Initial Project Document and Group Identification
Divide and Conquer
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Wheelie Smart

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Group 12

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Project Narrative

The future is now! Innovative technology advances are being designed and developed in everyday items, from smart refrigerators to smart shower heads. These smart devices allow people like you and me to live an easier life; wake up to the smell of coffee and shower in just the right temperature. Smart devices are not only being used to make life easier, but also to make life safer. Although the flying car has not yet been fabricated, cars now have features such as the blindspot detection, blindspot cameras, and lane-keep assist to prevent accidents from occuring. What about the vehicles sharing the road with cars, trucks, and motorcycles? The bicycle! Wheelie Smart is a smart bicycle and smart helmet which will aid bicyclists in having a safe ride.

Teaching your children to ride a bicycle is a part of family tradition. Parents all over the world put their children on bicycle seats with a helmet, pads, and training wheels to go for a ride. Most Americans know how to ride a bicycle whether they learned in their early years or taught themselves further down the road. The amount of bicycles on the road is on the rise as more and more people use them to commute, exercise, or as a hobby. Although there has been a decrease in bicycle accidents, the toll of fatal accidents is mounting. Since 2010, bicyclist death statistics appear to be on the rise. According to the Federal Highway and Administration (FHWA), there were a total of 8,908 bicyclist deaths between 2007 and 2018; an average of 742 cyclists each year. In 2018, 857 bicyclists were killed in traffic accidents.

Bicyclists collide with pedestrians, obstacles, cars and sometimes even just lose balance and fall. The most common accident occurs when a cyclist falls but the most serious are those which involve a car. These accidents can be caused by many factors but the best way to avoid crashes is through prevention. Wheelie Smart will implement an application along with a waterproof LCD Display which will aid the bicyclist with helmet detection, safety checklist, path planning, etc. to make sure the bicyclist is starting their ride with precaution.

Regular bicyclists, especially those who ride on the same path on a daily basis, do not prioritize wearing a helmet when riding their bicycle. Sometimes people tend to just forget about wearing a helmet and it is too late when they realize it. Before even getting on the bicycle, the rider will have to put on the customized Wheelie Smart Bicycle helmet. This helmet will have a sensor which will signal the mobile application and tell it that the helmet is on the rider's head, within range of the bicycle, and that it is safe for the rider to get on the bicycle. Once this step is complete, the auto locks on the bicycle will be unlocked. This is crucial because the study done in 2015 shows that 54% people who were treated for bicycle injuries at a hospital were not wearing a helmet.

According to the National Highway Traffic Safety Administration (NHTSA), most bicyclist deaths occur in the evening between 6 and 9 o’clock. This occurs between the hours of

6 and 9 o'clock, not only are streets busy but it is also dark outside. This causes bicyclists to not be visible to drivers behind the wheel of other vehicles. Due to the lack of visibility, drivers usually don't notice that they are sharing a road with a bicyclist until it is too late and a fatal accident between the vehicle and the bicyclist is unavoidable. Due to this, the Wheelie Smart Bicycle will use light sensors to detect the brightness/visibility outside to maximize visibility for bicyclists to see and be seen thus minimizing accidents.

Do you ever wonder why your car has cool technology such as a monitor to show weather outside, the speed of your vehicle, etc. and not your bicycle? Well, the Wheelie Smart Bicycle's waterproof LCD display will be utilized for multi-purpose. The LCD display will display the speed of the bicycle, heart rate of the bicyclist, GPS, and weather. The most significant feature, to ensure a safe ride, on this display being the speed of the bicycle and the bicyclist's heart rate. The reason for this is that it will aid the bicyclist in avoiding an accident by preventing him/her from losing control due to the speed of the bicycle. The heart rate will also be recorded in the application and will show if a bicyclist is losing control due to a possible heart attack.

