

Introduction

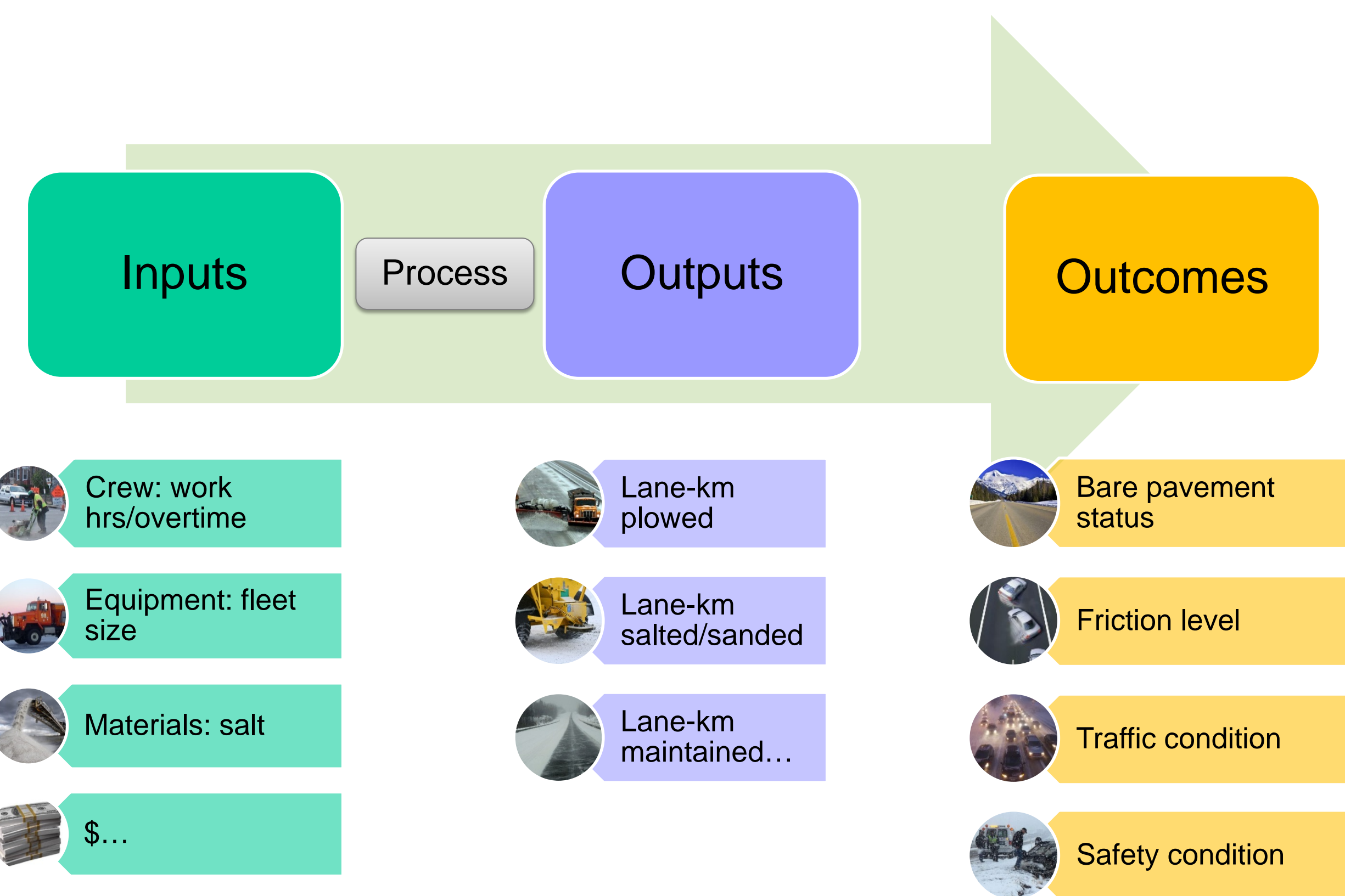
Background

For transportation departments responsible for winter road maintenance (WRM), performance measurement and establishment of service standards are the essential ingredients for their ensured success. This has become even more so recently due to increased privatization of winter maintenance work and increased public concerns over the detrimental effects of road salt on the environment, the infrastructure, and the vehicles. However, there are two particular challenges in establishing appropriate WRM performance measures and service standards. First, the main determinant of winter maintenance efforts and outcomes is the snow storms which vary over space and time considerably, which makes it difficult to conduct some of the common performance measurement tasks such as performance benchmarking and trend analysis. Secondly, the relationships between the outcomes of maintenance operations (e.g., safety and mobility), outputs (e.g., bare pavement recovery time and pavement friction), and inputs (e.g., amount of salt used and hours of operations) are confounded by many uncontrollable variables such as storm severity, road characteristics, and traffic conditions, making it difficult to develop performance measures and service standards that are both outcome oriented (attributable) and controllable. Therefore, WRM remains to be a sector that lacks uniform performance measures and service standards.

Why Measure Performance?

