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# **Product Design Specification (PDS)**

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**Smart bicycle helmet**

**PDE3420 System Design and Validation**

***BEng Electronics Engineering***

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## 1. Introduction

The main objective of this project is to redesign the bicycle helmet, with additional features required by the customer along with keeping the safety as the topmost priority. The report comprises of the market analysis to look for the current product's features and prices. Followed by customers' requirements and an objective tree explaining those requirements. Along with that there are functions and specifications of the design.

## 2. Need statement

The designer is asked to design a device for converting a standard helmet to a smart helmet. The device automatically indicates the vehicles approaching behind about the direction on which the user is about to turn. along with that it requires to be compact and lightweight to keep the efficiency of the cyclists unaffected. In addition, it needs to stand on par with the other smart helmets that deliver extra features like location service and Bluetooth connection with the cell phone. The device must be designed in a way to attach firmly with any standard helmet without any difficulties. This implies that there is adequate requirement of an attachable device for helmets that keeps up with the modern world with more functions than just providing protection.

### 3. Market Analysis

After identifying the requirements of cyclists in a general format, the team further proceeded towards scrutinizing the current market scenario that our product would enter. This would provide us with valuable customer opinions alongside the info on how the designer would develop a strategy. This will be based on comparable products and companies producing them using market information.

#### 3.1 Define problem

Although standard helmets fulfil the requirement of providing safety against collision. there are still certain untouched possibilities which would provide a much better experience upon evolving. This is something that could be worked upon using modern world technology. The list below shows the expected customers of new device:

##### 3.1.1 Potential customers

- Professional cyclist
- NGOs working towards road safety
- Mountain bikers
- Delivery riders
- Regular bicycle commuters
- Environmental activist
- Corporate (for cycle share programs or cycle to work program)

##### 3.1.2 Customer need

They are looking to make their existing helmets into smart helmets at a reasonable cost. Which also keep them motivated to continue cycling. They can also use this to monitor the amount of workout they have done and track their fitness. This will also make their cycling experience more fun and enjoyable.

#### 3.2 Research strategy

A strategy is required to evaluate the market and look for all the critical information required. This information will help find all the keywords used in the document for research purposes along with find the methods to mine the information required for device and customer requirements. For this report direct and indirect research was conducted.

##### 3.2.1 Direct research

For gathering more related info from the market, we referred to the websites of manufacturing companies that were involved in creating equivalent products. Alongside this, we enquired regarding any such helmets/device from salespeople that hitherto existed in the market. With the aid of this data, we were able to fabricate related questions, which when asked to potential users, provided us with their opinions of the same.

##### 3.2.2 Indirect research

The team carried indirect search to gather additional information regarding the products which already exist in the market. Sources like articles, research papers, magazine reports gave a good insight into how the product is currently thriving in the market along with its pros and cons.

### 3.2.3 Keywords




Smart helmet, smart bike helmet, smart bicycle helmet, internet of things helmet, connected helmets, POC sports helmet, Cosmo ride, helmet rear lights, kids' safe helmet, taillights, helmet indicators.


### 3.3 Market overview

In this section the team has represented the market information.

#### 3.3.1 Products

During the research, the team came across many such bicycle helmet rear light of them the few good products are mentioned below

product	features	Cost (£)	Rating (out of 5)	limitations	Link to purchase
 Serfas Helmet Safety Light	<ul style="list-style-type: none"><li>• 95 hours of battery life</li><li>• Velcro strap attachment</li></ul>	50	4	Only act as safety lights	<a href="https://www.amazon.co.uk/Serfas-Helmet-Mount-Light-3-LED/dp/B00FVT5HSU">https://www.amazon.co.uk/Serfas-Helmet-Mount-Light-3-LED/dp/B00FVT5HSU</a>
 Planet Bike Blinky 3H bike taillight	<ul style="list-style-type: none"><li>• 8.5 hours</li><li>• Mounting attachments</li></ul>	20	4	Battery life and act as safety lights	<a href="https://www.planetbike.com/blink-3h-bike-tail-light/">https://www.planetbike.com/blink-3h-bike-tail-light/</a>
 SIGEM LED Safety Lights	<ul style="list-style-type: none"><li>• 100 hours</li><li>• Clip mounting</li></ul>	12.99 for pack of 3	4.5	Safety lights Less intensity	<a href="https://www.amazon.co.uk/Bonuses-Flashing-Visibility-Running-Jogging/dp/B077XQW1LM">https://www.amazon.co.uk/Bonuses-Flashing-Visibility-Running-Jogging/dp/B077XQW1LM</a>
 COSMO RIDE - CONNECTED LIGHTING	<ul style="list-style-type: none"><li>• 8 hours</li><li>• Waterproof</li><li>• Cosmo app</li><li>• Mounting attachment</li><li>• Red and orange LEDs</li></ul>	64.99	3.5	Remote to indicate turns	<a href="https://www.decathlon.co.uk/p/cosmo-ride-connected-lighting/_/R-p-327543">https://www.decathlon.co.uk/p/cosmo-ride-connected-lighting/_/R-p-327543</a>

