2. DESIGN REQUIREMENT SPECIFICATIONS

KidGuard is a solution to a guardian's nightmare, harm to a child. KidGuard is designed with children's safety in mind. The device attaches to the underseat and is engineered to alert guardians that a child has been left in a car and that the conditions inside are unsafe. KidGuard's marketing requirements, engineering requirements, constraints, and standards are detailed in the following sections.

2.1. Requirements

KidGuard detects a child in the car seat using weight detection and monitors the interior temperature of the vehicle. This device alerts the user that the child is in the vehicle. Furthermore, the user is notified of the temperature upon leaving the vehicle and until the user acknowledges the notification.

2.1.1. Marketing Requirements

KidGuard's marketing requirements outline the needs of its customers:

1. KidGuard detects weights ranging from 5 to 110 lbs (2.27 to 50 kg) to identify if a baby is present.
2. KidGuard notifies the user if the user is out of range and the baby remains in the vehicle.
3. KidGuard senses the car's interior temperature.
4. KidGuard's powering system operates for 4 to 6 hours.
5. KidGuard is user-friendly.
6. KidGuard is universal to all car seats and is easily operable.

Figure 2-1 displays KidGuard's marketing requirements in more detail.

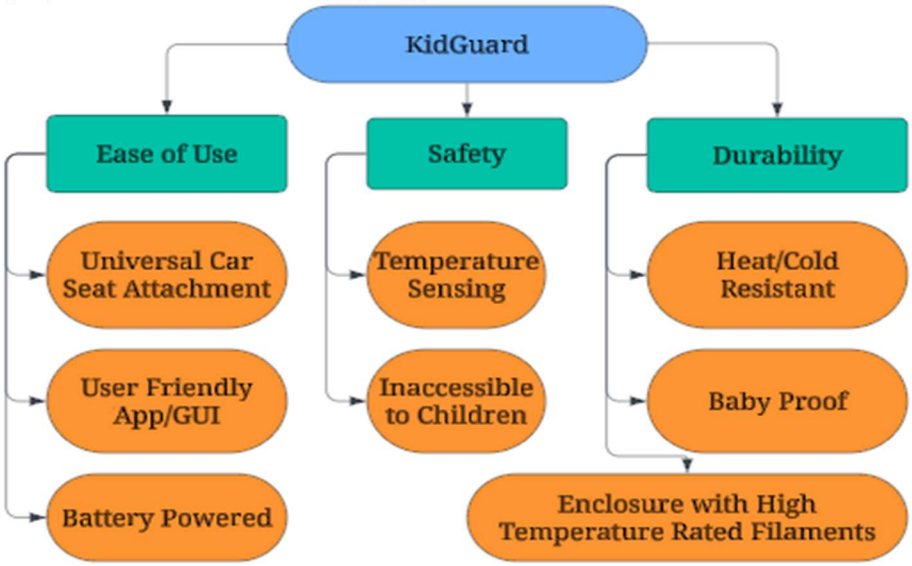

Figure 2-1. KidGuard's Objective Tree

These marketing requirements are the basis for the engineering requirements.

2.1.2. Engineering Requirements

KidGuard meets the engineering design requirements listed in Table 2-1 to achieve the marketing requirements.

Table 2-1: Engineering Design Requirements

Marketing Requirements	Engineering Requirements	Justification
1	The load sensor detects a maximum of 110 lbs/50kg	KidGuard detects if a child is seated in a standard car seat.
2	The user receives recurring reminders on their smartphone when they are further than 5 meters from the active device.	A guardian further than 5 meters away from the device may forget their child.
2	KidGuard includes long-range communication with a maximum of 5 km.	This range ensures the user has constant communication with KidGuard within a large area.
3	The thermal sensor detects temperature changes in a vehicle ranging from -58°F to 302°F (-50°C to 150°C).	Children can perish when their body temperature reaches 107°F (42°C) [1].
2, 3	A notification is sent to the user after leaving the 5-meter range of KidGuard and when the vehicle interior temperature is 85°F (29°C).	At 85°F (29°C), the interior is sweltering. These temperatures pose risks to the child.
4	KidGuard is battery operated.	KidGuard requires a rechargeable battery source.
5	KidGuard features an App/GUI for ease of use.	KidGuard updates the user's device.
6	KidGuard is portable and compatible with all models of car seats.	Car seats come in different models and sizes [2].

