Transforming transportation in Tropolis

October 2013 | by Keita Hill

Client Goal

The fictional city of Tropolis in Canada has a metropolitan population of 2 million. Tropolis is growing rapidly at 3-5% per year. Car traffic is meanwhile growing at 4-6% per year. The City has expanded roads in recent years, but the growth in capacity has not kept up with increasing demand. Facing ongoing road congestion problems, the City Council of Tropolis has recently decided to shift away from road expansion and instead invest more heavily in public transportation. The Tropolis transportation department has asked ICA & Co. to provide advice on how to achieve this transformation.

Description of Situation

Car use in Tropolis is high, with 80% of all trips in the city made by car. Walking, public transit, biking and other options make up the remaining 20% of trips. The City of Tropolis operates a public transit network consisting of buses and light rail transit (LRT), which carries 11% of daily trips. Over the next 20 years, the City is looking to invest in its public transportation network to improve service range and quality and reduce the number of trips citizens choose to make by car. The City hopes that this will bring soical, environmental and health benefits, while reducing the cost of road construction and maintenance.

Procedurally, a strong candidate will:

- ☐ Take notes containing the most important information.
- ☐ Ask clarifying questions if required.
- ☐ Summarize the pertinent points.
  Example: "Tropolis is a Canadian city of 2 million with 8 million trips being made by car each weekday, and that's growing by about 5% per year. The City has asked us to determine how best to increase the accessibility and quality of the public transit network in order to reduce traffic congestion and save money on road expansion."

Answers to Clarifying Questions

How are trips defined?

— A trip occurs every time a person leaves one address in the city to go to another. If two people travel together, that counts as two trips. Trip data is collected by having a random sample of citizens keep track of every trip they make by foot, bike, public transit or car over a period of two weeks. This includes commuting to work or school, shopping, and recreational trips.

What are the primary goals behind reducing car use?

— The City's key strategic concern are the environmental, health and social benefits. A secondary goal is to reduce the cost of building and maintaining the road network. The main political drive for changes is traffic congestion at rush hour.

Does Tropolis have particular types of trips they are targeting to shift towards public transportation?

— Weekday commuter trips at rush hour are the most important, as they are the main contributor to rush hour traffic.

How many trips are made in Tropolis?

— I'm going to ask you to estimate that number. We know from a trip survey that 90% of trips are passenger trips and the remaining trips are delivery or logistical trips. The average resident of Tropolis makes 4.5 passenger trips per weekday. Based on that, how would you estimate the number of trips on a weekday? (If the candidate suggests taking a 24 hour screenline or doing a traffic survey, direct them away from this, asking instead for a rough estimation like the following.) Number of Passenger Trips = Number of trips per person × Trips/person, so 4.5 × 2 million = 9 million trips/day. Then, Total trips = 9 million passenger trips / 0.9 = 10 million trips.

1. What are the issues you would want to investigate to assess the existing transportation system in Tropolis?

Procedurally, a strong candidate will:

☐ Ask for time to structure and organize their thoughts before presenting them.

A *good* answer might consider both the accessibility and quality of available transportation options. The candidate may also compare these metrics to other cities.

Issues related to **access to the road and transit network** might include:

☐ Service range of buses and LRT, and how this varies by day of week, time of

day and region

- ☐ Where traffic congestion occurs and at what times
- ☐ Price of transit fares to the resident versus gas, insurance and capital costs of cars

Issues related to **quality** might include:

Public transit:

- ☐ Time to destination by car versus public transit
- ☐ Customer perceptions of public transit: for example, convenience, comfort, social acceptability, LRT versus buses
- ☐ Customer Service, safety, cleanliness, convenience of fare products
- ☐ Service frequency / average wait time, number of transfers

Cars:

- ☐ Road quality; for example, potholes, snow removal, etc.
- ☐ Driving experience
- ☐ Traffic light timing, speed limits, design of roads
- ☐ Convenience and cost of finding parking, refuelling and maintaining a vehicle

A *great* answer will consider the broader financial objectives of the City, in addition to the need to reduce traffic congestion.

- ☐ Cost of building and operating public transit versus road expansion and maintenance.
- ☐ Infrastructure alternatives, such as bike lanes and pedestrian boulevards.
- ☐ Policy alternatives to reducing car use such as toll roads, gas taxes, or increasing the cost of parking
- ☐ Risks, such as: Political opposition; Challenges acquiring land for new transit projects; transferring employees from road construction projects to transit projects.
- ☐ An attempt to qualify values like congestion, customer satisfaction, and transit time into an overall value per dollar spent.

2. Exhibit 1 shows the present day costs of maintaining roads and operating transit in three types of administrative regions in Tropolis.

What can you observe from this chart?

