

## Summary

The company is fully focused on how to make the supermarket shopping experience user friendly for the customers in terms of calculating the price, weight, and discount on the product and then before you step into the final line to cash out all the items you purchase you should by yourself that today how much you are going to pay for the purchase items.

This report will explain about the company purposely, vision and mission and provide complete solution for this need in the market, brief dialog on brainstorming in finding the solution. Rough sketches for different concepts and CATIA rendering of the final concept.

The complete material selection for the manufacturing of the product, optimal manufacturing process and gives the proper functioning of the product along with the profit/loss costing. It also focuses on value management implementation of every stage in developing of the product by adding some extra features and focus on how we can reduce/minimise the potential cost and indicate about its environmental consideration, save disposal of our product after its life cycle.

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# 1 Introduction

MOBILL was established in February 2021, with the sole purpose of giving the customers smooth experience of buying and billing the items/products in the supermarket. The raw material and the manufacturing are only the home-base.

Our focus is only on how to make the public interface easier whenever they step in the supermarket for the shopping for daily food items and other things too. People generally face a lot of problem regarding the information of any product.

Even sometimes it is so complex to find out the price of the product, date of manufacturing, expiring date, discounts, list of ingredients and many more information like where it is place in the supermarket and how to get there for that product. So, keeping all this issues in mind, we came up with this product idea.

MOBILL, is the unique product which help the customers to know how much they are going to pay for their shopping even before reaching to the cash counter. Trolley equipped with the sensors which can read the bar and gives customer all the relevant information about the products.

There are various departments in the company that is research and development department, design and development department, manufacturing department, sale and marketing department and business development department.

Here we will discuss about the manufacturing process also about the material which we are using to make this trolley. Will give suitable data about its weight and how it is differing with different material selection, also about the sensors with we are placing in it to calculate its price, weight, and other relevant information, in addition to this different tire arrangement for the trolley which help it to move easily in any direction and the breaking arrangements which is so essential in stopping the moving trolley.

We also, discuss about the future accepts of the trolley that, how we can fit it with different arrangements to make it easier to excess, move and gather information about the items and the stores.

In this project we will give all the details about, how we are going to upgrade the conventional trolley which we are using in the supermarket with the new technology and then the future of the supermarket trolley means the next generation trolley.

The motive of our company is:

**“Pick It”, “Scan It”, “Evaluate It”.**

## 2 Company name and logo



Figure 1 – Company Name & Logo

### 3 Management Team / Hierarchy

#### 3.1 Role Allocation

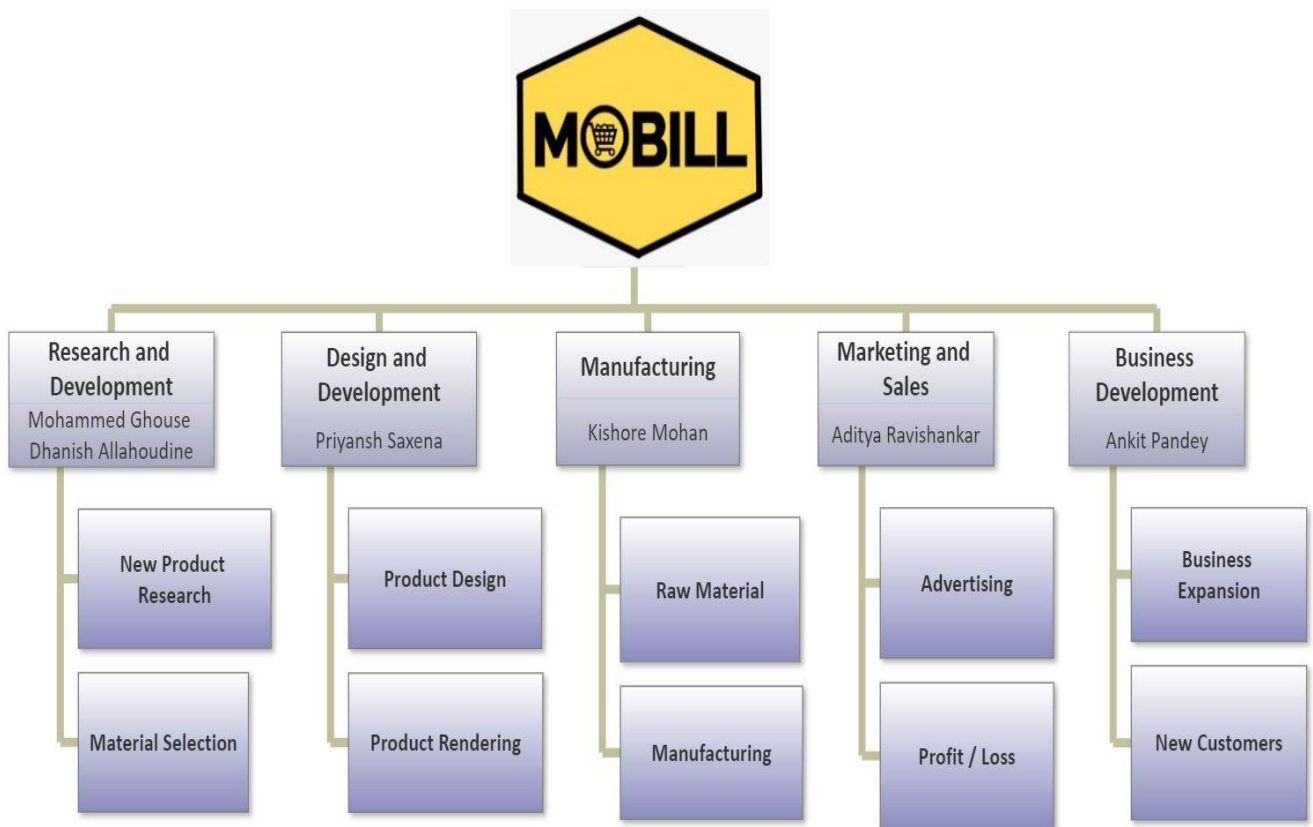


Figure 2 – Management Hierarchy

Table 1 – Team Members

Research & Development Officer	Mohmmmed Ghouse Danish Allahoudine
Design and Development Officer	Priyansh Saxena
Manufacturing Officer	Kishore Mohan
Sales & Marketing Officer	Aditya Ravishankar
Business Development Officer	Ankit Pandey



## **3.2 Individual Roles and Responsibility**

### **3.2.1 Research & Development**

In an organization, the research and development department play a vital role in the product life cycle. While the department is always separate from sales, productions and other divisions, the purpose of these sectors is concomitant and often require a coordinated effort. Understanding the functions of the research department empowers you to enhance the duties at the small business.

The research department directs and has a complete analysis to support the project before a new product is developed. The research phase incorporates determining the product's specifications, production cost, and a production line. In additionally research includes an evaluation of the demand for the product before the design begins to make sure it is a modest product that customers want to utilize.

The research department gets ready with the development stage. This is the time at which the new product is evolved with the requirements and thoughts created during the research stage. The developed product should meet the product guidelines and demanding specifications.

The existing product of the organization also falls under the scope of innovation, research, and development. The department consistently and constantly evaluates the products given by the company to certify they are still working. Possible and future changes or upgrades are thought of. Sometimes the research department is approached to resolve a problem with an existing product that breakdowns or to come up with new solutions if the fabricating process must change.

The research department handles the quality inspections on the products built by the company. The department has confidential information, knowledge of the requirements and specifications of the project. This permits the team members to make sure the products meet the standard quality, so the company produces the quality products. The quality checking team and research department collaborate on quality checks.

The research department supports the company with others in the industry. The department research and inspects the product other business is developing and the new patterns inside the industry. This exploration helps the company in creating and updating the product manufactured by the company. The team coordinates the future of the company depends on the information or intelligence it provides and the products it manufactures. (Online)

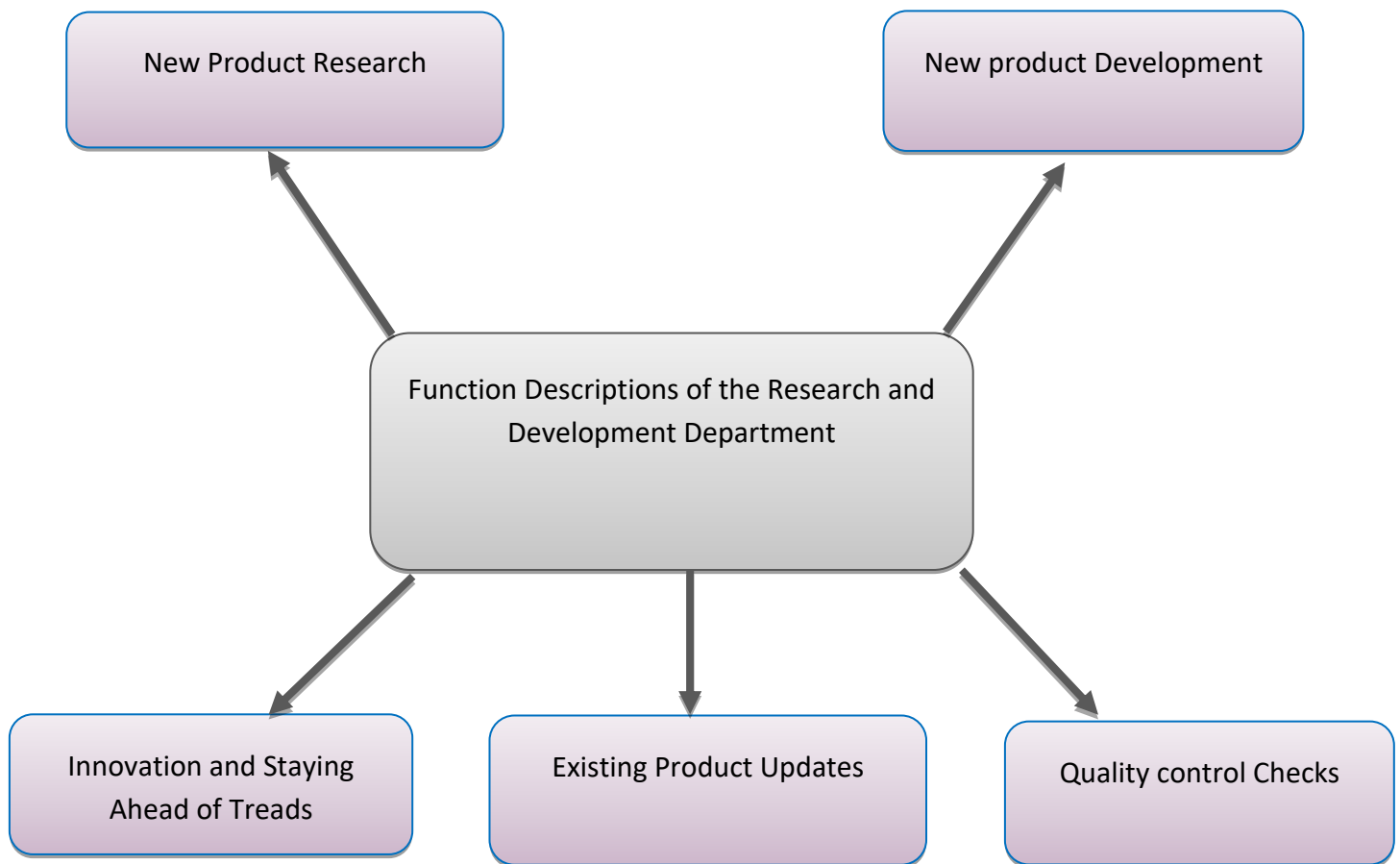


Figure 3 – R&D Function descriptions

### 3.2.2 Design & Development

Design and Development team uses Tools and Technologies to create design of the projects. Various tools and technologies include CAD, CAE, CAM etc. These tools are used to create 2D, 3D models, solid and surface modelling. CAD designer must have strong skillsets.

- Analysing the situation and generates the ideas to solve the existing problems.
- Prepare plans and strategies to bring the ideas out in the real world. Also, add innovations that can make task easy.
- Compare the strategies and calculate the aspects like Cost, Time, Resources, and risk associated with it.
- Select the best possible design that brings customer's and stakeholder's satisfaction. Consequently, brings profit to the organization.
- Preparing sketches and use 2D and 3D design tools to design the model with dimensional Accuracy.
- Prototype the object or product using 3D printer also analysing the design using DFMEA, FMEA, Six Sigma, etc. to achieve the best possible output.
- Managing the development team to produce various ranges of object and products. Also, update the existing products to save aspects like time, cost, resources, labour, etc.

- Track and monitor the Task completion and ensure the performance with proper safety and instruction.
- Holding the responsibility of Cost, Budget, Environment, and safety.

### 3.2.3 Manufacturing

A manufacturing manager should manage and support the production process to ensure that the production schedule is met and should continuously work with various manufacturers on continuous improvement for production which includes people management and cost reduction. There is various manufacturing process involved in the production of shopping trolley. In this company, I as Kishore Mohan take the role of a manufacturing manager and my key responsibilities is to:

- Apply lean manufacturing technique in the manufacturing method and should know the latest manufacturing techniques to reduce waste, manufacturing cost.
- Form a production team and utilise them properly and ensure that the daily/weekly/monthly production target is met as per the customer requirements.
- Ensure day to day planning and schedule for production.
- Take responsibilities for proper scheduling of various operations along with enough raw material for continuous flow or production, manpower to operate the machine and tooling for change over time.
- Troubleshoot and consult with R&D, product development team to resolve any issues in manufacturing.

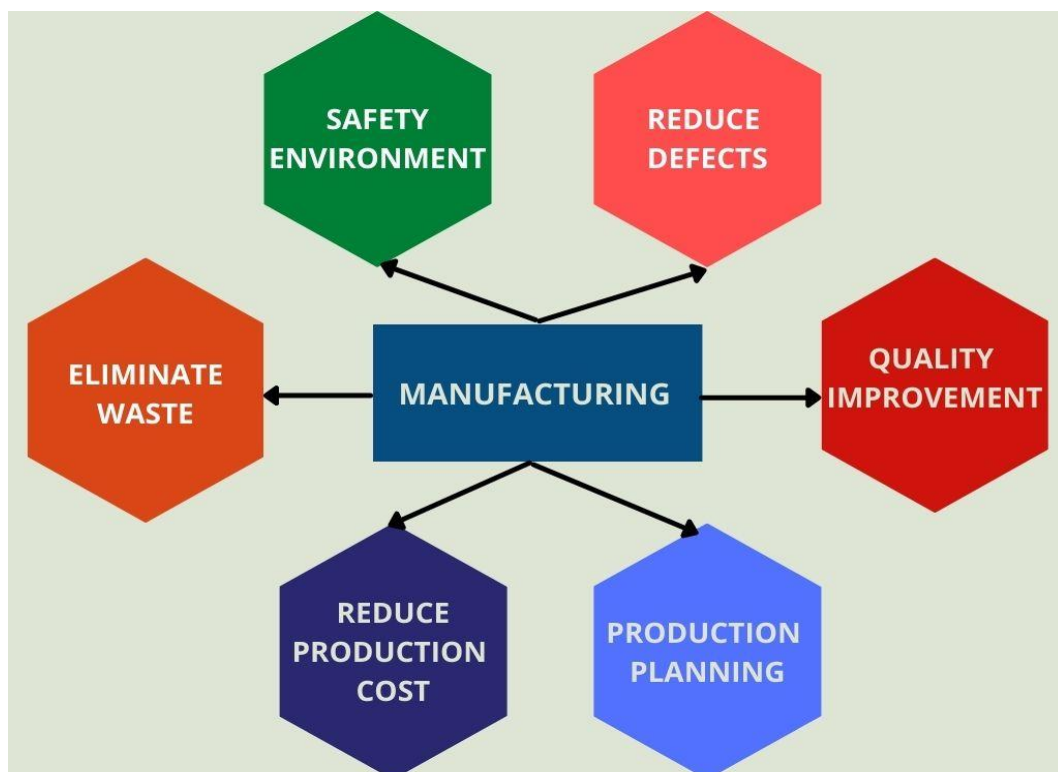


Figure 4 – Manufacturing descriptions

- Ensure maintenance activities of machines to avoid breakdown during the production process.
- Contribute towards increasing the quality of the products and should reduce the defects that are caused during the manufacturing and perform root cause analysis to resolve the problems to reduce the defect.
- Make sure proper 5'S is followed in the manufacturing area while production and should take care of the SHE (Safety, Health and Environment) of the workers in department.

#### **3.2.4 Sales & Marketing**

What is the role of a marketing manager in a company? Marketing is where it brings and manages profitable customers and investors in one place. The role of marketing manager plays a critical role in attracting new customers and keep hold of current customers by providing customer satisfaction and to keep hold of company's position in the marketplace throughout the product life cycle (Gary Armstrong, 2009) Making use of resources available to us in most efficient way.

In this company, I as Aditya Ravishankar who would be taking up the role of a Marketing Manager, and my responsibilities would be:

- Analysing the data of customer behaviour and their purchase items. Based on the analysis I would recommend the target customers a smart shopping cart which would ease their way of shopping through various supermarkets. Executing marketing strategies for establishing product life cycle for our product and providing the needs, wants of the customers and the investors.
- Developing and executing the marketing plan for offline and online marketing advertisement for promotion of our product through various platforms and collab with various investors and providing samples to various supermarkets. Profit & Loss cost estimation of product when put in use in marketplace. Finding out whether our company functions in a best ethical way of promoting and executing our products. Providing best measures for safe disposal of waste.

#### **3.2.5 Business Development**

The task of the Business Development is to assist the sales and growth of the businesses by resulting in the acquisition of latest customers. He ought to be able to return up with new shopper acquisition ideas and keep senior management advised regarding business and rival activity. The role and responsibilities include:

- Generating the new ideas, it should be upgrade vision of the prevailing product or the entire new product, and to make contacts with potential purchasers to make new business opportunities, keep prospective shopper info updated.
- To develop the construct of the merchandise and to play role within the testing procedure.
- Marketing strategy development embody creating cold imply new business leads.
- To conduct market survey and look at regarding the merchandise.

- By analysis, the business ways to a way to promote the new product in market and promote product information and services.
- Arrange conferences for senior managements with prospective purchasers.

