Safe Bike Equity: Can Cycling Become the Great Equalizer?

Suzana Duran Bernardes, Ph.D. Student
C2SMART University Transportation Center | NYU Tandon School of Engineering

C2SMART
CONNECTED CITIES WITH SMART TRANSPORTATION

NYU

Meet the Team

Suzana Duran Bernardes
Ph.D. Student at NYU Tandon
Principal Student Researcher

Kaan Ozbay
Professor & Director of C2SMART
Principal Investigator

Di Yang
Ph.D. Student at NYU Tandon
Principal Student Researcher

Vikas Malis
Masters Student at NYU Tandon
Intern

Presentation Outline

Context

Proposed Data Collection Device

Proof of Concept

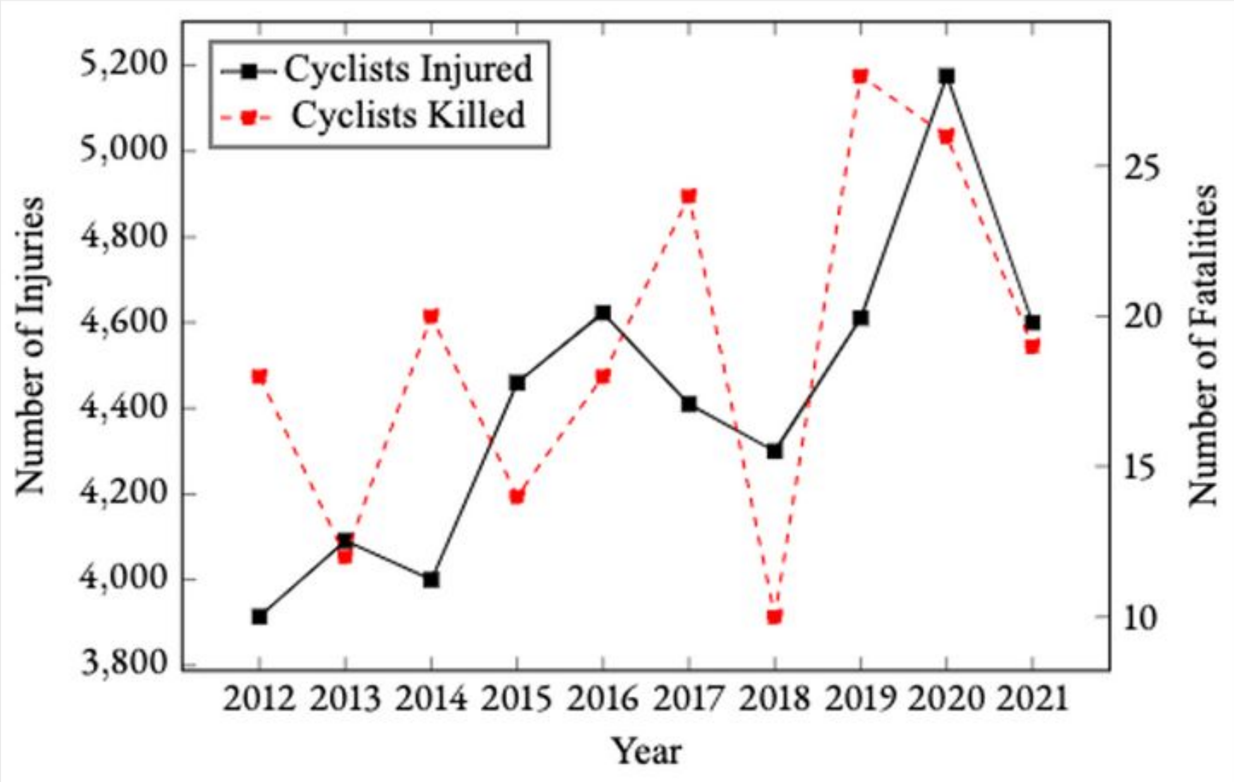
Potential Applications

Conclusions

Where to Find More Details

Context: Biking in NYC

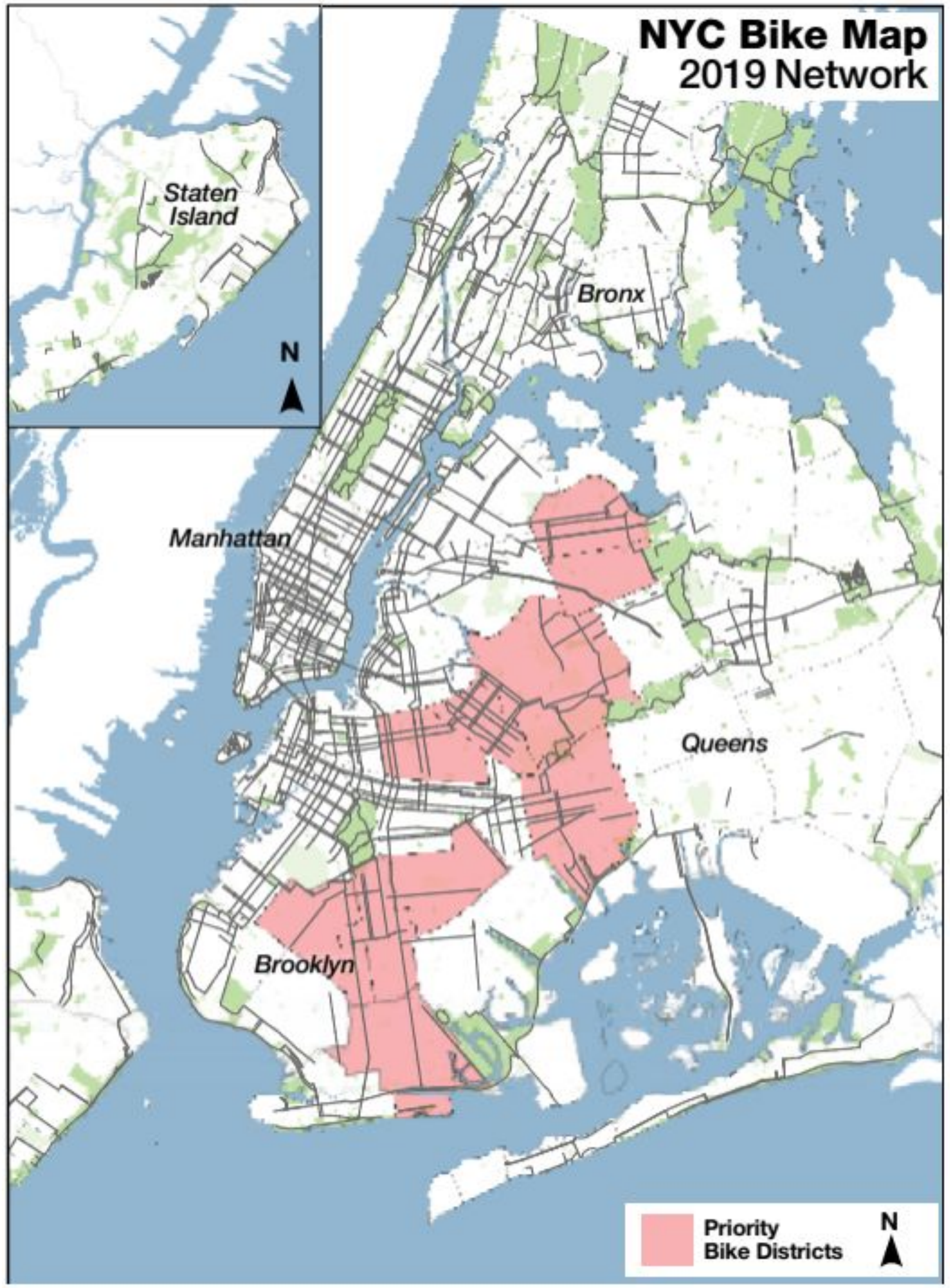
- 1234+ miles of bicycle lanes
- 116% increase in daily bicycle ridership from 2009 to 2019



citi bike in 2020

- 5% — Ridership drop across NYC
- 68% — Male ridership
- 36 — New stations
- 20k — Size of bicycle fleet
- 2020 — Community Programs Expansion