Marketing Requirements:

1. KidGuard detects weights ranging from 5 to 110 lbs (2.27 to 50 kg) to identify if a baby is present.
2. KidGuard notifies the user if the user is out of range and the baby remains in the vehicle.
3. KidGuard senses the car's interior temperature.
4. KidGuard's powering system operates for 4 to 6 hours.
5. KidGuard is user-friendly.
6. KidGuard is universal to all car seats and is easily operable.

These design requirements for KidGuard, combined with various constraints, inform the design.

2.2. Constraints

KidGuard is faced with design specifications. KidGuard meets all the constraints listed in Table 2-2.

Table 2-2: Constraints

Type	Name	Constraints
Economic	Cost	KidGuard has a budget constraint of $1000.
Economic	Time	KidGuard needs to be completed by December 2024.
Environmental	Heat Resistant	KidGuard's conclusive design withstands exceptionally high temperatures.
Manufacturability	Enclosure	The casing protects the product from external factors, including children, spills, and food.
Usability	Reliability	KidGuard communicates with the user's handheld device without fail.
User Interface	Communication	KidGuard transfers data about the baby via push notifications.

KidGuard meets not only the constraints but also the engineering standards.

2.3. Standards

KidGuard abides by the safety and engineering standards listed in Table 2-3.

Table 2-3: Engineering Standards

Specific Standard	Standard Document	Specification/Application
No. 213	Federal Motor Vehicle Safety Standard (FMVSS)	KidGuard adheres to the standard and does not impede the original function of the child restraint system [2].
Institute of Electrical and Electronic Engineers (IEEE) P1451.5.5	Standard for a Smart Transducer Interface for Sensors and Actuator -- Wireless Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats - LoRa Protocol	KidGuard uses LoRa to transmit data to a mobile device for viewing [3].
IEEE 802.11n-2009	IEEE Standard for Information technology– Local and metropolitan area networks– Specific requirements– Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 5: Enhancements for Higher Throughput	KidGuard uses Bluetooth to indicate a break in connection with a mobile device [4].

2.4. REFERENCES

[1] “Child Heatstroke Prevention: Prevent Hot Car Deaths.” National Highway Traffic Safety Administration (NHTSA). https://www.nhtsa.gov/campaign/heatstroke (accessed Mar. 5, 2024).

[2] “Federal Motor Vehicle Safety Standards; Child Restraint Systems, Incorporation by Reference,” Federal Motor Vehicle Saftery Standards standard No. 213, Federal Register. (2020, Nov. 02). https://www.federalregister.gov/documents/2020/11/02/2020-21477/federal-motor-vehicle-safety-standards-child-restraint-systems-incorporation-by-reference (accessed Mar. 5, 2024).

[3] “Institute of Electrical and Electronic Engineers Standards Association (IEEE SA) - standard for a smart transducer interface for sensors and actuator -- wireless communication protocols and transducer electronic data sheet (TEDS) formats - LoRa Protocol,”IEEE standard p1451.5.5, IEEE Standards Association. (2021, May 21). https://standards.ieee.org/ieee/1451.5.5/10611/ (accessed Mar. 5, 2024).

[4] “Institute of Electrical and Electronic Engineers Standards Association (IEEE SA) - IEEE Standard for Information technology-- local and metropolitan area networks-- specific requirements-- part 11: Wireless LAN Medium Access Control (mac) and Physical Layer (PHY) specifications amendment 5: Enhancements for higher throughput,” IEEE standard 802.11n-2009, IEEE Standards Association, (2009, Oct. 29). https://standards.ieee.org/ieee/802.11n/3952/ (accessed Mar. 5, 2024).