	<ul style="list-style-type: none"> <li>• Fall detection</li> </ul>				
Livall BH51M NEO Helmet 	<ul style="list-style-type: none"> <li>• Fall detection</li> <li>• Front light</li> <li>• Walkie-talkie</li> <li>• Livall riding app</li> <li>• Indicator &amp; brake lights</li> </ul>	149.99	4.2	Not work on all helmets	<a href="https://livall.co.uk/product/livall-bh51m/">https://livall.co.uk/product/livall-bh51m/</a>

### 3.3.2 Company

#### Cosmo connected

Cosmo is a French start up from 2015 with the mission to secure all people in mobility. They development of connected objects for the physical safety of motorcyclists and cyclist. They have annual revenues of \$5 million. They sell Smart helmets, smart glasses, smart backpacks for riders.

#### Livall

LIVALL produces outdoor gear/sporting goods such as bling helmet, bling jet, nano cadence sensor and phone holder. The company has its headquarters in Shenzhen, Guangdong Province. Livall have annual revenues estimation of \$8.4 million They company's products range consistent Cycle helmets, hiking helmets, smart accessories.

#### Sigem sports

Sigem sports is a family-owned business. The company is specializing in LED safety lights and other sports products. They are based in United states of America. The company produces Safety led lights.

#### Planet bike

Planet bike was founded in 1996 from Madison, WI. They aim was to build good bike accessories. Planet bikes have annual revenues estimation of \$5 million. They manufacture various types of Bike accessories.

### 3.4 Conclusion

The gathered data from research suggests that this kind of product is moreover utilised by people like professional cyclists, delivery riders, mountain bikers, environmental activists, corporates, etc. All these customers in general, demanded a handful of features and improvisations which were recurrent. These were: longer battery life, automated mechanism involving less user inputs, mood lighting, etc. Some of the devices had external remotes to indicate the turns. Also, the lights would not be visible in unfavourable weather conditions like fog and mist. Some of the products were too large causing extra weight load.

## 4.Customer requirements

### 4.1Customer survey

After knowing the market for the product and understanding the need of the device, the team now designed a questionnaire for the targeted customers and the answer from the customer are recorded and presented in the table below

Sr no	Questions	Answer
1	What weight should it have?	Light weight as possible
2	What size it should be?	As compact as possible
3	Is should be Water resistant?	yes
4	What type of attachment would you prefer for helmet?	Firm and easy
5	How long should a battery last?	At least a week for a full charge
6	Expected product life?	Should be 5 years at least
7	How frequent would you get the Maintenance?	Maintenance free
8	What is you required Communication range?	It should be able to communicate with a phone with few meters
9	Are Back turn indicator required?	yes
10	Should indication be automatic?	yes
11	Are Mood lights required?	yes
12	Any suggestions for UI design (for web)?	as user friendly as possible
13	Does the helmet require Night detection?	yes
14	Do you need any warranty?	5 years
15	Auto braking lights?	yes
16	Reminder for charging?	yes
16	Mood selection?	yes
17	Should product be environmentally friendly	Not important
18	Any extra features	rechargeable
19	Estimated cost?	£100
20	Operating weather?	All weathers (fog, snow, rain)

This questionnaire informed the team about the experiences that customers had with the current products alongside their expectations and budget in general.