C2SMART
CONNECTED CITIES WITH SMART TRANSPORTATION



Source: NYCDOT, 2019. Green Wave: A Plan for Cycling in New York City

Context: Biking in NYC

01 Safety priority districts in areas farther from Manhattan
(e.g., higher number of cyclists injured or killed)

02 Less access
to bicycle infrastructure

03 Lower incomes
than other areas across the city

Biking is not equably an option across New York City.

Context: Current Data Collection Methods

Surveys

Cycling Videos
(Safety Perception)

GPS Receivers

Video Camera

Crowdsourced Fitness

Instrumented Bicycles

Virtual Reality

Project Objectives

Smart Bicycles - Data

Safety Impact:
Countermeasures

Social Impact:
Safe Equity

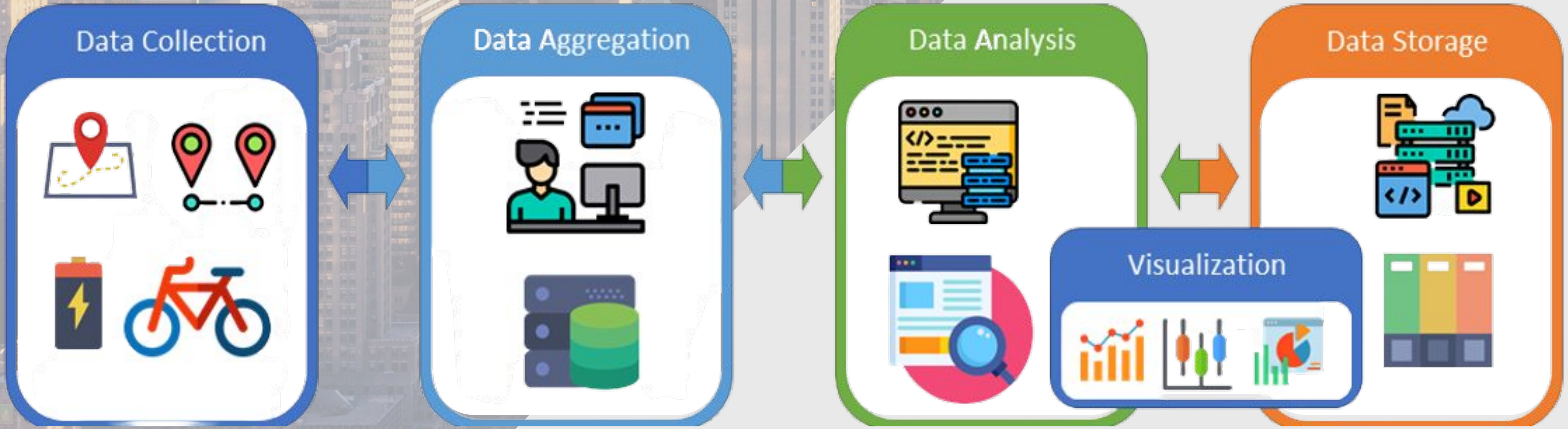
Proposed Data Collection Device: Hardware

Components

- Raspberry PI ninicomputer
- Temperature sensor
- Two ultrasonic sensors
- Global Positioning System (GPS) receiver
- 3-Axis Accelerometer & a 3-Axis Gyroscope