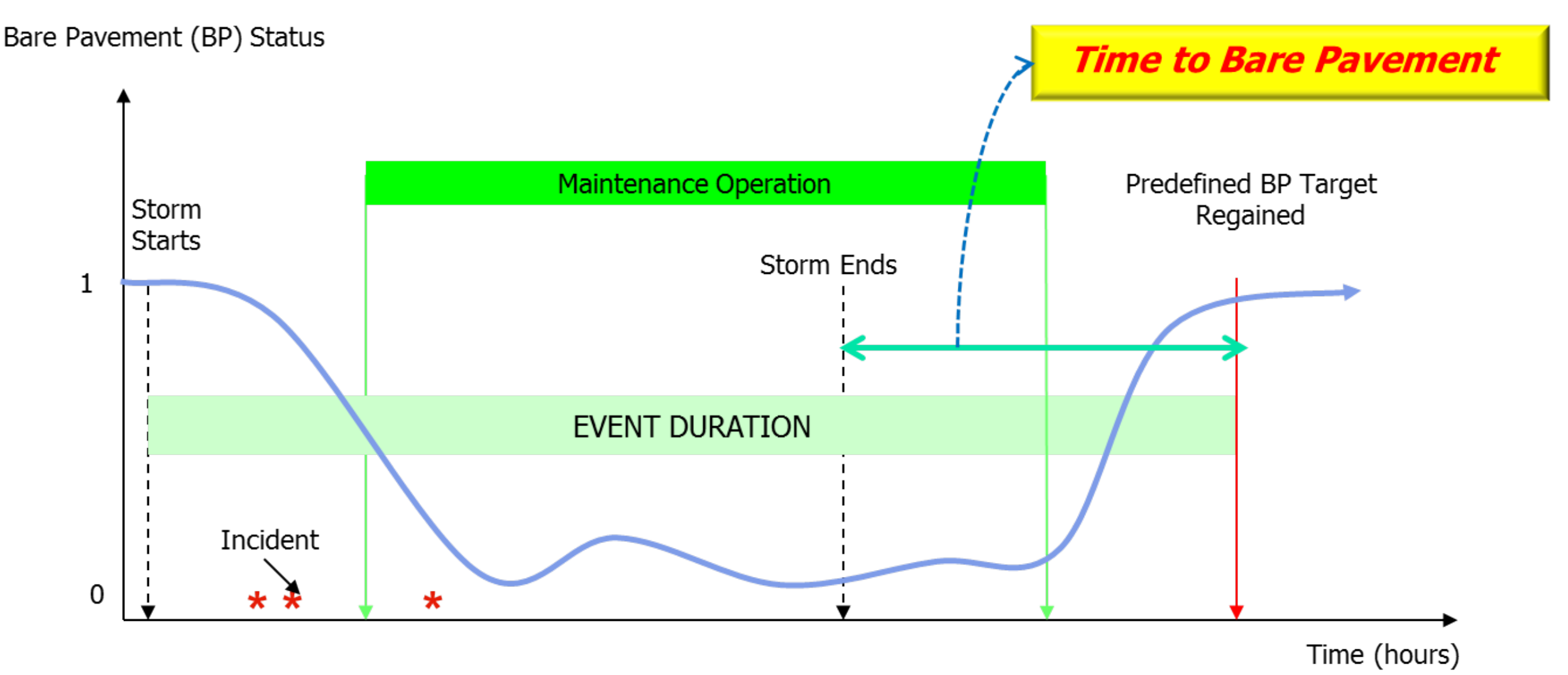
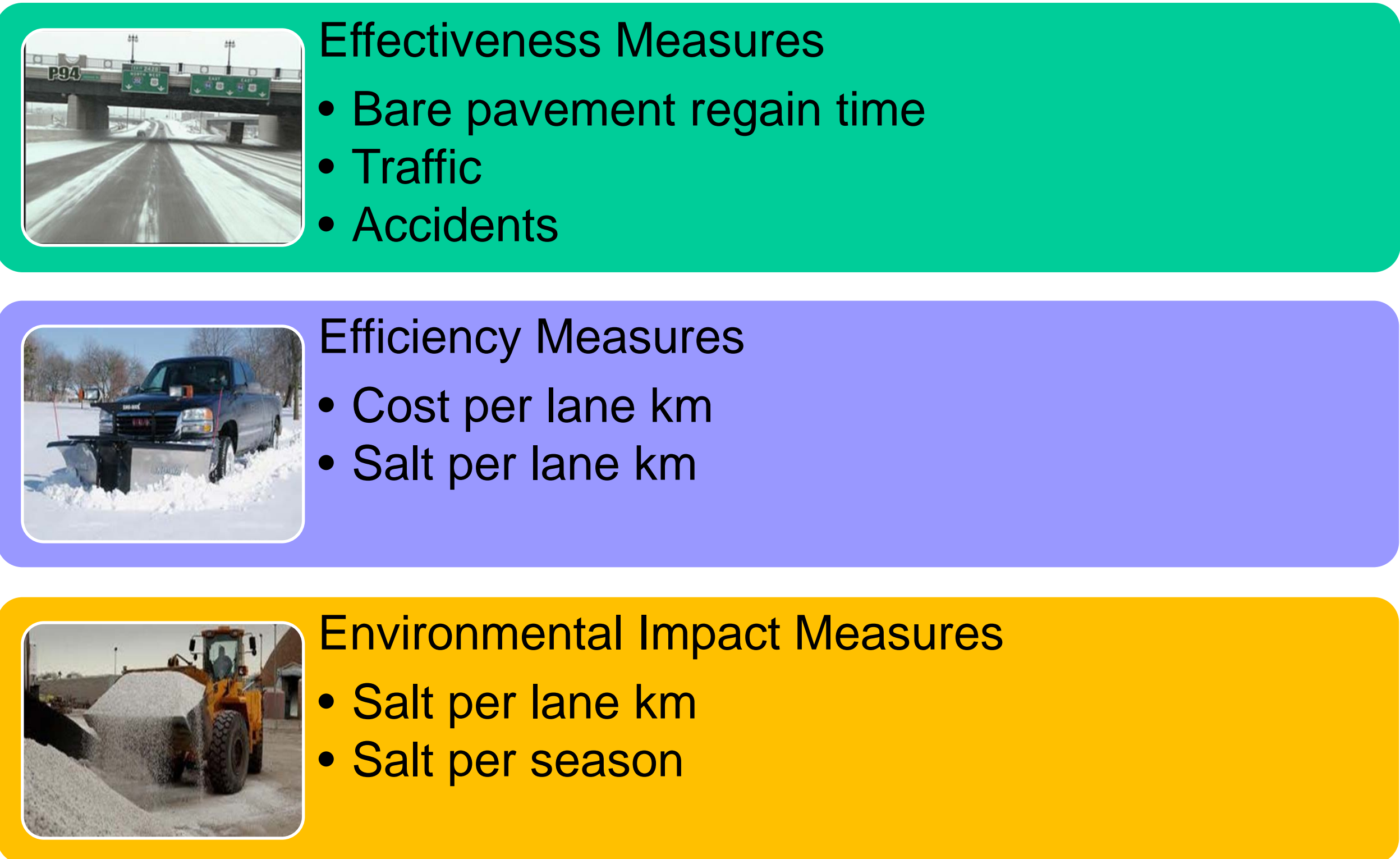
- To tell a convincing story, we must use numbers with meanings, i.e., performance indicators. We can use these performance indicators to tell
- how well we are doing
 - how well we are meeting our goals
 - are our customers satisfied
 - are our processes in control
 - where could we improve