Along with speed and weather conditions, hazardous obstacles may be preexisting on the road. Debris from a previous accident, glass, gravel and potholes are all possible hazards which may cause a bicyclist to lose control and be in an accident. To avoid this from occurring, the Wheelie Smart will use Machine Learning to train a model to recognize these hazards and alert the bicyclist to go around them. By avoiding the hazardous obstacles, the bicyclist will also be preventing an accident.

The word bicyclist is mentioned a lot in here but who is this bicyclist? The bicyclist is the future customer for our product and can be anyone ranging from 4 years old to 99 plus years old. Our product is designed mainly to keep the bicyclist safe, who ride their bicycle in unsafe environments such as the main road or on a steep trail. The mobile application's user interface will be designed simple so that even a child can utilize the app. There will also be advanced mode for a professional bicyclist who requires more features than a kid riding a bicycle in their neighborhood.

Wheelie Smart is not an expensive and luxurious bicycle. The product aims to be an inexpensive bicycle and helmet set, relative to those currently on the market. On average, a bicycle is priced at about $300 and a helmet at about $75. We do not wish for Wheelie Smart to be unattainable to the greater public. Instead, it will be an affordable smart bicycle which will aid beginner bicyclists as well as the experts. There will be an option to opt-out of certain features which an adult commuting to work on a busy street may need but a kid who is riding around in residential areas won't. The main objective of this product is to provide rider safety for all

bicyclists so we aim to minimize the cost but at the same time develop innovative technology which is feasible for anyone!

The Wheelie Smart is a product which includes a smart bicycle and a smart helmet. The product will aid bicyclists during their ride whether it be for commuting to work, exercising, or just biking for fun. It will include an application for an easy to use experience while at the same time using features to aid the bicyclist to complete a safe ride. The ultimate goal of Wheelie Smart is to ensure bicyclist safety by implementing various features which will add precaution before a ride, prevention during a ride, and helpful tips after a ride. Ultimately, the features, as described above, will avoid both minor and major accidents. Wheelie Smart is the future technology which will change rider safety for the better.

Wheelie Smart is really smart!

Specifications

No.	Requirements	Specifications	Description	Category
1.	Emergency button	30 seconds	Contact authorities within 30 secs	Core
2.	Speakers	7-10 ft	Detect hazard within 7-10 ft and warn the bicyclist	Core
3.	Lights	5 seconds	Light brightens adjust within 5 seconds when in low visibility conditions such as rain, fog, etc.	Core
4.	Helmet detection range	5 ft	Is detected if <5 feet away from bike	Core
5.	Auto lock range	5 ft	Bicycle will auto lock unless the Bicyclist is wearing the helmet within 5 ft of the Bicycle	Core
6.	Power supply output voltage	12 VDC	12 VDC will be used as power supply	Core
7.	Power consumption	75%	It must be less than 75% of the total power to keep our electrical components protected.	Core
8.	Object Detection	10 ft	Object detection sensor detects objects such as pedestrians and cars within 10 ft	Core

9.	Wireless communication operating range	32 ft	At least within 32 ft	Core
10.	Wireless communication frequency	2.4 GHz	2.4 GHz	Core
11.	Bicycle Weight	7 lb	7 lb or less extra weight on bicycle	Core
12.	Helmet Weight	1 lb	Less than 1 lb of extra weight on helmet	Core
13.	GPS	5-7 m	5-7m of accuracy	Core
14.	Battery life	8 hours	>8 hours	Core
15.	Cost	$525-$700	Low cost, $525-$700, Smart bicycle considering the average normal bicycle cost is $350-$700.	Core
16.	Log-in time	30 seconds	Log-in on app should take less than 30 seconds	Advance
17.	Temperature, speed, exercise time	100%	Must be displayed on the LCD, 100% of the time while bicycle is active	Advance
18.	Camera	120º 5 seconds	Must cover 120 degree angle and send feedback from live feed to detect hazard; delay should be < 5 seconds	Advance
19.	Heart rate	¼ of the expected ride duration	Must properly detect heart rate and display it to LCD every 1/4th of the expected ride duration	Advance
20.	ML training	97%	Training model would classify objects and detect the weather conditions with accuracy >97%	Aspirational Goal