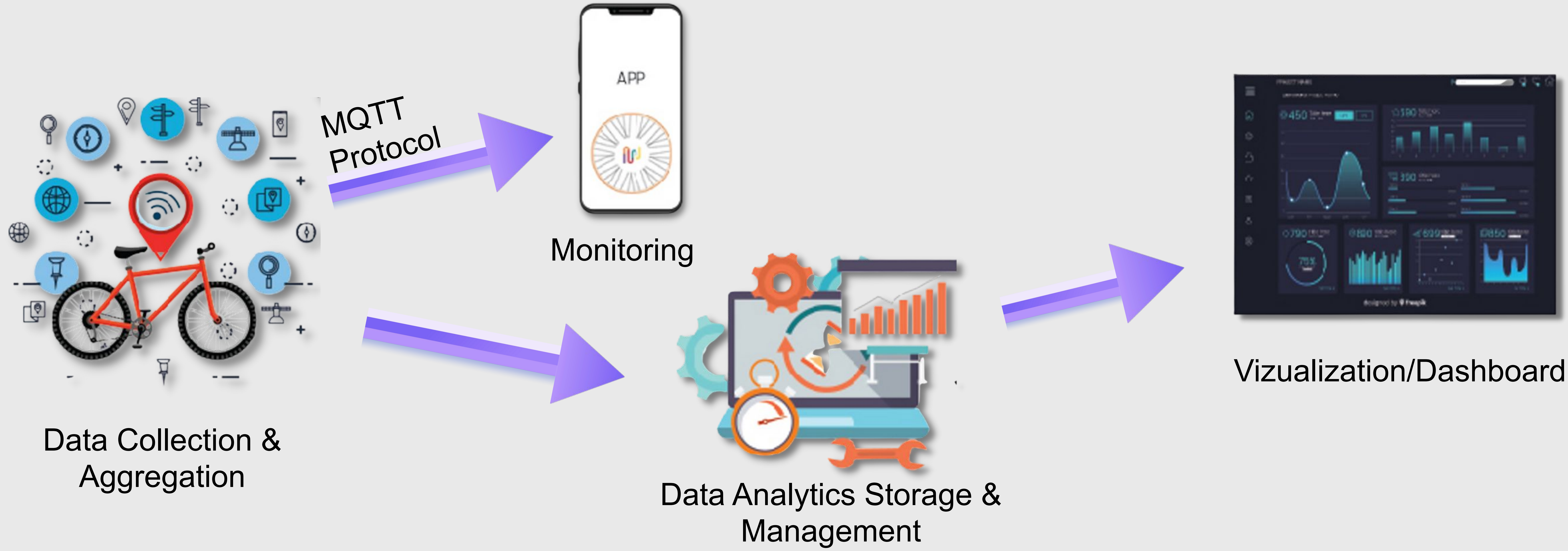
Advantages

- Cost-benefit: about $200 per unit
- Portable
- Customizable
- Variety of applications



Proposed Data Collection Device: System

Proposed Data Collection Device: System



Data Output | Explain | Messages | Notifications

	dtg timestamp without time zone	latitude real	longitude real	altitude real	eps real	epx real	epv real	ept real	speed real	climb real	track real	usreading_r real	usreading_l real	gyro_x real	gyro_y real	gyro_z real	acce_x real	acce_y real	acce_z real	temp real
258	2020-02-18 21:51:26.714355	40.6288	-74.0247	36.786	24.15	11.143	36.722	0.005	0.122	0.026	100.559	45.14	15.63	-1.93893	2.38931	-2.85496	3.28006	-8.80109	1.56102	29.9418
259	2020-02-18 21:51:27.980087	40.6288	-74.0247	35.405	24.15	11.143	36.722	0.005	0.395	-0.003	114.207	44.68	15.99	-1.77863	2.49618	-2.93893	3.25133	-8.78193	1.57778	29.9418
260	2020-02-18 21:51:29.58788	40.6288	-74.0248	35.196	24.15	11.143	36.722	0.005	0.164	-0.065	70.1347	44.68	16.03	-1.74809	2.35878	-2.83969	3.32076	-8.73884	1.59214	29.8476
261	2020-02-18 21:51:31.175577	40.6288	-74.0247	33.815	24.15	11.143	36.722	0.005	0	0	0	45.22	16.02	-1.74809	2.35878	-3.05344	3.29682	-8.82503	1.66158	29.9418
262	2020-02-18 21:51:32.5315	40.6288	-74.0248	33.606	24.15	11.143	36.722	0.005	0.085	-0.091	23.7325	43.06	15.62	-1.77099	2.52672	-2.87023	3.27527	-8.76757	1.62806	29.9888
263	2020-02-18 21:51:33.868333	40.6288	-74.0248	32.225	24.15	11.143	36.722	0.005	0.244	-0.137	150.469	45.17	16.05	-1.74046	2.51145	-3.00763	3.30879	-8.78911	1.63285	29.9888
264	2020-02 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	29.8947
265	2020-02 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	29.9418
266	2020-02 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	29.8476
267	2020-02 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	29.8947
268	2020-02-18 21:51:42.964633	40.6287	-74.0248	32.304	24.15	11.143	36.722	0.005	0.515	-0.01	160.555	45.77	16.16	-1.72519	2.48092	-2.8855	3.29203	-8.79151	1.57299	29.8947
269	2020-02-18 21:51:44.254926	40.6287	-74.0248	32.304	24.15	11.143	36.722	0.005	0.095	-0.081	180	44.05	15.72	-1.70229	2.51145	-2.81679	3.3447	-8.7963	1.60651	29.9888

