ECE411
Fall 2020
Homework #3

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In this assignment, we were asked to recommend an electric vehicle by using Analytical Hierarchy Process (AHP).

1st, we defined our criteria:

- Initial cost
  - It determines payment; it has a large impact
- Range (charge/mi.)
  - Frequency of charging; electric efficiency
- Safety rating:
  - Safety of myself and loved ones are priority/valuable
- Comfort:
  - Spending lots of time in car; it should be comfy

2nd, we determined the criteria weightings:

| | Price | Range | Safety | Comfort | Mean | Weight |
|---|---|---|---|---|---|---|
| **Price** | 1 | 3 | 1/2 | 2 | 1.3161 | 0.2723 |
| **Range** | 1/3 | 1 | 1/4 | 3/4 | 0.5 | 0.1035 |
| **Safety** | 2 | 4 | 1 | 4 | 2.3784 | 0.4921 |
| **Comfort** | 1/2 | 4/3 | 1/4 | 1 | 0.6389 | 0.1322 |

$$Geometric\ Mean = \sqrt[n]{\prod_{i=1}^{i=n} x_i} = \sqrt[4]{1\times 3\times \tfrac{1}{2}\times 2} = 1.3161$$

$$Weight_{row} = \frac{Geometric\ Mean_{row}}{\sum_{r=1}^{r=n} Mean_r = 1.3161+0.5+2.3784+0.6389} = \frac{1.3161}{4.8334} = 0.2723$$

3rd, we introduced the three alternatives and considered the followings when picking the alternatives,

- Safety tests
- Comparable price tag
- Brand diversity

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- 2020 Tesla Model 3: mid-range $, Safety tests, one of the most popular
  - Price tag: $39,990 (base model)
  - 250 miles/per charge
  - Safety rate 9.8
  - 7.4 interior design

- 2020 Nissan Leaf: mid-range $, Safety tests, high praise on re-design, features++
  - Price tag: $31,600 (base model)
  - 150 miles/per charge
  - Safety rate 8.4
  - 6.8 interior design

- 2020 BMW i3: mid-range $, high tech interior, Safety tests
  - Price tag: $44,450 (base model)
  - 153 miles/per charge
  - Safety rate 9.2
  - 6.6 interior design

4th, we calculated rate alternatives relative to the criteria:

$$\alpha = \frac{\{cost\}}{cost} \qquad\qquad normalized\ \alpha_i = \frac{\alpha_i}{\sum_1^n \alpha_j}$$

- Price:
  - Tesla Model 3: $\frac{31{,}600}{39{,}990} = 0.7902 \rightarrow \frac{0.7902}{2.5} = 0.3159$
  - Nissan Leaf: $\frac{31{,}600}{31{,}600} = 1.0 \rightarrow \frac{1.0}{2.5} = 0.3998$
  - BMW i3: $\frac{31{,}600}{44{,}450} = 0.7109 \rightarrow \frac{0.7109}{2.5} = 0.2843$

- Safety:
  - Tesla Model 3: $\frac{9.8}{9.8+8.4+9.2} = 0.3577$
  - Nissan Leaf: $\frac{8.4}{9.8+8.4+9.2} = 0.3066$
  - BMW i3: $\frac{9.2}{9.8+8.4+9.2} = 0.3357$

- Miles/per charge:

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- Tesla Model 3: $\frac{250}{250+150+153} = 0.4520$
- Nissan Leaf: $\frac{150}{250+150+153} = 0.2712$
- BMW i3: $\frac{153}{250+150+153} = 0.2768$

- Comfort:
  - Tesla Model 3: $\frac{7.4}{7.4+6.8+6.6} = 0.3558$
  - Nissan Leaf: $\frac{6.8}{7.4+6.8+6.6} = 0.3269$
  - BMW i3: $\frac{6.6}{7.4+6.8+6.6} = 0.3173$

5th, we compared scores for the alternatives:

| | Weight | Model 3 | Leaf | i3 |
|---|---|---|---|---|
| **Cost** | 0.2723 | 0.3159 | 0.3998 | 0.2843 |
| **Safety** | 0.4921 | 0.3577 | 0.3066 | 0.3357 |
| **Range** | 0.1035 | 0.4520 | 0.2712 | 0.2768 |
| **Comfort** | 0.1322 | 0.3558 | 0.3269 | 0.3173 |
| **Score** | | 0.3558 | 0.3310 | 0.3132 |

6th, we reviewed the decision....

After computing scores for the three alternatives, it appears that the 2020 Tesla Model 3 has the highest score out of all. The key to this winning is that safety weights the most and 2020 Tesla Model 3 has the highest safety rating. Also, this model's score for electric efficiency is much higher than 2020 Nissan Leaf and 2020 BMW i3, where it can travel up to 250 miles per charge. Its comfort level is also higher compared to the other two alternatives. Although with the highest safety rating, electric efficiency, and comfort level, 2020 Tesla Model 3 has a moderate initial cost. Therefore, there's no surprise if this model has the highest score compared to the other two alternatives. If we make our recommendation based on the scores, the 2020 Tesla Model 3 would be our recommendations. However, the scores are close. So, the buyer can choose between the three possible options. Maybe the buyer likes a specific color, and that only one of the brands manufacture it. Perhaps the buyer prefers one brand over another? Based on the mentioned preferences, the buyers can eliminate and pick between the options.