Table 1 - Specifications

House of Quality

			↑↑		↑↑			
			Engineering Requirements					
			Auto-Lock	Emergency Button	Helmet Detection	Speaker	GPS	Light
			(-)	(-)	(-)	(+)	(-)	(-)
Marketing Requirements	1) Easy to Maintain	(+)				↑↑	↑↑	↑
	2) Safety for Rider	(+)	↑↑	↑↑	↑↑	↑	↑↑	↑
	3) Ease of Use	(+)		↑		↓	↓	
	4) Cost	(-)	↓		↓↓	↓		↓
	5) Reliability	(+)	↑	↑↑	↑↑		↑↑	↑
	6) Autonomus	(+)	↑↑		↑	↑		↑
	7) Durability	(+)	↑		↑↑			
	8) Accuracy	(+)	↓				↓↓	
	Targets for Engineering Requirements		≤ 5 ft	30 seconds	< 5 ft	7-10 ft	5-7 m	5 seconds

Legend	
↑↑	Strong positive correlation
↑	Positive correlation
↓	Negative correlation
↓↓	Strong negative correlation
(+)	Positive polarity
(-)	Negative polarity

Table 2 - House of Quality

Figure 1 - Prototype Design

Above is a prototype design which shows the placement of various components that will be used to design the Wheelie Smart Bicycle and Helmet. The figure shows estimated locations of safety features. Please note that the image does not accurately represent the resulting components that will be determined once the appropriate research has been completed.

