Cycling Safety and Protection focusing to prevent serious injury

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DESP3045 Personal Project Viability Report

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Executive Summary

The following report contains research around cycling accidents, existing products and current cycling accessory market. Which concludes that there is a big potential for cycling product in the future as the market is expected to grow exponentially and the main reason that cycling accidents occur is them not being seen.

1. Introduction

This report will highlight safety concerns for pedal cyclists, by looking into common attributes connected with KSI (killed or seriously injured) cycling collisions and existing products will allow for a greater insight to be gained into the dangers posed to cyclists. Gaining these insights will allow for a deeper focus into potential product areas and highlight any gaps in the market for innovation.

By designing a product that highlights a contributing factor and focuses on supressing the likeliness of these events occurring, could make cycling safer and give riders more confidence on the road. The potential for the product could be expanded with a modular interface, allowing for upgrades and changes in the future.

2. Opportunities for Innovation

- The market for cyclist accessories is growing, predicted to 'grow at a CAGR of roughly 8.2% over the next five years" (Absolute Reports, 2020).

- Look but failed to see (LBFTS) accidents are the highest contributing factor related to cycling accidents. "37% of all accidents involving a pedal cyclist in 2015 were a result of look but failed to see accidents" (Department for Transport, 2015).

- Cycling are often not seen as they are small. All road users pose a danger especially HGVs, who are less likely to be involved in an accident with a cyclist but more likely to be involved in a fatality. "In 2016, only 1.5% of cyclist collisions involved an HGV" (ROSPA, 2018) However, "HGVs were involved in 16% of cyclist fatalities" (ROSPA, 2018).

2.1 Basis of Innovation Opportunities

It is clear that the market is growing for cycling accessories (see section 4.42) and there is a big potential for cycling accessories. Cycling accidents have many contributing factors, but failed to look, more commonly known as look but failed to see accidents are the highest. Cyclists not being seen puts them in danger, especially when involved in an accident with an HGV as they're the deadliest vehicle for a cyclist to collide with.

3. Chosen Product Type and the nature of Innovation Opportunity

Both of the following types of project / innovation have merits, and both can achieve high grades. For the purposes of this project, 'product innovation' can objectively be described as one of two scenarios. Discuss whether your product innovation with either be:

a) The product(s) will use existing technologies but applied in a different way. This will continue the evolution of cycling accessories. The product will help ease the dangers posed to cyclists on a daily basis.

b) The product(s) use existing technologies and be part of a growing market for cycling accessories. The concepts will be developed focusing on supressing dangers to a cyclist.

4. Research

4.1 Understanding statistics behind cycling accidents

4.11 Times of accidents.

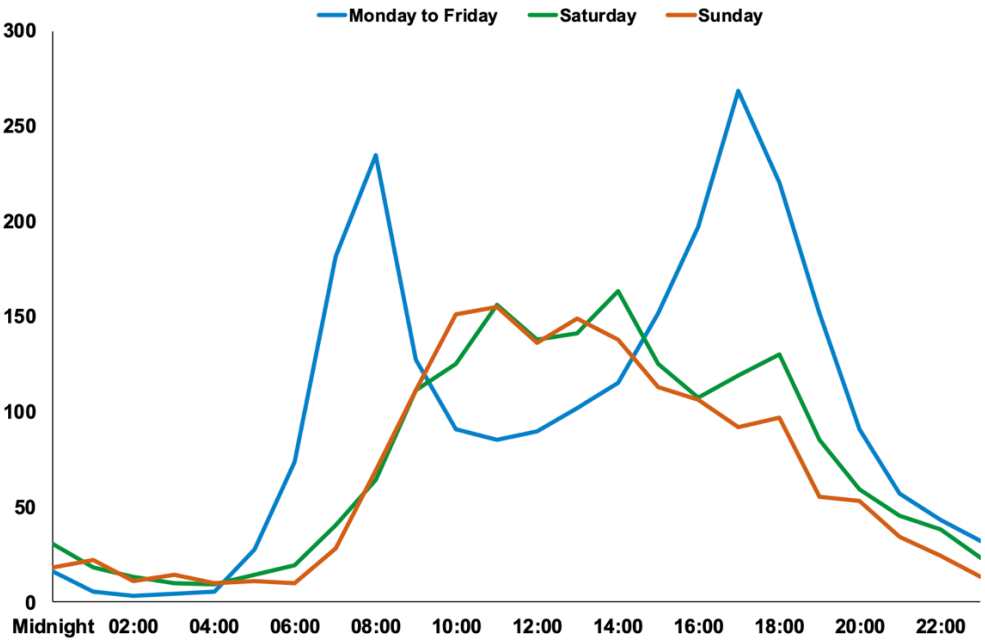

Figure 1 (Department for Transport, 2015)

The majority of pedal cyclist KSI (killed or seriously injured) casualties occur, Monday to Friday, the two peak traffic times, 7am to 9am and 3pm to 7pm as shown in figure 1 (Department for Transport, 2015). These busy periods account for 78 percent of KSI casualties and 34 percent of the total pedal cyclist incidents recorded in 2015 (Department for Transport, 2015).