The following steps involve in Business Development:

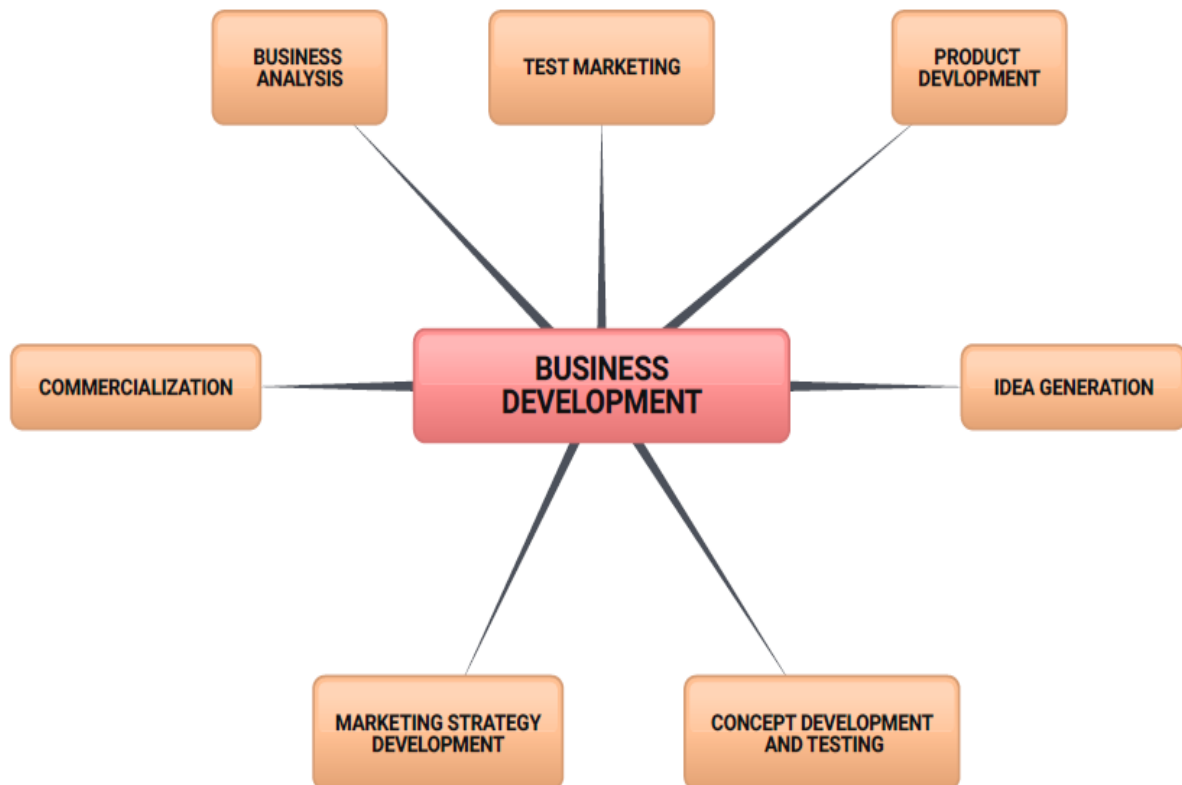


Figure 5 – Business Development

## **4 Project Proposal and Mission, Vision Statement**

### **4.1 Project Proposal**

#### **4.1.1 Problem**

While during shopping we usually keep on buying things instead of keeping in mind how much money we have with us in the terms of cash and balance in card because of which we must leave most of the things on the cash counter without buying it. The most pressing concern while shopping in supermarket is that when we buy more products it's difficult for the customers to scan each and every product in self-checkout counters and also in the billing section the customer has to take out every product from the basket for the billing which is time consuming.

#### **4.1.2 Benefits**

If we talk about the current era no one has this type of product in the UK market. Keeping things under the consideration of what people must face in the supermarket their problem regarding the bills and other things. The advantages like lighter in weight, easy to move in all direction and user-friendly sensors. And, if comparing the appearance, it is much attractive than the already existing trolley in the supermarket.

#### **4.1.3 Deliverables**

All the accessories and manufacturing of the product, part assembly and packing is done in the UK based factory. The product sales are online and offline sales.

##### **4.1.3.1 Network Sales**

MoBill will be delivered in batches to the supermarkets with the return and exchange period of 10 days from delivery date. The warranty period of all the electronic parts that is display, barcode scanner, battery has one year, and the other parts of the trolley comes with five years of warranty. Its guarantee provide cover against material and manufacturing faults. This means that if the product develops the fault during the guarantee period, we will arrange for it to be repaired or replace. Our product will be serviced in the span of six months for two years by the qualified personnel from the date of delivery.

4.1.3.2 Warranty Claim Chart

<div><div>MOBILL</div><div><a href="http://www.mobill.co.uk">www.mobill.co.uk</a> <a href="mailto:mobilluk@gmail.com">mobilluk@gmail.com</a></div></div> <div></div>	
WARRANTY CLAIM CHART	
SERVICE DATE	(DD-MM-YYYY)
PURCHASE DATE	(DD-MM-YYYY)
DELIVERY DATE	(DD-MM-YYYY)
RETAILER NAME	(_____)
SERIAL NUMBER	(_____)
ENGINEER NAME	(_____)
ENGINEER SIGNATURE	

Figure 6 – Warranty Claim Chart

#### 4.2 Mission Statement

“We intend to save your time as the product brought to light and outlay your shopping.”

#### 4.3 Vision Statement

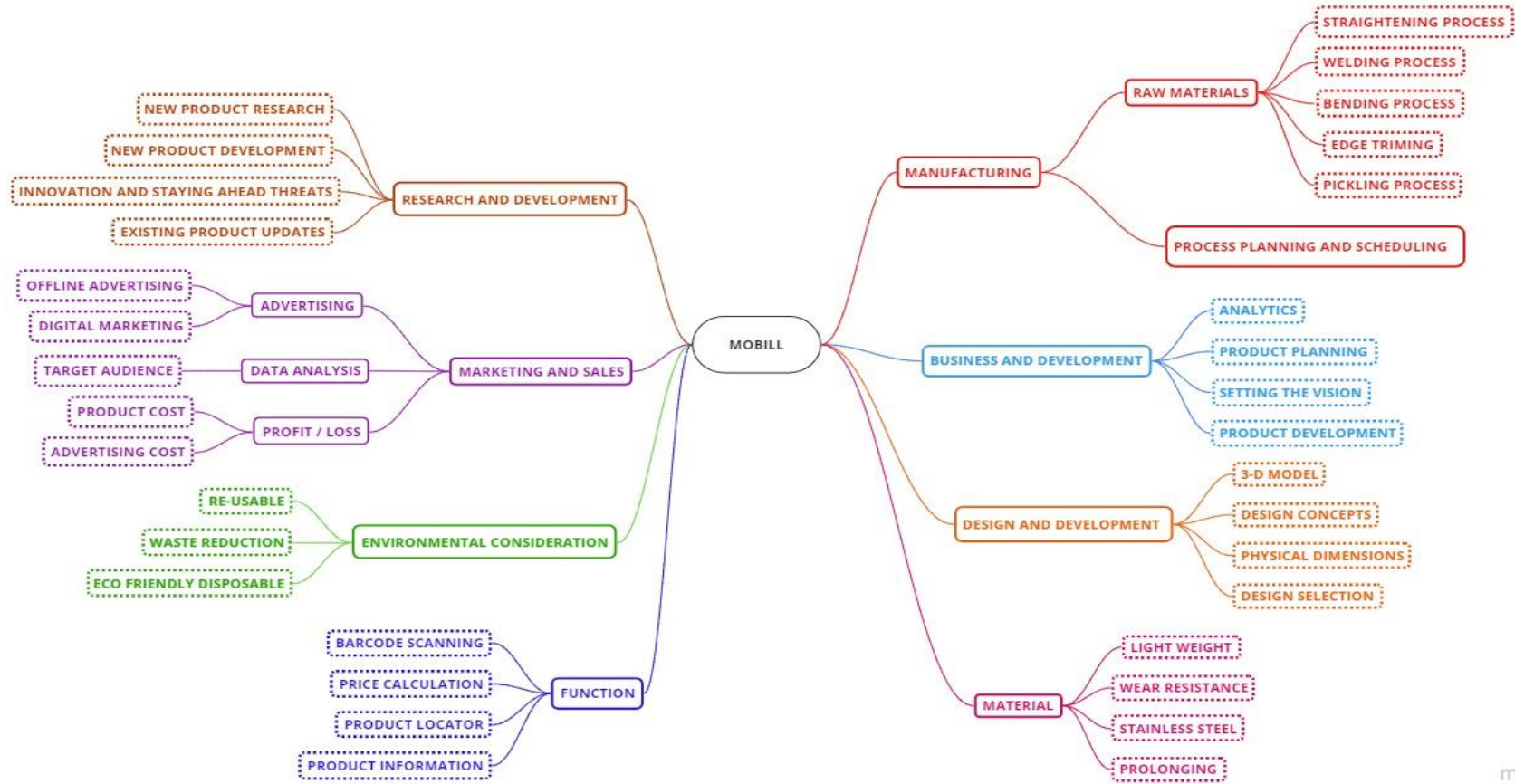
“By the modernizing change in the shopping world with the smart cart.”



Figure 7 – Mission & Vision



## 5 BRAINSTORMING



miro

Figure 8 – Brain Storming

## 6 Product Selection

### 6.1 Rough Sketch

#### 6.1.1 Rough Sketch Concept 1

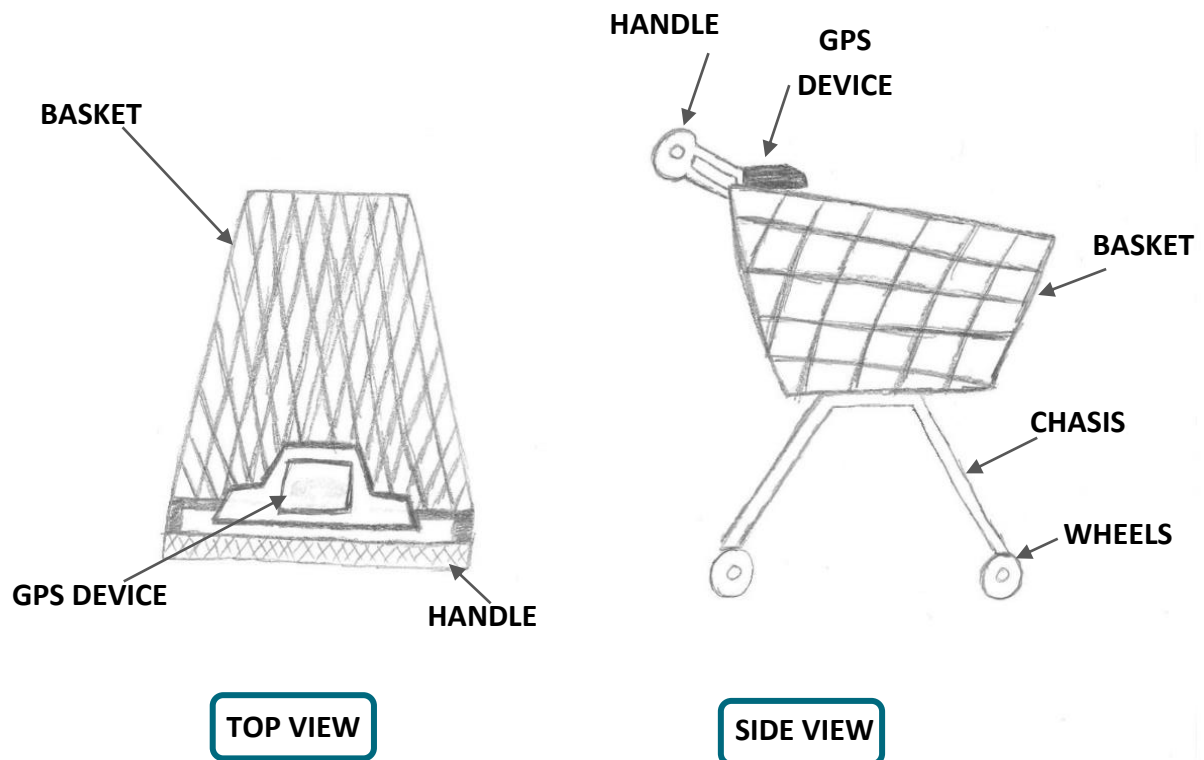


Figure 9 – Rough Concept 1

In the first concept, we introduced G.P.S system which has the layout and the list of products placed in the supermarket. So, this will be easy for the customers to locate the products in the supermarket which they want, as most of the times when the staff members are less in number, they use to invest more time in searching the desire product without knowing the availability or where the product is located. So, this GPS system will make it easy for them to locate the items along with the pathway for the product without the help of any staff members i.e., where a particular product is placed in the supermarket.

### 6.1.2 Rough Sketch Concept 2

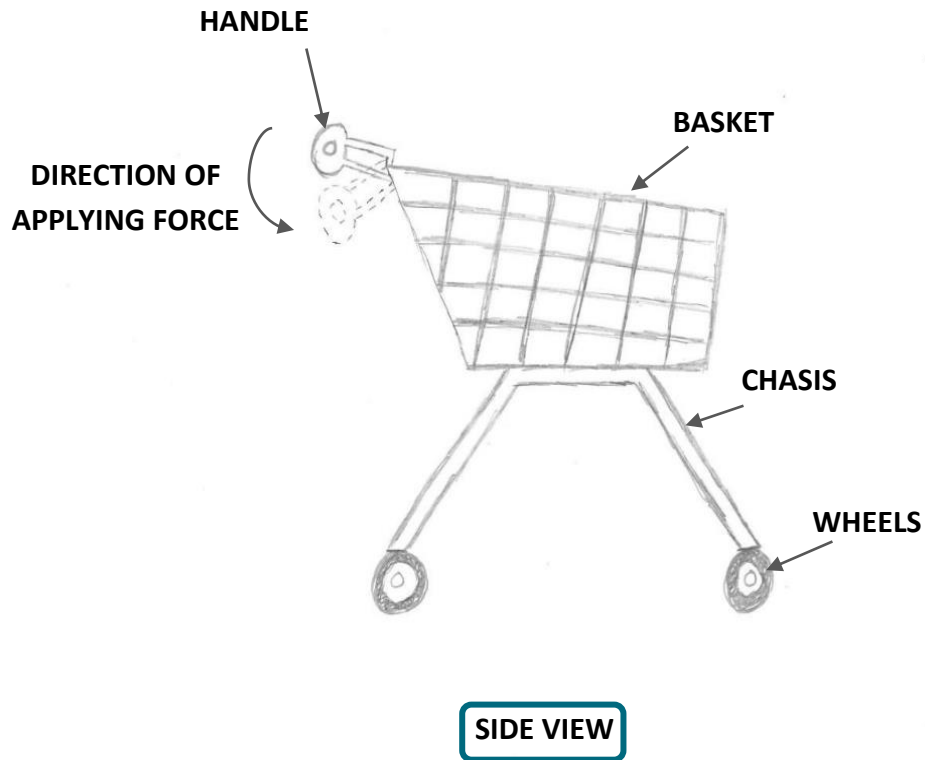


Figure 10 – Rough Concept 2

In the second concept, we are providing a braking system in the trolley. The handle works like a lever and when we are applying a desire force in downwards direction, the position of lever changes, and it will dislocate from its original position to downwards. By this action, the customer can apply force in opposite direction for the movement of trolley. As a result, the brakes will be applied and generate friction force which helps in stopping the moment of trolley. As soon as they release the lever, it will come back to its original position and the brakes will release the contact with the tyres of trolley and they are able to move it in the desire direction. This will help customers to control and avoid the unnecessary movement of trolley even with heavy shopping.

### 6.1.3 Rough Sketch Concept 3

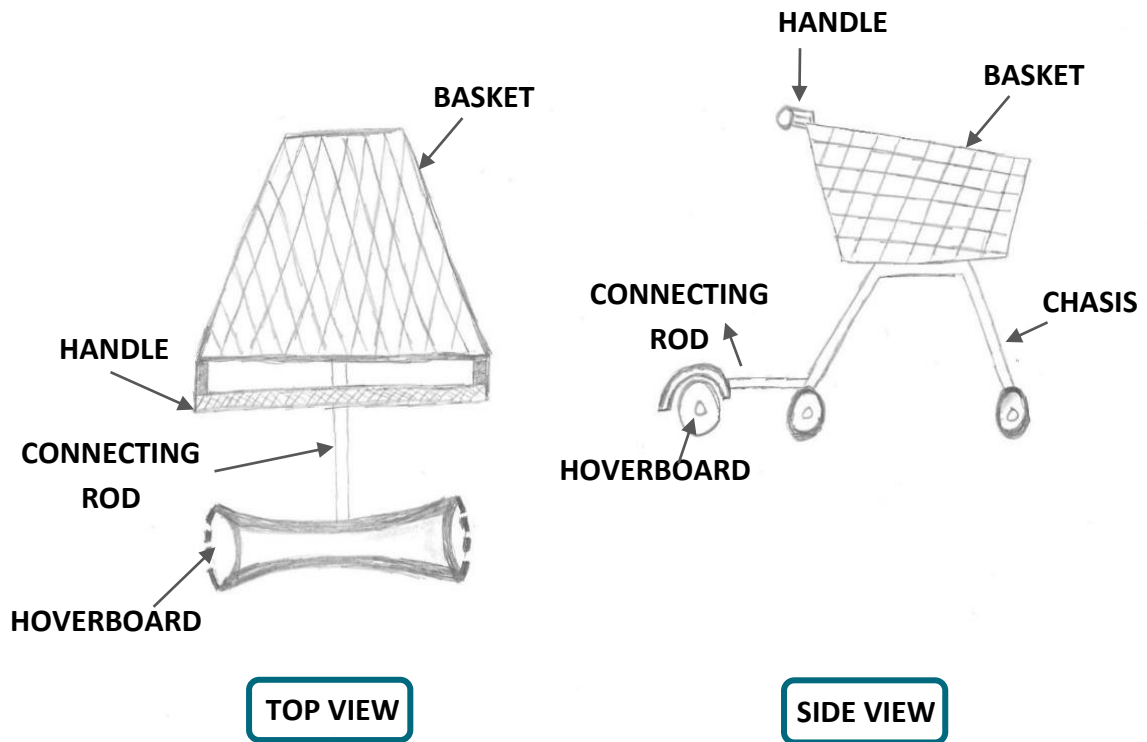


Figure 11 – Rough Concept 3

In the third concept there will be a hover board integrated with the trolley with the help of a connecting rod. The concept behind this is to move the trolley without any efforts. With the heavy shopping the customers tend to struggle with the moment of the trolley. That is why we attached the hover board with the trolley which is detachable and can be used only if a customer wishes to. It works in very simple principle as when the customer pushes the hover board in the forward direction the whole setup will move in any direction as a same unit. This is as same as operation the hoverboard just with the extra connection as the trolley. Further we can connect electric wheelchair instead of hoverboard so that the old and disable people can effortlessly shop like others.