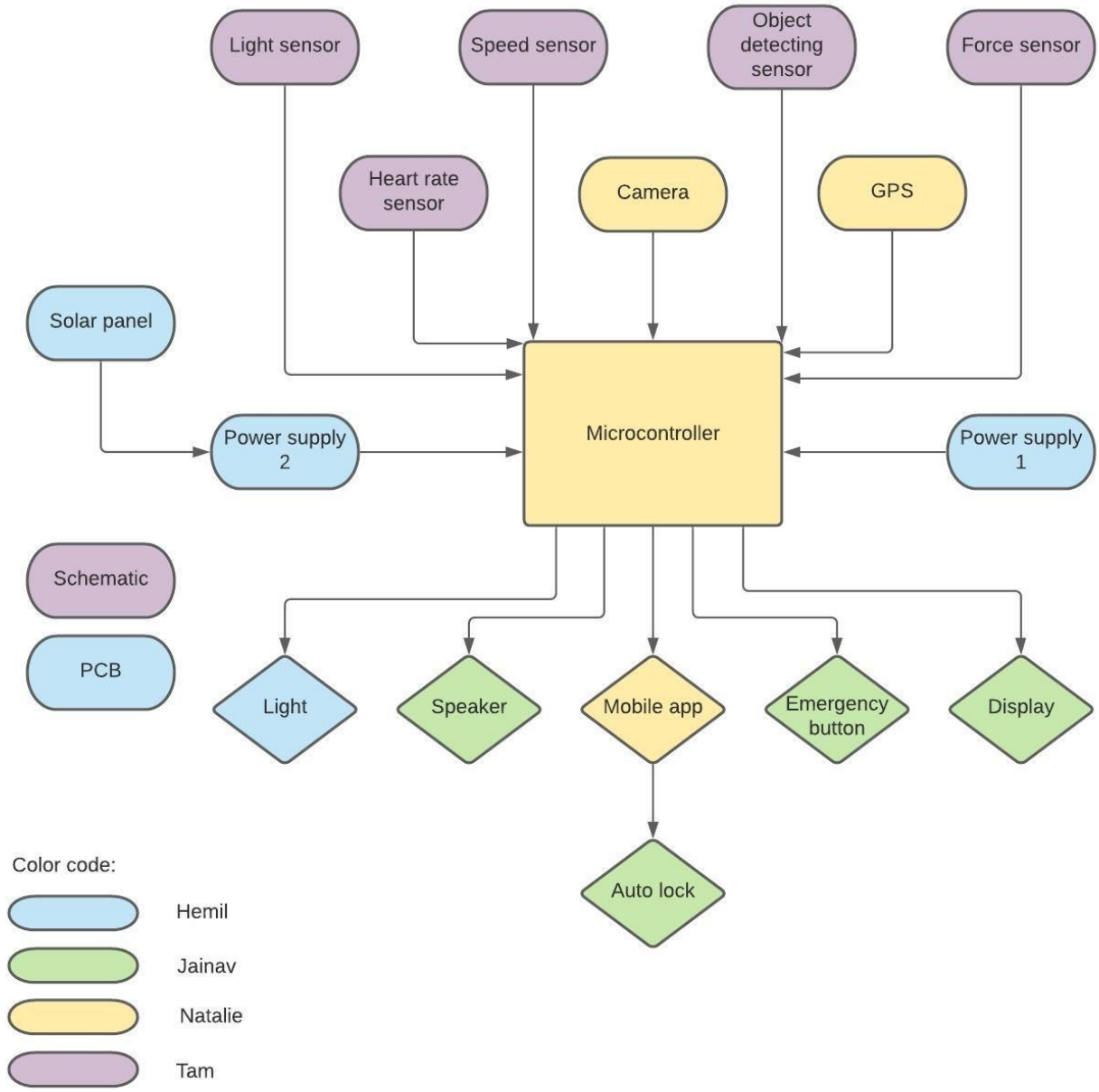

Figure 2 - Block Diagram

Above is a block diagram which illustrates the hardware and software components that will be used to design the Wheelie Smart Bicycle and Helmet. The figure shows the group member responsible for the block, the name of each block which describes its function, and shows the inputs and the outputs of the microcontroller using arrows. All of Hemil's blocks are blue, all of Jainav's blocks are green, all of Natalie's blocks are yellow, and all of Tam's blocks are purple.