Peak times are especially dangerous for cyclists as this is the period where everyone is either in a hurry or anxious about getting to work and not being late. This can cause road users to not pay proper attention to driving, opening up the opportunity for a failed to look properly incident.

4.12 Contributing factors for cyclist accidents

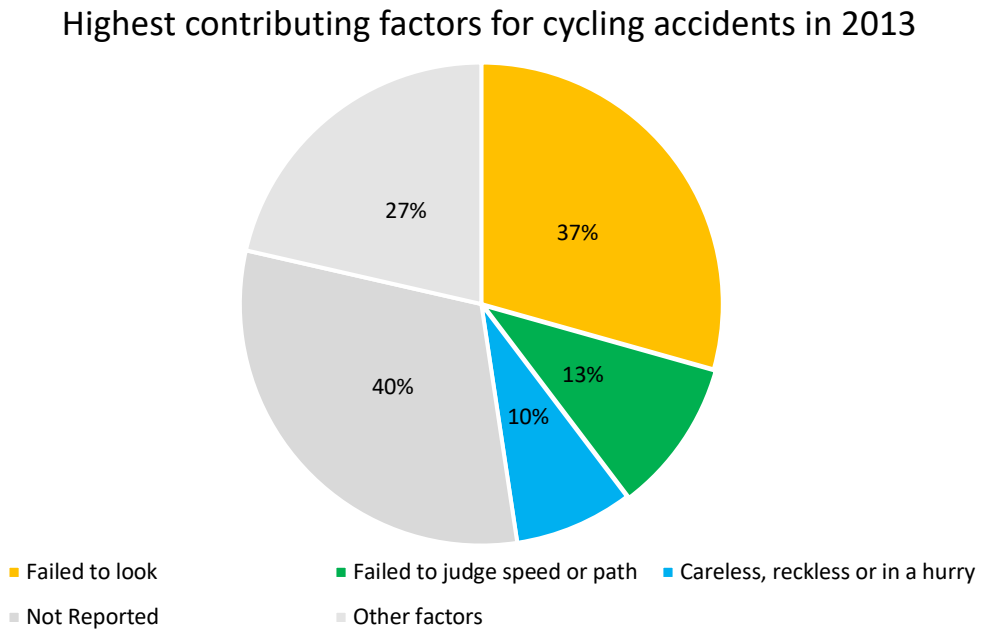

Figure 2 (Source: Personal Collection)

The highest contributing factor for cycling accidents in 2013 was failed to look accidents which made up 37% (Department for Transport, 2015) of all accidents involving a pedal cyclist. The next highest contributing was failed to judge speed or path accidents which contributed to 13% of accidents involving a pedal cyclist (Department for Transport, 2015). In these types of accidents, the pedal cyclists intensions/signalling was incorrectly judged which resulted in an accident. The third highest was contributing factor was careless, reckless or rod users in a hurry which contributed to 10% of all accidents involving a pedal cyclist (Department for Transport, 2015).

Failed to look accidents are also referred as 'looked but failed to see' accidents in road safety literature. Look but failed to see (LBFTS) accidents are more common during the day (Department for Transport, 1999) this is due to an increased road use, and that cyclists tend to cycle during the day. These types of accidents are caused by drivers looking but failing to see the cyclist.

4.13 Pedal cycling accidents – scenarios

The common cycling accidents, in terms of scenarios are the following:

- “Motorist emerging into path of cyclist” (ROSPA, 2017)
- “Motorist turning across path of cyclist” (ROSPA, 2017)
- “Cyclist riding into the path of a motor vehicle, often riding off a pavement” (ROSPA, 2017)
- “Cyclist and motorist going straight ahead” (ROSPA, 2017)
- “Cyclist turning right from a major road and from a minor road” (ROSPA, 2017)
- “Child cyclist playing or riding too fast” (ROSPA, 2017)

In these common cycling accident scenarios, the most common scenario was a cyclist entering the road from the pavement (ROSPA, 2017), including when a cyclist crosses the road using a pedestrian crossing (ROSPA, 2017). This type of accident was recorded to be the scenario for 20% of serious collisions (ROSPA, 2017) and over 30% of serious collisions involving a child cyclist (ROSPA, 2017).

4.14 Vehicle involved in collisions.

The most common type of vehicle involved in a road collision with a cyclist is a car or taxi (ROSPA, 2018). The rider is usually hit from behind by the front of the vehicle. In a 25% of fatal cyclist collisions, the rider is hit from behind by the front of a vehicle.

