Project 3: Smart Traffic Lights: Data: Queue delays and related gasoline wastage
(NOTE: This project is applicable only in a community having at least one smart traffic light.)

Background and Motivation. There are two types of traffic lights: Smart and Dumb. A Dumb traffic light operates on a fixed clock schedule, turning each respective direction of traffic red or green, independent of the status of vehicles going through or waiting at the intersection. A Smart traffic light uses electronic sensors high above the intersection to ascertain the status of vehicles waiting at the red light (both sides) vs. vehicles transiting through the green light direction. A Smart traffic light will change red to green and green to red based on real time status of vehicles at the intersection, with the goal of minimizing delays for all. Since Smart traffic lights require considerably more technology than Dumb ones, they are more expensive and tend to be placed at only a few busy intersections, those that can most benefit by the adaptive behavior of the light.

Vehicles waiting at the red light of a Dumb traffic light while there are no vehicles going through on the green direction are needlessly being held in a waiting line, a "queue". There are costs to this needless waiting: lost minutes of productivity of the driver (and passengers) and fuel for the car needlessly consumed. The goals of this student project are to study this traffic light system in their community and to collect vehicle waiting time data at one or more heavily traveled intersections that are currently controlled by Dumb traffic lights, and to estimate the costs and benefits of switching one of more Dumb lights to Smart ones.

Student Activities. Students investigate which traffic lights in the town are Smart and which are not. They can most likely obtain a list of the Smart lights from Town offices. For the Dumb ones on heavily-trafficked intersections, they sample red light queue delays and then estimate the number of gallons of gasoline used (wasted) each day in queue, as well as the number of people hours wasted each day. They will need to consider that not all such queue delays are waited time, since there may be vehicles transiting the intersection in the green direction -- meaning that the delay was necessary.

Our preference is for the students to undertake their analysis at two or more heavily used intersections currently controlled by Dumb traffic lights. For each intersection, at least two times of the day will be required in the sampling: Very busy and very non-busy. In most situations, the maximal benefit of Smart lights occurs in non-busy (light traffic) periods. Why? In order to collect the data, hopefully the students can identify both Very busy and very non-busy periods that are outside of school hours, possibly morning rush hour prior to school and post-evening-rush-hour traffic say between 6:00 and 8:00 PM.

Students will design their data collection procedures by themselves, in their team. Our preference is that each intersection should have at least 60 data points for needless queueing for each period – busy and non-busy. They should realize that during rush hours the Dumb traffic light may not show much in the way of needless queueing (i.e., there may be many data entries of zero). The data obtained by the students should be scaled up to a one-hour period. So, if data were collected for 30 minutes, for instance, the numerical value of each entry would be doubled to approximate the likely entries over a one-hour period. We suggest that students work in pairs while collecting data at these intersections.

After the data collection, the students work together in their team to analyze the results. At this time, they should seek information on the costs of Smart and Dumb traffic lights and of any zoning or other issues that may prevent use of Smart traffic lights. Students assemble their work, featuring histograms of delay and estimated gasoline usage, with the key parameters of the histogram marked: Mean or average, median, mode and the two 5% tails. They arrange a meeting to go and present their results to Transportation or "Roads" or Public Works Department. There, they also will learn what the town's algorithm is to install Smart traffic lights (and what their budget constraints are). Teams can include what they learn from the professionals in their final report. Students write up final report, including possible recommendation for switching one or more currently Dumb lights to Smart ones.

The project ends with the formal presentation at the Final Event and submission of a final report.

Potentially useful web sites:

Finally, a traffic light that makes driving better

https://www.usatoday.com/story/tech/2016/10/31/finally-traffic-light-makes-driving-better/93051562/

The Hidden Genius and Influence of the Traffic Light

https://www.wired.com/2014/06/the-hidden-genius-and-influence-of-the-traffic-light/

A BEGINNER'S GUIDE TO TRAFFIC SIGNAL TIMING
http://www.foresitegroup.net/a-beginners-guide-to-signal-timing/