Research:

* Relevant transport optimization models
* Statistical technique to address limited data (i.e. Bootstrap)
* Advanced simulation techniques: Stochastic Processes.
* Look at existing fleet management softwares
* Cost estimate of building the storage, demand estimate=> james
* Models catering to high volatility (Scooter vs bus)

Simulation Model:

Optimization Model:

<http://www.transportmodeller.com/distributionoverview.html>

What to determine (decision Variables):

1. # of Kiosks
2. # of vehicles per kiosks (Maximum Parking capacity)

What is the objective (basic):

1. Maximise Profits (see SMRT’s objective)
2. Maximize self-redistribution

Constraints:

1. Solvency @ each kiosk. (i.e. P(finding a scooter)=[0.90, 0.95])
2. Budget Constraint=> optional

Parameters (Raw data):

1. Demand distribution
2. Cost estimates

Assumptions:

1. Land Rental cost= $0

Cost Estimates:

1. Variable Costs => ESD
2. Fixed Costs
   1. Manufacturing cost per vehicle ⇒ Depends on design of prototype (Electrical components, mechanical components)=> EPD
   2. Infrastructure building cost per kiosks ⇒ Depends on design of kiosk and things contained inside it. (i.e. charging, locking, RFID sensors) ⇒ EPD & ASD

Tasks of ESD in term 8:

|  |  |
| --- | --- |
| Tasks | Time Estimates (Days) |
| Identifying variables & relationships between cost and variables (Equations) | 5 |
| Model fitting to capture demand distribution since demand is r.v. | 4 |
| Design the simulation model (Equations, Pseudo code) | 14 |
| Simulation Run, Collect Statistics: Solvency using simulation at each Kiosk (Get from ASD where are the kiosks located) | 7 |
| Design the Optimization model (Equations, Pseudo Code) | 14 |
| Optimization 1: Maximize self-redistribution, limit Ops cost. | 7 |
| Optimization 2: Minimize ops cost, limit self-redistribution. | 7 |
| Pareto Plot (Operation cost vs Self-redistribution) [OPTIONAL] | 1 |

Deliverable: # kiosks to set up, #vehicles to place at each kiosk

REFERENCES

<https://www.smrt.com.sg/Journey-with-Us/Fares-Claims#BusFares>

Final slide,

why 2 node model when u hav generalized model?

- cos 2 node enable us to validate WORTH of redistribution. cos if it fails on 2 node. it suffices to say it will fail on generalized as it will require more trips (higher cost) between nodes per redistribution.

- gives a convinient and suitable platform where we can analyze the fundamental characteristics of crowd behavior if the project is implemented. It's like calculus in 2 dimensions. Generalized model is simply an extension.

Game theory to tackle redistribution problem:

How could you incentivize users such that they help to relocate scooters? What would be user payoff? What would be firm’s payoff? What are the nash equilibria?

The game is activated only at a certain period of the day. (typical when most imbalance is seen. I.e. surplus at 1 node, sarcity at another at same time t.)

Whoever uses the ride, in that period, gets paid instead of paying, as long as he brings a scooter from surplus location to scarce location. The user faces cost of travelling from home area to another area where exist a surplus location.

SMRT wants to minimize price it pays to these helpers.

Model as complete info, dynamic, for infinite period (include trigger punishment if neccesary)

**Pre simulation**: we are to decide , in a heuristic manner, how many kiosks and how many

scooters at each kiosk (or the MRT) we must initialize such that project budget is not

exceeded. We also set the proportion of the population looking to use the electric scooter

and distribution of demand over all kiosks from that proportion. Lastly, we set price (from

interpolation) and estimate cost per usage of the scooter between the MRT and every

kiosk.

**Simulation**: we generate the entry and exit population at the mrt every 15 minutes. Then,

proportion and distribute them accordingly. The output of these are demand and supply of scooters at each kiosk (/MRT). Following is the model dynamics at every kiosk or MRT:

Supply out of a kiosk(or MRT) = minimum(Demand at the kiosk(or MRT), Total number of Scooters remaining at the kiosk(or MRT)) at every 15 minutes.

Every 15 minutes, we observe how much demand is lost and how much operational cost

is incurred on a scooter. We simulate this process and collect statistics like percentage of

loss demand in the entire process, average loss demand for every 15 minutes interval and average operational cost over the entire process.

**Post simulation**: Using all the price and cost estimates (i.e. maintenance and purchasing cost of 1 scooter, cost of building each kiosk, together with the average operational cost and derivation of unique demand from simulation, we will build a profit function. This function will tell us how much is the monetary value of deploying a certain number of kiosks and a total number of scooters to accommodate in each of them. A possible extension to this function would be to include a subscription price per unique demand. However, this will introduce another decision variable as we will have to decide the subscription price for participating in the sharing system.

*Assumption Made:* Relative ratio of demand and supply among all kiosks is the same across all time

Intervals. Consider the following:

|  |  |  |
| --- | --- | --- |
|  | T = 1  Demand(1)= 500 | T = 2  Demand(2)=700 |
| Kiosk 1 = \*Demand(t) | 150 | 210 |
| Kiosk 2 = \*Demand(t) | 350 | 490 |

We notice that demand ratio between kiosk 1 and 2 always the same regardless

of the time interval. This is may not be always true in reality.

*Possible Extension:* A possible extension to this function would be to include a subscription price per

unique demand. However, this will introduce another decision variable as we will

have to decide the subscription price for participating in the sharing system.

**Pending Information:**

1. Electricity usage per unit distance [EPD]
2. Budget for the project [SMRT]
3. Cost of building a bus stop [SMRT]
4. Cost of purchasing and maintaining an Inokim Light. [EPD]

1. Budget allocated for a full scale project

2. Estimated infrastructure cost for building a bus stop

3. Space constraints at MRT

For questions 1 and 2, please use a value of SGD 100,000 per installation site. For further information, you can refer to the following news articles and new releases from LTA to help gauge the estimated cost of installing a bicycle rack.

Elizabeth Kamaldin (2012, Oct 30). MRT stations get 1,500 new bike parking racks. MyPaper. Retrieved from http://news.asiaone.com/News/Latest%2BNews/Singapore/Story/A1Story20121030-380347.html

LTA (2012, 29 Oct). More Bicycle Parking Facilities with Enhanced Security Features at MRT Stations Islandwide. Retrieved from http://www.lta.gov.sg/data/apps/news/press/2012/ANNEX%20A\_Bicycle%20Racks%20Batch%201.pdf

For question 3, please explore if the proposed scooter racks can be located next to existing bicycle racks at the station.