Heavy good vehicles pose a big danger to cyclists. In 2016, only 1.5% of cycling collisions involved an HGV (ROSPA, 2018). However, HGVs were involved in 16% of cycling fatalities (ROSPA, 2018) in the same year. The majority of these collisions occurred within a city, even though 75% of HGV milage is on non-built-up roads (ROSPA, 2018). From the years 2015-2018 HGVs were involved in around 70% of cyclist fatalities (ROSPA, 2018),despite only 4% of HGV road milage was driven in London (ROSPA, 2018).

There are three main types of scenario collisions:

- HGV Turning left across path of cyclist
- HGV and cyclist turning left
- HGV overtaking cyclist

HGVs are dangerous to cyclists due to their size. In almost all accidents involving an HGV the cyclist wasn’t seen. This is due to the fact that cyclist is small and visibility for HGV drivers is poor, especially in a busy city. HGVs don’t see the cyclist’s signals or misread their intensions, resulting in a collision.

4.15 Pedal cyclist injury

Pedal cyclist injury patterns:

- Limb injuries
- Chest/Abdomen injuries
- Head injuries
- Collar Bone injuries

Limb injuries are the most common injury of cycling accidents with over 40% suffering arm injuries (ROSPA, 2017) and around 25% suffering leg injuries (ROSPA, 2017).

Chest/abdomen injuries are less frequent at 5% (ROSPA, 2017), but when they happen, they are often serious and they are often paired with head injuries (ROSPA, 2017).

Head injuries, ranging from fatal skull fractures and brain damage to minor concussions and cuts, are common during a cycling accident (ROSPA, 2017). With hospital data showing that over 40% of cyclists, and 45% of child cyclists (ROSPA, 2017) suffering head injuries.

A study found that out of 116 fatal cycling accidents in London and rural areas, 70% of cyclist fatalities in London had moderate or serious head injuries (ROSPA, 2017). And 80% of cyclist fatalities in rural areas died as a result of a head injury (ROSPA, 2017).

A common injury for cyclists is collar bone injuries. This injury occurs when a cyclist falls and outstretches their arm or hand (Mayo Clinic, 2020). It can also occur if they fall on their shoulder (Mayo Clinic, 2020). There is no protection which an prevent a collar bone injury as there's no possibility of it. One big way to prevent collar bone injuries is to learn not to outstretch the arm when an incident occurs.

4.16 Dangerous road junctions.

Road junctions are the most dangerous road space for cyclist due to a fact that they require road users to communicate their intensions. Junctions are hazardous for cyclists as the small size of the bicycle fools' drivers into believing its further away than it actually is (CYCLE LAW Scotland, 2020). Other road users often look but do not see cyclists (CYCLE LAW Scotland, 2020). The most dangerous type of junctions for cyclists are crossroads and t-staggered junctions. In 2013, 50% of cycling KSIs occurred at these junctions (Department for Transport, 2015).

The most dangerous type of junction for road cyclists are t-staggered junctions, shown in figure 3. From 2011 to 2016, 168 fatalities and 47,785 casualties happened at a t-staggered junction (Department for Transport, 2018), accounting for 41% of all accidents within that time period (Department for Transport, 2018). A staggered junction is where a minor road meets a major road, but unlike a crossroads the other minor junction meets the major road offset.

T-staggered junctions

Figure 3 (Department for Transport, 2018)

Crossroads

Figure 4 (Department for Transport, 2018)

Crossroads, shown in figure 4 are the second most dangerous type of junction for cyclists as motorists often mistake or misread their intensions (Department for Transport, 2015). From 2011 to 2016, 12,555 casualties and 53 fatalities occurred at a crossroads (Department for Transport, 2018).

A risk from crossroads is the potential for fast turning vehicles to cut across cyclists when motorists take an exit quickly (Transport for London, 2016). When this happens, the cyclist is rarely seen. A proven way of reducing these accidents is to reduce the radius of the corner. A corner with a large radius, of 7 metres is far more likely to cause a road accident involving a road cyclist than a corner with a 1 metre radius. The corner radii should be reduced where possible to benefit vulnerable road users (Transport for London, 2016).

When designing a junction, the users' needs are taken into account. As junctions are dangerous for cyclists, their safety is the highest priority (Transport for London, 2016). There are a number of cycle-friendly interventions (Transport for London, 2016) which have been introduced which help cyclists at junctions. One example is exerting more control over different road users' movements (Transport for London, 2016). This is done by combining various smaller techniques which are the following; separate signal control for cyclists (separation in time) (Transport for London, 2016), protection for cyclists from turning movements (separation in space) (Transport for London, 2016), conversion to cycle-friendly roundabouts (Transport for London, 2016), ban selected movements for motorised vehicles

(Transport for London, 2016), conversion of priority to signal-controlled junctions (Transport for London, 2016). A combination of all of these elements allows the junction to be safe for cyclists, thus reducing the number of incidents.

