

Carnegie Mellon University

AutoMerge

A Transportation Alternative for NYC

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Problem

Problem

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Pilot Study

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Conclusion

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Overview

- ▶ NYC to become a leader in *smart city* infrastructure
- ▶ One piece: Evaluate autonomous vehicles
- ▶ By 2020, NYC expects its fleet to be autonomous.
- ▶ We will evaluate AutoMerge (AM) Inc as an alternative.

Alternatives

Description

Alternative 1 Do Not Implement AM.

This are the costs that would be incurred if the status quo continues so there is little uncertainty for this alternative.

Alternative 2 Implement AM.

Implementing AM comes with uncertainty with respect to AM performance.

Alternative 3 Perform a pilot study.

We decide size of pilot study. A larger the study reduces more uncertainty than a smaller one but costs more.

Some Costs, Calculations, and Assumptions

Congestions, Capital, and Human costs

	Variable	Value	Notes
Costs	(a) # buses with age < 5 years	2313	Source: [3]
Uncertainty	(b) # buses with age 5-9 years	1296	Source: [3]
Results	(c) # buses with age 10-20 years	1437	Source: [3]
Pilot Study	(d) Capital Cost per bus age < 5 years	\$ 5000	Source: [3]
Sensitivity	(e) Capital Cost per bus age 5-9 years	\$ 6500	Source: [3]
Conclusion	(f) Capital Cost per bus age 10-20 years	\$ 8500	Source: [3]
References	(g) Total Capital Cost(*)	\$ 45.7 Million	= (a)*(d) + (b)*(e) + (c)*(f)
	(h) Annual O&M Cost per Bus	\$ 1500	Source: [3]
	(i) Total Annual O&M Cost (**)	\$ 7.6 Million	= [(a) + (b) + (c)]*(h)
	(j) Annual Cost per Commuter	\$ 1739	Source: [5]
	(k) Annual hours in congestion per commuter	74 hours	Source: [5]
	(l) Cost per minute	\$ 0.39	$(h) / [(i) * 60]$
	(m) Total person trip per day	1.52 million	Source: [4]
	(n) Average time in daily person trip	49 minutes	Source: [4]
	(o) Total annual congestion cost	\$ 10.5 Billion	= 360*(l)*(k)*(j)
	(p) VSL (2015 \$)	\$ 8.7 Million	Source: [1]
	(q) Number of fatalities per year	16	Source: [4]
	(r) Total annual mortality cost	\$ 150 Million	= (p)*(q)
	(s) Average Cost of Injury	\$ 179,000	Source: [2]
	(t) Number of injuries per year	1740	Source: [4]
	(u) Total annual injury cost	\$ 311 Million	= (s)*(t)

Uncertainty

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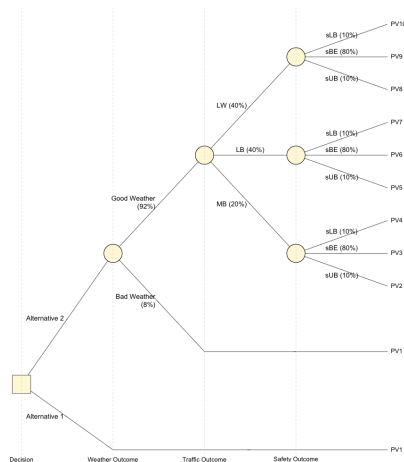
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- We account for uncertainty using decision trees.
- Source of uncertainty: Performance, Safety, and Weather
- We calculated Expected NPV for each outcome to evaluate.



Results

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- ▶ Alternative 2 outperforms 1 in total cost.
- ▶ Congestion costs are based on total travel time.

Expected Cost in Billions (\$)

	Alternative 1	Alternative 2
Capital Costs	0	0.05
O&M	0	0.06
Mortality	1.45	1.39
Injury	3.23	3.11
Congestion*	109.12	107.16
Air Pollution	10.55	10.55
GHG	0.8	0.8
Total	125.15	123.12

Pilot

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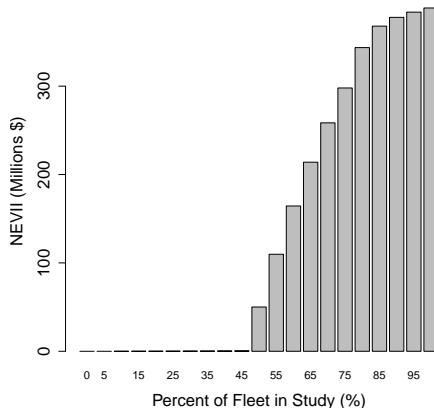
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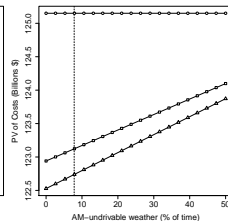
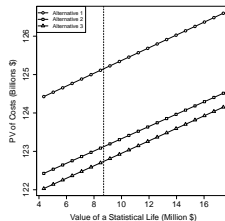
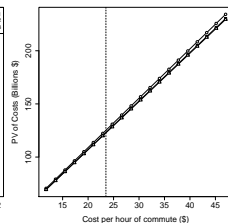
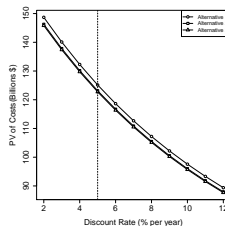
References

- ▶ Uses EVII and Bayes Theorem to compute
- ▶ Figure shows value study after associated cost.
- ▶ Value optimized at 100% of fleet



Sensitivity Analyses

- ▶ Input values varied between 50 and 200% or more.
- ▶ Discount rate, VSL, and per person cost of commute time all greatly affect net expected cost but similarly for all.
- ▶ Weather affects alternatives 2 and 3 more than 1 but alternative 1 remained more expensive.



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- ▶ Given uncertainty, investing in AM reduces cost over not investing.
- ▶ Using a risk-neutral metric, performing any pilot study with at least 50% of fleet adds value.
- ▶ Using 100% of fleet maximized value
- ▶ This recommendation is robust to necessary assumptions.

References

Questions?



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