Proof of Concept: Preliminary Results

NYC, USA

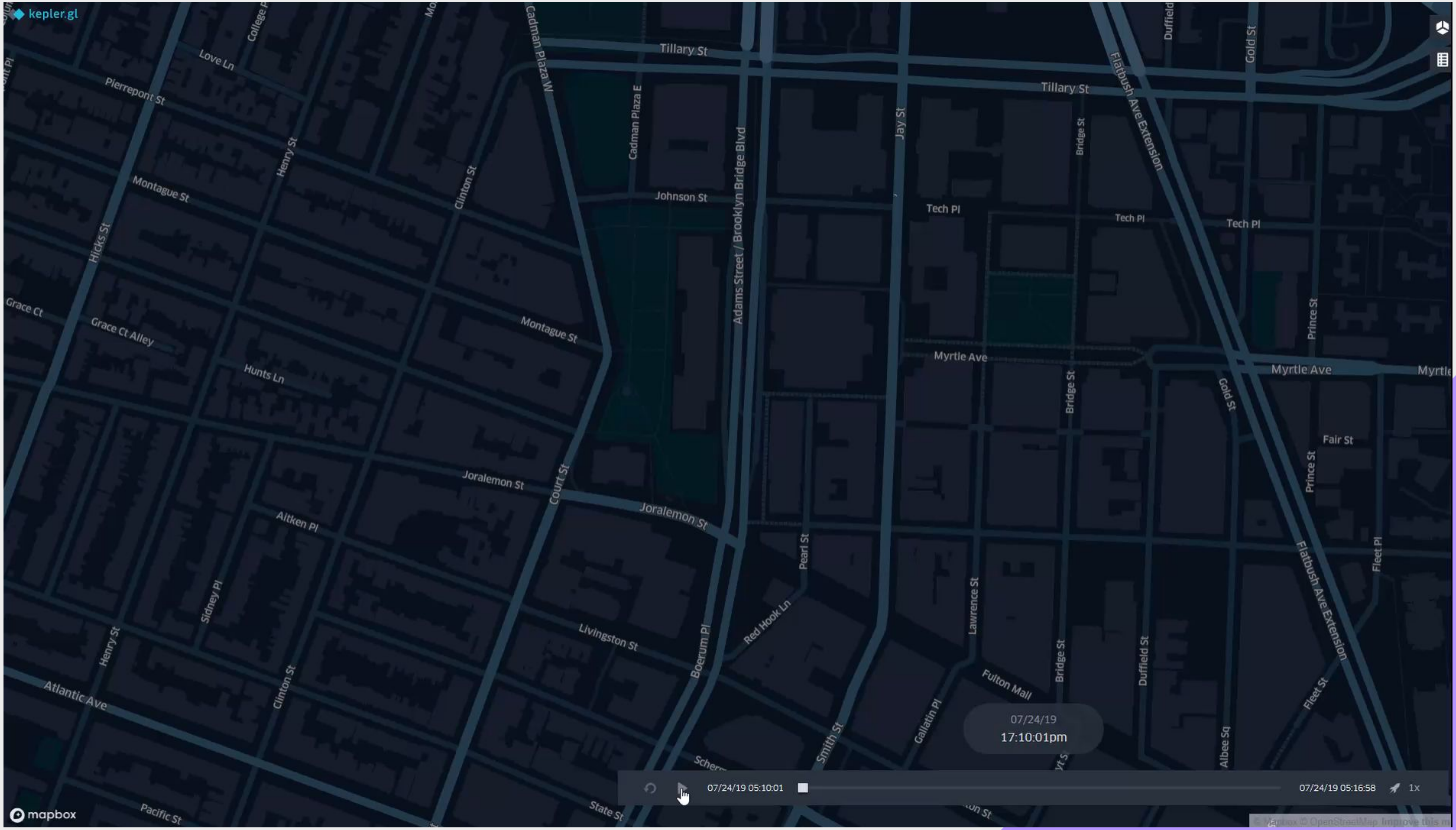
Summer 2019:

- Downtown Brooklyn area in Brooklyn, NY.
- Total time: 3h 20min.
- Total mileage: 23.4 miles.

A dashboard summarizes the key information.

Readings higher than 400 cm are capped because they are over the range of the ultrasonic sensor.

Proof of Concept: Preliminary Results



Sample Route:NYC, USA

Proof of Concept: Preliminary Results

Mapped Trajectory

Speed Time Series

Sample Route: NYC, USA

Proof of Concept: Preliminary Results

7.12 mph

Average speed for all records

5.46 mph

Average speed below safe distance

7.42 mph

Average speed at safe distance

Sample Route: NYC, USA

Partnerships: BSAFE-360

- New York City, USA
- Denver, USA
- Shanghai, CH
- Brasilia, BR
- Sao Paulo, BR

Proof of Concept: Preliminary Results

Tongji Part.

Summer 2020:

- 4 routes: One in Manhattan, NYC and two in Shanghai, China (Pudong and Yangpu districts).
- 4 people for 3 days from China
- 1 person 10 days from NYC
- Total mileage: +125 miles.

Afternoon peak hour: 5:30 - 6:30 PM Shanghai and NYC for July data for the chosen routes chosen.

Proof of Concept: Preliminary Results

Tongji Part.

Pudong

- 23.3% records unsafe
- 7.93 mph mean speed

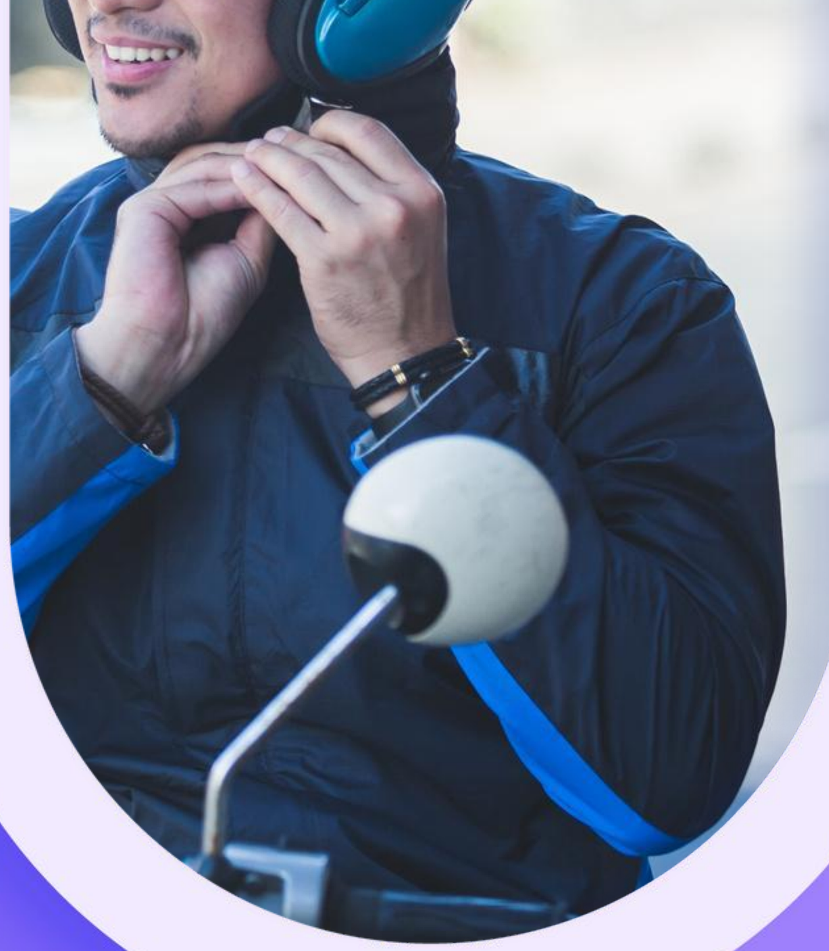
Yangpu

- 7.7% records unsafe
- 9.43 mph mean speed

Manhattan

- 11.7% records unsafe
- 8.97 mph mean speed

Potential Applications: Safety



Safety Assessments

- Development of Surrogate Safety Measures (SSMs) tailored to characteristics particular to bicycles.
