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Decision Making in a Complex Environment

Final Project- resource allocation using a complex AHP/'Ratings model

For this project, I decided to utilize the City of Pittsburgh Public Works department. I gave the city a budget of $75 million, and the department has the staffing to manage no more than 8 projects. The strategic objectives, and related projects are shown below:

1. Health
    a. Replace all remaining lead water pipes
        i. Cost: $10,000,000
        ii. Effect: Greatly improves the quality of drinking water, and reduced lead content
    b. Build 100 Smog Free Towers
        i. Cost: $6,000,000
        ii. Effect: Reduces pollution and improves air quality
    c. Stockpile PPE and ventilators for future pandemic
        i. Cost: $4,000,000
        ii. Effect: Better prepares the city for its response to a pandemic
    d. Install public use hand sanitizing stations across the city
        i. Cost: $2,000,000
        ii. Effect: Improves the sanitation of population and reduce risks of transferring illnesses
2. Recreation
    a. Build a dog park on the North Shore
        i. Cost: $500,000
        ii. Effect: Provides an additional space for people to take their dogs
    b. Build Swimming pools at all existing major city parks
        i. Cost: $2,000,000
        ii. Effect: Increases citizen satisfaction
    c. Repave Three Rivers Heritage trail Park
        i. Cost: $4,000,000
        ii. Effect: Improves the quality of the trail for users
3. Safety
    a. Install Smart Streetlights
        i. Cost: $5,000,000
        ii. Effect: Brighter LED Lights and gunshot detection reduce crime rates
    b. Install Automatic Crosswalks at all intersections
        i. Cost: $2,000,000
        ii. Effect: Reduces the number of pedestrians struck by motor vehicles
    c. Widen downtown sidewalks
        i. Cost: $2,000,000
        ii. Effect: Reduces the number of pedestrians struck by motor vehicles
    d. Add Designated Bike Lanes to all streets
        i. Cost: $2,500,000

ii. Effect: Decreases the number of cyclists involved in motor vehicle accidents

4. Transportation
    a. Widen Squirrel Hill Tunnel
        i. Cost: $35,000,000
        ii. Effect: Effect: Decreases congestion and risk of accidents
    b. Widen Fort Pitt Tunnel
        i. Cost: $50,000,000
        ii. Effect: Effect: Decreases congestion and risk of accidents
    c. Convert to All Electric buses
        i. Cost:$10,000,000
        ii. Effect: Provides cleaner transportation
    d. Widen Route 28 at Highland Park Bridge
        i. Cost: $20,000,000
        ii. Effect: Decreases congestion and risk of accidents

I started off by building my model:

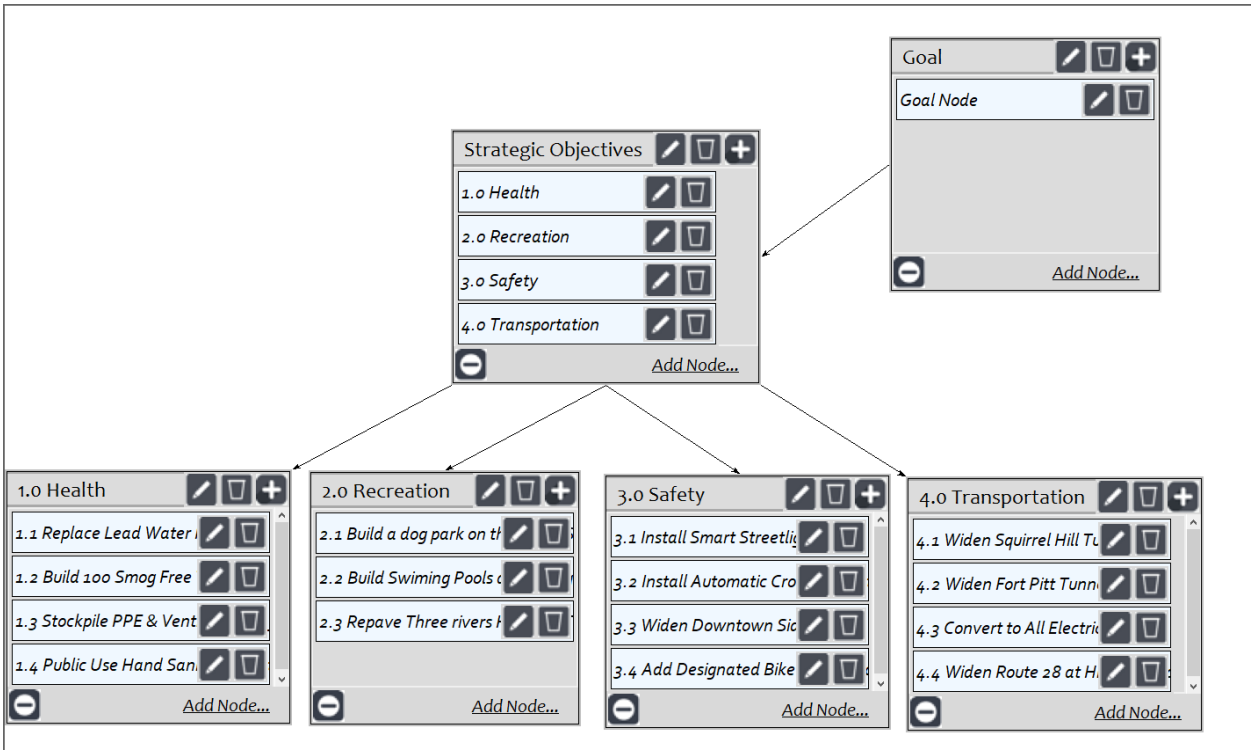

Figure 1 Model

Next, I performed pairwise comparison:

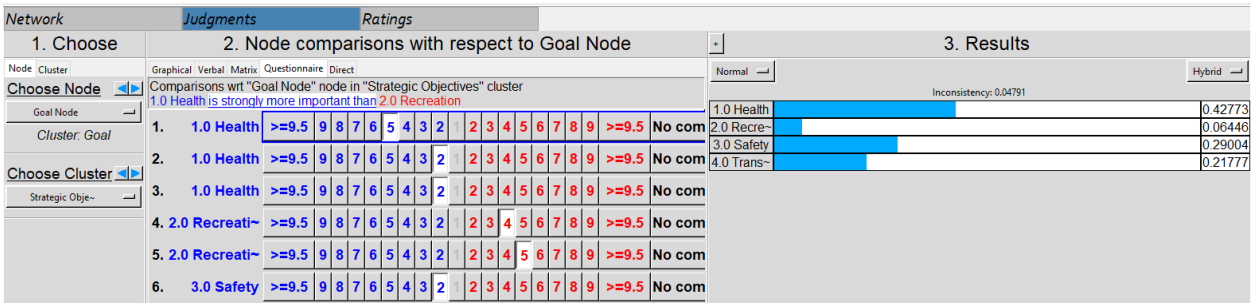

Figure 2 Pairwise Comparison

As I was performing the pairwise comparison, I found myself giving greater weights to the Health and Safety related objectives, and the lowest rankings to the Recreation objective.

After preparing the model, and performing the pairwise comparisons, I was able to generat the priorities.

Icon	Name	Normalized by Cluster	Limiting
No Icon	Goal Node	0.00000	0.000000
No Icon	1.0 Health	0.42773	0.213866
No Icon	2.0 Recreation	0.06446	0.032228
No Icon	3.0 Safety	0.29004	0.145022
No Icon	4.0 Transportation	0.21777	0.108885
No Icon	1.1 Replace Lead Water Pipes	0.60502	0.129393
No Icon	1.2 Build 100 Smog Free Towers	0.24266	0.051896
No Icon	1.3 Stockpile PPE & Ventilators for next Pan~	0.08693	0.018591
No Icon	1.4 Public Use Hand Sanitizer Stations	0.06540	0.013987
No Icon	2.1 Build a dog park on the North Shore	0.13650	0.004399
No Icon	2.2 Build Swimming Pools at existing major parks	0.62502	0.020143
No Icon	2.3 Repave Three rivers Heritage Trail	0.23849	0.007686
No Icon	3.1 Install Smart Streetlights	0.62024	0.089949
No Icon	3.2 Install Automatic Crosswalks at all Inters~	0.06533	0.009474
No Icon	3.3 Widen Downtown Sidewalks	0.19292	0.027977
No Icon	3.4 Add Designated Bike Lanes to all streets	0.12151	0.017622
No Icon	4.1 Widen Squirrel Hill Tunnel	0.36510	0.039754
No Icon	4.2 Widen Fort Pitt Tunnel	0.40303	0.043884
No Icon	4.3 Convert to All Elecric Buses	0.07231	0.007874
No Icon	4.4 Widen Route 28 at Highland Park Bridge	0.15955	0.017373

Figure 3 Calculated Priorities

After generating the priorities, I was able to transfer them into excel. I set up the below solver problem, and selected the projects that best fit the parameters given:

	A	B	C	D	E	F	G
1		Total	Cost	Effectiveness	Decision	Cost	Performance
2	Project	(From AHP)	(in Millions)	(Normalized)*100	Variables	(in Millions)	(effectiveness)
3	1.1 Replace Lead Water Pipes	0.60502	10	96.8001024	1	10	96.8001024
4	1.2 Build 100 Smog Free Towers	0.24266	6	38.82435762	1	6	38.82435762
5	1.3 Stockpile PPE & Ventilators for next Pandem	0.08693	4	13.90835493	1	4	13.90835493
6	1.4 Public Use Hand Sanitizer Stations	0.0654	2	10.46366516	1	2	10.46366516
7	2.1 Build a dog park on the North Shore	0.1365	0.5	21.83930114	0	0	0
8	2.2 Build Swimming Pools at existing major park	0.62502	2	100	0	0	0
9	2.3 Repave Three rivers Heritage Trail	0.23849	4	38.15717897	1	4	38.15717897
10	3.1 Install Smart Streetlights	0.62024	5	99.23522447	1	5	99.23522447
11	3.2 Install Automatic Crosswalks at all Intersecti	0.06533	2	10.45246552	0	0	0
12	3.3 Widen Downtown Sidewalks	0.19292	2	30.86621228	0	0	0
13	3.4 Add Designated Bike Lanes to all streets	0.12151	2.5	19.44097789	1	2.5	19.44097789
14	4.1 Widen Squirrel Hill Tunnel	0.3651	35	58.41413075	1	35	58.41413075
15	4.2 Widen Fort Pitt Tunnel	0.40303	50	64.48273655	0	0	0
16	4.3 Convert to All Elecric Buses	0.07231	10	11.56922978	0	0	0
17	4.4 Widen Route 28 at Highland Park Bridge	0.15955	20	25.52718313	0	0	0
18				Sum	8	68.5	375.2439922
19							
20				Budget	75		
21				Max number of Projects	8		

Based on the solver outcome, I was able to fund 9 projects, for $68.5 Million to maximize my performance. I funded projects 1.1, 1.2, 1.3, 1.4, 2.3, 3.1, 3.4 & 4.1.