4.2 Users

4.21 Users

The potential users for this product are cyclists and cycling enthusiasts. In the past 4 years, the number of cyclists has rose from around 5 million to around 7.5million (Lange, 2020) either for sport, leisure or travel. Cycling is undertaken by people in multiple social economic groups, as the price of bicycles range vastly. This makes for a large quantity of potential users.

4.22 User Interaction & Requirements

Cycling is taken up by users as a means of transportation. It is also used as a means of sport or leisure as it has great health benefits. As health there are great health benefits, cycling is a popular sport and a growing industry.

The users require the product to not hinder their comfort or ability to ride. The user needs weight to be kept to a minimum in order for them to go as fast as possible. Hardcore cyclists wear tight clothing, so it gives them the best aerodynamics and allows them to travel as quickly and efficiently as possible.

Cyclists use bike tracking apps like Mapmyride and Strava to track their journey. These apps help cyclists to analyse their journey and provide statistics, like average speed and journey length to help improve their next ride.

The interaction with cycling-oriented apps and accessories allow riders to be more efficient in the way they ride and allow them to improve overtime.

4.3 Product Analysis

4.31 Introduction to existing product provisions

Cycling accessories is a large product area with many possibilities. But cohering to the report title, the following product provisions will be products aimed at preventing an accident or preventing injury.

4.32 Product Type 1 – Bike light analysis

- **4.321 Normal bike light**

The first type of light is a normal, front and back light. This is a standard product to buy when purchasing a bike as it's a legal requirement to have a front and back light in the dark, under the Road Vehicles Lighting Regulations 1989 (Department for Transport, 2010).

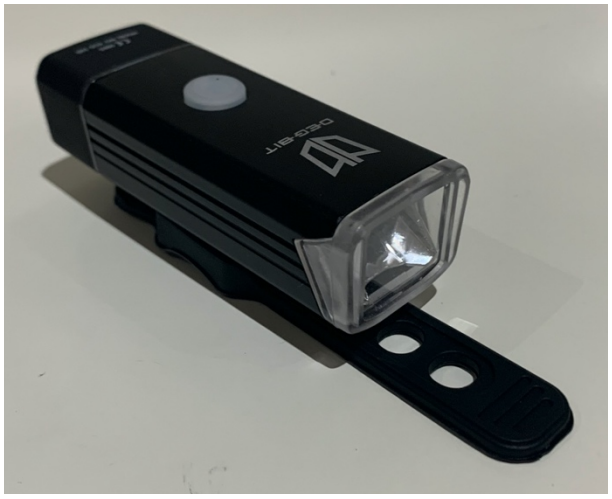

Figure 5 (Source: Personal Collection)

The light analysed above (figure 5) was bought on Amazon for £10. It has 4 different modes: steady bright beam, steady low beam bright quick flash and bright slow flash. The main body is metal, most likely aluminium as its quite light. The plastic components are made out of a low-density polyethylene as marked on the inside.

The manufacture of the metal casing is done in a few steps. Metal is extruded then cut to form the body. The other components are injection moulded as proven by various ejector pins marks.

The product is powered by an internal battery which is charged via the USB connection at the rear (see figure 6). This is an effective means of charging, but there's a risk of the connector breaking off.

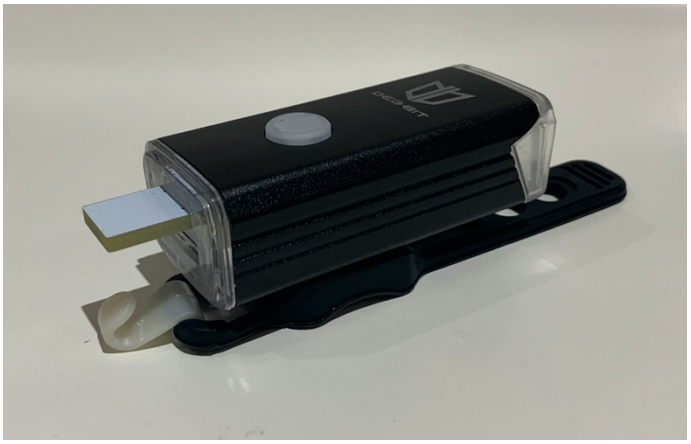

Figure 6 (Source: Personal Collection)

The product disassembles by prying the front plastic, which holds LED, outwards. This requires some force, eventually coming out. The reason this is hard to open is due to its water resistance, but no IP rating is given or advertised. Once the front is out, the circuit board and the battery slide out by pushing on the back USB connector.