	Population	Area (km²)	Road Maintenance Costs in Region (Million CAD$)	Transit Operating Costs in Region (Million CAD$)	Trips made by Transit (%)
Region A	100,000	5	7.5	50	50
Region B	400,000	80	120	120	25
Region C	1,500,000	500	750	300	5

Procedurally, a strong candidate will:

- ☐ Take a moment to look at the data and organize their thoughts.
- ☐ Ask clarifying questions if required.
- ☐ Take some extra time to calculate some rough relationships between the data; for example, population density = Population / Area
- ☐ Identify trends that are not immediately obvious; for example, road maintance costs are a function of a region's area

A *good* answer might include:

- ☐ One or more of the synthesis calculations below:

	Population Density (pop./km²)	Area (km²)	Road Maintenance Costs per person (CAD$)	Transit Operating Costs per person (CAD$)	Transit Operating Costs per rider (CAD$)
Region A	20,000	5	75	500	1000
Region B	5,000	80	300	300	1200
Region C	3,000	500	500	200	4000

* More than is expected

- ☐ Even though Tropolis has an average transit ridership of 11%, there are large differences in ridership across the different regions.
- ☐ Transit ridership is higher in regions with higher population density.

- ☐ Tropolis spends the most on both road maintenance and operating costs in Region C, even when adjusted for each user.
- ☐ Operating costs per user for the transit network are highest in Region C, even though the costs per person are the lowest.

A *great* answer might include reasons for the trends observed, their significance, and limitations to the above conclusions:

- ☐ The total road maintenance and transit costs are lowest in Region A, at $575/person, $600/person in Region B, and $700/person in Region C. This suggests that regions with high transit use have lower overall ongoing transportation costs.
- ☐ Since road costs appear to be a function of area instead of population, reducing road use may not substantially reduce maintenance costs.
- ☐ Since road users can originate and end in different parts of the city than their place of residence, it may not be accurate to allocate road and transit expenses across different administrative regions.
- ☐ The service quality in Region C is likely worse than the other regions, since the expenditures per person are lowest, and the ridership the lowest.
- ☐ There are likely signficant barriers to improving transit ridership in Region C. The cost per passenger is six times higher. Even though Region C's ridership is only 10% of Region A's, costs of providing that tranist service are still at 40% of Region A's costs.

A *great* answer concludes by relating back to the initial problem statement.

3. One of the clients at the Tropolis Department of Transportation mentions that there is some political pressure to improve the farebox recovery ratio. This ratio is the percentage of transit operating costs recovered through fares.

She says, "Very large cities are able to bring in more in fares than the cost of running their transit systems. I think a high population density drives high farebox recovery ratios."

Based on Exhibit 1, in Region A, what amount would have to be recovered from each trip for the transit system to break even? Supposing current fares are at $1.40, what does this tell you?

How many trips does each resident make per day?

— The average resident of Tropolis makes 4 passenger trips per day and 4.5 passenger trips per weekday.

What about discount passes, fare evasion, etc.?

— Let's ignore those factors and determine the average amount per trip that the system would have to bring in to cover costs.

A *good* answer might include:

- ☐ The breakeven equation: Costs = Revenues
- ☐ From Exhibit 1, Costs = 50 million
- ☐ Revenues = Number of Trips × Ticket Price
- ☐ Number of Trips = Pop. × 365 days × 4 trips/day × 0.50 = 73 million trips
- ☐ $50 million / 73 million = $0.68 per ticket
- ☐ In Region A, transit is making a substantial 50% profit. This supports the hypothesis that high density areas are more financially viable for transit.

A *great* answer might note the significance that transit is actually making a profit in the highest density regions of the city.

- ☐ A candidate may also try to calculate the values for Region B or C for comparison; in this case, give the figures as $0.82 for Region B, and $2.74 for Region C.
- ☐ From this data, it looks like moving from a population density of 3,000 to 5,000 people per square kilometer has a tipping point effect on the costs of providing public transit, due to increased ridership.
- ☐ The client may need to further consider the impacts of density on the effectiveness of the existing network.

4. At this point in the analysis, you run into the City Manager of Tropolis and she asks how the study is going. What do you say?

Procedurally, a strong candidate will:

- ☐ Be prepared to give a summary right away.

- ☐ Have a strong structure in the summary. A possible approach is to state what is already discovered, what is in progress, what which areas remain for further study.
- ☐ Support all claims with data.

A *possible* conclusion would be as follows*:*

We have looked mostly at the existing costs of transit and compared these to the road costs. Both are highest in regions of low population density.

1. In regions of Tropolis with population densities of 5,000 or more, farebox recovery ratios are greater than one; in fact, these regions bring in about 5 times more in fares than they cost to operate, in effect subsidizing transit operations in the rest of the city.

2. Three quarters of Tropolis' population lives in regions with densities averaging 3,000 people. If indeed we discover that the 5,000 person per kilometer density represents a critical threshold for viable transit, increasing the density of these areas through policy measures is an area for further study.

3. Spending per person in low density regions is lowest, but the cost per passenger is highest. This indicates that understanding the key drivers behind customer transportation decisions will be important to understand where improvements to service range and quality will drive the greatest increases in ridership.

End of Case. Thank the candidate for their insights.

Feedback / Citing this Case

The ICA values your feedback. Send your comments to ica@ualberta.ca.

Hill, Keita. 2013. "Transforming transportation in Tropolis." University of Alberta Interdisciplinary Consulting Association: Edmonton, Alberta.

Exhibit 1.

	Population	Area (km²)	Road Maintenance Costs in Region (Million CAD$)	Transit Operating Costs in Region (Million CAD$)	Trips made by Transit (%)
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