Philadelphia Household Travel Survey Project Evaluation

1) Make a list of the important economic costs and benefits.

Economic Benefits:

Time Savings:

- 2 million trips will save 15 minutes each annually. At an average wage rate of $30 per hour, the value of each saved hour is approximately $15.
- The number of time-saving trips will increase by 5% each year.

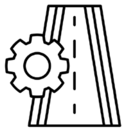
Local Economic Boost:

- $80 million of the $140 million investment will stimulate local jobs.
- A 1.15 multiplier effect suggests that each dollar spent generates an additional 25 cents in the economy.

New Investments:

- The project is projected to attract $300 million in new investments along the road.

Economic Costs:



Road Construction & Maintenance:

- The road construction will cost $140 million.
- An annual operating cost of $1 million is expected.
- Maintenance costs will rise by 3% annually due to inflation and wear.

Traffic Delays:

- Construction is estimated to cause 800,000 hours of delays in the first year.

Environmental Costs:

- An increase of 4 million vehicle-miles traveled per year is expected, with an environmental cost of 12 cents per mile.

2) Assuming a discount rate of 0.04, what is the economic net present value (NPV) of the project after 30 years?

Detailed NPV Calculation with a Discount Rate of 0.04

1. Time savings for travelers:

- Each trip saves: 0.25 hours
- Trips in the first year: 2,000,000
- Value saved per hour: $15
- Annual growth rate of trips: 5%

Using the formula: $$\text{Time Saving NPV} = \sum_{t=1}^{30} \frac{\text{Value per hour saved x Time saved per trip x Trips in first year} \times (1 + \text{Annual trip growth rate})^t}{(1+0.04)^t}$$

The accumulated value from time savings over 30 years is in the hundreds of millions of dollars.

2. Local economic activity:

- Local investment: $80,000,000
- Multiplier effect: 1.15

Economic activity benefit = Local investment x Multiplier effect = $92 million (This is a one-time benefit)

3. New investments along the road:

- New investments: $300,000,000
- The present value for the first year is: $288.46 million

4. Environmental cost:

- Increase in vehicle miles per year: 4,000,000 miles
- Cost per vehicle mile: $0.12

Using the formula: $$\text{Environmental Cost NPV} = \sum_{t=1}^{30} \frac{\text{Cost per vehicle mile} \times \text{Vehicle miles increase per year}}{(1+0.04)^t}$$

The accumulated environmental cost over 30 years is in the negative tens of millions of dollars.

5. Initial investment:
$140 million (This is a one-time cost)

6. Operating costs:
Initial operating cost: $1,000,000
Annual growth rate of the cost: 3%

Using the formula: $$\text{Operating Costs NPV} = \sum_{t=1}^{30} \frac{\text{Initial operating cost} \times (1 + \text{Annual cost growth rate})^t}{(1 + 0.04)^t}$$

The accumulated operating costs over 30 years are in the tens of millions of dollars.

7. Congestion during construction:
Hours of delay: 800,000 hours
Congestion cost = Hours of delay x Value saved per hour = $12 million (This is a one-time cost)

By summing up all the benefits and subtracting the costs, **the NPV at a 0.04 discount rate over 30 years is $453.04 million.**

3) Change the discount rate to 0.06 and describe how the evaluation changes.

Recalculating NPV with a Discount Rate of 0.06
Using the same methods and formulas as above but with a discount rate of 0.06, the NPV over 30 years is $392.38 million.

The higher discount rate reduces the present value of future benefits and costs, resulting in a lower NPV.

4) Are there any costs or benefits that you could not quantify?

Yes, there are several factors mentioned that are challenging to quantify monetarily:

- The social impact of dividing a poor neighborhood from an essential job center.
- The aesthetic and cultural value lost for rural communities who feel the highway will ruin the rural nature of their community and block their views.
- The potential increased accessibility to jobs and opportunities for many residents.

These factors are vital to consider, as they can have long-term implications on the well-being, satisfaction, and economic opportunities of the residents. Although these effects might not have direct monetary values attached to them, their impact on the community's quality of life is significant.

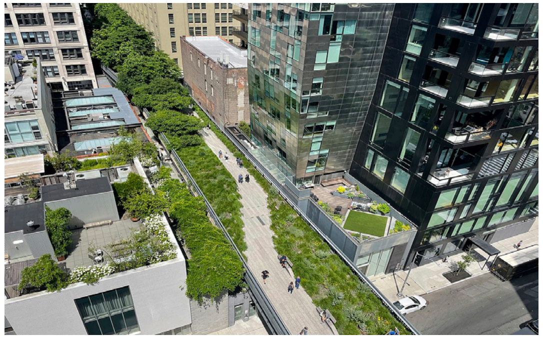
5) How do these unquantifiable costs and benefits stack up against your NPV?