Performance Measurement Framework

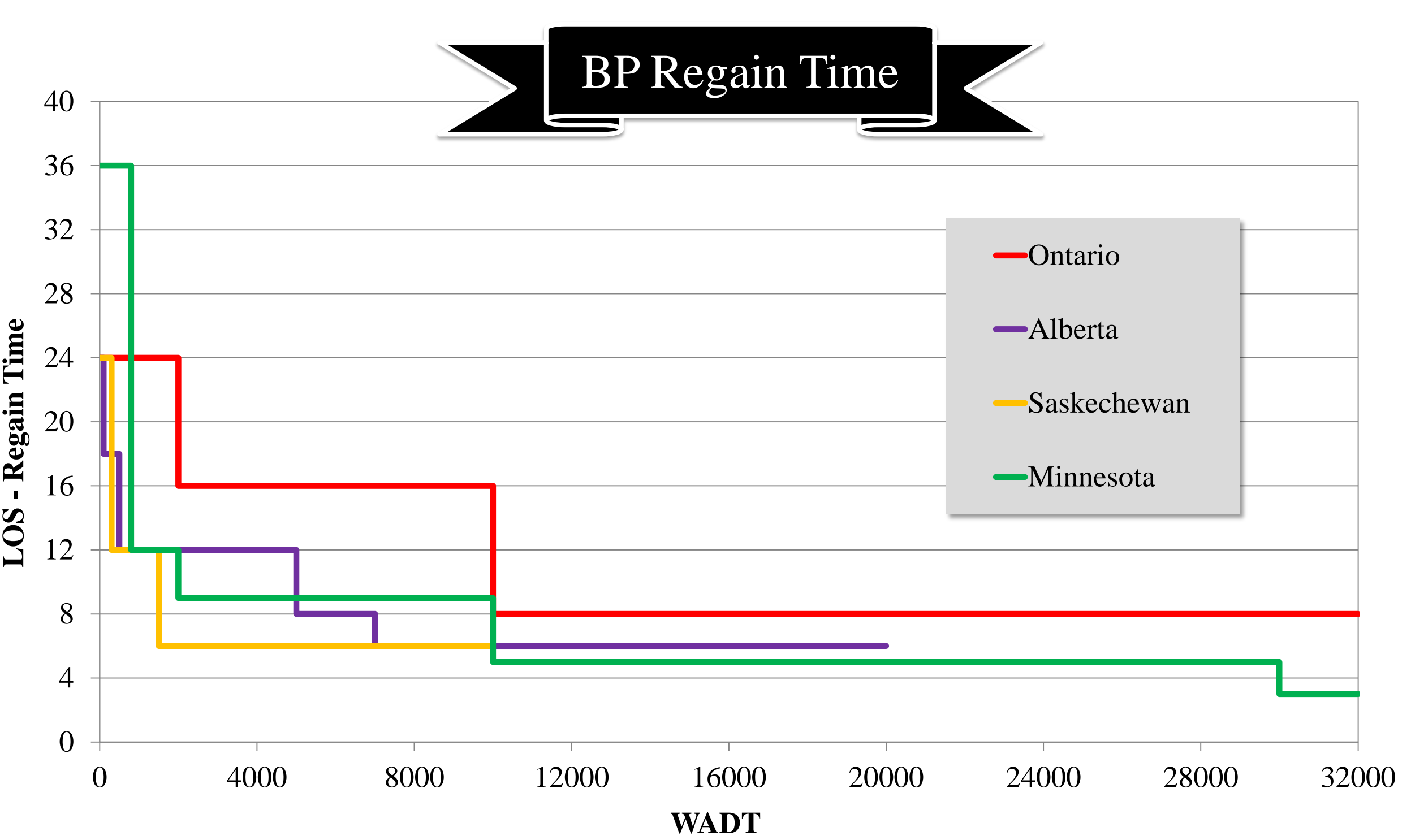


Current Practice

