

Practicum Team 01: Decision Matrix and Analytical Hierarchy Process (AHP)

For the decision matrix and analytical hierarchy process, we opted to decide on which battery to use for our LED20 project. There were three candidates: the LP401230, LP503035, and CR2032. The criteria we decided to base this decision on are voltage, capacity, cost, size, weight, life, and rechargeability.

Below is the LED20 Battery Decision Matrix. The weights and ratings relative to the criteria were decided via group consensus. The only calculations necessary for the decision matrix are in the "Score" row. The number you see is the summation of the weight multiplied by the rating for that criterion in the column above it.

LED20 Battery Decision Matrix				
Criteria	Weight	LP401230	LP503035	CR2032
Voltage	4	4	4	2
Capacity	4	1	5	2
Cost	2	3	1	5
Size	5	4	1	5
Weight	1	5	2	5
Life	3	1	5	2
Rechargeability	5	5	5	1
Score		79	85	67

(Table 1: LED20 Battery Decision Matrix)

From the matrix above, we can see that the LP503035 LiPo battery came out victorious.

Next, we began running calculations for the AHP. First, we determined the criteria weightings using the table below. To do this, we first decided on how to weigh each criterion relative to the other criteria. We then took the geometric mean of each row which is represented in the “Mean” column. The “Weight” column is then the geometric mean for that row divided by the total mean. By doing this, we obtained our criteria weights to be used in the AHP.

Criteria	Voltage	Capacity	Cost	Size	Weight	Life	Rechargeability	Mean	Weight
Voltage	1.00	0.33	1.00	0.25	1.00	0.50	0.33	0.54	0.07
Capacity	3.00	1.00	3.00	0.25	5.00	1.00	4.00	1.72	0.21
Cost	1.00	0.33	1.00	1.00	1.00	3.00	0.25	0.82	0.10
Size	4.00	4.00	1.00	1.00	4.00	1.00	2.00	2.00	0.25
Weight	1.00	0.20	1.00	0.25	1.00	3.00	0.33	0.65	0.08
Life	2.00	1.00	3.00	1.00	0.33	1.00	0.50	1.00	0.12
Rechargeability	3.00	0.25	4.00	0.50	3.00	2.00	1.00	1.37	0.17
							Total	8.10	1.00

(Table 2: Criteria Table)

We then created another table to determine alternative ratings relative to our criteria. These values would be used as a basis for our normalization calculations. The table below simply contains the values of each criterion in their respective units i.e. voltage [V], cost [\$], etc.

Alternative Ratings Relative to Criteria				
Batteries	LP401230	LP503035	CR2032	Total
Voltage	3.70	3.70	3.00	10.40
Capacity	100.00	500.00	210.00	810.00
Cost	5.95	7.95	2.10	16.00
Size	1354.70	4959.00	1005.31	7319.01
Weight	3.00	10.50	3.10	16.60
Life	2.00	10.00	4.20	16.20
Rechargeability	1.00	1.00	0.00	2.00

(Table 3: Alternative Ratings Relative to Criteria)

For the “Normalization” table, we performed the normalization based on either the maximum or minimum value in that category. For voltage, a higher value is preferred, so the formula becomes the criterion divided by the maximum value among the criteria. For size, a smaller value is preferable, so the formula becomes the minimum of the criteria divided by the criterion.

The outlier to this formula is the rechargeability criterion, which was based on the battery either being rechargeable or not. If so, the battery was given a value of one, and if not it was given a zero.

Normalization	LP401230	LP503035	CR2032	Total
Voltage	1.00	1.00	0.81	2.81
Capacity	0.20	1.00	0.42	1.62
Cost	0.35	0.26	1.00	1.62
Size	0.74	0.20	1.00	1.94
Weight	1.00	0.29	0.97	2.25
Life	0.20	1.00	0.42	1.62
Rechargeability	1.00	1.00	0.00	2.00

(Table 4: Normalization Table)

The full AHP table is below. The weight column is pulled directly from the weight column in the Criteria Table (2). The individual criterion values are then the ratio of the normalized value and the total normalized value. Similar to the “Score” row in the LED20 Battery Decision Matrix (1), the “Score” row in the table below is the summation of the weight multiplied by the normalized value for each criterion in the column above the score value.

LED20 Battery Analytical Hierarchy Process (AHP)				
Criteria	Weight	LP401230	LP503035	CR2032 (LMO Coin Cell)
Voltage	0.07	0.36	0.36	0.29
Capacity	0.21	0.12	0.62	0.26
Cost	0.10	0.22	0.16	0.62
Size	0.25	0.38	0.10	0.51
Weight	0.08	0.44	0.13	0.43
Life	0.12	0.12	0.62	0.26
Rechargeability	0.17	0.50	0.50	0.00
Score		0.30	0.37	0.33

(Table 5: LED20 Battery AHP)

The AHP agrees with our original decision matrix and shows that all three batteries would work for our project, with the positives and negatives being nearly equal. However, because we weighted particular criteria more heavily than others (capacity > cost, for example), the LP503035 was ultimately the best choice for our project.