### 4.2Wish table

After that the team analysed the requirements of the customer and organized the requirements into wish and demands along with that, they gave priority to the requirement on the scale of 0-10 with 10 as very important and 0 as least important. As shown in the table below

Sr. no.	Customer requirements	Wish/demand	Importance
1	Compact size	demand	10
2	Light weight	demand	10
3	Bright Lights	demand	10
4	Water resistant	demand	9

5	Firm attachment	demand	10
6	Easy to attach	demand	10
7	Long battery life	wish	9
8	connectivity	demand	10
9	Turn indicator	demand	10
10	Brake light	demand	10
11	Mood lights	wish	5
12	Night detection	demand	10
13	Low Maintenance and good product life	wish	7
14	Brake detection	demand	10
15	Turn detection	demand	10
16	Easy to charge	wish	10
17	Good built quality	demand	9
18	Energy efficient	demand	9
19	Match the colour of helmet	Wish	5
20	Cost under 100	demand	10
21	All electronics connected properly	wish	9
22	Fall detection	demand	8

This table will help us in further design phase with the essential requirements and what could be compromised, or what extra features should be incorporate in the device.

#### 4.3Objective tree

In this section we will

In this section we will be reorganizing the requirements under the objectives. This objective will help the design team understand the requirements in a better way. The team broadly categorize the requirements into 4 basic design objectives as follows

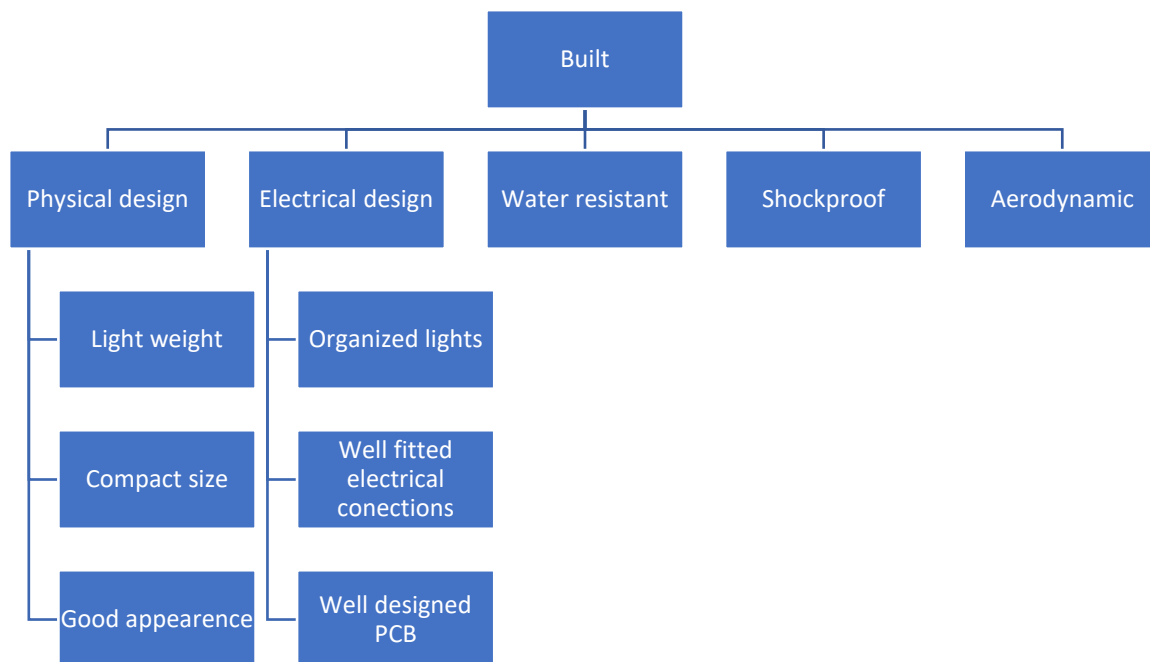
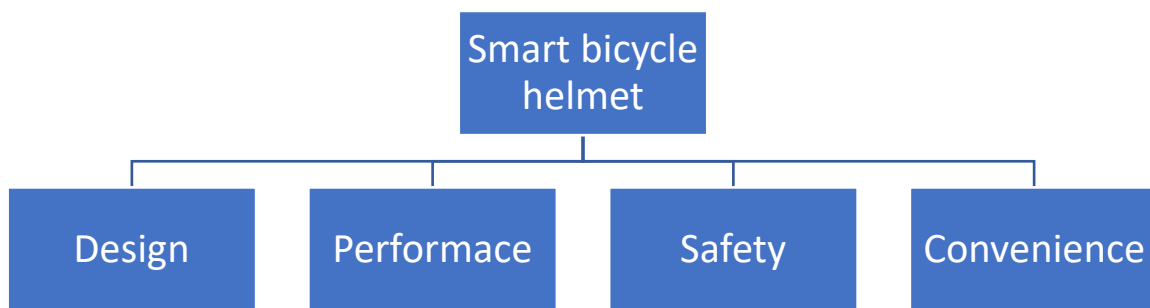
- Performance
- Built
- Convenience
- Safety