Performance Measures



Maintenance Service Standards

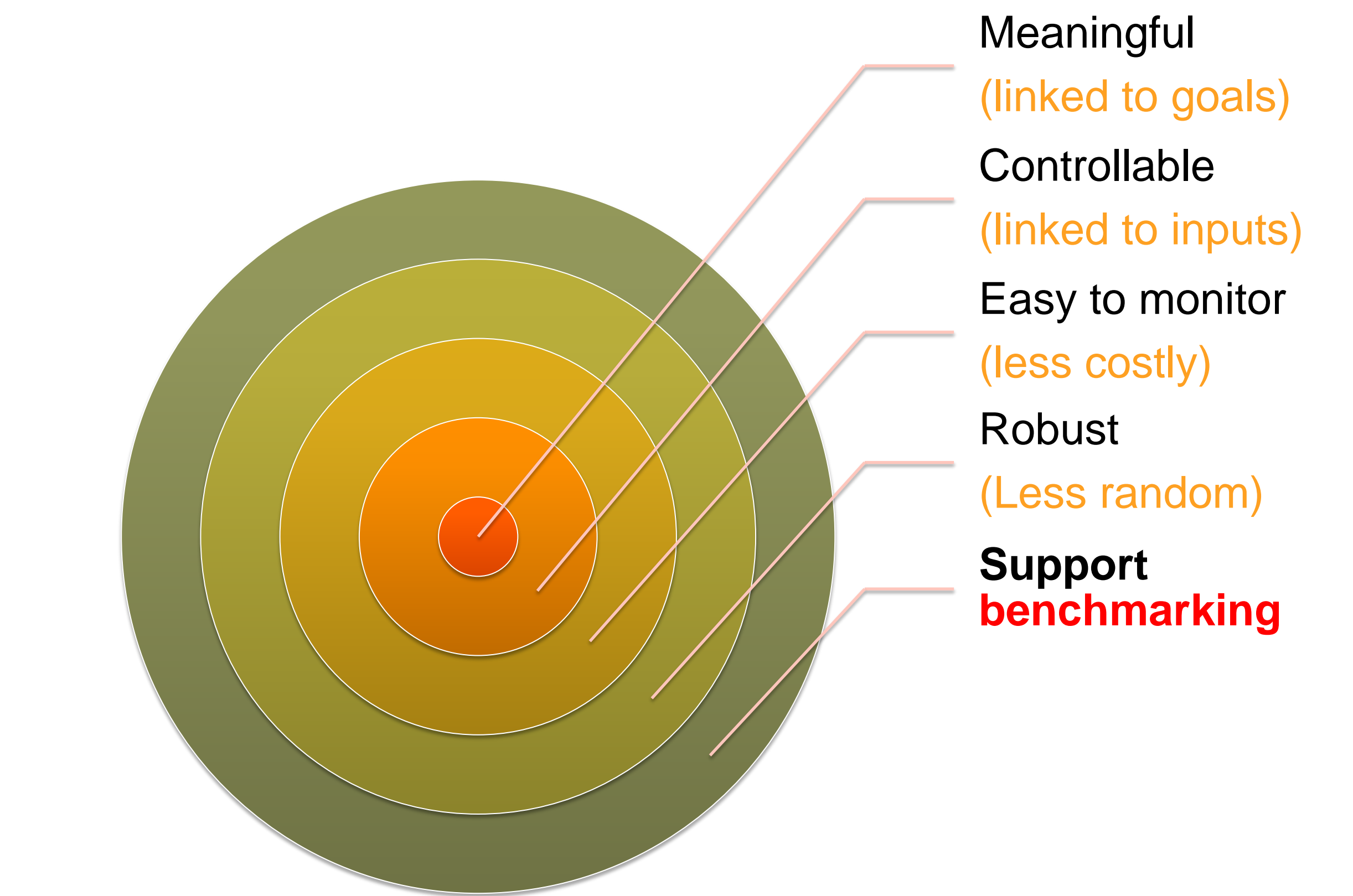


Other standards

