thereby having all the elements of production and distribution channel under a single ownership. So, in our case, we will manufacture the main apparatus, after the patients get into contact with us (through online portals), fabricate the shell with the help of a tie-up company, and distribute it directly to the patients. Also, there is a plan to tie-up with select medical centres that specialize in neurological and mental disorders, so that the patients will have some information available to them when they come in for treatment.

PROMOTION

Since it is the age of the internet, our major form of promotion will be online advertisements. There will also be print advertisements put up everywhere in select medical centres. Television ads can be considered; however, they will be very **sporadic** and will have a large time gap between runs.

Also, we will demonstrate the product initially in Medical Conferences, so that the doctors know that there exists a device such as ours, which will help patients suffering from Dementia and Alzheimer's to easily get reminded about taking their medicines on time. In this way, the doctors can recommend us to their patients who are in need of such a device. After that, we basically have to depend

on **word-of-mouth** promotion by the patient to their close ones, and friends. It is not a very dependable form of promotion; however, it is an age-old practice and many companies actually have taken advantage of word-of-mouth promotions.