- Cycling hotspot identification that do not need to rely on historical collision data.
- Machine Learning modeling for predicting collisions involving bicycles and for identifying key factors contributing to injuries and fatalities.

Safe Equity

- Data fusion of available bicycle related data sets (e.g., NYCDOT cameras, Citi Bike trip, infrastructure maps, demographics, collisions, and Bsafe-360 naturalistic cycling data) to have an all-around mapping of NYC's accessibility levels of safe cycling.
- Help improve perceived safety, which can help increase the number of people riding.
- Help agencies efficiently allocate resources to implement the best countermeasures at key locations.

Extra, Related Work: ARISE

Bike-to-vehicle Proximity Effect on Cyclist Stress Levels

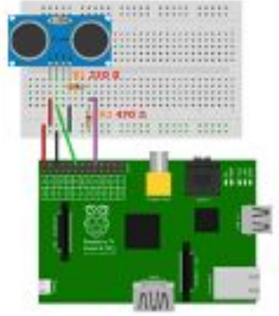
Jessica Katzman, High School for Math, Science & Engineering and Awestaa Zia, Townsend Harris High School
Mentor: Suzana Duran Bernardes, Professor: Dr. Kaan Ozbay
NYU Department of Civil and Urban Engineering, Urban Mobility and Intelligent Transportation Systems Lab

Introduction

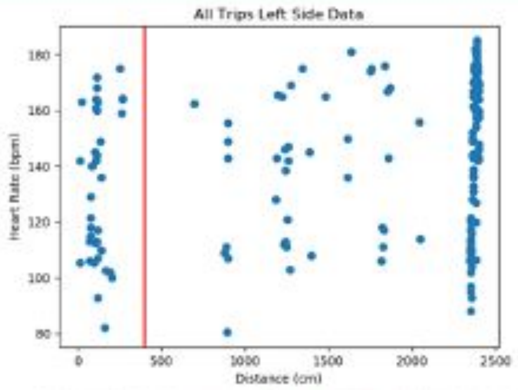
In New York City, increasing rates of cyclist fatalities have discouraged many New Yorkers from biking. This study aims to understand the effect of car proximity on the stress levels of cyclists. We believe that increased car proximity will contribute to high levels of stress in cyclists.

