Integrated Preventive Maintenance and Logistics Decision-making and Its Extensions

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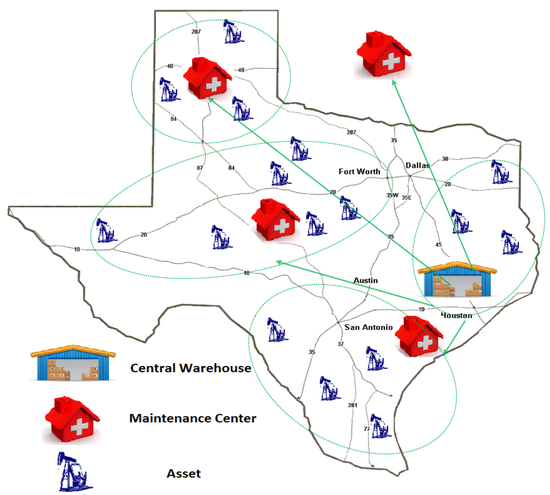
INTRODUCTION

Motivation

Improve maintenance service on geographically distributed assets by developing an integrated decision-making policy to capture maintenance and logistics decisions

Contribution

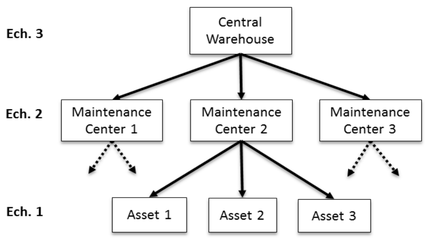
- A novel decision-making framework to jointly optimize maintenance and logistics operations for geographically distributed systems
- Improved asset availability and reduction in operating cost
- Evaluation of effects of the advanced system operations, namely inventory sharing between facilities, opportunistic maintenance operation imperfect maintenance operation, expedited RM delivery and (s,S) batch replenishment policy



METHODOLOGY

Problem Description of Basic Model

- Multi-facility logistic network
- Multi-part degrading assets
- Usage-based PM policy
- (S-1,S) replenishment policy



Solution Methodology

$$minimize \quad \frac{1}{T} E\left\{\sum_{j=1}^{n}\left[h_j H_j + s_j S_j\right] + \sum_{i=1}^{k} d_i D_i + \sum_{i=1}^{k}\sum_{j=1}^{n}\left[(V_{ij}^{r} + A_i\alpha_i)N_{ij}^{r}\right] + (V_{ij}^{p} + B_i\beta_i)N_{ij}^{p}\right]\right\}$$

$$[(v_1,V_1),(v_2,V_2),\cdots,(v_n,V_n)]$$

$$\begin{bmatrix} PM_{11} & \cdots & PM_{1n} \\ \vdots & \ddots & \vdots \\ PM_{k1} & \cdots & PM_{kn} \end{bmatrix}$$

$$[\alpha_1,\alpha_2,\ldots,\alpha_k]$$

$$[\beta_1,\beta_2,\ldots,\beta_k]$$

Decision Variables:
- PM Recovery Rate
- Delivery Acceleration
- PM Trigger Time
- Inventory Level

- Inventory-related costs (storing & delivery)
- Downtime penalty costs
- RM ordering costs
- PM ordering costs
- Decision risk

- i : Index of asset
- j : Index of component
- Φ : Joint decision
- H_j : Cumulative inventory storing time
- S_j : Cumulative inventory restocking time
- D_i : Cumulative asset downtime
- N_{ij}^{r} (N_{ij}^{p}): Reactive(preventive) maintenance counter

Extension I

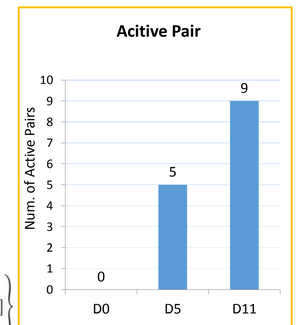
Opportunistic Maintenance

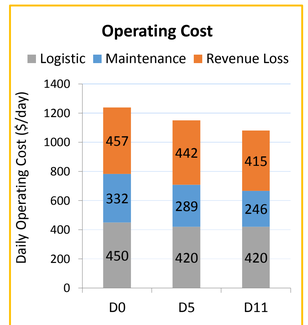
"convenient" replacement of equipment components by taking advantage of unplanned or planned shutdown