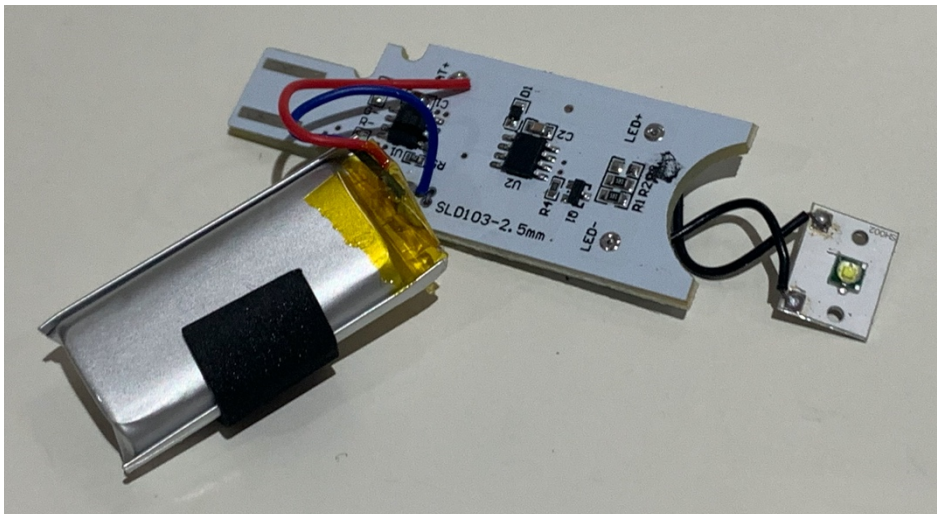

Figure 7 (Source: Personal Collection)

The figure 7 above shows the PCB, battery and LED which are the internal components and make the light functional. These components aren't able to be upgraded due to the product having no modularity.

Figure 8 (Source: Personal Collection)

Figure 9 (Source: Personal Collection)

The packaging of the product was purposeful, with a plastic shroud protecting the light from and drops or damage during shipping. The packaging has the correct details about the product on it. Stating the right model number and brand etc (seen in figure 8). The aesthetics of the packaging makes the product look bad, with the graphics used and the colour scheme (seen in figure 9) making the product look less appealing.

But the packaging feels cheap, with little consideration for the environment. As seen from figure 10 below there's a substantial amount of plastic used for the packaging, even though this can be recycled. Using a more environmentally friend recourse like paper or cardboard would add to the product's sustainability.

Figure 10 (Source: Personal Collection)

- **4.322 Bike light indicator**

Figure 11 (Blinkers by Velohub, 2020)

Another bike light product area is bike indicators, these allow cyclists to show their intentions and movements to other road users, making their cycling experience better and safer. The specific product above (figure 11) is priced at £152 and sold at the online retailer Amazon (Blinkers by Velohub, 2020). This type of light is to try and make the cyclists intensions clearer.

- **4.323 Smart bike lights**

Figure 11 (KAROBUYSHOP, 2020)

The smart bike light above (figure 12) draws out a safe area which shows other road users a safe distance to overtake. It uses two laser lines to draw out this area. This product also enables the cyclist to create a larger road presence, and thus deterring other road users from overtaking too close.

4.33 Product Type 2 – Cycling armour analysis

Figure 12 (Troy Lee Designs, 2020)

Another product type is mountain bike body armour, shown in figure 12. Armour isn't normally used by road cyclists. However, it can be vital for saving someone's life should an incident occur. Pricing for cyclist armour can range from £20-£200+ depending on the manufacturer and the protection level. The cheaper armour is normally the least protective with the more expensive armour providing the most protection.

4.34 Product Type 3 – Smart cycling helmet

Figure 12 (Livall, 2020)

This smart cycling helmet is different from a normal cycling helmet. This smart cycling helmet has 3 light strips which act as a brake light, left turn signal and right urn signal. The turn signals allow the cyclist to indicate and communicate to other road users about his intensions.

4.35 Comparison and Conclusions

The bike light indicator and the smart cycling helmet both do the same function of communicating the cyclist's intensions to other road users. But the indicator which attaches to the bike is more effective than the bike helmet indicator. The main reason for this is that there's no possibility of the function being affected by the movements, as when a cyclist turns their head, it could hide the side indicating. The bike indicators compared to the smart bike lights are more likely to be used, as people might be embarrassed to use the smart bike lights, due to the quirkiness of it. The cycling armour helps protect the user from injury if a fall occurs, like the cycling helmet which aims to protect a cyclist's head in the event of a collision or fall. Helmets are more popular amongst cyclists are there a bigger expectation for them to be warn. To conclude, a bike light is more effective if it is attached to the bike rather than the user, as it is free from its function being blocked by and movements.