#### 6.1.4 Selected Design

##### 3-D Design



Figure 12 – Selected Design

##### Different 3-D Views



Figure 13 – Selected Design Different Views

## 6.2 Typical Dimensions of Final Product (All Dimensions in MM)

### 3-D Top View

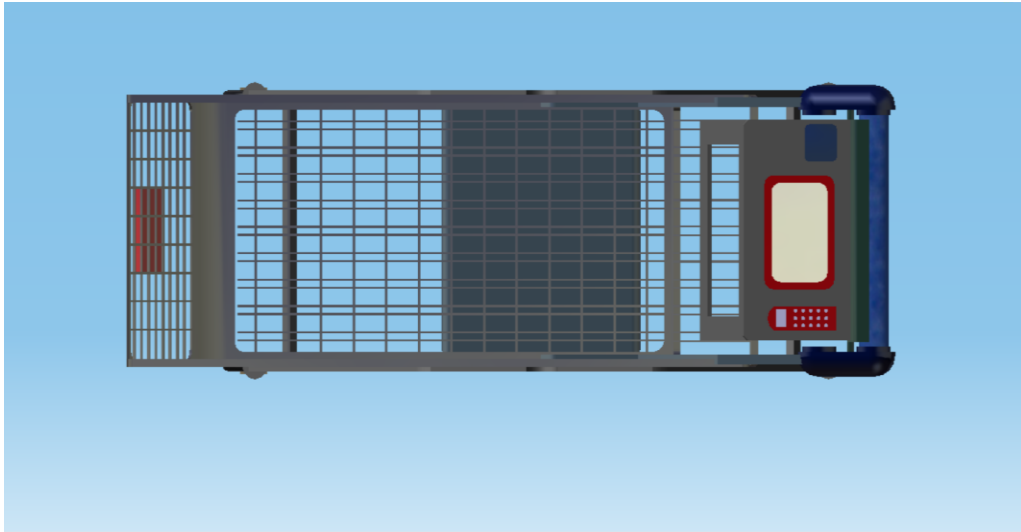


Figure 14 – Top View Model

### 2-D Top View

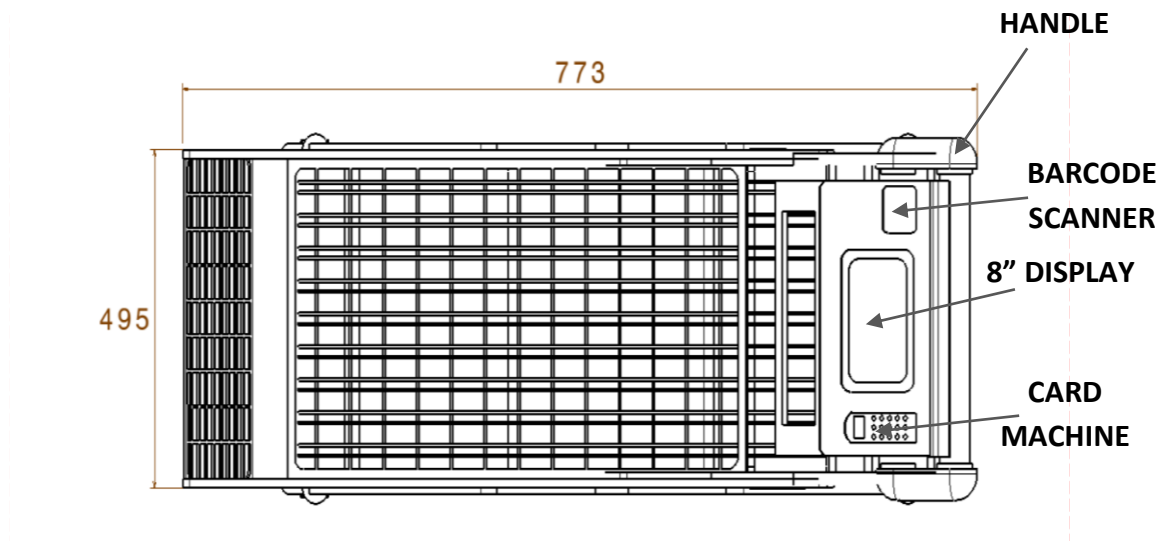


Figure 15 – Top View Drawing

3-D Side View



Figure 16 – Side View Model

2-D Side View

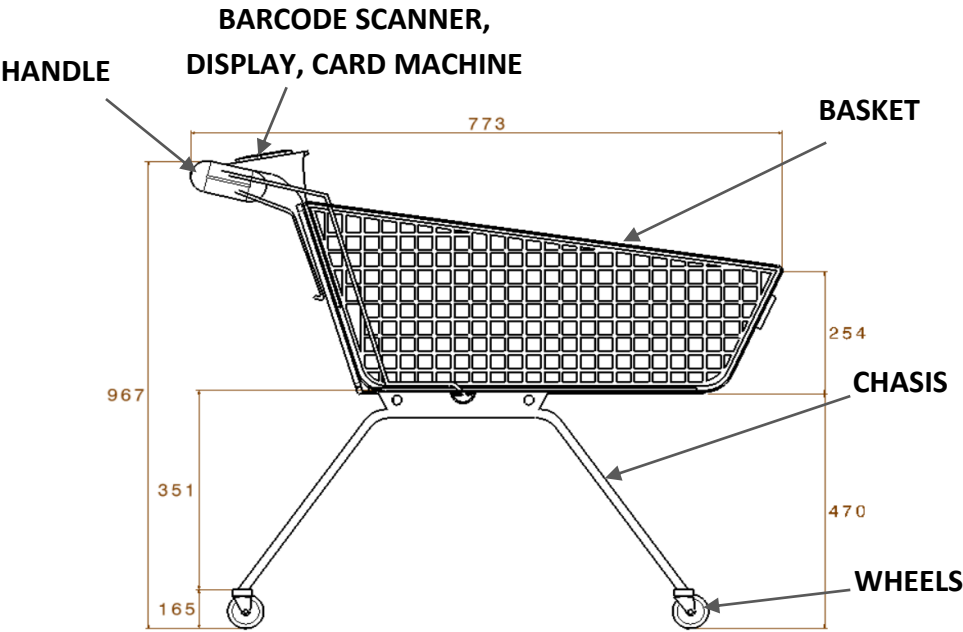


Figure 17 – Side View Drawing

**3-D Front View**

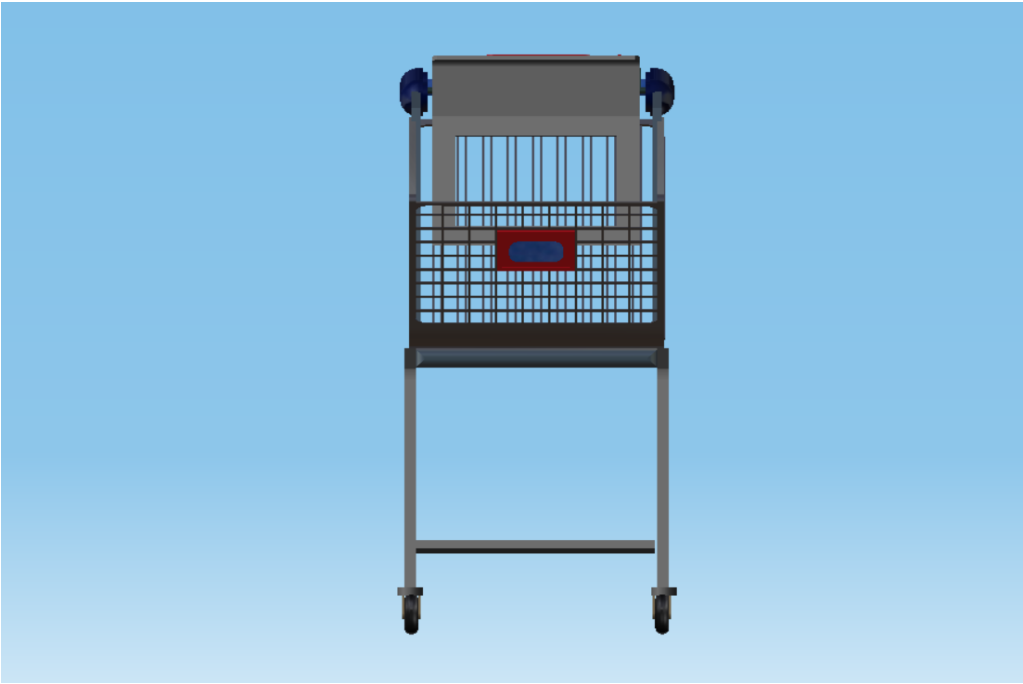


Figure 18 – Front View Model

**2-D Front View**

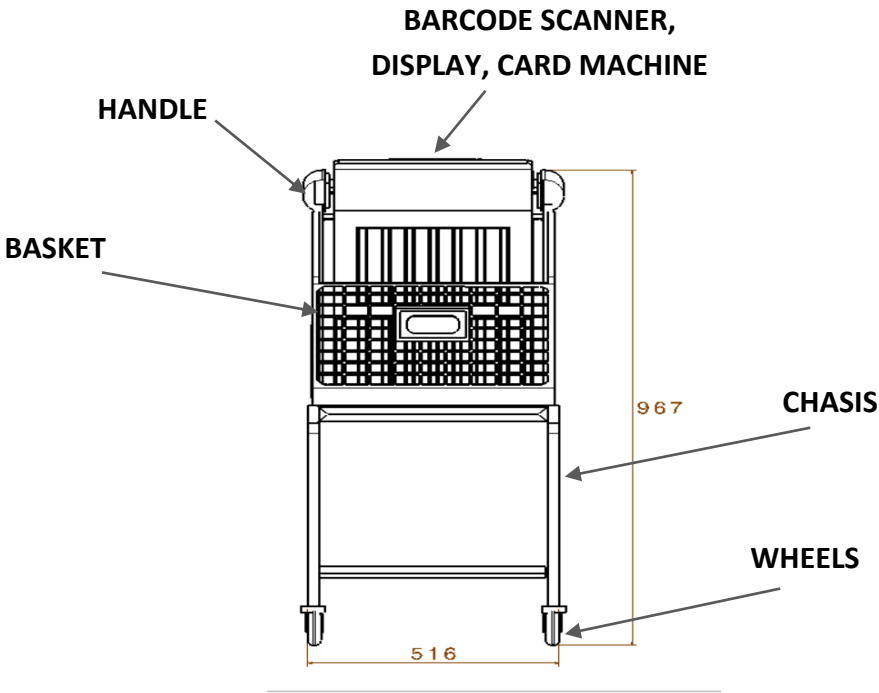


Figure 19 – Side View Design



## 6.3 Material

### 6.3.1 Selection

#### 6.3.1.1 Material for the Chassis and Basket

##### Ferritic Stainless Steel

The supporting frame of the trolley is made of ferritic. Ferritic is stainless steel. They are generally known as 400-grade stainless steel. They are non-heat-treated steel they have a chromium configuration of 10-30%. This configuration has good corrosion resistance and stress resistance cracking. Ferritic steels are well known for their ductility. This steel is used in a range of industries, kitchenware, and automotive chassis. In Ferritic stainless steel, the approximate amount of nickel used is 0.5% as they are comparatively less than austenitic grades. Ferritic stainless steels are used in the annealed condition. Chromium present in 12%-15% where carbon is less than 0.1%. So, this can only strengthen by the hardening process but not by heat treatment. (Lambert. P, 2009). Ferritic stainless steel has a naturally occurring corrosion resistance surface therefore it is not necessary for applying an additional protective layer and no risk of corrosion risks at cut edges. Ferritic by and large have low temperature, toughness, particular thicker segments. It has an alternated microstructure which ensures durability for the external application (40°C) this is comparable to carbon steel. (Cashell, KA; Baddoo, NR. 2014)

**Table 2 – Chemical Composition of Ferritic Stainless Steel (Lambert. P, 2009)**

Composition (%)				
C	Cr	Ni	Ti	Others
0.08	12			
0.08	12			0.2 Al
0.03	11	0.5		
0.08	17			
0.08	17			
0.015	18			Nb
0.05	17		0.6	
0.05	17			0.6 Nb
0.03	11		0.5	
0.025	17		0.6	

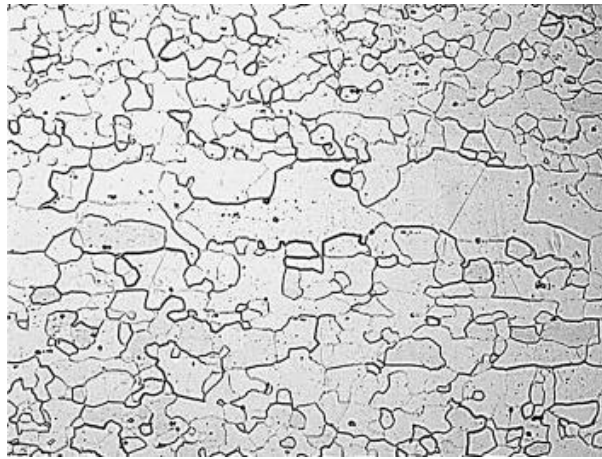


Figure 20 – Microstructure of Ferritic Stainless Steel (M.K. Banerjee, 2017)



Figure 21 – Ferritic Stainless Steel in Wire form (Google)

### 6.3.1.2 Material for the rollers/wheels

#### Polyurethanes (PU)

Brief diagram showing the detail chemical composition of the polyurethanes basically its bonding.

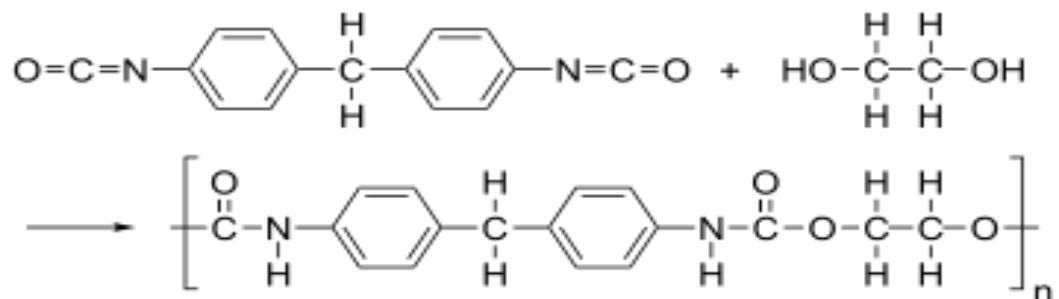


Figure 22 – Chemical composition of Polyurethanes (Wikimedia)



Figure 23 – Polyurethane (PU) Rollers (Google)

Polyurethanes are known to be a very hard material. Wheels made of this material will be completely be manufactured with polyurethane or combination of a polymers and nylon. They have a long life, durable and there is a shock-absorbing cushion between the wheel and floor. They have resilience, toughness, resistance to corrosion, and cost. They also have irregular abrasion and tear resistance. They are superior to rubber. They can withstand heavy load and have exceptional to wear properties. Polyurethane has low density, flexibility. Polyurethane is resistant to wear, tear, weather, and erosion. They also exhibit good electrical insulating properties. They have a low melting point of 150°C. The expansions of item life cycle and asset protection are significant ecological contemplations that frequently favour the determination of polyurethanes. Polyurethanes (PUs) address a significant class of thermoplastic and thermoset polymers as their mechanical, thermal, and compound properties can be adapted by the reaction of different polyols and polyisocyanurate. (Zia, khalid Mahmood. 2007)

#### 6.3.1.3 Material for the handle

##### Polycarbonate

Polycarbonate pitches can be separated into two primary classes dependent on their carbon chain spine in the polymer, aliphatic and aromatics. (Artham, Trishul, 2008, January 9). Polycarbonate has high toughness they are transparent, and the carbonate groups are linked together with their organic functional groups and provide a unique combination of properties. They are technical plastic and amorphous thermoplastic. Polycarbonate has high impact strength, high dimensional stability, and good electrical properties. They are also available in a different colour. They are commonly used as plastics and in industries, automobile components, electrical devices. Polycarbonate is good to hear resistance and they are pliable. They formed without cracking or breaking at room temperature and be like aluminium. Their application is in a wide range of industries. Polycarbonate is a transparent, glasslike thermoplastic polymer. It has uncommonly high effect strength and durability even at low temperature, has great heat and electrical resistance. It is organically inactive and has great compound resistance. (I Boustead, 2005, March 1)

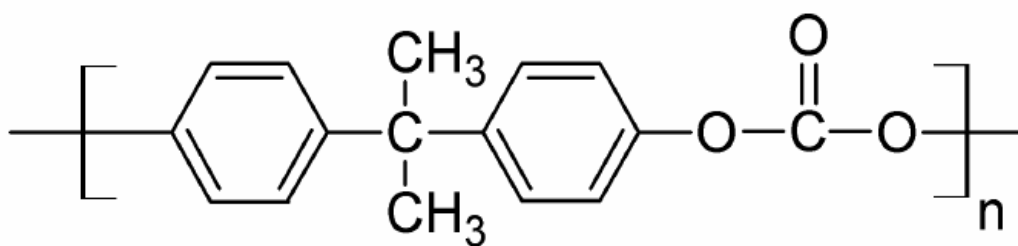


Figure 24 – Chemical Composition of Polycarbonates (Researchgate)

## 6.3.2 Justification

### 6.3.2.1 Ferritic Stainless Steel

This material is used for this project because it is stronger compared to plastic. In the modernized world, the smart trolley used or manufactured till today is in fiber or hard plastic. Ferritic is less corrosive and has ductility property so it can withstand vibration and as chromium present, it is less corrosive. They provide good stability of tensile property. (Lambert, P, 2009).

### 6.3.2.2 Polyurethane

Polyurethane is used for wheels. This is because they are a combination of polymer and nylon. They can high resistance to heat, stress, and tear they can absorb shock and long-lasting. They have less density, flexibility but high toughness. Their properties and characters are more superior to rubber. (Zia, khalid Mahmood. 2007)

### 6.3.2.3 Polycarbonate

Polycarbonate is a hard material, in this project, it is used in the handle as it is remarkably beneficial plastic with high resistance. It can be easily moulded, and smooth to work with. It is also scratch-resistant. They are unbelievably light and yet unfeasible. It is an industrial product and is also used in many other different applications. They have good electrical insulator properties. (Artham, Trishul, 2008, January 9).

## 6.4 Manufacturing Process

There is an ample of manufacturing process involved in the production of a Shopping Trolley. The processes include, wire straightening, jig loading, spot welding, edge trimming, bending, die punching, pickling and parts assembly. The components or parts in a shopping trolley are the basket, chassis, castor, handle, and wheels. The dominant material used for the manufacturing of shopping trolley is ferritic stainless steel.