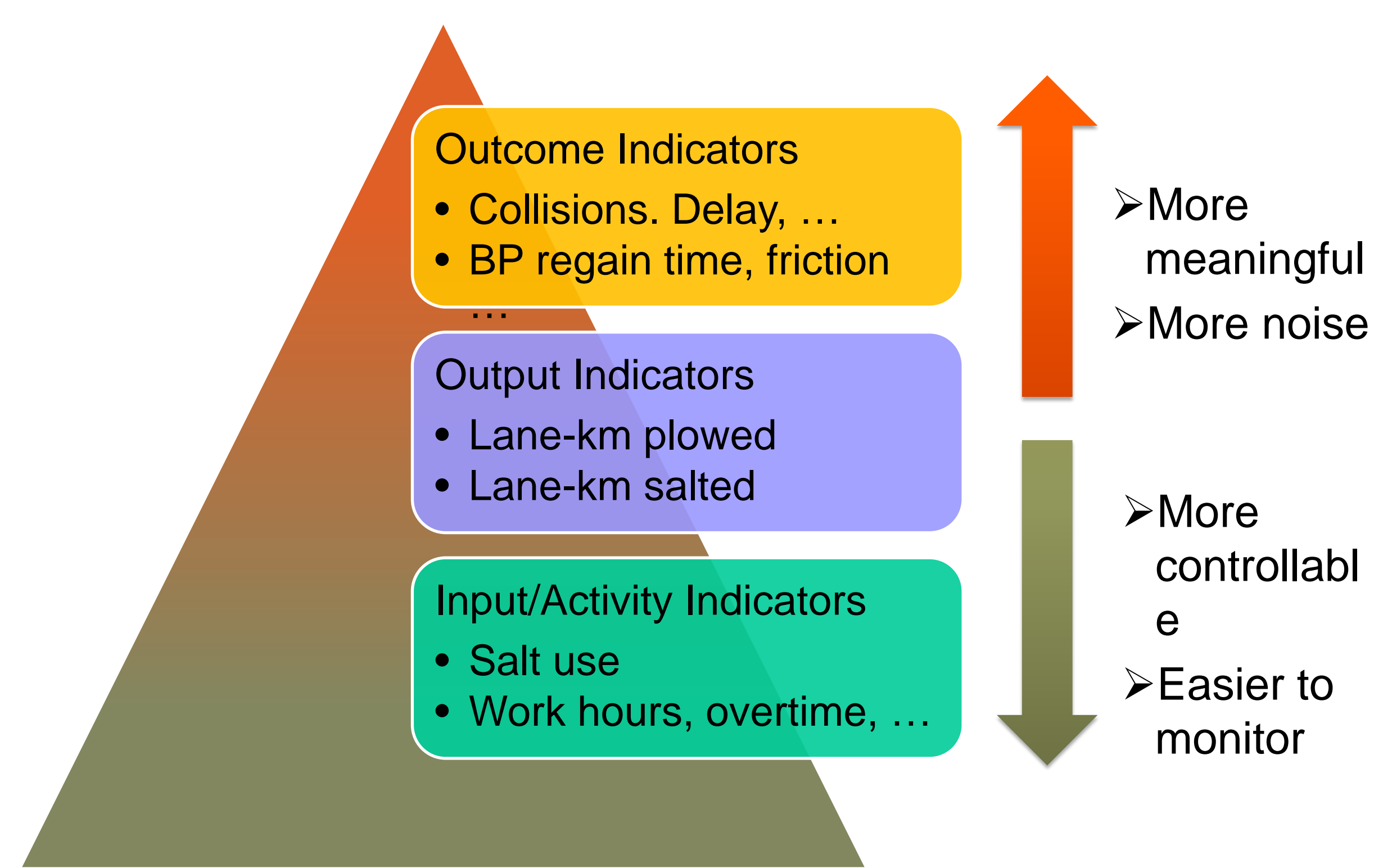
- Snow depth
- Circuit time
- Response time
- Salt usage