In the table below we have categorized all the requirements in the objectives

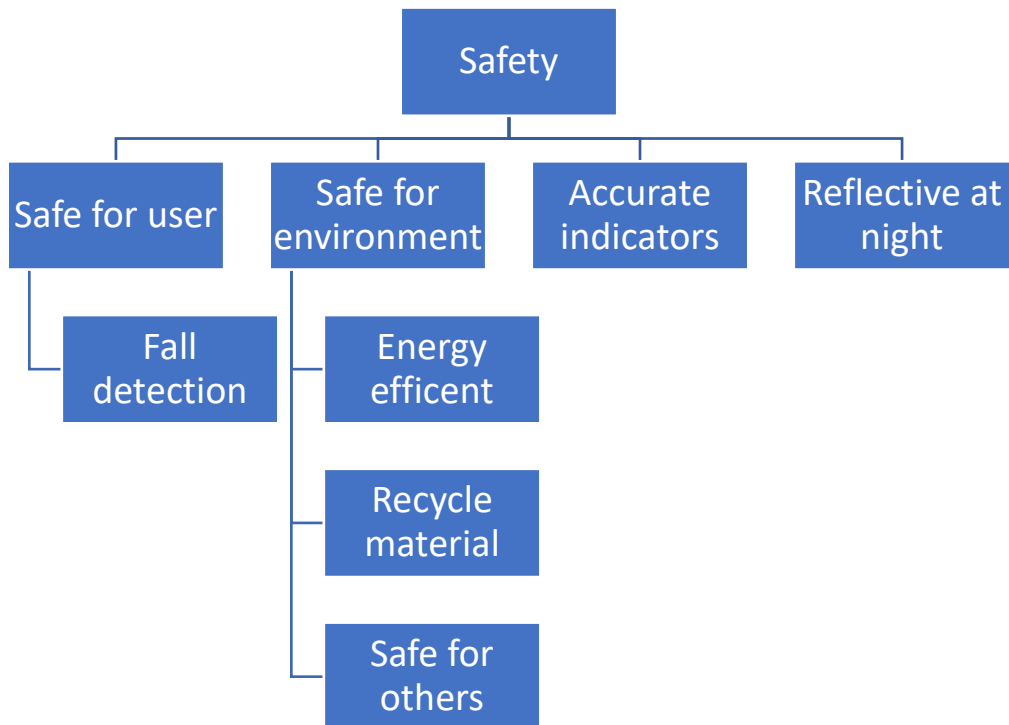
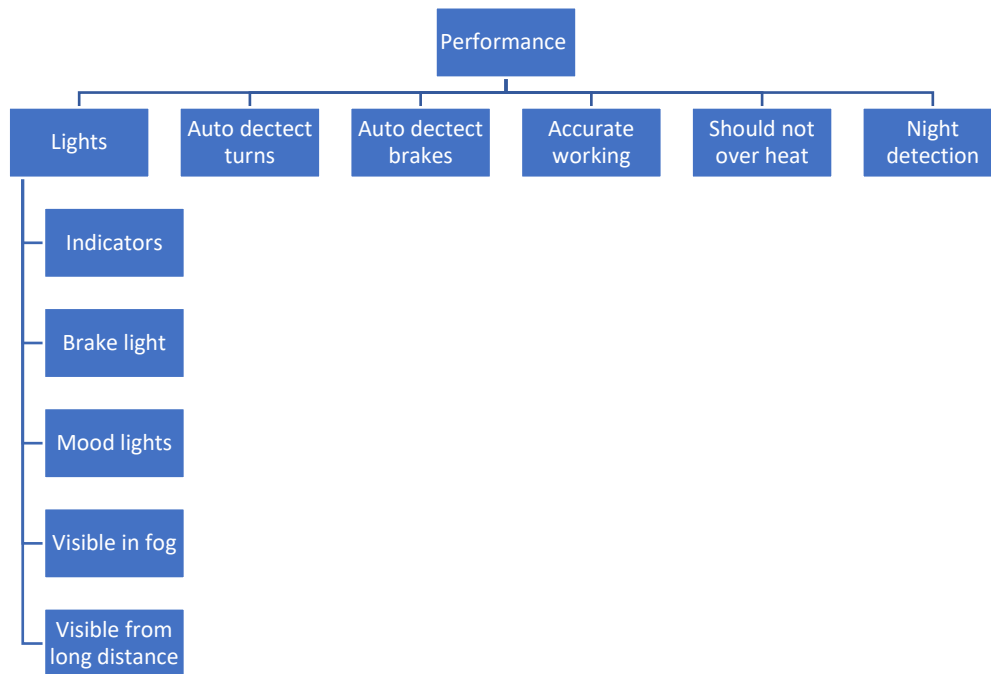
Performance	Built	Convenience	Safety
Light visible from long distance	Compact size	Easy to attach to helmet	Safe for users
Work in bad weathers	Light weight	connectivity	Do not distrust driver
Night detections	Firm attachment to helmet	Long battery life	Safe for environment
Brake lights	Good built	Work with multiple helmets	Safe for other vehicles
Indicator lights	Electronics fitted firmly	Turn detection	Wrong indicator