### 6.4.1 Wire Straightening Process

In this process the raw material ferritic stainless steel is used in the form of wire to shape the basket of the trolley. Wire is loaded into a wire coiler which feeds to an accumulator which accumulates the wires and feeds to the straightening machine which applies a specific amount of equal pressure or force using rollers at all directions, the wire is fed between the rollers which is situated at various location both vertically and horizontally at the top and bottom to straighten the wire and cut it to a specific length using a saw blade. The length of the wire to be cut depends on which part of the trolley it is required to form. The fixed rollers say the same position and the guide rollers are adjusted according to the diameter of the wire (Bobby D. Peters, 2017).



Figure 25 – Wire Straightening Machine (Cometo)

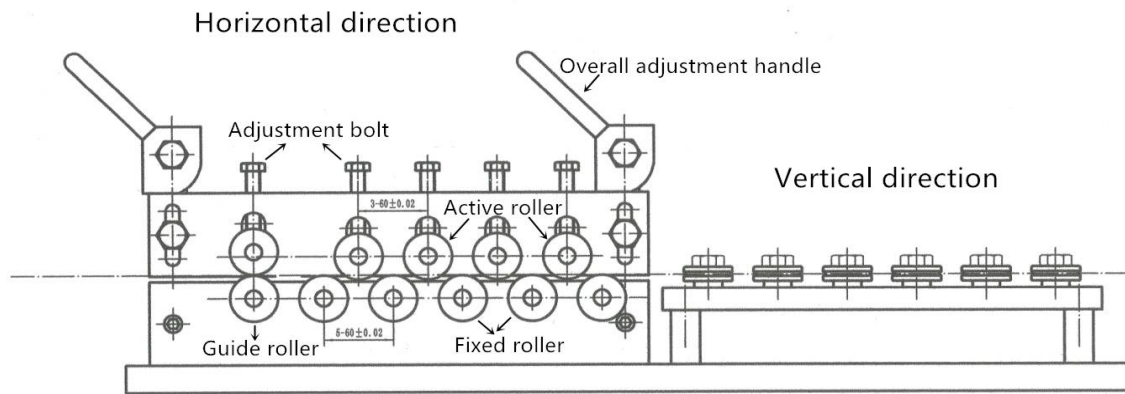


Figure 26 – An illusion of Wire Straightening Process (wire-straightener.com)

The trimmed wire which are longer in length are bended at two sides using a bending frame or angle manually to form a rectangle shape to support structures of the basket. They will be used to brace the basket to give it extra strength and are used at the sides of the basket.

#### 6.4.2 Welding Process – Spot Welding

The straightened wires are then placed in an automated machine which first feeds the wires in the jig loader and rolled out to the welding machine which has a preloaded set of wires. These preloaded wires are fed above the wires loaded in the jig loader to form the wires like a mesh formation where the intersection of horizontal and vertical wires form the basket floor portion, the wires lie in a single plane the horizontal wires position is deviated downwards and the vertical wires are placed above this in a flat surface. So that they lie across one another to form a one-piece bottom part of the basket. The horizontal wires provide rigid support to the structure the diameter of horizontal wires is larger when compared to the vertical wires and the number of vertical wires placed is more than the number of horizontal wires. Then a multiple welder machine resistance spot welds at every intersection that joins the wires together (Bobby D. Peters, 2017).

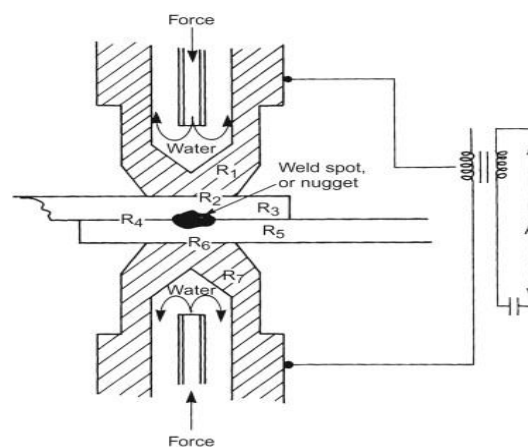


Figure 27 – An example of Resistance Spot Welding (Michael Pfeifer, 2007)

### 6.4.3 Die Pressing Process

The finished wire grids are then loaded into a die pressing machine which presses the centre of the mesh by applying a load of 20 tons approximately to eliminate any bend caused by the welding process, and then an arm which is operated with the help of hydraulic cylinders raises towards the top to fold the corners of the mesh wire to form the trapezoidal shape of basket. Three or four rectangular wire supports are clamped to the wire basket at the sides.



(a)



(b)

Figure 28 – An example of (a) & (b) Die Pressing of Wire Mesh (Google)

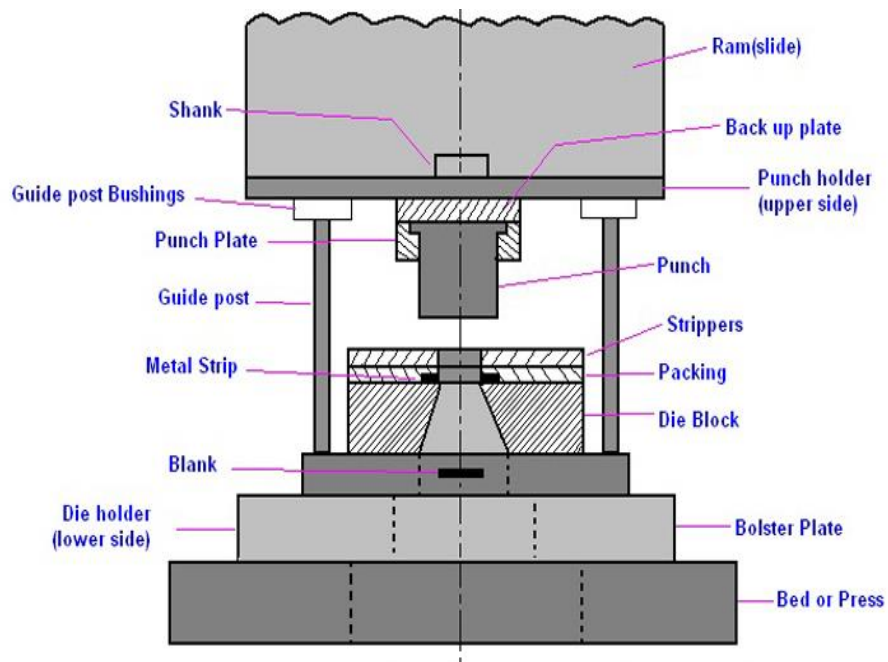
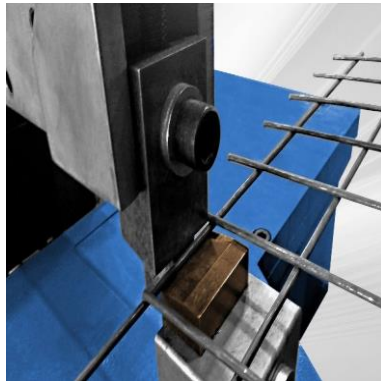


Figure 29 – An example of Die Pressing (engineeringhut)

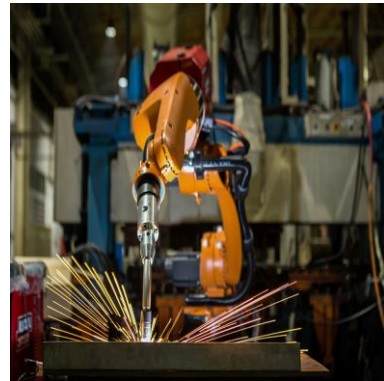


#### 6.4.4 Edge Trimming and Welding Process

After the die pressing and bending process a robot welds the sides of the basket with the rectangular support wires which was bended at both ends using a manual bending fixture. The welded basket is then trimmed of any excess pieces of wire using an edge trimmer. Edge trimmer is operated hydraulically with a blade that removes the unwanted or excess edges in the wires of the basket. A die machine manufactures the castors from steel for the wheels of the trolley.



(a)



(b)

Figure 30 – An example of (a)Edge Trimming & (b) Welding Process (cliffeng.com)

The final form of the trolley basket after edge trimming and welding process.

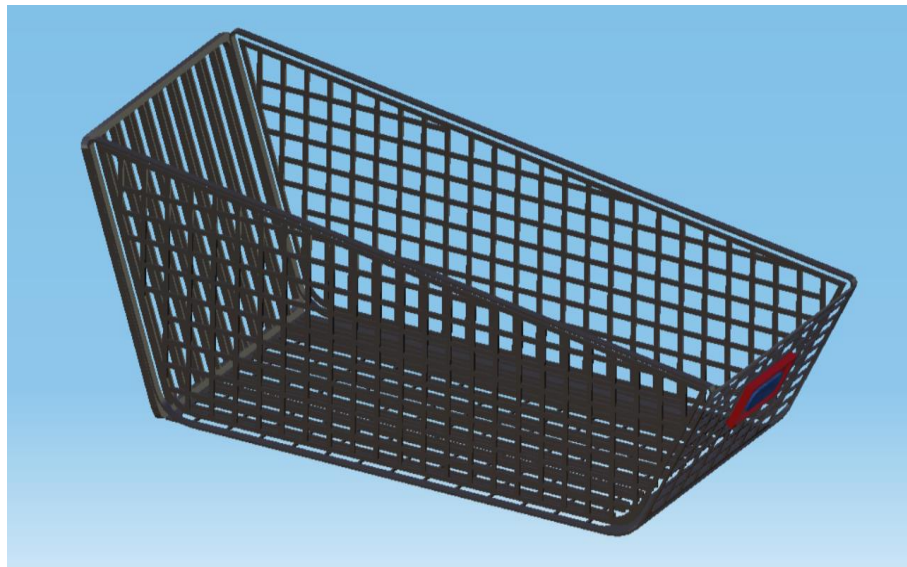


Figure 31 – Final Structure of Basket



#### 6.4.5 Bending Process

After manufacturing the basket of the trolley, the next process involves in the manufacturing the chassis of the trolley. The raw material used for the manufacturing in chassis is ferritic stainless steel in the shape of a tube. Approximately a 4 meters long tube is fed into the bending machine to produce the chassis of the trolley in the desired structure. After this the chassis is completed and ready to be assembled with the basket.



Figure 32 – Tube Bending Machine (hornmachinetools)

Final Form of the Chassis of the trolley after the tube bending process.

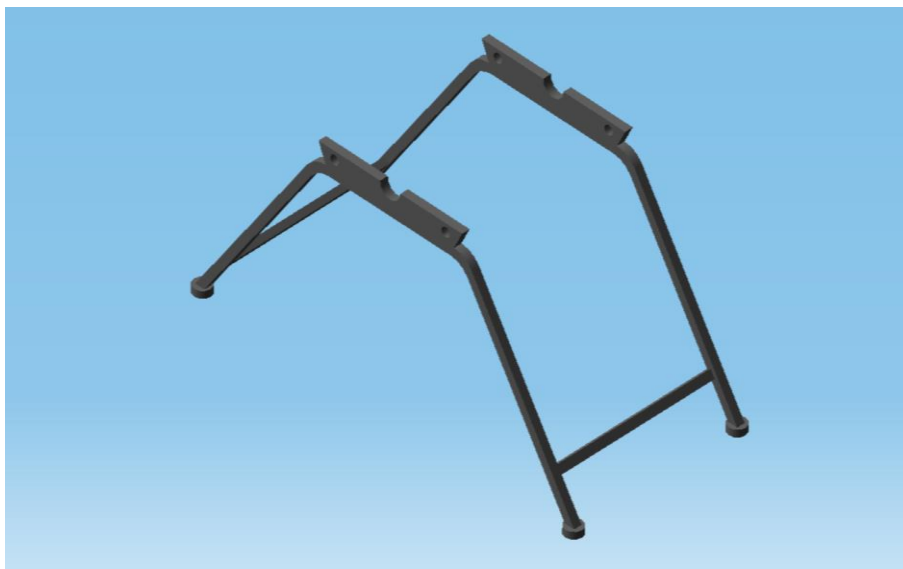


Figure 33 – Chassis after Bending Process

#### 6.4.6 Pickling Process

Many manufacturing processes performed at high temperature produce an oxide on the material, so pickling process is important as it removes any impurities in the steel and galvanizing it will protect the material from getting corrosion which increases the life of the trolley (A.S. El-Tabei, 2021). There are two steps involved in the pickling process that is surface preparation and galvanisation. In this process the pickling tank used here is Polypropylene Pickling tank because it provides good level of chemical corrosion. The setup is designed in such a way that a crane is provided with a hook above the tanks which helps to dip the component in each tank. The first bath cleans the metal components of the steel with the help of hydrochloric acid which removes oxides and any dirt surrounded in it from the welding process then followed by rise in water. Then the steel is dipped in the flux solution, this will remove any oxidation that has been developed from the pickling process, Once the material has completed the surface preparation process it is dipped in the zinc bath which operates at high temperature and finally cooling, and inspection is done. (online)

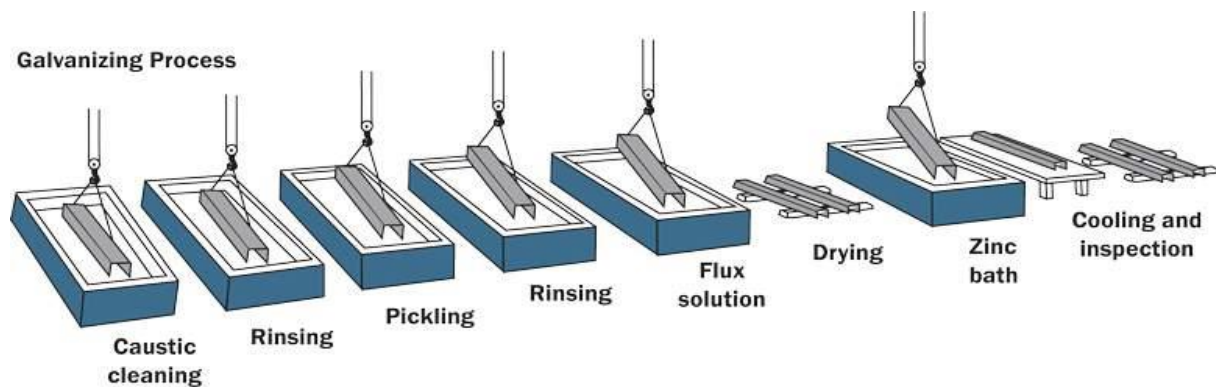


Figure 34 – An illustration of Pickling Process (galvanizeit.org)



Figure 35 – Pickling Process Tanks (tecnoplastusa)

#### 6.4.7 Part Assembly

Finally, the basket is assembled to the chassis and at the top of the trolley handle along with mounting frame is fixed to place the electronic parts like an 8" touch display, barcode scanner, battery, POS machine and PU rollers are riveted to the castors both the rollers and castors for the trolley is purchased from vendors and assembled in the factory. After completion of parts assembly, the trolley undergoes many testing and inspection to check the safety, life of the trolley and quality checking is done to check whether the final products meet the customer requirement before sending it to the packaging and delivery.

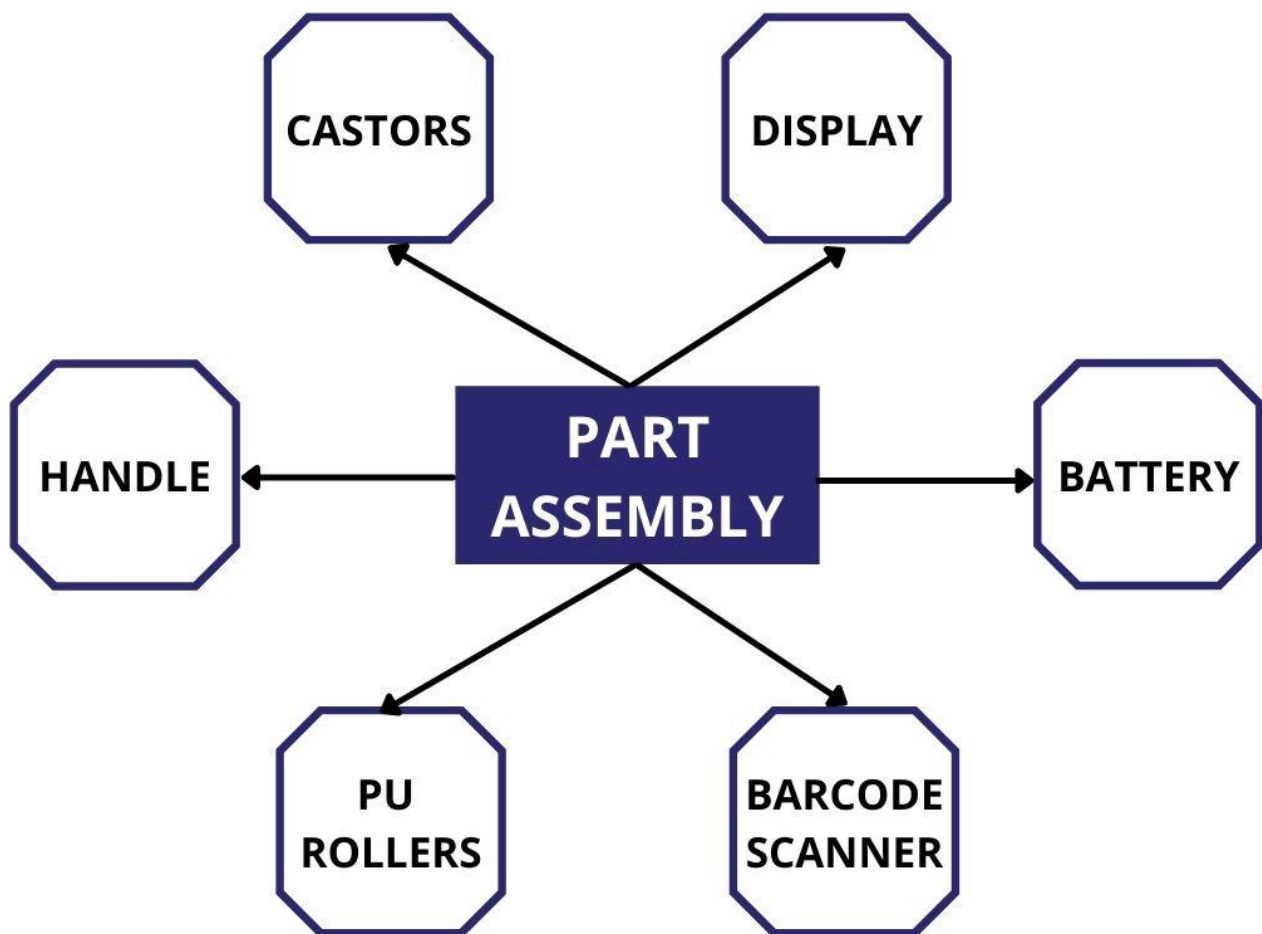


Figure 36 – Part Assembly

## 6.5 Product Function

### 6.5.1 Technical Background

#### 6.5.1.1 List of Components

**Table 3 – List of Components**

S. No.	Component Name	Quantity
1	Raspberry Pi Embedded Chip	1
2	Barcode Scanner	1
3	12 V Battery	1
4	8" LCD Touch Screen	1
5	USB Wi-Fi Device	1

#### Raspberry Pi Embedded Chip

The raspberry pi 3rd generation is a powerful system which can run a full operating-system. The raspberry pi 3rd generation is available in the market from the year 2016. We will be using Raspberry Pi 3rd generation as we can develop application inside the system itself. This embedded system controls the whole operation, it is equipped with 1.2GHz, 64-bit quad-core ARMv8 processor, 1GB RAM. We will be installing an Android 9.0 (Pie) on the embedded chip (G. Arva, 2017) This chip will be integrated to the 8" LCD touch monitor.