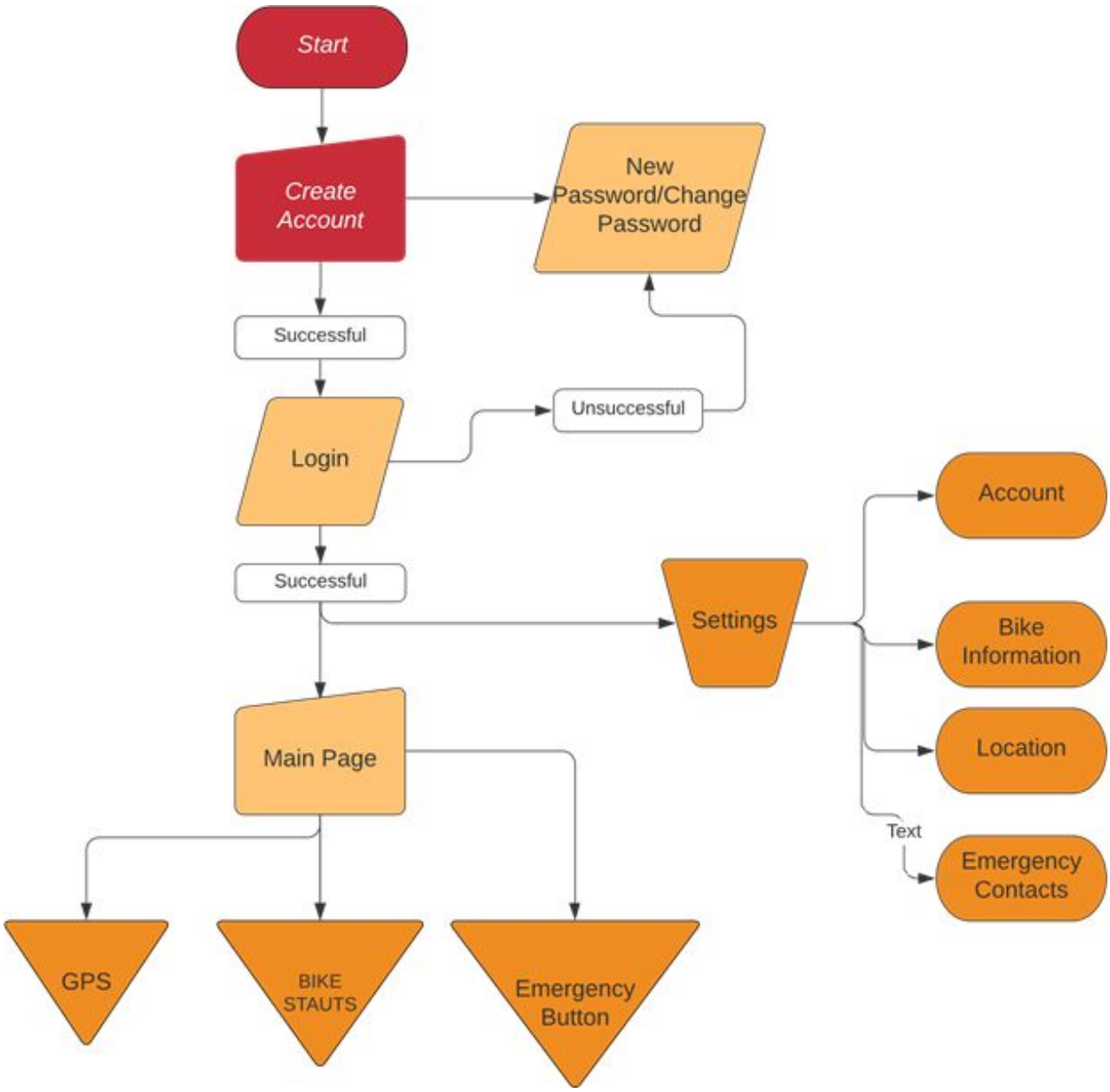

Figure 3 - Software Block Diagram

Above is a software diagram which illustrates the software components that will be implemented in the mobile application. As you enter the application, you will be guided to a page to create your account. Once the account is created successfully, you will be redirected to the login page where you will input your credentials. If you are unsuccessful in the login process, or you forgot your password, you will be redirected to change your password. Once you are logged in, you will see the main page which will hold the details of GPS, bicycle status, and Emergency Button. The user will also have the ability to edit details about the account, bicycle information, the location of the user, and the user's emergency contacts through setting options.

Budget

Group 12 has a non-sponsored Senior Design Project which will be self-funded. Our initial agreed upon budget was a maximum of $150 per person. After researching the components and their prices, the total outcome of the component came out to $411.75, or approximately $102.94 per person. Initially, the group is under budget. Being under budget will allow for the group to repurchase a part(s) if deemed necessary due to a part(s) being defective or broken. Below is a figure showing the components needed to complete the Wheelie Smart Prototype.

Name	Quantity	Estimated cost
Bicycle	1	$0 (donated)
Helmet	1	$19.99
MCU(Arduino Uno)	1	$25.00
Battery (12V)	2	$39.99
Solar panel	2	$12.99
Camera	1	$30.00 ($25-$30)
PCB	1	$100 ($75- $100)
Solar Charger	1	$35.99
Object detection sensor	2	$7.90 ($3.95 ea.)
Light sensor	1	$9.95
Force sensor	1	$6.95
Speed sensor	1	$40.00
Heart Rate sensor	2	$42.00($21.00 ea.)
GPS module	1	$10.99
Lock	1	$10.00
Light	1	$10.00
Speaker	1	$10.00
Total		$411.75

Table 3 - Budget

Initial Project Milestone

*Note: The following start and end dates for tasks are for the 2021 year.