4.4 Market Opportunities

4.41 Consumers

The consumer for this product is cyclists and cycling enthusiasts. In the United Kingdom, men are still the most popular gender to cycle. With four out of ten adult men cycling at just over 40% (Mintel Press Team, 2015), compared to 31% of adult female cyclists (Mintel Press Team, 2015). One in twenty people cycle every day (Mintel Press Team, 2015), a fifth mainly cycle on the weekend (Mintel Press Team, 2015) and 13% cycle to their place of work (Mintel Press Team, 2015).

The product area doesn't need to have an oriented gender, but the product could be styled to a more masculine design, as the majority of cyclists are men.

4.42 Market progression and forecasts

The worldwide market for bicycle lights is projected to grow at a CAGR of roughly 8.3% over the next five years (Absolute Reports, 2020) and will reach 400 million USD in 2024, rising from 250 million in 2019 (Absolute Reports, 2020). A different report states that the market would grow by 132.27mn units over the next 4 years which is a progression of CAGR of 8% (Anon., 2020)

In the past several years the global market for bicycle lights has developed as the laws surrounding bike lights have. It was reported that in 2016 the actual global sales for bicycle lights were around 15 million units (Absolute Reports, 2020).

The global average price of bike lights is increasing. The average unit price increases from 14.2 USD in 2012 to 15.23 USD in 2016. The prices of this product category will increase over the years, following the same pattern as the previous years.

Europe is the largest consumer region of bicycle lights, equating for 36.34% of all sales in 2016 (Absolute Reports, 2020). North America is the second largest consumer region of bicycle lights, equating around 28.08% of all sales in 2016 (Absolute Reports, 2020).

The scopes of these reports covered the top key players of the bicycle light market, which are the following:

- Augusta Benelux BVÂ
- CATEYE Co LtdÂ
- Garmin Ltd
- Giant Manufacturing Co Ltd
- Lezyne USA Inc
- Mujo International Ltd
- NiteRider Technical Lightning Systems
- Serfas
- TOPEAK Inc
- Trek Bicycle Corp

The companies above are all direct competitors of one another and will subsequently be a direct competitor of this product. The top 5 companies account for around 30% of the market share, making the market concentration not high (Absolute Reports, 2020). There are thousands of smaller companies who contribute to the market. But these smaller companies all have small shipments (Absolute Reports, 2020).

4.44 Advertising and Selling

Bike accessories are advertised mainly through the internet. Products are targeted at potential users through social media like Facebook and Instagram. Products are also advertised through videos posted to social media which ‘influencers’ are paid to promote and draw traffic to the product page.

Bike accessories in the United Kingdom are mainly sold at online retailers like Amazon. There are also quite a few physical retailers which are popular, some being Halfords and Evans cycles. Throughout the United Kingdom there are also a lot of smaller, individually ran businesses. Amazon is the main retailer who have a large variation in the type of products, whereas Halfords and other concentrated bike stores are focused on the essential items and the ones typically included or discounted when purchasing a bike. Cycling is no longer considered a cheap means of transport, cycling is now regarded as a lifestyle accessory (Mintel Press Team, 2015).

4.5 Technology

4.51 LED Technology

LED technology is constantly being improved and upgraded. Smaller lights are becoming brighter and the tech has advanced from year ago. LED's are the best option for bike lights as they draw relatively low power and are really bright.

A bike light must conform to BS 61023 and marked accordingly (Department for Transport, 2010) if the light emits a steady light. For any flashing modes, the flash rate must be between 60 and 240 equal flashes per minute (Department for Transport, 2010).

4.52 Cycling armour technology

Cycling armour often uses tough impact resistant plastics like ABS and polycarbonates.

4.53 Battery types

Battery technology is changing rapidly. The top types of batteries for use in small electronics are the following:

- Li-ion
- Li-polymer

Lithium-ion offers the highest capacity for the lowest cost, but they have a gradual self-discharge when not in use (Triggs, 2020). Lithium-ion batteries have a small potential for a safety issue (Triggs, 2020), with cases of some batteries exploding. Lithium-polymer batteries are safer in comparison and have a very low self-discharge level (Triggs, 2020). However, they come at a higher price and a shorter life span. For this product, Lithium-ion batteries are a batter choice as they offer a lot of capacity for a small.

4.6 Sustainability & Ethics

4.61 Manufacturing

For this type of product, injection moulding is the main option when it comes to manufacture. The manufacture needs to be efficient (UNDP, 2020) to stay in line with the UNDP sustainability goals. Making injection moulding more efficient and more sustainable can be done in a number of ways. One way is to recycle the waste material produced during the injection moulding process (Cockram, 2016). Another way is to consider how the raw materials are being transported and delivered to the factory, as well as the packaging it comes in (Cockram, 2016).