**Figure 37 – Raspberry Pi Chip (Google)**

## Barcode Scanner

Honeywell Barcode scanner will be installed near the LCD monitor for manually scanning the product items before placing into the basket. The barcode values are preloaded in the database and will be accessed using a Wi-Fi, it instantly identifies the product by scanning the EAN code (which has four black and white bars arranged in parallel). The barcode scans the code and pre-process it to find the threshold of the code and this pre-processing is done by the process called spiral searching method and it matches with reference available in our database and print out the product name on the LCD (E.Ohuchi, 2004).



Figure 38 – Barcode Scanner (Google)

## 12-V Battery kit

The Lithium battery we use is 12V and requires only minimal amount of energy about 85Ah to charge it. With one charge cycle, the battery can last up to 2 – 3 days and with proper care of charging it, the battery life lasts about two – three years.



Figure 39 – Battery (Google)

## 8" LCD Monitor

The 8 "LCD monitor is integrated to the embedded chip. It is a 128x240 resolution multi-colour touch display which will be helpful for customers to view, edit or cancel the scanned products. The customers could view their product as soon as they scan the product with the help of barcode scanner.

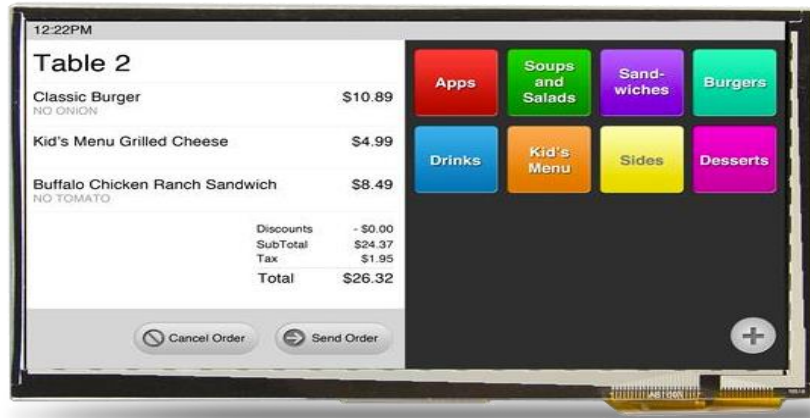


Figure 40 – LCD Monitor (Google)

## USB Wi-Fi Device

The USB Wi-Fi is connected to the backend database of the shop. It transmits a signal to the database when a product is scanned, and it helps in displaying you the product name and its price on the monitor.



Figure 41 – USB Wi-Fi Device (Google)



### 6.5.2 Product Function

Internal Circuit Flow Chart of MOBILL

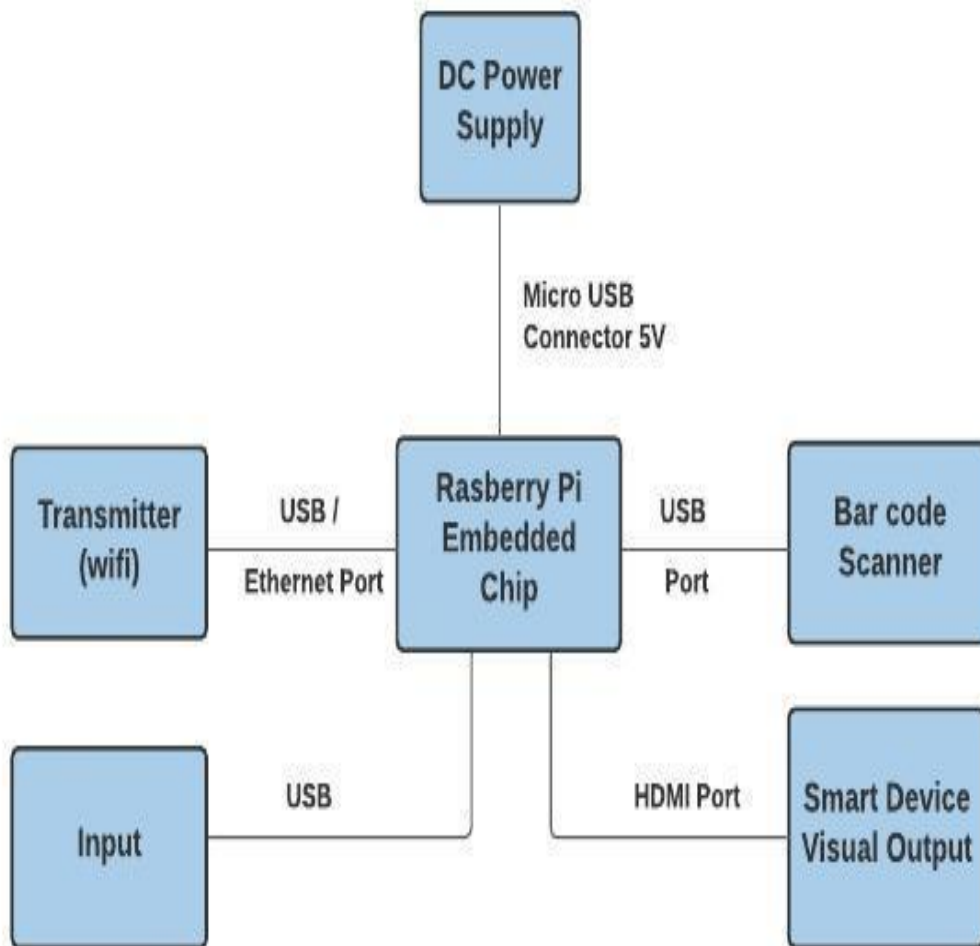


Figure 42 – Internal Circuit Flow Chart (S. Sainath, 2014)

The MoBill system is integrated with a barcode scanner which is fitted in the board in front of the handle. The only purpose of the scanner is to help the user to self-scan the product which they are going to purchase. Every product comes with a unique barcode, which we must scan. As the product gets scanned, the information is sent from the barcode scanner to the Raspberry Pi chip, which is placed inside the cabinet. The chip will calculate all the information from the server of the supermarket with which it is connected and display all the information regarding the product on the display screen, as this whole system is connected to the Wi-Fi device, which sends all the information to the server regarding the product which the customer scanned and has in his basket.

### Billing Flow Chart of MOBILL

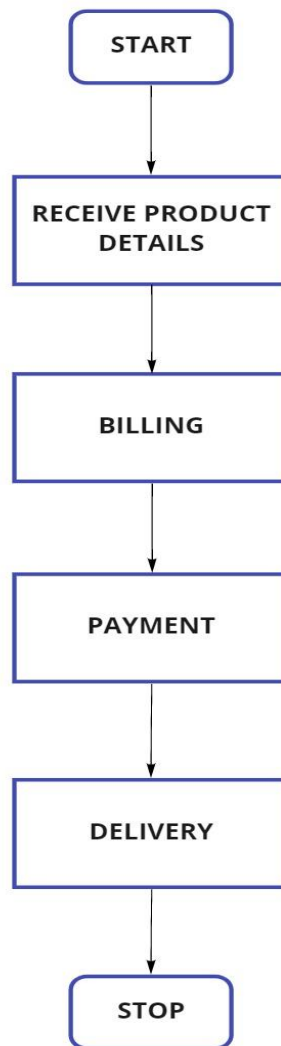


Figure 43 – Billing Flow Chart (S. Sainath, 2014)

This flowchart implies how the billing system of MoBill works. As soon the customer switch on the display the whole system gets started, when the customer scans the product MRP (Maximum Retail Price) along with product information i.e., the date of manufacturing, expiry date, weight, number of quantities and discounts of all the product is displayed in the screen. After this they receive the bill of material before proceeding to the payment page, then the payment is done by the customer via the card payment machine after the payment confirmation from the server receipt is generated and provided to the customer.



## Working Flow Chart of MOBILL

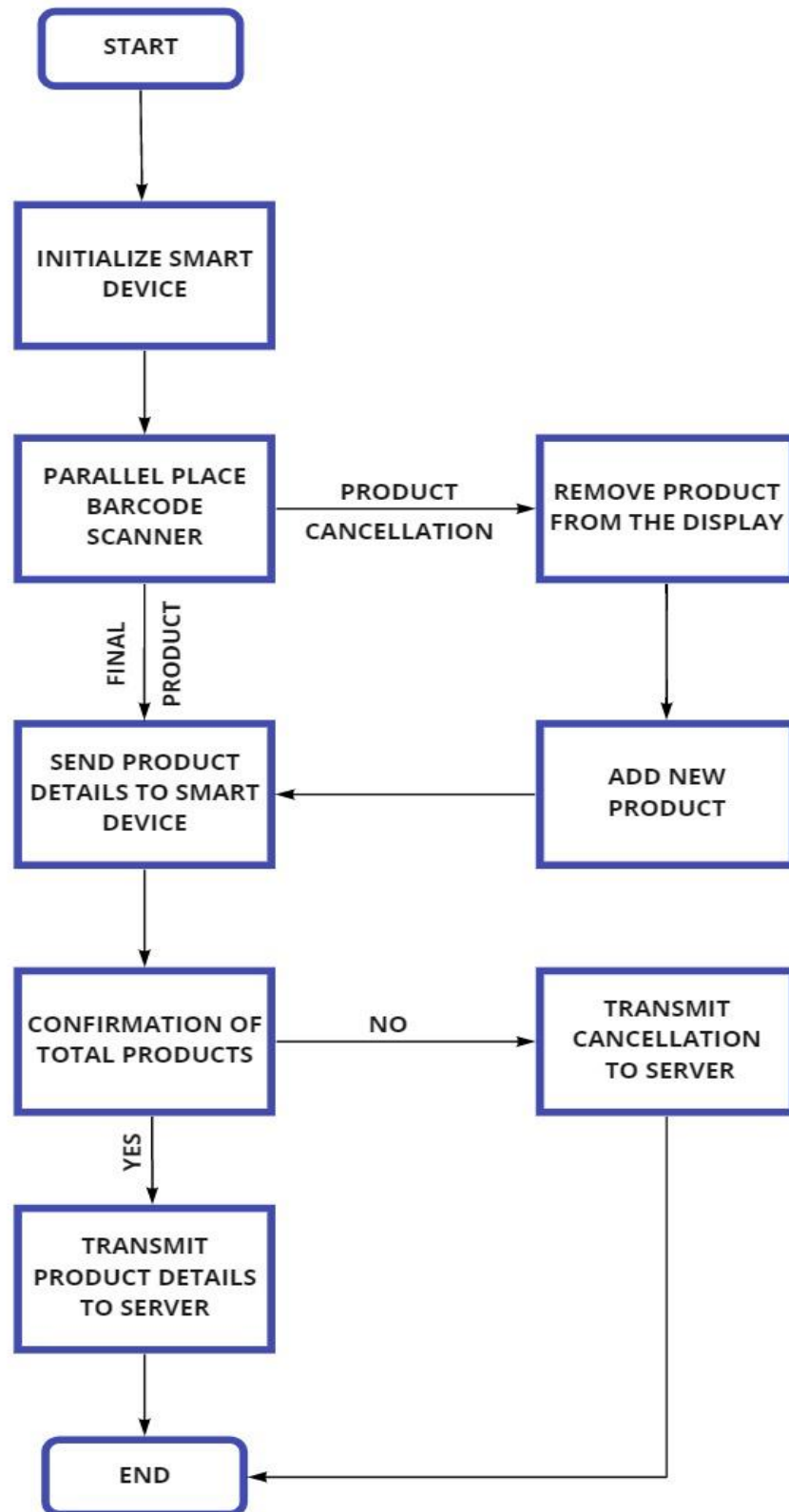


Figure 44 – Working Flow Chart (S. Sainath, 2014).

This flowchart indicates the complete step by step functioning of MoBill. When the customer initialises the device and start picking the product, they want to scan it in the barcode scanner before placing it into the trolley. The barcode scanner is located parallel to the surface along with the display screen and the card payment machine. After scanning the product, they get the full detail of the along with MRP and product information i.e., the date of manufacturing, expiry date, weight, number of quantities and discounts of all the product is displayed in the screen. After scanning any product if they want to remove any item it can be done in the provided display screen and continue with adding new products.

All the details of the new product will be added with the existing list of products which will include the total MRP of all the products with the discounts and offers, after this the customer will be asked for further proceeding, if they are satisfied with the total product cost, they can proceed for final payment transaction otherwise they can cancel the transaction.

All the details will be sent to the master server which is monitoring all the smart trolley billings and transactions.

## 6.6 Product Costing

The Costing of a products depends on various costs such as factory overhead, planning and design, manufacturing cost, packaging, marketing, and the cost for disposal of the product after its life cycle. The manufacturing cost includes the components that are purchased from suppliers, raw materials, components that are manufactured in the plant, disposal of the waste generated from the manufacturing process, assembly cost including the components required for assembling like fasteners and overhead cost. The cost of parts which are manufactured in the factory is the cost of raw material, equipment's, tooling for changeover, maintenance, energy, and labour or manpower used for the manufacturing process. The major cost depends on the price of the raw material.

**Table 4 – Cost Table**

<b>COST TABLE</b>				
<b>MANUFACTURING COST FOR 50 UNITS</b>				
	<b>QUANTITY</b>	<b>PRICE (£)</b>	<b>UNIT</b>	<b>TOTAL COST</b>
Raw Material (Ferritic Stainless Steel)	1100	0.75	kg	£825
Labour Cost (including manufacturing and packaging)	325	8	Hours	£2600
Energy consumed	25	14.4	kwh	£360
Maintenance cost	10	2		£12
Inventory cost	15	3		£18
Overhead cost	1	10		£10
				£3825
<b>Manufacturing Cost / Unit is</b>				<b>£76.5</b>
<b>COMPONENTS COST For (1 UNIT)</b>				
<b>COMPONENT NAME</b>			<b>QUANTITY</b>	<b>COST</b>
LCD touchscreen display			1	£45.49
Raspberry pi 3			1	£19.85
Barcode scanner			1	£27.02
Battery				£25.99
Castors with wheel			4	£2.4
Trolley handle				£4
Cost of trolley				£76.5
				<b>£201.05</b>

REVENUE GENERATION			
	QUANTITY	PRICE (£)	TOTAL REVENUE
Total sales quantity	1000	£201.65	£201650
Cost of Product	1000	£76.5	£76500
Cost of R&D	1000	£3.5	£3500
Cost of Design	1000	£3	£3000
Cost of Marketing	1000	£2.5	£2500
Total Sales Revenue			<b>£287150</b>

### Targeting the selling price for the product

**Selling price = cost price + Mark-up percent**, (Rob Holland, 1998) where the cost price is the retailer paid for the product and the profit margin or mark-up percent is proportion of total cost by profit.

Selling Price = Total Cost price \* (1 + Mark-up percent)

$$= £ 202 * (1 + 27\%)$$

$$= £ 202 * (1 + 0.27)$$

$$= £ 202 * 1.27$$

**Selling Price = £256.54** of our product **MoBill** in marketplace.

Assumptions: -

- 1) Initially the no of units produced is 50 units.
- 2) The raw material consumed for 50 units is 1100kg, cost of ferritic stainless is £0.75/kg.
- 3) Labour cost for 50 units including manufacturing and packaging is 325hours and the average wage for labour in UK is £8.
- 4) Energy consumed is 25 Kwh and the energy price in UK is £14.4.
- 5) Assumed Maintenance, inventory, overhead cost.
- 6) Cost for R&D is 3.5%
- 7) Cost for Marketing is 2.5%

## **7 Value Management**

In Value management, it is important to be concerned with upgrading and sustain a balance between the needs and wants of the partners and the assets expected to be fulfilled. Stakeholders make value decisions changes. Value management is a blend of planning tools and strategies to find the ideal balance of project advantages comparable to project expenses and risks. The process of planning, evaluation, and developing of idea or project to make the correct decision about the balance risks and costs.

### **7.1 Value Management Analysis**

#### **7.1.1 What other material will do the job?**

Martensitic Stainless Steel:

It is the alloys of chromium and nickel mostly. The composition contains at least 15% chromium and 8% of nickel, 1% carbon, 1% of molybdenum, and other elements like nickel, phosphorus, vanadium sulphur. As the different elements are present, they attain different grades and properties. They predominantly fulfil the properties of hardness, high strength, wear, and corrosion resistance. Their mechanical property is improved by heat treatment which gives high tensile strength. As they are good heat resistance, they can withstand the temperature and can be given shape easily. So, in the future the trolley can be developed or build with different stainless-steel material that's martensitic stainless steel. This material can also resist stress, tension, and it is also corrosion resistance. (Murakami, Yukitaka, 2019).

#### **7.1.2 Can we use a standard part?**

Yes, we can use a standard part. We have selected wheels and handles as a standard part of this project. It is due to the cost-cutting. The utilization of standard parts or segments allows the manufacturers to keep the expenses of the individual product as less as possible. And all beyond it is also done to maintain the quality of the product. Standard parts are used because the trolley is manufactured with many components and parts where some parts are manufactured with the same materials. Whereas in this project we are using polycarbonate for the handle and polyurethane for the wheels. The wheels are manufactured along with the castor so to reduce the cost of the project the standard part of the wheel is bought. So, hence we can use, and it is better to use the standard part rather than manufacturing it as it is already available in the market it not only reduces the cost but also saves time.