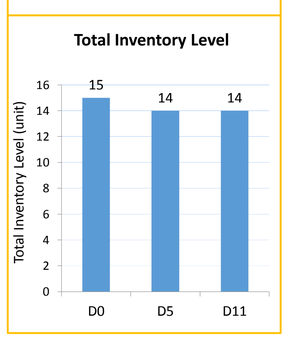
Dependency group: a set of parts that can be maintained together

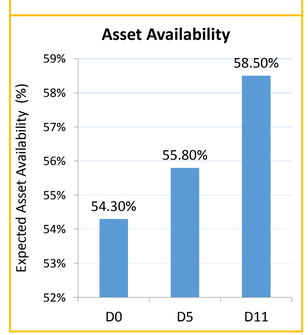
Simulated System 1: 1 maintenance center, 10 assets, 52 DVs

Dependency pair set : $D_0 \sqsubseteq D_5 \sqsubseteq D_{11}$

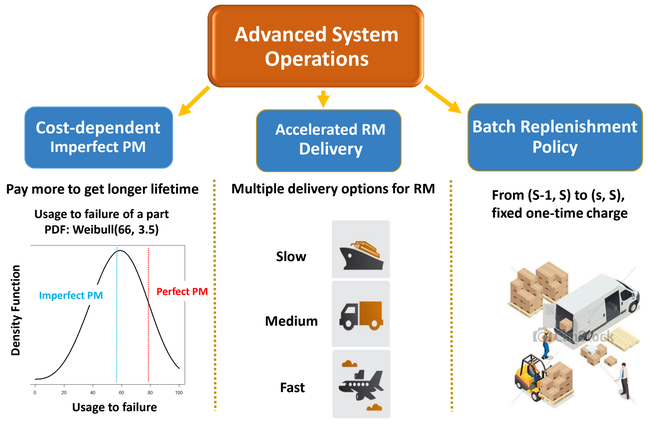




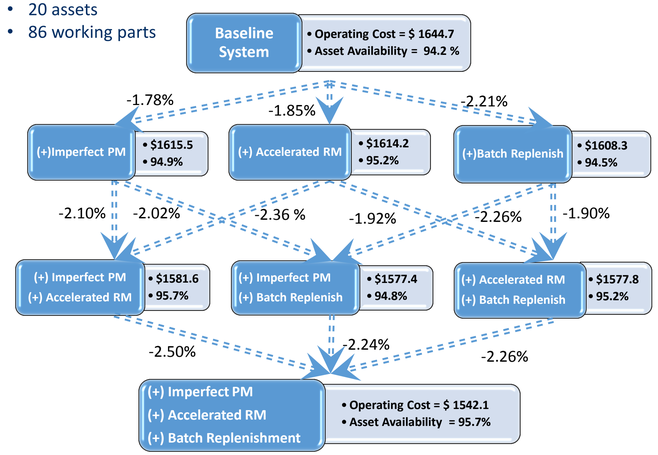


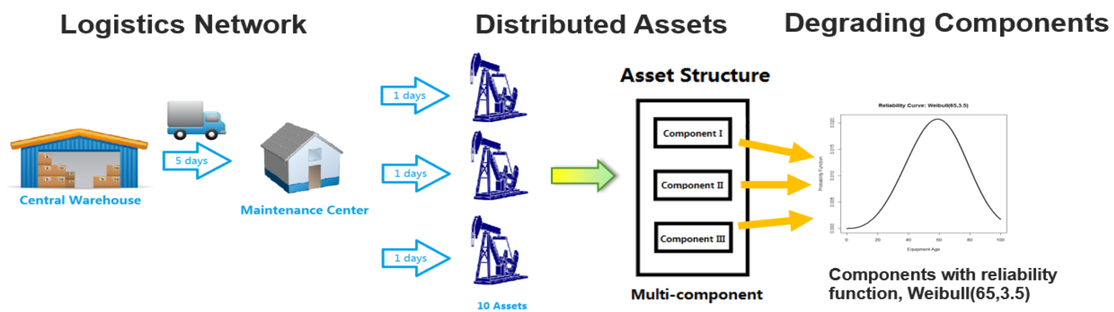


Extension II



Simulated System 2:
- 1 maintenance center
- 20 assets
- 86 working parts





ONGOING WORK

1. Logistic network optimization: optimize the locations and interconnections of the maintenance facilities and assets
2. Integrated decision-making for the system with uncertainties in the system parameters