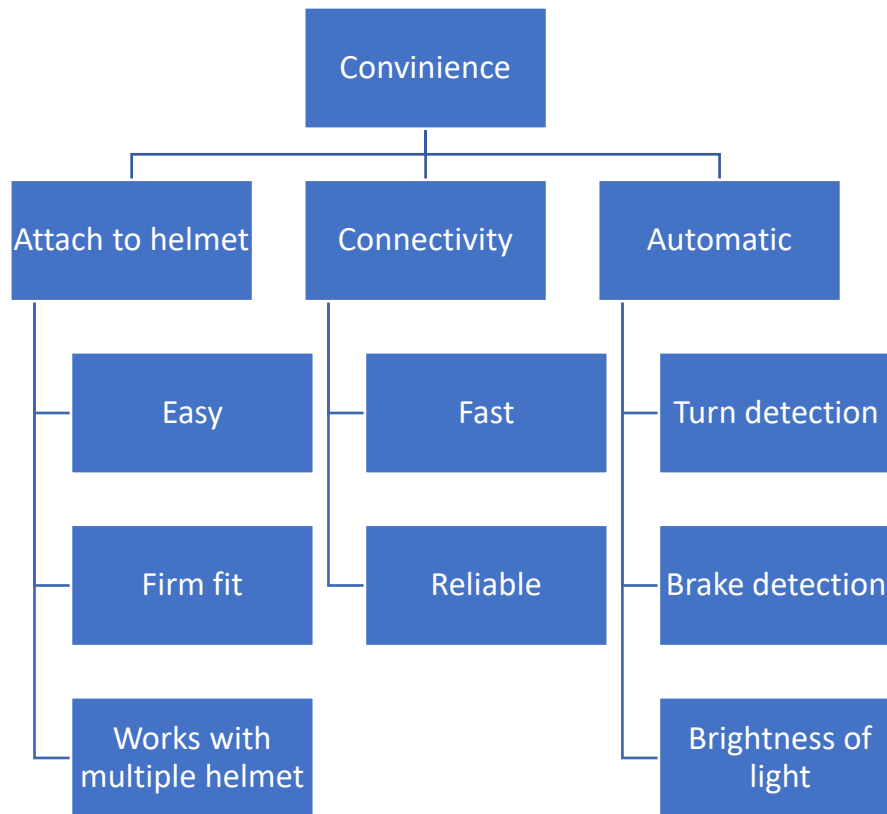
Mood lights	Water resistance	Auto brightness	Reflective at night
Working accurately	strong		Fall detection
Should not overheat			

Now, from the table the team has designed an objective tree from the objective table. In the tree we will reorder the list into set of high and low objectives. The tree shows the objectives in a hierarchical way.