#### **7.1.3 Can assembly be simplified?**

Yes, the assembly can be simplified. An improvement in the product is necessary for the development or manufacturing. Simplification of the process can make the production faster and easy for the company to complete the product within the deadline. When it comes to a higher level of assembly the assembly should be simplified. This makes productivity large and efficient

and allows you to work with larger sets of data and production. So, assembly simplification is done with the help of solid works software.

#### **7.1.4 Is the part or the process necessary?**

All the materials used in this project and to build this product has been modified so some parts and processes are eliminated and then developed. The part eliminated is the baby seat in the trolley. This is eliminated because as it is the smart trolley all the bar code reader billing machine and other parts are kept near the handle so the baby seat might be a disturbance for the customer to scan or bill the product. The processes eliminated during the development of the smart trolley are the manufacturing of wheels and castors because we have bought the wheels and castors set which is already available in the market. And the other process eliminated is the manufacturing of trolley handle. This is because we have chosen polycarbonate as the material from which the handles will be manufactured as this part has already been sold out in the market so to reduce the time and for the cost cutting the handle, part has been bought. Hence in this project, few processes and parts are not necessary.

#### **7.1.5 Can we combine the part and process?**

Yes, some of the parts can be combined. This process can be done for the future development of the product. The parts which can be combined are the bar code reader, billing or scanning machine, battery all these items can be combined and building together with the display. By doing this lot of space can be minimized and make the customer buy or bill the products easily and reduces the time wastage.

#### **7.1.6 Value Management in Manufacturing Process**

Manufacturing of shopping trolley involves a various manufacturing process such as wire straightening, welding, die pressing, edge trimming, tube bending and pickling process. Time consumed for each process plays a vital role in the production of shopping trolley and any delay in one process may affect the overall delivery time of the product. The process should be planned and scheduled in such a way to reduce the time of the processes.

The complete performance of an industry depends on the design of the manufacturing facility or layout, a well-designed layout will improve material handling (J.W. Herrmann, 1995). The major delay in the processes would be the time taken for the material handling after completion of one process. It is usually done with the help of Electric Overhead Travelling (EOT) cranes which will be used to handle the material from one process to another which consumes a lot of time depending on the availability of the crane, to reduce this time taken for material handling can be done by the help of installing the manufacturing setup as an Integration line i.e., Integrated system manufacturing which reduces manufacturing cost increases the quality of the product (Hyunbo Cho, 1995). In this all the process are placed in the sequential order, after completion of one process the output product is transferred to the next process with the help of a conveyor this reduces the waiting time for the next process. Value management in manufacturing also involves combining two steps of a manufacturing process into one step, in the manufacturing of shopping

trolley after the steel wire which comes from the wire straightening process are loaded into a jig loader or fixture placed horizontally and vertically, the wires placed in the vertical direction are deviated from the one which is placed in the horizontal direction so that it forms a wire mesh formation for the trolley of the basket and then they are aligned and loaded to the welding machine which spot welds at every intersection, this two steps has been combined into a single process with the help of integration and a loading stand. The straightened wires are placed in an automated machine which feeds the wire in vertical direction and fed via the conveyor to the welding machine which has a preloaded set of wires in the loading stand which will be fed automatically one by one with the help of kicker which is operated pneumatically, and these wires fall above the vertical wires and the welding machine resistance spot welds these wires together, combining these two steps reduces the time of manufacturing to an certain amount.

#### **7.1.7 Can delivery and storage of parts be made efficiently?**

Yes, we can make storage and delivery parts more efficiently. There are many reasons for efficiently organize storage, that is for reducing the storage cost by optimal utilization of space, to reduce the number of lost parts while storing and this can be done by labelling and keeping track of each part in the warehouse, thus increasing our customer service.

The parts should be organized and stacked in such way the parts do not get lost or damaged. To neglect such thing to happen and for safety concerns of each and evert parts being stored, label each part with a RFID tag or barcode code, so whenever a part is scanned it will be updated into our database and we can keep a track of it which will be useful during the time of dispatch or delivery [Online]. Always produce and purchase parts only when an order is placed, to reduce storage space.

Delivering → On time → Customers are satisfied.

Delivering → Before on time → Customers are delighted.

Delivering → Late on time → Customers are disappointed.

The departments who are involved in manufacturing each part in our product, should fulfil the orders in most efficient and effective way and thus, making fast delivery which will make good customer satisfaction. Always arrange parts next to each other or in the order of date of delivery. As we know during the time of delivery, tracking parts will be taking so much time so keeping parts nearby the loading dock will give the delivery executive an ample amount of time to load his goods and make his delivery on time.

Delivery only the required parts for the required order, do not overload your order to safe time, as it will lead to misplace of order during delivery or will cause damage to the parts. Thus, these measures can be considered for efficient way of storing and delivering parts.

## 7.2 Value Management Cost Analysis

Table 5 – Cost Comparison

VALUE MANAGEMENT COSTING (PER TROLLEY)								
COST BEFORE VALUE MANAGEMENT				COST AFTER VALUE MANAGEMENT				
Description	Qty	Price	Total Cost	Description	Qty	Price	Total Cost	Difference in Cost
Manufacturing Cost of Rollers and Castors	4	5	20	Cost of Rollers and Castors when purchased from supplier	4	2.4	9.6	£10.4
Raw material cost of Martensitic Stainless Steel	22	1.3	28.6	Raw material cost of Ferritic Stainless Steel	22	0.75	16.5	£12.1
Cost of RFID Sensor (SIEMENS)	1	50.5	50	Cost of Barcode Reader	1	27	27	£22.98
Cost of Battery	1	50	50	Cost of Battery	1	26	26	£24.01
Labour Cost	12	8	96	Labour Cost (After combining manufacturing Process and parts purchased)	6.5	8	52	£44
Manufacturing cost of Handle	1	7	7	cost of Handle when purchased from supplier	1	4	4	£3
Energy Consumed (Kwh)	5	14.4	72	Energy Consumed (Kwh)	3.1	14.4	44.6	£27.36
Inventory Cost	0.6	3	1.8	Inventory Cost	0.3	3	0.9	£0.9
Cost of Parts (Fasteners)	15	0.5	7.5	Cost of Parts (Fasteners)	5	0.5	2.5	£5
Total Cost Saved								£149.75

In the value management costing we have saved costing in term of purchasing the parts (castors, rollers and handle) the manufacturing cost of this is more than purchasing the part from the supplier, Raw material of ferritic stainless steel is less than martensitic steel, Initially we planned to add RFID sensor which is nearly twice the cost of barcode scanner, Labour cost after Value management is reduced as we are purchasing the parts from suppliers and after combining the manufacturing processes and also the energy consumed by the manufacturing processes.

The Cost difference of our product after applying value management is **£149.75**.



### 7.3 Environmental Consideration

For the benefit of environment, there are different areas to be concerned like during packaging, transportation, and safe disposal of our product. The products should be packed mentioning the direction of use and clear description of any hazards. We consider all environmental aspects while marketing a product to the customers. We will be producing products in most effective and efficient way and utilizing minimal resources and maximizing the efficiency and output.

In the concern of being environment friendly, we will be using our packaging material in such a way that it can be recyclable. The wastage of packaging material will be safely disposed and go through the recycling process. The recycled materials can also be resold into the marketplace. Thus, providing a safer environment to our society.



Figure 45 – Represents the process involved in recycling (Google)

## **8 Environmental Consideration**

### **8.1 Importance of Environmental considerations**

Protection of our environment from the factors that include environmental consent is waste disposal from factories, the climatic change caused by the waste disposal & pollution caused during emulsion of toxic gas into environment and preservation of resources. Optimal utilization of resources that are available to us and safe disposal of waste will make a huge impact on the environment.

In the 21<sup>st</sup> Century, Customers are more Environmental Conscious and aware of the product they are purchasing and using. And therefore, this creates pressure on the producer to produce more sustainable products. Companies now started to redesign their existing product and started innovating new environment-friendly products to fulfil their existing customer demands and stay still in the competition. Different techniques such as Design for sustainability and design for environment (DFE) are implemented to decrease the environmental effects of the product. Costing should also be considered, the product should redesign in a way that it does not affect the cost of the product for that, Design for Cost is taken into consideration. However, it can be challenging for the organization which can be in the proposed price and sustainable at the same time. (Elvin Karana, 2007), (Awuchi, 2020).

The environment is already affected by several means, Production and manufacturing contribute approximately 15% to environmental degradation. So, the producers and the users need to produce and use things selectively that creates a peaceful environment. To initiate this Authorities, and legislation comes into play. They developed and are constantly developing policies and procedures and assigning those to industries and firms and promoting awareness among the public. (Elvin Karana, 2007), (Awuchi, 2020).

### **8.2 Factory regulations in UK**

The primary factor to consider while constructing a factory is about the environment and the people around that area. A factory should be located far away from the main city area, so the pollution and waste generated does not affect the people in the surroundings. The factory layout with floor plan should be approved by the UK government and the plan must have fire hydrant line all over the factory to obtain the safety regulation permit.

The Environmental regulations for UK factory work on many environmental permits including registration and licenses and it is necessary to obtain a permit or license for the factory and the manufacturing process. The permit rules include the air quality, land, and water pollution and is reviewed periodically (Richard Kneller, 2012). The manufacturing process of MoBill should comply with the UK government regulations in term of energy-efficient and air quality standards should be within the provided limit because air pollution plays a vital in UK population. As the manufacturing of shopping trolley has some intense process it consumes more raw materials and water. UK government has introduced many implemented many policies for the manufacturing

industries to produce an environment friendly process to manufacture the product with lower energy to reduce greenhouse gas (GHG) emissions (A. Giampieria, 2019). The company must take responsibility for the waste generated from the production process from the starting point and to the point of disposal of the waste.

### **8.3 Energy Consumed**

- The Lithium battery we use is 12V and requires only minimal amount of energy about 85Ah to charge it. With one charge cycle, the battery can last up to 2 – 3 days and with proper care of charging it, the battery life lasts about two – three years.
- These battery backs up our LCD screens, where the energy consumed by LCD is about 3V.
- The barcode scanner consumes about 165mW.
- In accord with environmental considerations and to provide long lasting experience and durability, we have used only recyclable and rechargeable lithium batteries in all our products.

### **8.4 Safe Disposal**

Safe disposal of Industrial waste is necessary for the environment, health, and safety concerns. Safe Disposal is disposing the waste in a way that it does not cause harm to environment and human health. Industrial Waste means and waste produced due to industrial activity. This waste can be Solid, Liquid, or gas and there are different methods to dispose of them separately. Examples of waste produced in the industry are as follows-

- 1) Toxic Fumes and gases
- 2) Oil and Lubrication Spills
- 3) Laboratory Waste
- 4) Raw Material waste
- 5) By-Product and fuel

Most of the waste can be disposed of, but some of the waste disposals require special attention and have a specific way of disposing of like Radioactive and chemical waste which can cause serious harm to health and life. (Online)

In a business organization, we need to have greater environmental responsibility in the utilization of resources and decision making as the society will be looking forward into companies' contribution to our environmental concerns in producing & manufacturing our product.

Environmental consideration will help the business organization to make realistic decisions and ensure effective implementation. (Online)

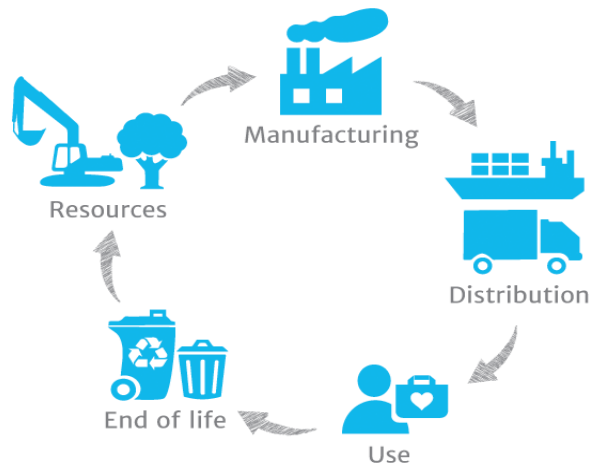


Figure 46 – Represents Safe disposal (Google)

## 8.5 Ways of Safe Disposal

To dispose of the waste, it is crucial to Characterize Waste, these are carried out in few steps like Identifying Hazard, Expose and risk assessment. Solid waste is the source of toxic Fumes and gas, hazardous waste, and chemicals. If a proper waste disposal system is not applied waste gets collected and can be a problem for workers. The commonly used methods for waste management and disposal Sanitary Landfill, composting, pyrolysis, incineration, etc. Furthermore, Proper ventilation should be installed to protect from toxic gases, piping, and the leakage preventing system should be installed and Raw material should be used and utilized according to necessity. (Nils Nörmanna 2016).

Reducing the number of resources in manufacturing a trolley will lead to a reduction in the wastage of resources generated. Reducing the purchase cost of material by buying it at a lower price from the market and eliminate the amount of waste disposed and providing a healthier environment to the workers & employees. Reducing the energy consumption used in manufacturing by switching off the machines when not in use and precise use of machines will lead to less consumption of energy (Gary Laustsen, 2012). During manufacturing numerous amounts of water get wasted so, reducing, or recycling the water by treating it properly will help us save water consumption and reduce the overhead cost.

Reusing our tools and equipment will help us to reuse our waste. Reusing our materials and resources will cut off the cost by not buying extra goods or raw materials. Increase reuse of resources will promote our company's potential of producing its product in the marketplace.

Recycling of waste materials and resources like the usage of water will reduce the cost, recycling the scrap metals collected from the machinery used during manufacturing trolley. Recycling and reusing of best coolants (Engine Ice TYDS008-02) which is biodegradable and phosphate & silicate free. It is even toxic-free. This coolant reduces the operating temperature and prevents it from overheating and is safe for use in almost all metals. (Nils Nörmanna, 2016).

## 8.6 Safe Disposal of Materials

### Ferritic stainless steel

Ferritic stainless steel is unique from other types of steel. It contains nickel, chromium, and few other alloy components. These steels are not hardened or heat-treated material. The stainless-steel industry has exhibited to be incredibly safe and be of no harm to the environment or the ecosystem. This is because it uses fundamental energy sparingly, saves non-sustainable sources, and restricts the waste stream. Stainless steel is made of about 50-60% reused material and contains it. Unlike many, industrial and engineering design materials like stainless steel can be remelted again and again at each phase of this cycle with no loss in quality. So ferritic is 60-70% recyclable. The items or products which are produced using stainless steel will not get futile at the end of their life this is all because stainless steel can be removed systematically and accordingly and send to the recycling system. The reusing of ferritic scrap generally is largely invaluable reducing the expenses of producing the stainless steel, saving valuable alloying elements, and helping to protect the environment. Developing recycling of ferritic stainless steel and a different market for ferritic scrap is a coherent and appealing opportunity in metals recycling as well. Hence looking after all the environmental safety, the ferritic stainless steel is a safe disposal alloy.

### Polycarbonate

Polycarbonate is a synthetic resin where the polymer units are connected along to carbonate gathering including many moulding materials. Polycarbonate is solid to the point that it is less resistant to affect in any case. Yes, it is completely recyclable and as it is produced from natural resources it provides an astounding yield for plastics recycling factories. The standard way for recycling is polycarbonate is to sort, shred and wash and then transformed it into a grind for manufactures to use again. So, the process sees the material being shredded before its granulated. Polycarbonate with its natural characteristics is an economical material with an insignificant effect on the climate or the ecosystem. It is completely recyclable toward the end of its life. Polycarbonate can also be recycled through chemical methods. Acids like hydrolysis, glycolysis are neutral or alkaline in the environment. The advantage of polycarbonate is that it can be reused as secondary raw material which can be remanufactured. Recycling of polycarbonate is ecological friendly (Antonakou, Achilias, 2013).



Figure 47 – Disposal of Polycarbonate (Google)

## Polyurethane

Polyurethane is a synthetic resin where the polymer units are connected by urethane groups. Polyurethanes are petrochemical-based polymers. Significantly, they are recycled or reused whenever possible. They are feasible with manufacturing and recyclable. Indeed, they are naturally eco-friendly than most of the other plastics. Polyurethane deposited or produced is a natural and ecological issue this problem can be solved by mechanical and chemical recycling. Sometimes if they cannot be recycled, they are processed for energy recovery. Polyurethane used here is thermoplastics they make up the maximum used overall plastic worldwide. They can be reused by heating them until they become in a liquid state a thereafter, they are remoulded and given a new shape. Polyurethane is a high-level material that is substantially more harmless to the ecosystem. (Gama, Godinho, 2020).

## Safe Disposal of E-waste

All materials are not lifelong, some of them have end of life. Overuse or not at all using a product does have depreciation effect on all materials we use. Hence, those materials must undergo proper treatment of disposal without causing any environmental hazards. The battery we have in our product is Lithium Battery which can be either recharged or recycled but if disposing, it should be done properly as they generate huge amount of heat & energy and are having high risk of explosion. So, the disposal of such batteries must undergo lot of process before its being disposed. Some of the chemical compound like Nickel, Cobalt can be recovered and recycled by proper means of removal from Lithium batteries.

The LCD screens can be recycled. We live in a society where newer technology are introduced in our society every year. So, to adapt ourselves in society we will be changing our LCD screens in our product even though the old ones work fine. So, instead of throwing away the old ones, they can be recycled. Almost all 90% of parts in LCD can be recycled and put in for different use. For e.g., the plastic in LCD can be recycled and reused for different purpose. The same goes with the Barcode Scanner, the plastic parts and IR sensors present in it are ripped off and recycled.