Truly sustainable plastic injection moulding process can be achieved by using new machinery designed to be as efficient as possible, reducing the amount of waste produced during production (Cockram, 2016). Being conscious of the transport and packaging of the product after production also impacts sustainability of the product

4.62 Materials

This type of product is most likely going to be injection moulded and mad out of plastic. A number of materials were looked at for the materials to manufacture the product. This included the following: Starch-based thermoplastics, Polylactide, Polypropylene and Polyurethane.

Starch-based thermoplastics has the least embedded energy as a result of production and has the lowest CO2 footprint as a result of recycling. But it can produce worse moulded results (Tábi & Kovács, 2007) when its recycled and remolded.

Polylactide has a larger CO2 footprint as a result of being recycled and has more embedded energy as a result of production than starch-based thermoplastics. But polylactides have a higher. Polylactide is also highly biodegradable.

Polypropylene has a slightly higher CO2 footprint as a result of being recycled and slightly more embedded energy than polylactides. But polypropylene has a much lower biodegradability, making it much more suitable for long life span products. As a result, polypropylene is a more suitable for this type of product.

4.63 Design for Disassembly & Recycling

Designing for disassembly and recycling will allow the product to be more sustainable. For the product to recycled and disassembled efficiently, there are a few features which can't be integrated into the product's design. The first being snap hooks, these make the product hard to disassemble. The next is over-moldings, over-moulding make it hard for the product to be stripped back to its' base materials. The product can't have any adhesive glues holding components together, as this is hard to remove to allow components to be recycled. The disassembly needs to be easy, so as little energy is put into the process of disassembly and recycling, giving the product a smaller carbon footprint.

4.64 Ethics of Materials and Manufacturing

When it comes to sourcing the materials, time is saved if the supplier is in the same country, state or county as the factory (Gravalot, 2020). Sourcing materials locally allows the production process to sustainable as the environmental impact is far lessened by any transport of the raw materials. But this comes at the addition of a higher cost, as workers in East and South-East Asia have a much lower hourly rate than those in the US or western Europe (Gravalot, 2020). Where the product is manufactured also impacts the sustainability of the product. Local versus international production is something to consider. If the product is produced locally then the cost of production is higher, making the product retail price higher. But the environmental impact is lessened as no overseas shipping isn't needed. Whereas manufacturing internationally is cheaper and enables a much higher volume of output (Gravalot, 2020). But can produce lower quality results (Gravalot, 2020) and is susceptible to global disasters, like COVID-19 (Gravalot, 2020).

4.65 Life Cycle and End of Life

The end of life for the product needs to be aimed at sustainability. Ensuring the product can be recycled easily and all the features can be taken apart will ensure the best end of life. The best end of life scenario for this product would be for it to disassembled with ease. The product must comply with ISO 15270:2008 standards for recycling and recovery of plastic.

5. Overall Analysis & Conclusion

The comprehensive research identified that failed to look, more common referred to as look but failed to see accidents, are the highest contributing factor in different scenarios as to why cycling accidents occur. The potential for cyclists not being seen by other road users is the biggest danger cyclists face. A cyclist is involved in a collision with a car more often, but collisions with HGVs are more deadly due to their size. Analysing existing products showed that they aren't designed with a great deal of end of life in mind, using permanent fittings like snap hooks to hold certain parts together. The market research showed that the market for cycling accessories is growing with a significant growth predicted over the coming years.

6. Design Brief

The overall aim for this project is to prevent/worsen cycling accidents. The brief is to design and develop an improved product which will make the cyclist more visible, to try and counteract look but failed to see accidents. The product must not inhibit the use of the bicycle or user and must not make the action of cycling more difficult. This product must always be functional while in use, not being able to be blocked or hidden. The product must not be excessive in size or weight, fitting into the cycling lifestyle

7. Product Design Specification

7. 1 Introduction

This section is a detailed design specification for the product proposal. The BS 7373-2:2001 specification guide was used to identify criteria for a product specification. The standards for this documentation will be reflected in the upcoming specification.

7.2 Functional Requirements

7.21 Basics

7.211 Motion
The product(s) must be about to be attached to a bike or bicycle user without being detached or loosened by intense motion or movements.
The product(s) must attach without inhibiting the user's movements or the bicycles efficiency.
The product(s) must improve the user's visibility without being affected by motion or movements.

7.212 Forces
The product(s) must withstand bending forces inadvertently applied by the user during use.

7.213 Loading
The product(s) must be able to withstand normal load from the user during use.

7.214 Storage
The product(s) may be stored in a damp or wet environment. The product(s) must be about to be stored for over the winter period without the need for service or repair.

7.22 Use/modes of operation

7.221 Intended use
The product(s) must protect/prevent a cyclist involved in a collision.
The product(s) must include an instruction manual providing information about different modes of operation.
The product(s) must be used on a bicycle or by a bicycle user.

