

Part 2 - Experiment and metrics design

The neighboring cities of Gotham and Metropolis have complementary circadian rhythms: on weekdays, Ultimate Gotham is most active at night, and Ultimate Metropolis is most active during the day. On weekends, there is reasonable activity in both cities.

However, a toll bridge, with a two way toll, between the two cities causes driver partners to tend to be exclusive to each city. The Ultimate managers of city operations for the two cities have proposed an experiment to encourage driver partners to be available in both cities, by reimbursing all toll costs.

1. What would you choose as the key measure of success of this experiment in encouraging driver partners to serve both cities, and why would you choose this metric?

I would want to see that yearly/monthly Cash Flow has increased. Simply increasing trips across the bridge is not necessarily valuable because of the added expense of the bridge toll. I would want to ensure that the income generated from the potential trips across the bridge outweigh the added expense of the bridge toll. At minimum, a goal would be that the cash-on-cash return on investment (ROI) are higher than other ways the business would spend this money. For example, if I know the business generates 20% returns on the capital they reinvest in the business, this project would need to achieve > 20% returns for it to be worthwhile.

2. Describe a practical experiment you would design to compare the effectiveness of the proposed change in relation to the key measure of success. Please provide details on:

a. how you will implement the experiment

First I would need to determine what the total expenses for this project would be: expenses related to the tolls, marketing costs for launching this new feature, other costs etc. Let's say for example it is \$10,000. If I know I need to make more than a 20% return on my investment I would want to see that the business earns more than \$2,000 dollars (20% of the \$10k initial investment) of yearly cash flow (\$166.67/month after expenses) from this project.

Knowing this I would figure out how many additional rides the project would need to generate to hit this cash flow/ROI goal. For example let's say an average ride generates the company \$10 dollars in cash flow. So \$166.67 monthly cash flow goal / \$10 cash flow per ride = 17 rides. So in this example, I know this project would need to generate greater than 17 rides per month to make it a worthwhile investment.

With this information we could design an A/B testing experiment where some of the riders and drivers selected at random are made aware and have access to this toll free plan and another randomly selected control group do not. We could see how much this increases ridership and rides.

b. what statistical test(s) you will conduct to verify the significance of the observation

Let's say after conducting this experiment you see that 30% of the riders in the test group (toll free group) increased their rides by 10% vs. the control group (paid regular tolls, not aware of the plan) who experienced no change. If the test group was 1,000 drivers/riders then 300 of them (30%) increased their rides by 10%. Let's say the average driver/rider makes 10 trips a month then an increase of 10% would yield an additional 1 ride a month. Which in total comes to 300 new rides x \$10 cash flow per ride = \$3000/month in new cashflow. Which would make a 240% return on investment (\$3k monthly cash flow x 12 months) / \$10k initial investment for this project.

This seems to be totally worth... BUT is this change due to random chance? You could use bootstrapping to define measures of accuracy (ie. bias, variance, confidence intervals, prediction error, etc.) and test a null hypothesis that offering toll free rides does not increase cash flow.

c. how you would interpret the results and provide recommendations to the city operations team along with any caveats.

If the observed p-value from the above experiment enabled you to reject your null hypothesis. I would advise the company to roll this program out on a larger scale. Potentially they could use the data already collected during the A/B test to see which of the riders and drivers made the most trips across the bridge and target your marketing to this cohort.

If the observed p-value from the above experiment did not enable you to reject your null hypothesis (or even if it did and you simply wanted to increase the profit margin further):

I would advise the company to look into giving drivers/riders a partial discount for the toll (for example if the toll is \$10 - rider pays \$2, driver pays \$2) and see what the results would be in that scenario.

You could also bring this data to the entity that is in charge of the bridge tax and see if the company can get a reduced toll fee since they're paying in bulk AND increasing traffic (aka tax revenue) across the bridge. So if following the above example, for your total 10,000 total drivers if 3,000 (30%) of them increase their bridge trips by 10% - 3,000 new bridge tolls a month @\$10/toll generates the entity that oversees the bridge \$30,000/month = \$360,000 a year in additional revenue.