Figure 48 – Disposal of E-Waste (theproche.com)

## 9 Market the Product

### 9.1 Marketing Research

#### 9.1.1 Questionnaires

We have sent out these questionnaires to 35 people

1. Which age group you belong to?

- Below 18
- 18 – 25
- 25 – 35
- Above 35

2. What is your gender?

- Female
- Male
- Prefer not to say
- Other

3. What is your Marital Status?

- Single
- Married
- Prefer not to say

4. What is your Occupation?

- Student
- Employed
- Self – employed
- Prefer not to say

5. How often you visit supermarkets?

- Everyday
- Twice a week
- 2 – 3 times a month
- Rarely

6. Which supermarket you often visit?

- Tesco
- Sainsbury's
- Asda
- Morrison's

7. What difficulties you face while shopping?

- Finding a product.
- Standing in a long queue for billing.
- Payment Issues
- Other

8. How often do you use the trolley in the supermarket?

- All the time
- Most of the time
- Sometime
- Prefer not to say

9. Which social media you use often?

- Instagram
- Twitter
- Facebook
- WhatsApp

10. Which method type you prefer for billing in supermarkets?

- Smart Method
- Traditional Method
- Prefer not to say

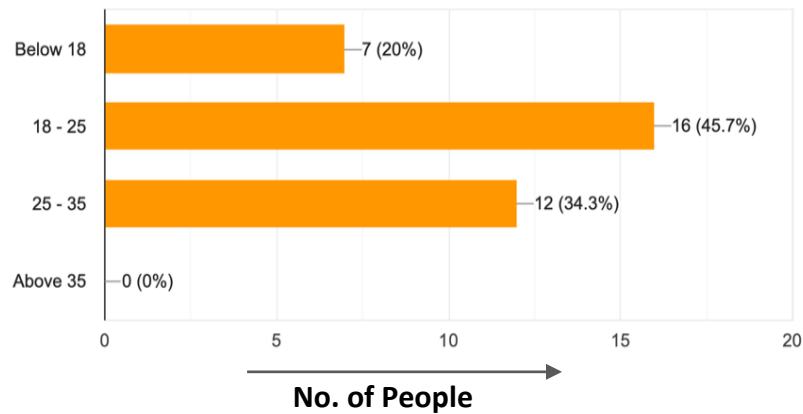


### Analysis collected from the above questionnaires from various consumers.

For the research purposes, we have done an analysis based on the data collected from the questionnaires. This analysis is for understanding the customer behaviour and targeting customers for shopping cart trolley recommender.

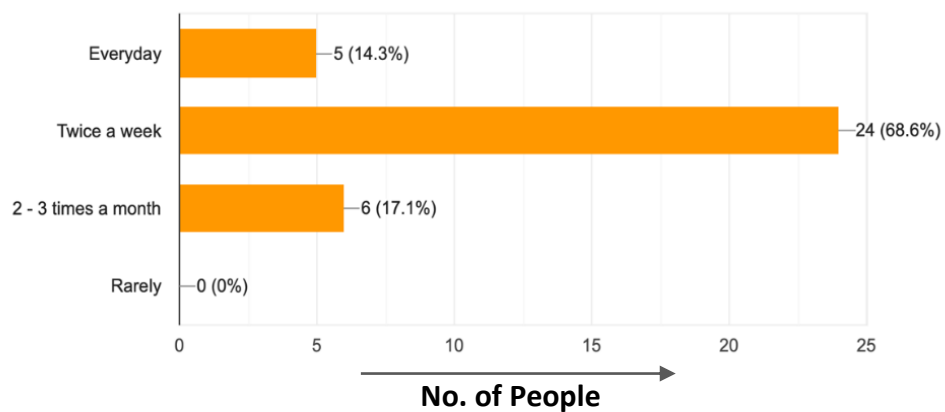
Which age group you belong to?

35 responses



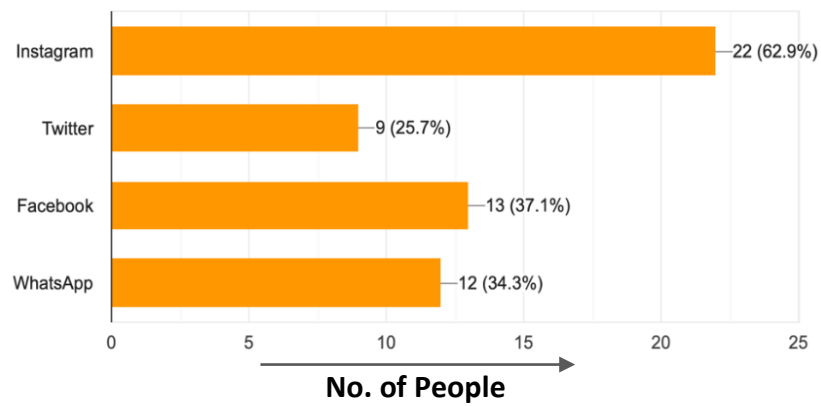
How often you visit Supermarket?

35 responses



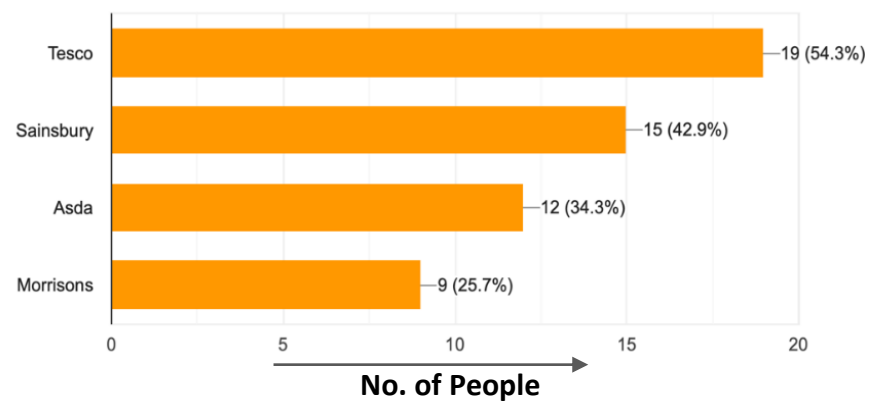
### Which Social media you use often ?

35 responses



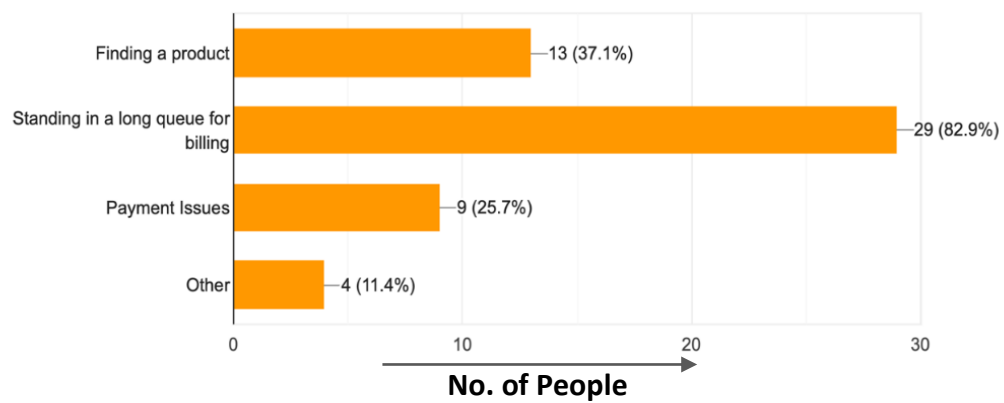
### Which Supermarket you often visit ?

35 responses



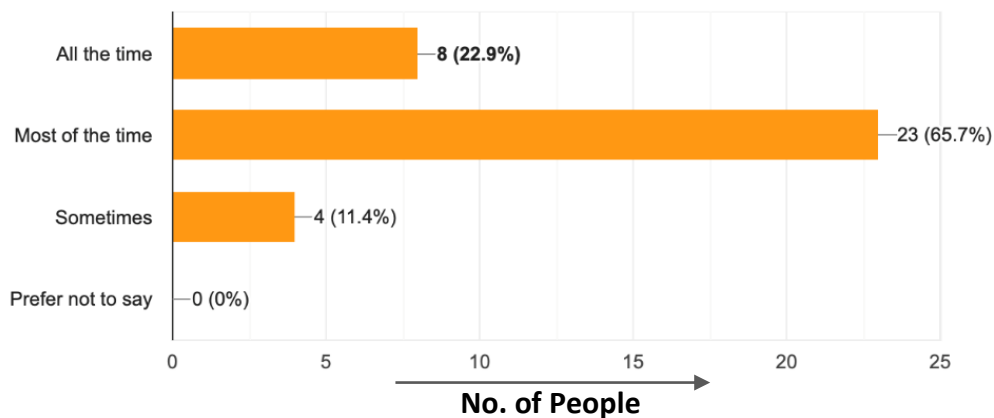
### What difficulty you face while shopping ?

35 responses



How often do you use the trolley in the supermarket?

35 responses



### Data Analysis

From the analysis, we could clearly say that people from different age groups visit the supermarkets a lot, but we see that people who fall in the age group 18 - 25, 25 – 35 are the most visited people in supermarkets. Those people who visit are the mostly Males (Females do purchase but compared to our data a slightly back in number to our data), these people who buys are single followed by married people little back. Hence, these people become our target people for recommending our Shopping cart trolley.

We also know people from different occupation visit and make their purchase in supermarkets but from the survey we see that Students by a lot accompanied by employed people slightly back. These people visit the supermarket twice a week rather than every day. We know social media platforms have been a large marketplace for businesses like ours for advertising and promotion and targeting wide range of consumers at one place, so we have asked people which social media platforms they use frequently and from this analysis they mostly use Instagram followed by Facebook & WhatsApp.

There are lot of supermarkets to target consumers to use our product, so we have asked these people which supermarkets they visit often, and we analysed that Tesco is most visited followed by Sainsbury's. Yet, these people do face problems like standing in a long queue for billing mostly and finding a product too. And they use shopping trolley most of the time and they preferred smart billing method rather than traditional billing method. Thus, by introducing our product at these supermarkets and promote our product, people do visit and use our product and their shopping becomes easy.

## 9.2 Marketing Strategy

Creating the best value for the customer through all our measures through making it better product and channelizing our product and good communication to the customers. The fundamentals of marketing strategy are for maximizing customer satisfaction using adequate resources available to us. (Michael J. Baker, 2014)

By understanding the marketplace and customers, we need to target.

- Needs. Understand what the customer really needs.
- Wants What the customers really want.
- Demands If it all meets up their demands, they eventually end up buying our product.

This can be achieved by analysing the data of customer behaviour for selection of target customers to recommend them a futuristic shopping trolley for shopping through supermarkets.

### PRODUCT LIFE CYCLE

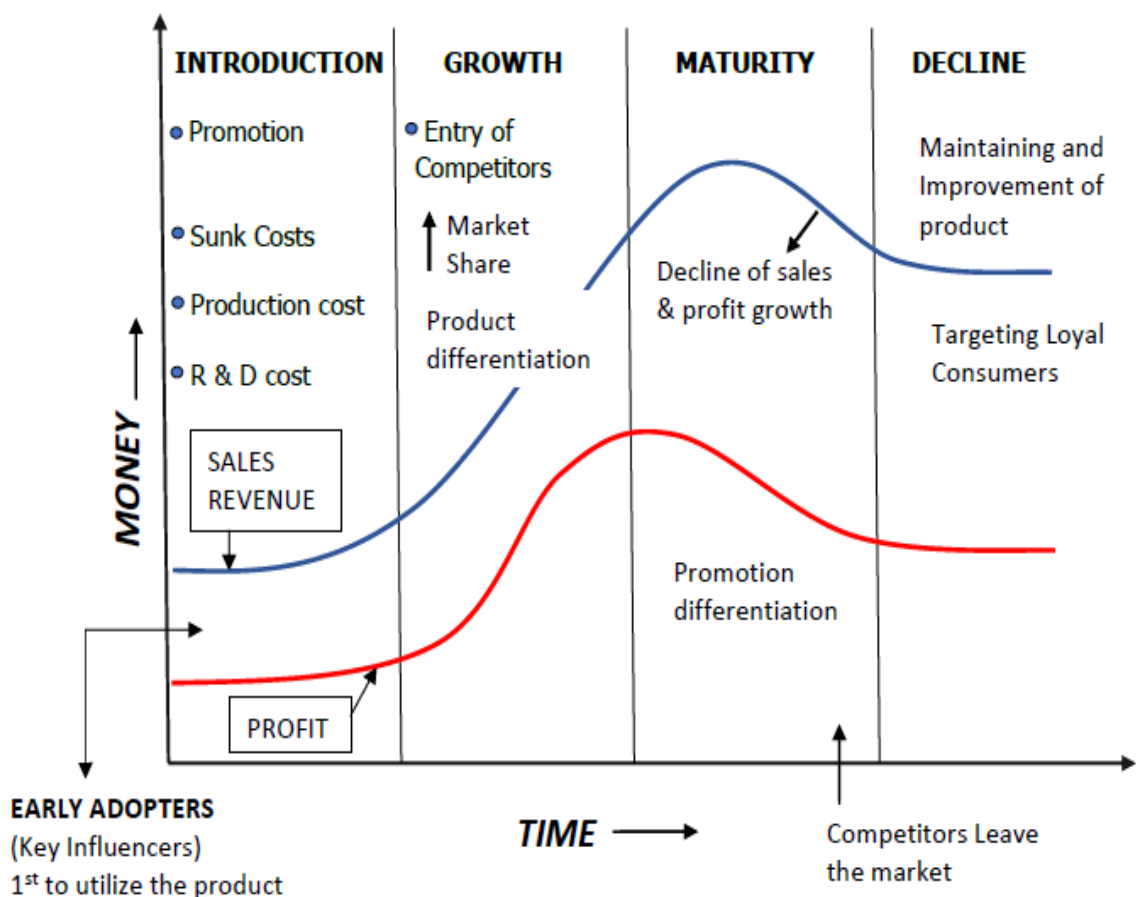


Figure 49 – Product Life Cycle Graph

The product life cycle represents the theoretical model that explains the different stages of product that goes through from Introductory in marketplace until their decline / depreciation.

There are 4 specific stages that represents in terms of revenue as well as probability.

From the graph, we could see as the time increases in respect of money for a product, the revenue gets increased and gradually goes to decline.

### **I. Introduction Stage**

In this stage, the product is first being introduced in the market and this stage is also called as money sinkhole since, there is no competition the company will be spending great deal of money which involves in developing awareness about their product and their businesses. The sales revenue and the profit are as it is in development and expect absolutely no return. This stage involves costs in Research and Development, Product development, Manufacturing and in Advertising. The pricing strategy plays a vital role. The 1st stage targets the early adopters, who are key identifiers in determining our product and determines whether there are any flaws in our product before being introduced in the marketplace (William D, 1997).

### **II. Growth Stage**

This is the stage where the product blows up in the marketplace. It is the ideal time for the company to focus on increasing the market share. We need to gain customer confidence by providing discount policy and improving product availability. The sales revenue and the profitability get increased rapidly and this is the stage where we meet our competitors. We will be adding more features and improving our flaws to distinguish in the market among the product that produced by our competitors. Since ours is a new product, new consumers desire to buy our product and there will be more awareness of our product among the marketplace and hence there will be less hesitancy for them to buy our product. This stage targets broader audience and expand our distribution among the marketplaces (William D, 1997).

### **III. Maturity Stage**

This stage is where variations of similar product has been introduced among the competitors and the company's business starts to see a slow decline as it comes to a saturation point among the marketplaces. This decline occur due to the price reductions and various similar products in the market as the level of competitors pushes the company to reduce price to remain competitive. The promotion and advertising focus on product differentiation in terms of quality and trustworthy which gains even more popularization among the consumers (KJ Yogesh, 2016).

#### **IV. Decline Stage**

Here In this stage, we see the sales starts to decline, and the company maintains small level of profit. We can maintain and improve the product by finding whether it has a new purpose of use or by adding additional features or technology to continue in the marketplace. Only fewer competitors stay in this stage who are finding a way to bloom through the marketplace. Our final aim will be focusing only on loyal customers who continues to buy our product. The distribution of our product stays limited (KJ Yogesh, 2016).

#### **9.3 Advertising**

Advertising is all about creating messages to persuade and motivate people to act and we have those target people of the age groups (18-35) as they have more ability to accept new things in the market. Our offline advertisement would be in distribution of business cards, speak at events like in schools and colleges, few other places and our online advertisement be in Social media marketing in Facebook, Instagram, Pinterest and so on. The role of our advertisement is to grab customers to see our product and use it to ease their shopping through supermarkets without any disturbances or difficulties.

##### **9.3.1 Offline Advertisement**

Offline advertising helps us to meet people face to face and interact with them and develop trust, is one of a great way of showcasing our product. The offline advertising can be selected as follows:

##### **Billboards and Distribution of Pamphlets**

Billboards are designed with few to no words so that viewers have time to process the message while passing by in a car or train. And, these ads are used for brand awareness, so they usually only include a brand name or website which helps us to attract more people to see our product. We can also pass our printed pamphlets to our neighbours and businesses and pin in a public bulletin board, or even slip in between books and magazines. When people investigate our product advertisement, they will look forward to using our product in supermarkets.

##### **Providing Samples to Supermarkets**

To promote our product, we will be bringing up our best marketing speakers to explain about our products in various supermarkets and providing them with a visual representation of our business. We will be providing them with at least 15 samples to use of products and after satisfaction of using our products they could pay advance and book few more of our products.