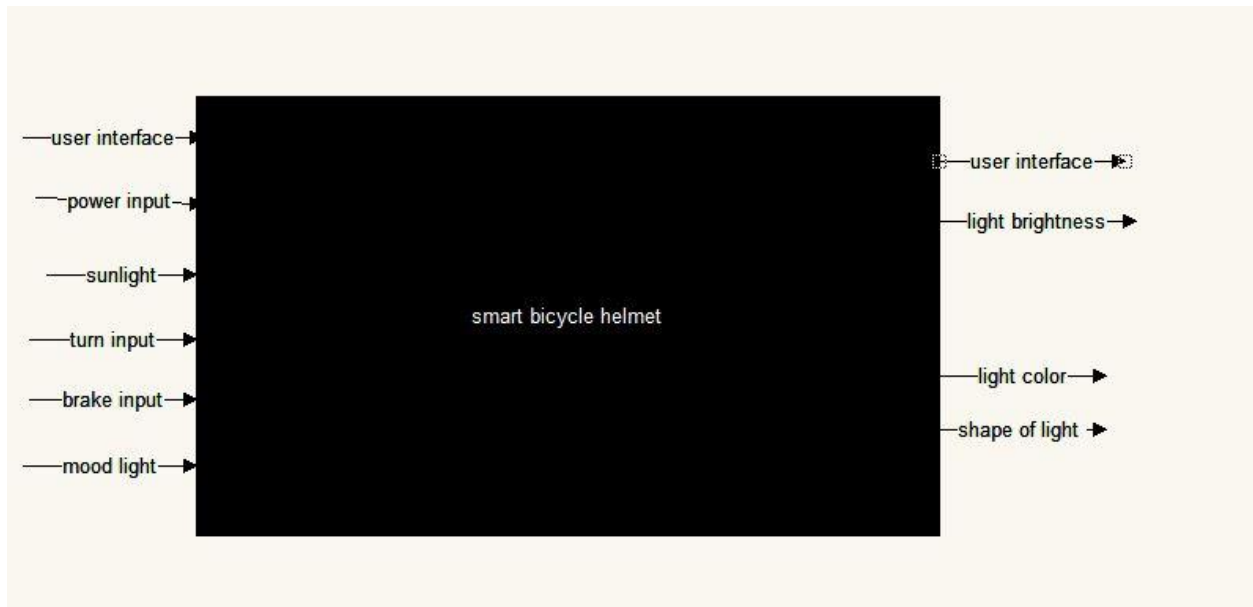
So, in this way team had processed to customer requirements and the agreements between the design team, this had made easy to review the requirements for the design team in the later stages.

## 5.Function

Here, the team will showcase the functions of the device in the relation with the inputs and the outputs. In a generalized way functions are solution-neutral and just describes what product should be doing. This step is broken down in 2 steps for convenience.

