A decision tool for portfolio selection aiming to replace Air Supply Houses

Funding Sources: General Motors Company

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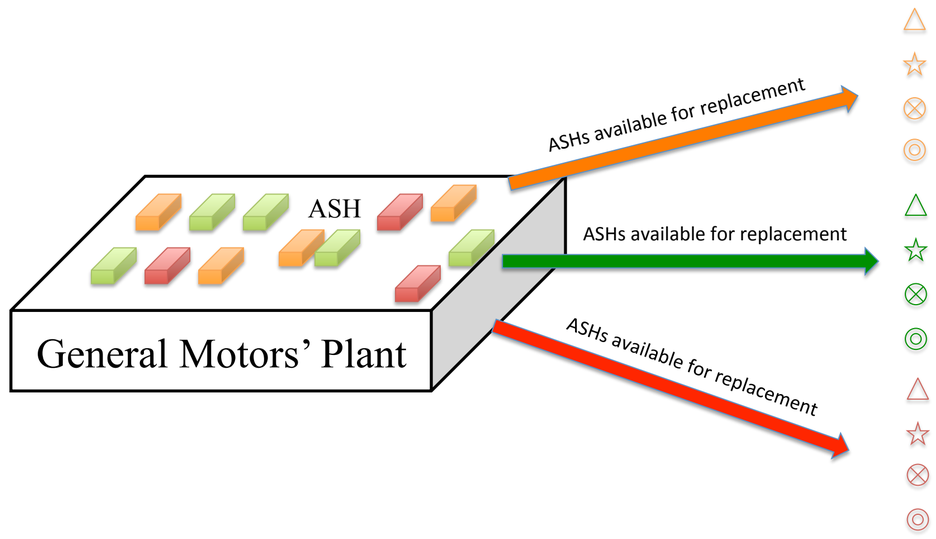
Objectives

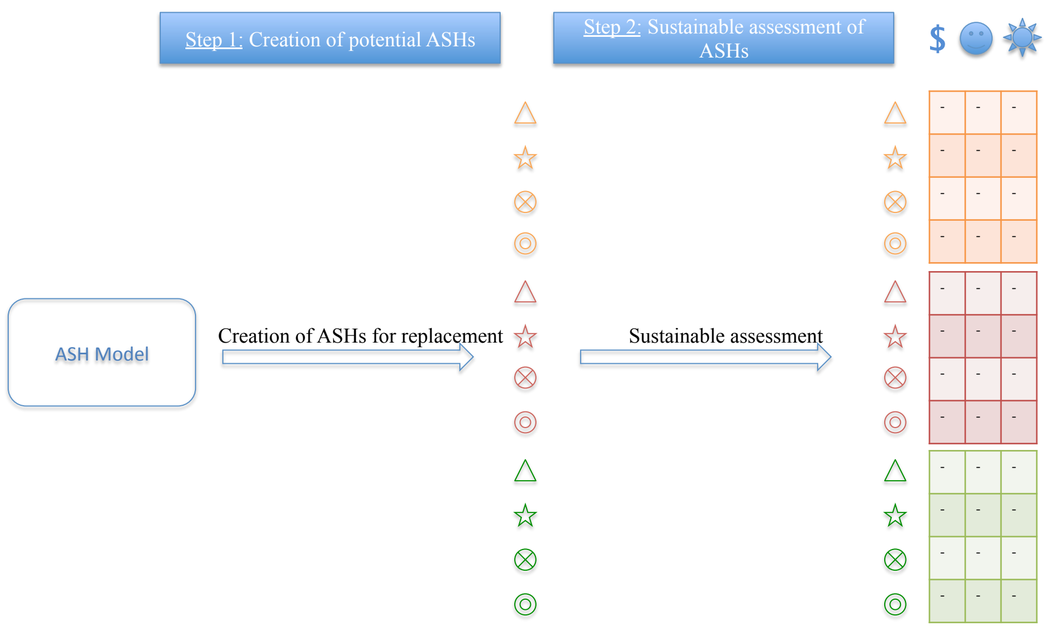
- Create a decision tool for portfolio selection aiming to retrofit Air Supply Houses on a General Motors' plant with a sustainable objective in mind:
  - Selecting the Air Supply Houses available for replacement
  - Assess the sustainable impacts of Air Supply Houses: economical, environmental and social impacts
  - Evaluate the different alternatives with the 3 criteria: economical, environmental and social impacts
  - Allocate capital with financial and technological constraints

Introduction

- Assessing sustainability is a Multi-Criteria Decision Problem
- To simplify the problem, only 3 families of ASHs and only 4 ASHs available for replacement are assumed



Model Overview: Step 1 & 2



Model Overview: Step 3 & 4

Details: Step 1 & 2

- **1st step: Creation of potential ASHs**
  - Reason: Difficulties to obtain data from ASH manufacturers
  - Method used: Selection process developed by ASHs manufacturers
- **2nd step: Sustainable assessment**
  - Reason: These data are needed in order to rank the ASHs
  - Method used:
    - Social assessment: *pairwise comparisons*
    - Environmental assessment: *energy consumption* $Energy = \frac{HP \times H \times L \times 0.746}{\eta}$
    - Economical assessment: *Cost present value*

$$TCO = I + T + \sum P \times F + \left(\frac{P}{Y} + E \times R_E + \sum O + H \times R_M\right)\frac{1-\left(\frac{1}{1+r}\right)^5}{r}$$

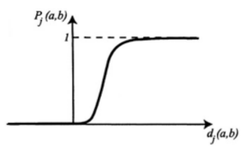
Details: Step 3

- **3rd step: Ranking method**
  - Reason: To know the best ASHs for replacement by categories
  - Method used: PROMETHEE II Method

OBJECTIVE

$$\max\{g_1(a), g_2(a), ..., g_k(a)\ a \in A\}$$

Utility function



Preferences

Between the criteria: weights

PROMETHEE II

Pairwise comparisons

- Positive outranking flow
- Negative outranking flow
- Net outranking flow

Details: Step 4

- **4th step: Portfolio selection**
  - Reason: Choose the best ASHs with the financial resources available and the CFM capacity needs
  - Method used: Linear Programming
  - Software used: LINDO

$$[\max] U = \sum_{i=1}^{m}\sum_{j=1}^{n_i} U(A_{ij}).x_{ij}$$

subject to

$$\sum_{i=1}^{m}\sum_{j=1}^{n_i} c(A_{ij}).x_{ij} \le \$Budget$$

$$\sum_{i=1}^{m}\sum_{j=1}^{n_i} CFM(A_{ij}).x_{ij} = CFM_{total}$$

$$x_{ij} \ge 0$$

Maximize the total utility

Financial and needs constraints

Conclusion

- Case study
  - 3 families of ASHs: 2,500 CFM / 10,000 CFM and 15,000 CFM
  - 4 different ASHs within each category
  - An investment budget of $45,000 and a CFM need of 30,000
  - 3 analysis performed:
    - 1st analysis: Environmental is the most important criterion, Economical the second and Social the least
    - 2nd analysis: Environmental is the most important criterion, Economical the second and Social the least
    - 3rd analysis: Criterion are equally important
- Conclusion

3 different portfolios are selected for the 3 different analysis, so weights have huge impact on the final result and should be selected carefully.

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