7.222 Modes of operation
Any steady light modes should comply with BS 61023.
Flashing mode.

7.223 Misuse
The product(s) shouldn't be misused, as it may cause damage.

7.225 Storage and distribution
See subheading 7.214 Storage

7.226 Transportation
The product(s) should be efficiently in order to make the transport as efficient as possible, taking up the smallest space during transport.
The product(s) must be transported without being damaged.

7.23 Environmental Conditions

7.231 Temperature.
The product(s) must be fully operational between the temperature of -20˚C to 50 ˚C to allow for full use of weather conditions.

7.232 Humidity
The product(s) must be functional through a various range of humidity levels. As humidity changes based on season and geographical location.

7.233 Moisture
The product(s) must be water resistant in line with a IP65 water resistance rating.

7.234 Dust and Dirt
The product(s) must be dust resistant in line with a IP65 rating.

7.235 Shock
The product(s) should be shock resistant in the event of a cyclist incident.

7.3 Performance criteria

7.31 Operational performance

7.311 Quality/tolerances
The product(s) must be manufactured to the highest degree. With tolerances being kept to the minimum in order to keep cost as low as possible.
The product(s) must comply with temperature outlined in subheading 7.231 Temperature.

7.312 Wear
The product(s) must withstand potential daily use.

7.313 Ease of use
The product(s) must be easy to use in order to expand the potential users.

7.314 Marketing area
The product(s) will be marketed to the cycling industry.
The product(s) will be marketed to UK and Europe.

7.32 Durability and reliability

7.321 Mean time to failure
The product(s) should withstand repeated drops.

7.322 Mean time to repair
The product(s) should not be repaired by the user under any circumstances. A repair service should be considered.

7.323 Dependability
The product(s) must be dependable as the user might use it every day.

7.324 Product life span
The product(s) should last a minimum of 2 years, depending on daily use and intensity of use.

7.33 Availability

7.331 Failure mode operation
In the event the product(s) fails a method to safely dispose or repair.

7.34 Adaptability

7.341 Ease of modifying.
The product(s) should prevent tampering and or modification from an unqualified individual.

7.342 Design features to support future enhancements.
The product(s) should include elements of modularity making it easy to swap components.

7.343 Anticipated future requirements.
The product(s) should be designed anticipating a chance in light or protection technology, allowing new technology to be implemented overtime.

7.344 Recyclability of materials and/or components.
The product(s) should be recycled. Any plastics used should be sustainable and able to be recycled.
Disassembly should be considered during the design process to allow for the maximum amount of sustainability and recyclability.
The product(s) must comply with ISO 15270:2008 standards for recycling and recovery of plastic. (see viability report section 4.65 Life cycle and End of life.)

7.35 Manufacturability

7.351 Preferred method of production
The product(s)'s production method should be appropriate for the manufacturing quantity and the materials used.

7.352 Scale of production
The product(s) should be designed for methods of mass production.

7.4 Physical properties

7.41 Geometry

7.411 Weight
The product(s) should be as light as possible.

7.42 Aesthetics

7.421 Appearance
The product(s) must reflect an expected feeling of quality and professionalism to increase the chance of a purchase.

7.422 Finish
The product(s) must be resistant to light scratching.

7.5 Support requirements

7.51 Maintenance

7.511 Inspection interval
The product(s) must be visually inspected before use, for any signs of cracking or damage which could hinder the performance or effectiveness.
The product(s) should allow for the manufacturer to service it.

7.512 Modularity of parts
The product(s) should allow for a certain amount of modularity.

7.513 Cleaning
The product(s) should be capable to be cleaned by the user. User must ensure the product is clean, so effectiveness isn't affected.

7.514 Disposal/recycling.
The product(s) must have a plan and be designed for end of life.

7.52 Training

7.521 Intuitive operation
The product(s) must be designed with operation in mind. Operation should be easy and intuitive.

7.522 Required training.
No training should be required to operate product(s)

7.523 Instructions.
Instructions should be included to help ease the product interaction.

7.53 Labelling and packaging

7.531 Label and font size.
Font sizes and labels must be clearly legible. With no obstruction from packaging protection.

7.532 Label warnings/Markings.
Must meet BS ISO 28219:2017 Standards for packaging, labelling and direct product marking with linear bar code and two-dimensional symbols.

7.533 Type of packaging and disposal of packaging.
Packaging must protect product during transport.
Packaging must be fully recyclable and marked with the appropriate recycle notes.

7.534 Volume
Packaging must be as small as possible to enable efficient product shipping.

7.535 Required Protection
Packaging must protect the product(s) from the following: Moisture, UV, Drops during shipping and Compression.

7.536 Accessibility/opening of packaging
The product(s)'s packaging must be opened without tools to prevent damage to product(s) enclosed.

7.6 Safety

7.61 Standards

BS 61023 – Stead light standard
ISO 15270:2008 – Standards for recycling and recovery.
ISO 28219:2017 – Standards for packaging.

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