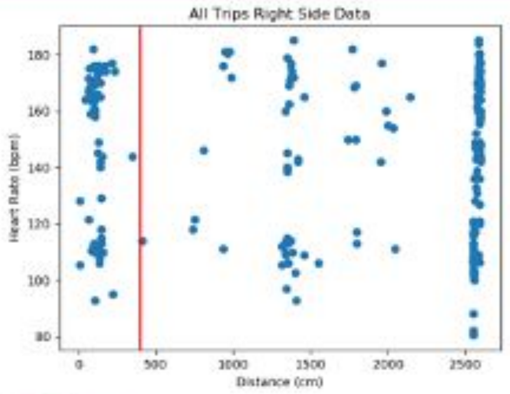
Methodology

- Assemble the Raspberry Pi, real time clock, GPS, ultrasonic sensors, and Apple Watch.
- Collected cycling data around the MetroTech area. The data collected was the heart rate of cyclists (bpm), distance of bike from cars (cm), and location (coordinates).
- Export data to organize and analyze using Python.

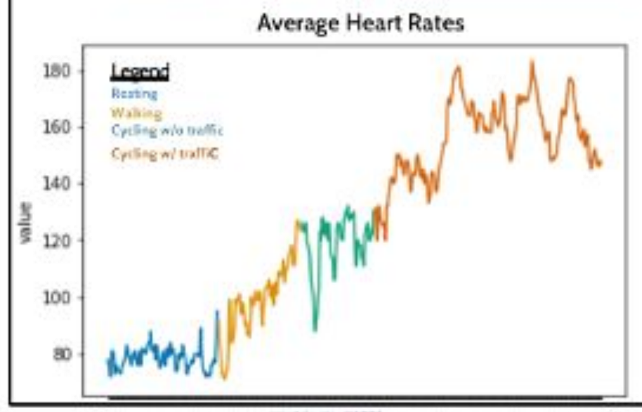


Results





- A shorter distance results in a higher heart rate.
- Other factors may be causing a high heart rate as well and must be considered alongside the distance.



Conclusions

- The heart rate cannot be related to the distance alone; other variables, such as speed and altitude, should be considered.
- However, we were able to observe that the heart rate is higher in the street without a bike lane, even though the altitude and speeds are not much higher.

Future Research

- Collect more data to analyze and find patterns of stressful events.
- Improve cyclist experiences by mapping high-risk bike routes.
- Develop an app to help cyclists reach their destination in not only an efficient way, but a safe way.

Conclusions: Looking Ahead

The BSafe-360 device was stable during the data collection process and shows promise to be an all-in-one data collection tool.

A dashboard can be adapted to different quantities of rides and variables, which facilitated the data analysis process.

This data will help to fill the gap existing in non-motorized vehicles safety research and help agencies to improve efficiency on decision-making processes.

Conclusions: Further Reading

Publications

- Bernardes, S. D., Kurkcu, A., & Ozbay, K. (2020). Design, Implementation and Testing of a New Multi-Sensor Mobile Device as a Tool for Cycling Data Collection in Highly Congested Urban Streets. International Journal of Traffic and Transportation Management (JTTM), 02(01), 07-13.
- Bernardes, S. D., Kurkcu, A., & Ozbay, K. (2019). Design, Implementation and Testing of a New Mobile Multi-Function Sensing Device for Identifying High-Risk Areas for Bicyclists in Highly Congested Urban Streets. Procedia Computer Science, 155, 218-225.

Presentations & Website

- Project Page at C2SMART Center's website.
- Bernardes, S. D. (2021). Bsafe-360: A Mobile Bicycle Data Collection Platform for Improving Bike Safety. Vision Zero Research on the Road, Part IV. Online - New York, NY USA.
- Bernardes, S. D. (2021). Bsafe-360: Leveraging Bicycle Safety through Emerging Data Collection Technologies. C2SMART Webinar. Online - New York, NY USA.

Thank you!

http://c2mart.engineering.nyu.edu

C2SMART Connected Cities with Smart Transportation Department of Civil & Urban Engineering

Center for Urban Science + Progress (CUSP)

@ New York University (NYU)

Contact: suzanaduran@nyu.edu