Number	Task	Start Date	End Date	Status	Responsibility
Senior Design I					
Group & Ideas					
1	Project Idea	1/11	1/15	Completed	Group 12
2	Group Formation, Role Assignment & Project Selection	1/11	1/22	Completed	Group 12
3	Bootcamp Assignment	1/21	1/29	Completed	Group 12
Project Report					
4	Initial Divide & Conquer	1/18	1/29	Completed	Group 12
5	Divide & Conquer 2.0	1/18	2/12	Completed	Group 12
6	60 page Draft	3/15	4/2	In Progress	Group 12
7	100 page Report	3/29	4/16	In Progress	Group 12
8	Final Documentation	1/18	4/27	In Progress	Group 12
Research & Design					
9	Schematic	2/3	4/27	Research	Tam
10	Microcontroller	1/26	4/27	Research	Natalie
11	Power Supply	1/26	4/27	Research	Hemil
12	Solar Power Panel	1/26	4/27	Research	Hemil
13	PCB Layout	4/17	5/17	Research	Hemil
14	GPS	2/4	4/27	Research	Natalie
15	Sensors (light, speed, ultrasonic, force, heart rate)	1/26	4/27	Research	Tam
16	Camera Module	1/26	4/27	Research	Natalie

17	Light	1/26	4/27	Research	Hemil
18	Speaker	1/26	4/27	Research	Jainav
19	Auto Lock	1/26	4/27	Research	Jainav
20	Mobile Application	2/4	4/27	Research	Natalie
21	**Order & Test Parts**	4/19	4/27	Research	Group 12
Senior Design II					
22	**Build Prototype**	TBA	TBA	Research	Group 12
23	**Testing & Re-design**	TBA	TBA	Research	Group 12
24	**Finalize Prototype**	TBA	TBA	Research	Group 12
25	**Peer Presentation**	TBA	TBA	Research	Group 12
26	**Final Report**	TBA	TBA	Research	Group 12
27	**Final Presentation**	TBA	TBA	Research	Group 12

Table 4 - Initial Project Milestones

Decision Matrix

Criteria		**Options**		
		Wheelie Smart	**Palm Tree Trimming Robot**	**Smart Recycler**
Sponsorship		Self-funded	RFTek Inc.	Self-funded
Estimated Cost		~$400	~$2000	~$1000
Technology Requirement	**Electrical**	✓	✓	✓
	Software	✓	✓	✓
	Mechanical		✓	✓
Motivation		To create a safer environment for bicyclists, not limited to the age of the rider.	To safely cut palm tree fronds and ensure that it results in no damage and no injury.	To reduce negative impact on the natural environment by picking up garbage,

				sorting it into different categories, and disposing the trask in their respective bins for recycling.

Table 5 - Decision Matrix

After consideration, Group 12 has decided to go with the Wheelie Smart project as we took into account all the above criteria as well as each member's strengths and weaknesses. Even though the Palm Tree Trimming Robot project is sponsored, the project itself requires deep knowledge in the mechanical aspects in order to meet the requirements given by the sponsor. For the Smart Recycler project, none of our team members are familiar with the technology which is used to distinguish between different materials (metal, paper, plastic, etc.).

Research

- https://www.nhtsa.gov/road-safety/bicycle-safety
- https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6895036
- https://bayareabicyclelaw.com/safety-laws/bike-stats/
- https://www.nsc.org/safety-first-blog/bicycle-safety-statistics-may-surprise-you#:~:text=Alarmingly%2C%20more%20than%20half%20of,2016%20were%20not%20wearing%20one
- https://www.iihs.org/topics/fatality-statistics/detail/bicyclists
- https://injuryfacts.nsc.org/home-and-community/safety-topics/bicycle-deaths/