Alternative Performance Measures

Goodness of Performance Measures



Trade-Off of Best Performance Measures



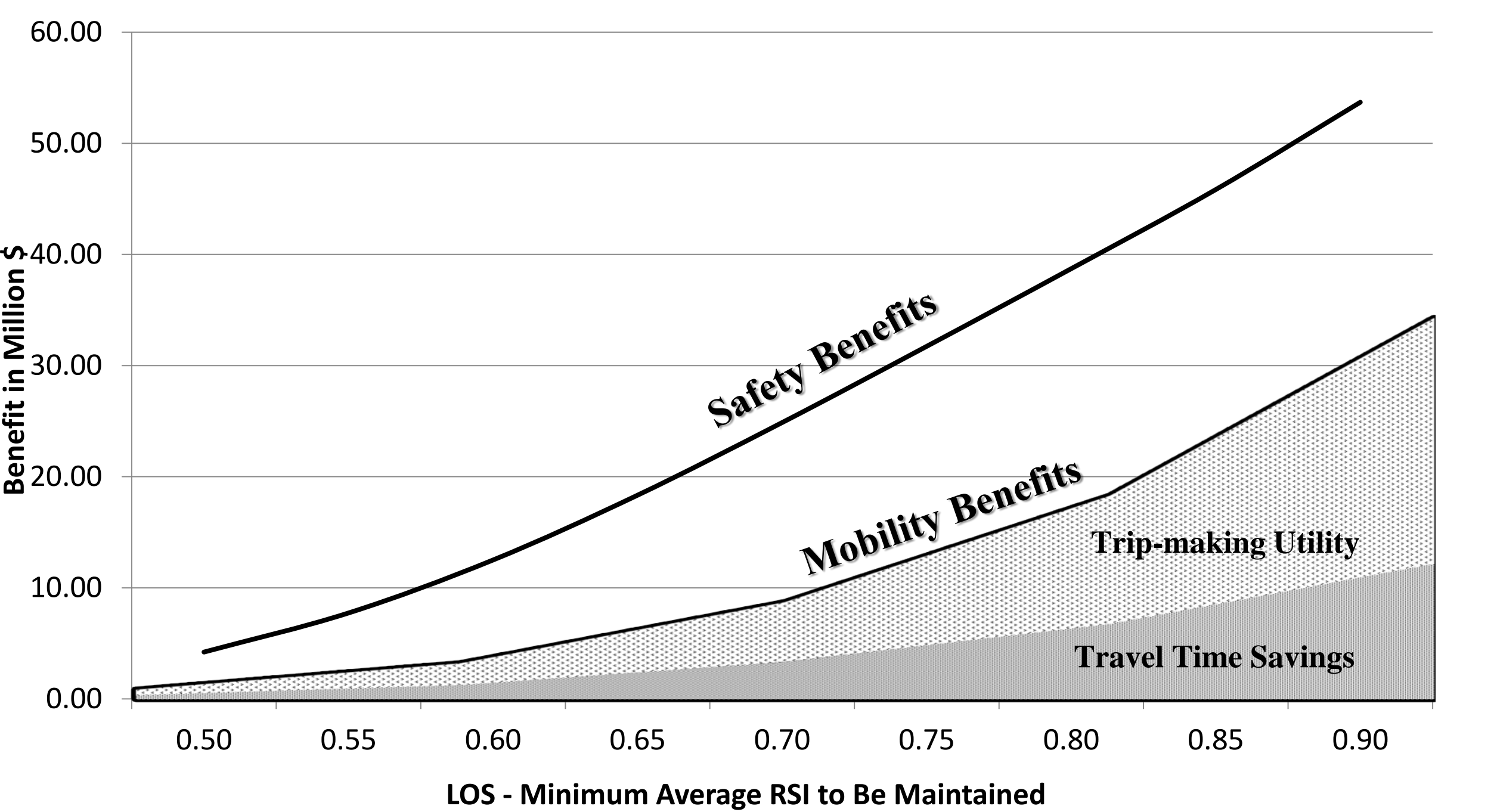
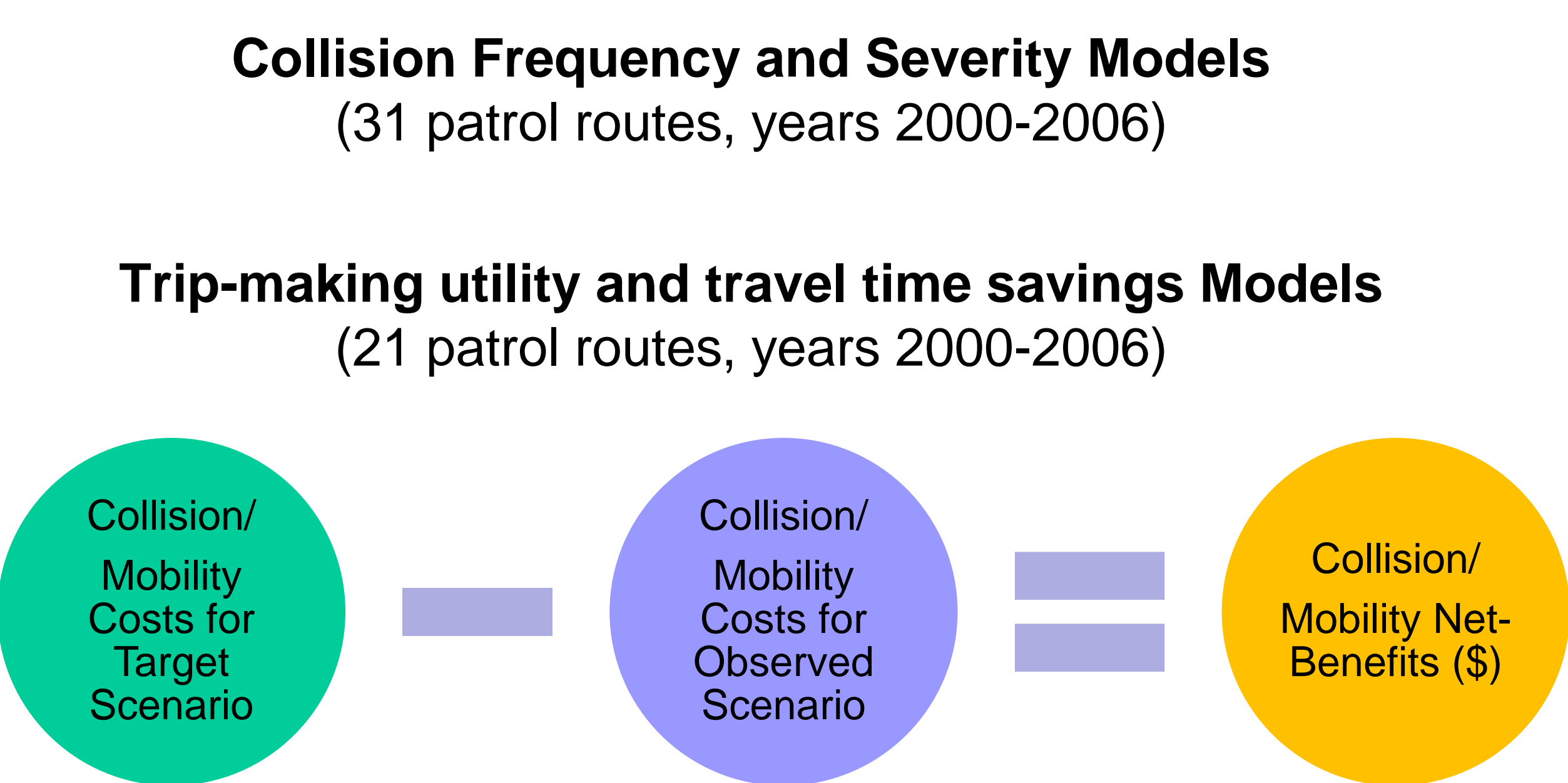
A Rating Matrix of Performance Measures

Goodness of PM	Meaningful	Controllable	Easy to Monitor	Robust	Support Benchmarking
PM					
Average Collision Rate	H	L	H	L	L
BP Regain Time	H	M	H	M	M
Friction Level	H	M	L	M	M
Traffic Speed Recovery Time	H	L	M	L	M
Average Speed	H	L	M	L	M
Lane-km plowed	M	M	H	H	L
Lane-km salted	M	M	H	H	L
Total Cost per lane km	M	M	H	H	L
Total Salt Usage	L	H	H	H	L
Work hours	L	H	H	H	L

H: High, M: Median, L: Low

Case Study – Ontario Highway Network

Safety & Mobility Benefits of Alternative LOS



Relation between Collision Frequency and RSI

Optimum level of service from safety perspective can be identified by investigating nonlinear relationship between collision frequency and road surface index through nonparametric modeling.