### 9.3.2 Online Advertisement



Figure 50 – Online Advertisement (Google)

As of today, we know that over 3 billion people are spending lot of time surfing through the internet. The internet offers us direct access to almost more than 10 million people in UK which includes more than half of our target people and it also provides us with different channels to advertise our product. The online advertising can be tempting and can manipulate the tastes and liking of the consumers. We know that most of the search engines have their own paid advertising, so by SEO we could promote our advertisement & website to our people who come in search of our product and get paid through these SEO by CPC (Cost per Click) of their Ads (Avi Goldfarb, 2014) By, Social media advertising, according to report from 2021, the best social platforms to advertise are Facebook, YouTube, Instagram, Twitter & WhatsApp. If we choose to advertise through these platforms it would help to reach our target audience & investors, encourage them to buy or use our products. Collaborating with top retailers in the market, we will be promoting our product to the consumers. These vendors could buy our product directly from our website. (Fossen, 2019)

### 9.3.2.1 Website Overview

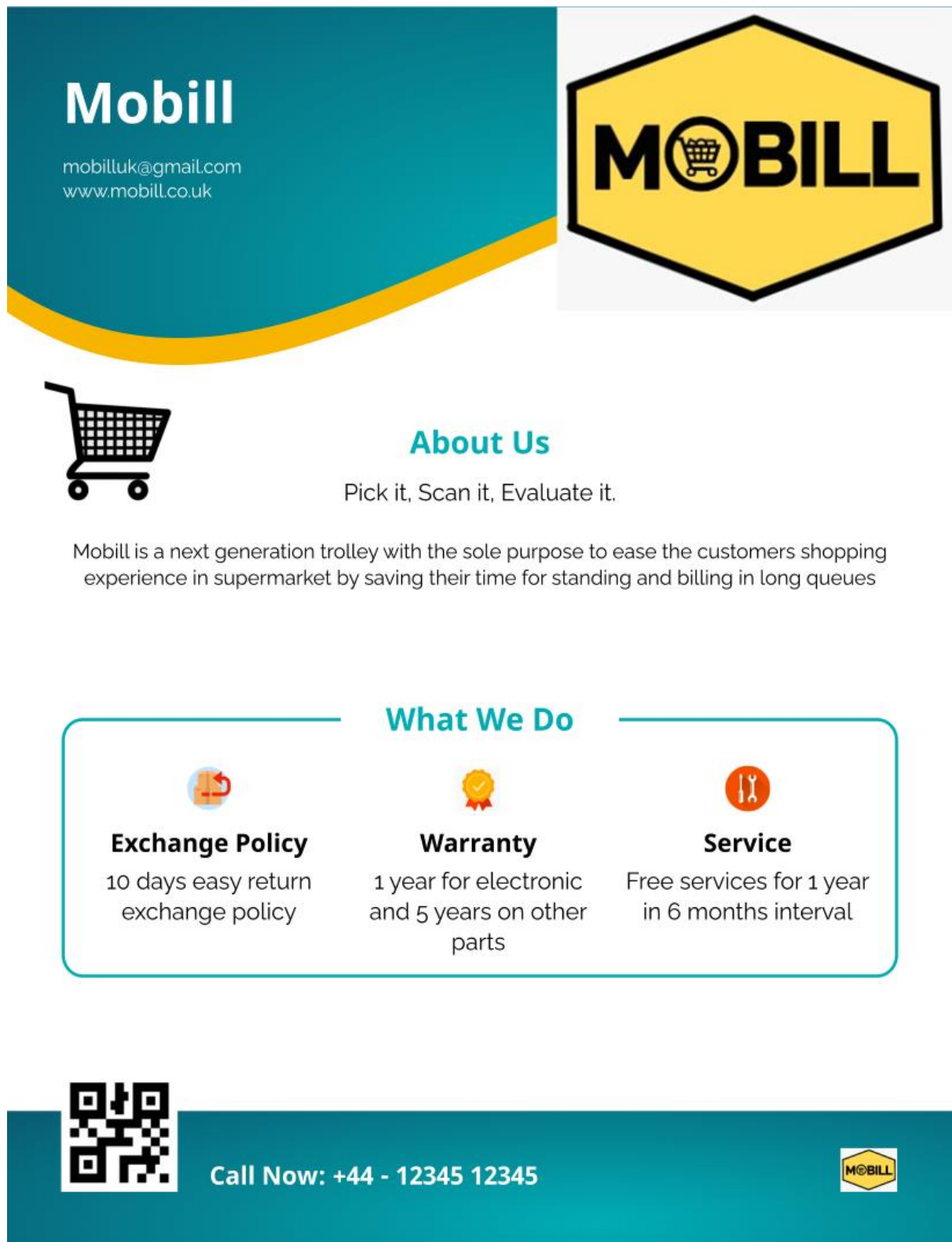


Figure 51 – Website Overview



## **10 Engineering Ethics**

### **10.1 Ethics**

Ethics and Values set the base of mankind and nurturing civilization for many years. But what does the word “ETHICS” mean? It has several meanings. It refers to the moral values, beliefs, and principles of the individual or society. Another two-word meaning can be “morally correct” (Van de Poel, Ibo., 2001).

Ethics and principle are crucial for every individual. It tells us about the art of living, how to respond to the situation optimistically with our sense of understanding, rights, and duties. Also, it teaches us how to recognize and deal with problematic situations from judgment and observations. Ethics is an active process, it means that, when a person is performing ethics, he must be able to prove his position with logical and theoretical reasonings. To perform ethics, a person must have self-control over feelings and emotions and be stable enough to balance both. (Van de Poel, Ibo., 2001)

### **10.2 Engineering Ethics**

Ethical values and Principals play a crucial role in every organization. These ethical values ensure the proper working of the organization ensuring the safety standards within the organization. As far as Engineering is concerned, it is the method of developing such a mechanism that can fasten and ease the task in the available number of resources. We as Engineer studies this specific field to create, innovate and design the things that can solve real-world problems under the consideration of surroundings. Generally, Ethics are accepted by society and when this ethical principle is applied in the organization which aims in providing a solution for real-world problems with technology, then we can say that the organizations following the Engineering ethical values. (Karen L. Rich)

The core role of an Engineer is to make an impact on the life of the common person and enhance his quality of life. So, here the ethical value comes into play. In order, to ensure the constructive impact for the people they are working for or with the people they are working with, they must be clear, honest, intellectual open-minded, and resolute toward health, safety, and the environment.

### **10.3 Importance of Engineering Ethics**

Industrial Revolution is considered the prime period in the history of mankind. Worlds expand and start moving, many industry setups which flourished life of every individual. If we closely look at our history, we can find several incidents that shook the whole world and cause a huge loss to human life and mankind whether it was the Chernobyl disaster, Bhopal gas tragedy, or Fukushima nuclear disaster. Then some incidents occur in everyday life like a bridge or building collapse, and other industrial accidents as well, which not only cause damage to the life of the users and the producers but also cause huge damage to a large amount of money invested for operation and manufacturing, resources loss and time loss. (Anke Van Gorp., 2005)

To overcome these challenges practitioners constantly developing a system that brings safety not only for the people working in the firm, industry, or consumers who are using the products and services, but also save resources and cost invested in the development. In response to this, some Engineering societies also developed and established which forms the code of ethics such as ASME, AIEE, and AIEE. Furthermore, the government and authorities passed legislation reserving title rights to professional engineers. For instance, In Canada and America, all people working in the field of technology, health, public welfare, and the environment must have a license to continue their practice.

Methods and ways to promote an ethical system continues. Ethical values are not only associated with life and property, but also with the morality and behaviour of the person working in an environment. (Anke Van Gorp., 2005)

#### **10.4 Ethical Principal**

One of the best initiatives was taken in 2005, the Royal Academy of Engineering in collaboration with the Engineering Council, developed the statement with the help of experienced engineers and professionals to follow the engineering practices and behaviour values. The statement was revised again and again and the latest one was introduced in 2017. The statement contains four major fundamental principles with a set of Rules and Responsibilities published by the professional technical Institutions. According to the statement, all Engineering and technical professionals should dedicatedly work ethically and responsibly. (Royal Academy of Engineering)

To bring the Ethical principles statement to real life, several case studies were prepared by experienced engineers, that reflect the significance of the ethical principles to engineering practice. Both the Institution affirms that irrespective of the positions of the engineers, they should be educated and passionate to think and work following the principles proposed. These statements were then given to Education qualification providers, Employers, and training institutes so that this could be recognized and praised by the public and professionals. (Royal Academy of Engineering)

**The four major fundamental principles which support statements are as follows: -**

##### **1) Accuracy and rigor**



**Figure 52 – Accuracy and Rigor (Google)**

- **Updated with knowledge and relevant skill sets** - Our company has policies which ensure the smooth operation in all departments. For that Human resource and recruitment team play a crucial role, they conduct time to time knowledge and skill test.
- **Act Carefully**- Engineers are expected to work consciously and carefully taking care of minute details so we can provide the best service to our customers.
- **Should not mislead others**- Staff members are not expected to lie, cheat, or mislead anyone.
- **To identify, analyse and mitigate any possibilities and circumstances that hinder the progress**- Proper record maintain in our organization which make sure that any situation or challenges hinder the progress.
- **Perform the task only in the areas where they are experts**- As mention above. Our human and Resource team will recruit knowledgeable and skilful employees and assign departments according to their skillset.

## 2) Honesty and Integrity



Figure 53 – Honesty and Integrity (Google)

- **Be honest and trustworthy**- Engineers are expected to be faithful, loyal, and understanding towards companies' policies.
- **Be moral and avoid Bribery**- Immoral activities like immorality and Debauchery cannot be entertained.
- **Avoid deceptions and report to the authority if find any professional misconduct**- Whenever or wherever anyone found other perform illegal acts should directly report to the authority. So that proper actions can be taken on time.
- **Respect the Privacy**- Our company have flexible and strict policies, and they are expected to be followed by each member of the staff.

### 3) Respect Law, life, and Public Goods



Figure 54 – Respect Law, Life and Public Goods (Google)

- **Ensure that their work is lawful and justifiable-** Our company is authorized by the government and we are strict to the policies and policies and our employees are also expected to follow these procedures.
- **Acknowledge the importance of Data Protection and Security-** Data privacy is crucial. Strict policies and procedures are created which ensure data security and protection and revealing these to public or competitor can be a serious offense.
- **Consider the availability of resources-** Our Head of the department will make sure. the product design, manufacturing, disposing of should be planned and done in a way that our product will create and manufactured in the optimum number of resources without wasting material, time, and resources.
- **Ensure the importance of health and safety of others-** Life is the priority for our company. Proper systems, for instance, fire protection, shock protection, etc are installed which ensure the safety of the employee. We also provide compensation for any loss.

### 4) Responsible Leadership and Communication

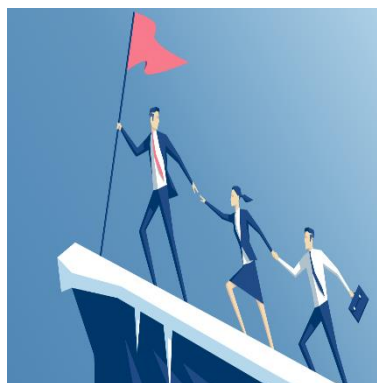


Figure 55 – Responsibility, Leadership and Communication (Google)

- **Encourage Equality and Diversity**-Our company motivates, promotes, and encourages our employees to do their best in roles. We also provide incentives and appraisal to our employees.
- Aware of the surrounding, what is the need of the society, and how to fulfil those needs with the help of Engineering and Technology.
- Nurture Relations promote awareness and recognizing the impact and benefits of engineering achievements.
- **Questions statements and policies that cause professional concerns**- Our beliefs in human rights. Our staff members have the right to ask questions to the authority from the lowest labour to the CEO. Rights are equal to everyone.

### 10.5 Implementation of Engineering Ethics in MoBill

MoBill considers Engineering Ethical principles, mentioned in the statement provided by the Royal Academy of Engineering, and prepares strategies accordingly which ensure smooth and proper operations in the organization.

- Over the main goal is to satisfy the need of the customer and generate profit for the organization.
- Material selection is done to ensure the health and safety of the customer and environmental concerns are also taken into consideration.
- Establishing the best manufacturing setup which ensures the health and safety of the employees and workers and does not cause any harm to the environment.
- We have strict restrictions and rules regarding immoral activities like bribery, corruption, and whistleblowing.
- We planned proper strategies and procedures which ensure data security and privacy.
- Employees at the different levels are treated equally with respect.
- We maintain the quality of the product including the series of quality checks and various inspections before delivering a product to our customers.
- Time is money, we make sure our product deliveries on time.
- Breaching the company policies and the procedure is a serious offense.

### Ethics in Research and Development

The research and development of an organization have standards, and it is always separate from other departments. The ethics of the research and development oversee the leads for logical specialists. The importance of the moral standards of ethical principle is to protect the dignity, rights, and government assistance of the research members. The advantages of moral standards of ethics come from the discussion between the team members, management, and the organization. Equity and autonomy are the keys to ethical review. The empowerment to enhance the functions at the small business is to understand the working functions of the research and development department. All the researchers are required to observe the highest standards of professionalism, trust, honesty, and good working skill in every aspect of their work and projects.

There are few reasons why it is important to stick to ethical standards in the research and development sector:

- They advance the aims of research like knowledge, truth, and evasion of mistakes.
- Intended to ensure intellectual innovation interests while empowering coordinated efforts.
- They ensure that the researchers can be considered responsible to the public. And additionally, help to build public or customer support for research purpose.
- They include other significant-good and friendly qualities like a social obligation, human rights, animal government assistance, consistency with the law, and wellbeing and security.
- Professional researchers are answerable to their employers and funders for following codes and policies relating to research ethics.

### **Ethics in design and development**

Design and Development is a process in which objects, Products, or Tools are created to fulfil human motives. The main goal of the person involved in the design and development field is to satisfy the customer's needs. The product should be designed ensuring, ease of use, health safety of the user and should be produced at a low cost, fulfilling market condition and brings profit for the organization. There are certain restrictions are also associated with the design and development, for instance, time restrictions, economic constraints. The department has the responsibility to finish the development on a certain date and should be produced under the budget proposed. (Anke Van Gorp., 2005)

The problem associated with the design and development varies from designing phases There are four designing phases and problems associated with it listed below; (Van de Poel, Ibo., 2001)

- **Analysing the problem-** This includes the conceptualization of the design and planning for the methods, process, product, and service.  
Problems-Different points of view, Different design requirements may vary from age, gender, colour, aesthetic, safety, and environmental concerns, etc.  
The ethical solution in this phase is provided in the statement provided by the royal academy of Engineering” paramount of safety, health, and welfare of the public.  
The design should be value sensitive considering the health and welfare of the users.
- **Conceptual Design-** This includes the design that should be created with innovation and creativity to solve the existing problems as well as a problem that can arrive in the future. The ethical solution to this problem is that the designs should always come up with safety and ecological concerns.
- **Embodiment Design-** In this process, a designer must select the best design from the other alternative. The problem associated with this is an agreement between various ethical design requirements. Some design requirements may be conceptualized in such a way that they can never meet. For example- a house cannot be built, there can be restrictions related to budget and location.
- **Formal Engineering methods-** Different analysis methods carried out and these methods have different criteria and different moral values, they are proportional and relevant or

not? The ethical solution to this problem can be referring to the historical data, proper evaluation and estimation should carry out to make the decision.

The major Ethical values related to Design and development-

- Satisfying customer needs and requirements should be the topmost priority.
- Design Consideration should be properly assessed and analysed.
- The designed product should be environmentally friendly and should not cause any harm to the user and producer.
- Costing is a major consideration that should be considered while designing the developing the products or tools. The design should be under budget constraints.
- The designer should select the design which requires less time, low cost, and suitable environment-friendly manufacturing process to develop.
- The goal of the organization is to generate profit so the product should be selected which adds value to the organization.
- Ensuring health and safety for both producers and the customers.

### **Ethics in Manufacturing**

Ethics in manufacturing involves ensuring all parts of the production are safe for the workers and the manufacturing process should not affect the environment and should follow the guidelines of a local factory or industry regulations as provided by the government.

- It should not compromise in quality of manufacturing the product irrespective of the deadline provided by the company and should not follow any shortcuts in manufacturing the product.
- The manufacturing department should not allow any new worker to operate on a machine without any knowledge or proper training about that machine and the work should be provided with necessary PPE'S (Personnel Protective Equipment's).
- It should not support any manufacturing process which affects the environment or the health of the worker, it should not force any worker to work on a production process which he/she is not comfortable with and long working hours of any worker should not be encouraged.
- The final product should meet the quality standards expected by the customer and should go through many quality checks, inspection and testing before packing the product and any defective products should be eliminated or removed from further processing.

### **Ethics in Business Development**

Ethical values are taken into consideration while preparing strategies and policies for Business Development. Maintaining consistency in the business and generating profit for the organization is the main goal for the Business development department. (Strong, K., Ringer, R., & Taylor, S., 2001)

The main Ethical principles applied in Business development are as follows.

- Developing contacts and maintaining healthy relations with the Stakeholders and Customers.
- Keeping proper check regarding demands and must be aware of the products in stock maintaining the regular check with inventory management.
- Be aware of the surroundings and seek an opportunity that can add value to the organization.
- Ensure the availability of the executive to the customers and resolve their issues on time.
- Promoting the products and services in a way that should not cause harm to the environment, health, and loss for the organization.
- Developing ways to bring Profit to the organization.

### **Ethics in Marketing and sales**

Ethics and social responsibility in marketing involves in promotion of fairness, responsibility, and honesty in their advertising. The golden rule: “Act in the way you would expect others to act toward you” & “Act in the way that results in the greatest good for the greatest number” (Gene R. Laczniak, 1985). These are all moral values that are being followed by the company while marketing. If our company is unable to live up to the claims, we made while advertising our product is unethical behaviour of marketing.

The ethics in marketing defines how a company satisfies its customers, benefit the society, and benefit the environment.

- Sales representative should always be honest with our product impact. False information during promotion of our product lead to dishonesty with the customers. Sales and the purchasing team should not do unethical behaviour like bribery as it has become major problem in our society. The sales team should always set a sales goal which in turn motivates the team to work efficiently and effectively. (Wood, G. 1995)
- Satisfying our customers plays a major role in our company, we should be transparent about safety and effective use of our product, always protect the consumer’s privacy and promote only sustainable products to the customers. Our company should also not make any false claims to our product or about our competitors which in turn promotes an unethical behaviour. Thus, the company should always aim in creating values for customers. (Online)
- The pricing of the product grabs the eyes of the society our company will price their product based on their target customers. We should be able to satisfy those customers and provide them with best quality of product with the price that can be affordable by the customers. The company will be spending our 2% of profit in CSR (Corporate Social Responsibilities) for the well-being of society.



## 11 Conclusion

For the report presented we can conclude that MoBill product is unique because it is easy or convenient to use, easy to handle, user friendly and creatively design in a way that it is different from the other products in the market. The product is environmentally friendly because it can be safely disposed and can be recycled easily without effecting the eco-system. All the material used in fabrication of this product are recyclable and product no harm to the environment. The product is maid under the ethical principal and value provided by the Royal Academic of Engineering. The product is manufactured under the environmental concerned with standard manufacturing process, design criteria, proper marketing, business, and research development which add profit to the organisation. The product is full filling the demands and requirement of the customers and the product will be update time to time keeping the satisfaction of the future demands and needs of the customers.

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## Student Self-reflection on performance

All students must complete the following sections for every piece of work they submit using this template. The aim of this is to help you use feedback more effectively to improve your marks and your skills as a professional engineer. This section is not formally marked, but your tutor may use it when discussing your work with you.

Describe how you have used AT LEAST ONE of the following sources of information to improve this piece of work:

1.) (PREFERRED) Feedback from previous assignment(s). This can be from the same module or from a previous module or previous year of study (e.g. comments from 1<sup>st</sup> year lab formal reports should be used to help improve your 2<sup>nd</sup> year lab formal reports).

2.) The marking criteria or rubric provided for this assignment.

3.) The Department Technical Writing Handbook for Students.

The online lectures and the module guide help us in completing this project. We all five members are from different background but still working as a team and putting our ideas and efforts. This module gave us space to express our ideas about developing a product and organization.

Are there any aspects of this work that you would specifically like the marker to comment/or advise on? For example: "I wasn't sure if my figure formatting looked professional and would appreciate feedback on this aspect"

Shopping cart is frequently used by the people of different age group. To help them out we added some more features in the shopping cart.