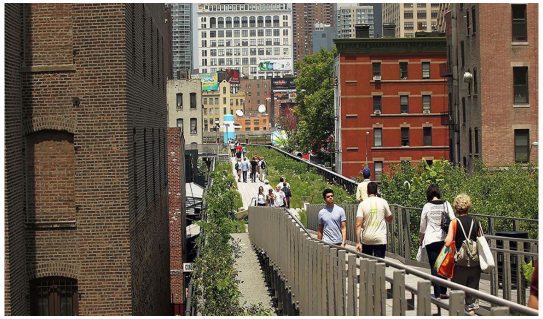
When evaluating the feasibility of a project, the Net Present Value (NPV) serves as a vital financial metric, offering a concrete estimate of the project's net benefits while considering the time value of money. This monetary figure is crucial for making economic assessments.

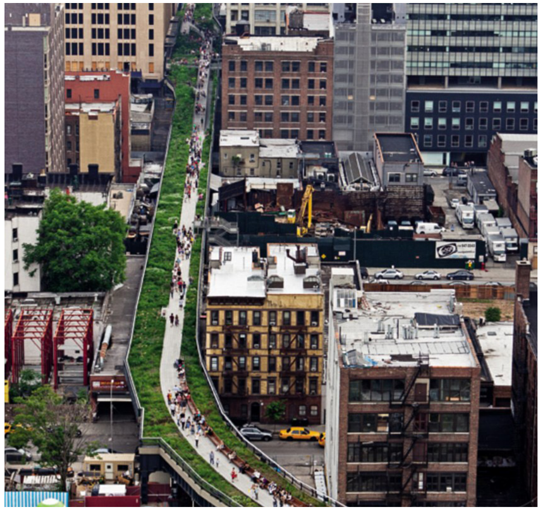
However, it's important to acknowledge that not all costs and benefits can be readily quantified in monetary terms. There are unquantifiable factors, such as a project's impact on the community's social fabric, happiness, and overall well-being, which play a pivotal role in its success and acceptance.

For instance, consider a scenario where a highway divides a community and restricts access to job opportunities. This could result in increased unemployment or underemployment, leading to long-term economic repercussions. Conversely, increased connectivity could also unlock potential, enhanced accessibility can stimulate economic growth and raise living standards for residents.

In essence, while NPV points to a postive economic outcome for the project, it is essential to balance this against potential non-monetary costs and benefits. A comprehensive evaluation takes into account both the tangible and intangible aspects, from economic indicators like jobs and growth to the less quantifiable dimensions of health and happiness. NPV provides a valuable numerical insight, but it alone cannot fully assess a project's worth. **To make a well-rounded judgment, we must listen to both the accountant's abacus and the community's voices, recognizing that some elements defy mathematical measurement and remain integral to a project's overall impact.**







6) Using the 2012 Philadelphia household travel survey, estimate the total time (use Model_TravTime instead of Survey_TravTime) that people spend traveling (include weights) and the average time people spend traveling.

The total time that people spend traveling (considering weights) is approximately 424,214,180.36 minutes.
The average time that people spend traveling (considering weights) is approximately 16.85 minutes per trip.

These figures are weighted averages, which means they account for the importance (or representation) of each trip relative to the overall population.

$$\text{Average Weighted Travel Time} = \frac{\text{Total Weighted Travel Time}}{\text{Sum of All Weights}}$$

7) Do the same calculation as above, but only for cyclists. What percent of total estimated travel time is accounted for by cycling?

Based on the provided data for cyclists:

- The total time that cyclists spend traveling (considering weights) is approximately 3,630,790.58 minutes.
- The average time a cyclist spends traveling (considering weights) is approximately 22.01 minutes per trip.

Percentage of Total Travel Time Accounted for by Cycling:

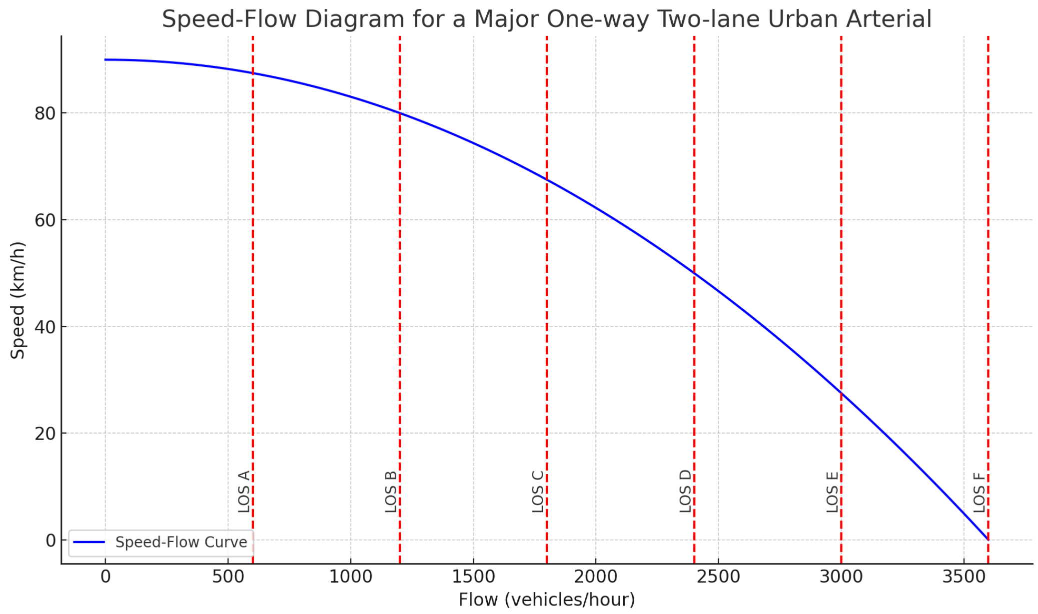
To ascertain the proportion of the overall travel time represented by cycling, we use the following formula:

$$\text{Percentage of Total Travel Time by Cycling} = \left(\frac{\text{Total Weighted Travel Time for Cycling}}{\text{Total Weighted Travel Time for all trips}}\right) \times 100$$

From our calculations, cycling accounts for approximately 0.856% of the total estimated travel time.

8) Draw a speed-flow diagram for a major one-way two-lane urban arterial. Label both the X axis and Y axis clearly and with numeric values. Indicate where on the diagram levels of service A through F go.

The x-axis represents the flow (in vehicles per hour).
The y-axis represents the speed (in km/h).
The blue curve represents the relationship between flow and speed. As flow increases, speed decreases.
The dashed vertical red lines divide the diagram into Levels of Service (LOS) A through F, which are equidistant on the volume axis.



Based on the assumptions:

Free-flow speed is 90 km/h
Capacity for the two-lane road is 3600 vehicles/hour
Levels of Service (LOS) A to F are distributed equidistantly across the volume range, with each interval being 1/6 of the total capacity.

9) Estimate how many people in total move through the space at maximum capacity by: car, large bus, small bus, and bicycle. Show your work.

- Cars: Assume its flow capacity is the same as in the previous speed-flow diagram, which is 3600 vehicles/hour.
- Bus: Due to its size and parking requirements, its traffic capacity is assumed to be 200 vehicles per hour.
- Minibus: Assume its traffic capacity is 500 vehicles per hour.
- Bikes: Assumed capacity of 1800 bikes per hour (depending on whether there are dedicated bike lanes).

Using the above flow capacity and the previously mentioned passenger capacity, we can re-estimate the total footfall for each mode of transport.

Based on the specific flow capacity and the previously mentioned passenger capacity, we get the following total footfall estimates for each mode of transportation:
Car: 5,400 people/hour (1.5 people/car)
Bus: 14,000 people/hour (70 people/bus)
Minibus: 10,000 people/hour (20 people/minibus)
Bicycle: 1,800 people/hour (1 person/bike)

10) Estimate an average hourly wage for each person (total household income/total hours worked in a year). (Use the HOURS data from the person file and assume 48 weeks of work per year. Use the midpoint method to switch income from a qualitative variable to a quantitative one.)

Data Pre-processing: Loaded the relevant datasets and filtered out individuals with no reported hours worked, ensuring they neither contributed to the total hours nor increased the household member count.
Income Conversion: Household income, initially provided as categories, was converted to a midpoint average value. For instance, the income bracket "$0 to $9,999" was represented by $4,999.5.
Household Aggregation: Summed up the hours worked for all working members in each household.
Wage Calculation: The average hourly wage for each household was derived using:

$$\text{Average hourly wage} = \frac{\text{Midpoint Income}}{\text{Total Hours worked in a year}}$$

Where "Total Hours worked in a year" is the aggregated hours from all working members multiplied by 48 weeks.

Analysis: Upon analyzing the resultant table, each entry provides a unique Household ID, the total hours worked by all working members of that household, the midpoint income, and the calculated average hourly wage. It's important to note:

Households with 'NA' in the average hourly wage indicates that the respective households refused to disclose their income.
By excluding non-working members from our calculations, the results present a more accurate representation of the earning distribution among households based solely on their active workforce.
This encapsulates the approach taken and the insights derived from the data.