- Black box
- White box

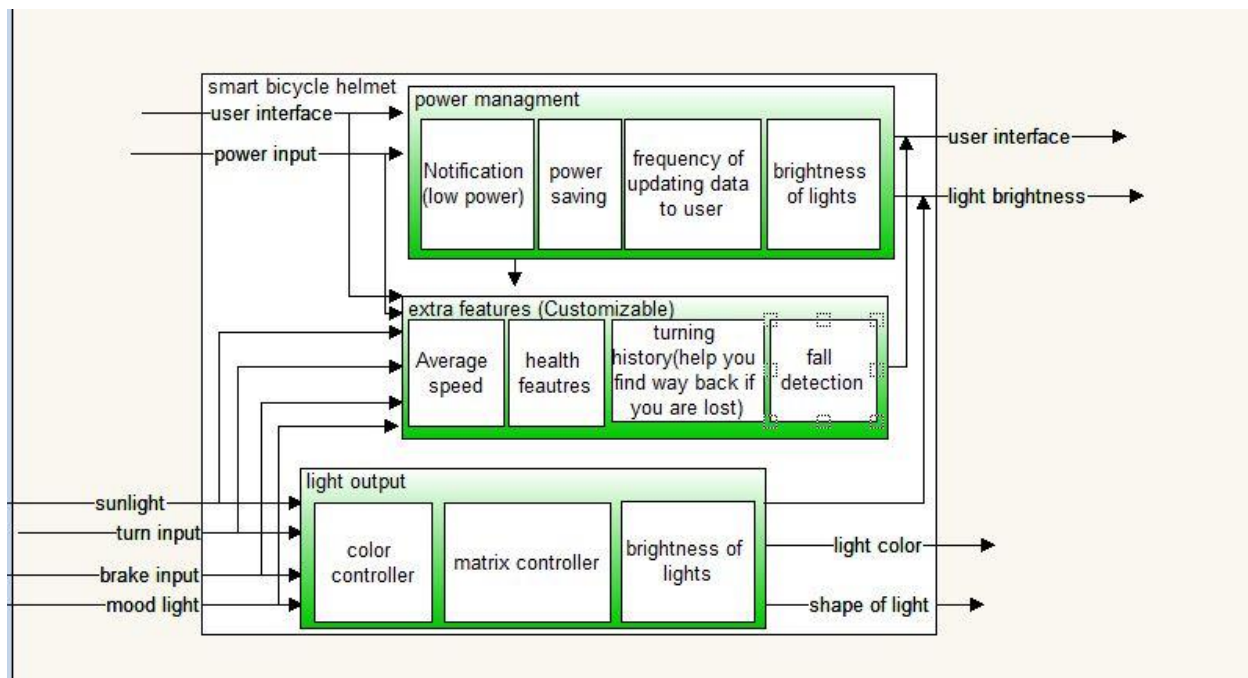
In the first step the team will show the device as a black box with all inputs being converted to desired outputs as shown in the image below.



In next step the team will break the main function into subfunctions. The team had 3 main sub functions

- Power management in this subfunction all the power related tasks will be performed. This will have inputs from users and power source and will correspond the output to user. It will also determine the brightness of the lights.
- Extra feature in this sub function we will have all the extra features that would be expected by the user (smart connected device) and will have corresponding output.in this we will have all the inputs which can provide more features and will have the output to the user as they expect.
- Lights output in this subfunction is responsible for the management of the lights. The output of the lights will be determined by the sunlight, turn input, brake input and mood lights.

The final design of the white box with all the detail is shown in the image bellow.



## 6.Customer specifications

The individual customers requirements will be converted into the engineering specifications, that emphases on the metric and the values. The required and the archivable targets are going to be set in this section, according to the customers' needs to attain a successful design. The specifications table is listed below.

Metric	Value
size	<100×70×30mm
weight	<1 kilogram
Lights	Multicolor and <1000mAh
battery	>2000mAh
connectivity	2–5-meter range
Turn indicator	Blinking every 1 sec
Mood lights	Multi color lights (RGB values)
Light sensor	2-100%
Maintenance	none
Brake detection	Look for decrease in speed
Turn detection	15° or more
Easy to charge	20W charger
Cost	<£100
Light brightness control	30-100%
connectivity	Cellular 5G, Bluetooth 5.0, Wi-Fi 6.0
Water resistance	All electronics
Number of parts	<30
Product life	>50
Electronics enclosed	>90%

Number of mood lights	>2
Number of product color	>6
Connection to helmet	Adhesive, 2-way tape, Velcro, custom parts
Energy efficiency	>80%
material	Waterproof, reflective at back

## 7.Conclusion

The need statement clarifies it properly that a mountable device is to be designed for helmets which would overcome the current limitations alongside providing user friendly features. A thorough market research provided with the customer opinions/demands and helped identify the priorities before the designing process starts. Simplifying the goals and deciding the functions in a structured manner turned it into a clear plan with specific details of what is going to be done by the device.

Other similar devices turned out to have had certain shortcomings like short battery life, requirement of external remote, lack of indicating LEDs, large size, etc. All this is to be worked upon while designing the product to make it much easier to use whilst also providing automated facilities. The objective tree is the systematic representation of all this. It all conveys that the product will enter a less occupied aspect of the market, leading to healthy sales and revenue. Hence, all this delivers a clear picture of the kind of device to be innovated alongside the features, scope, and budget of it all.