Varad

### *Mapping Perceived Urban Safety, A Spatial + Cognitive Index*

This project explores how the perception of safety in urban environments can be mapped and measured beyond traditional crime data. By combining spatial data from NYC Open Data with a custom-designed safety model built in **Grasshopper**, the project introduces an interactive web-based platform where users can assign weights to cognitive-spatial parameters such as **lighting**, **tightness**, **visibility**, **escape routes**, **shelter**, and **public access**. A precinct-level **Perceived Safety Index** is then generated in real time. The system integrates **MapLibre**, **GeoJSON layers**, and **live JavaScript calculations**, allowing users to simulate human-centric safety evaluations and compare them with official crime statistics.

Urban Safety Score Generation

For this prototype, we have developed a hybrid scoring system that blends spatial-cognitive modeling with empirical crime data.

1. <mark>**Precincts with Full Model Integration**</mark>:
   Urban safety scores for Upper West Side, Morningside Heights, and Central Harlem have been processed using our in-progress Grasshopper-based spatial model, which evaluates enclosure, escape visibility, sun exposure, and more.

2. **Remaining Precincts:**
   The rest of the city has been scored using a data-driven prototype model, which normalizes crime complaints from the NYPD dataset and simulates final scoring logic.

This setup allows us to test the visualization and system design today, while preparing the pipeline for full model integration over the coming weeks.
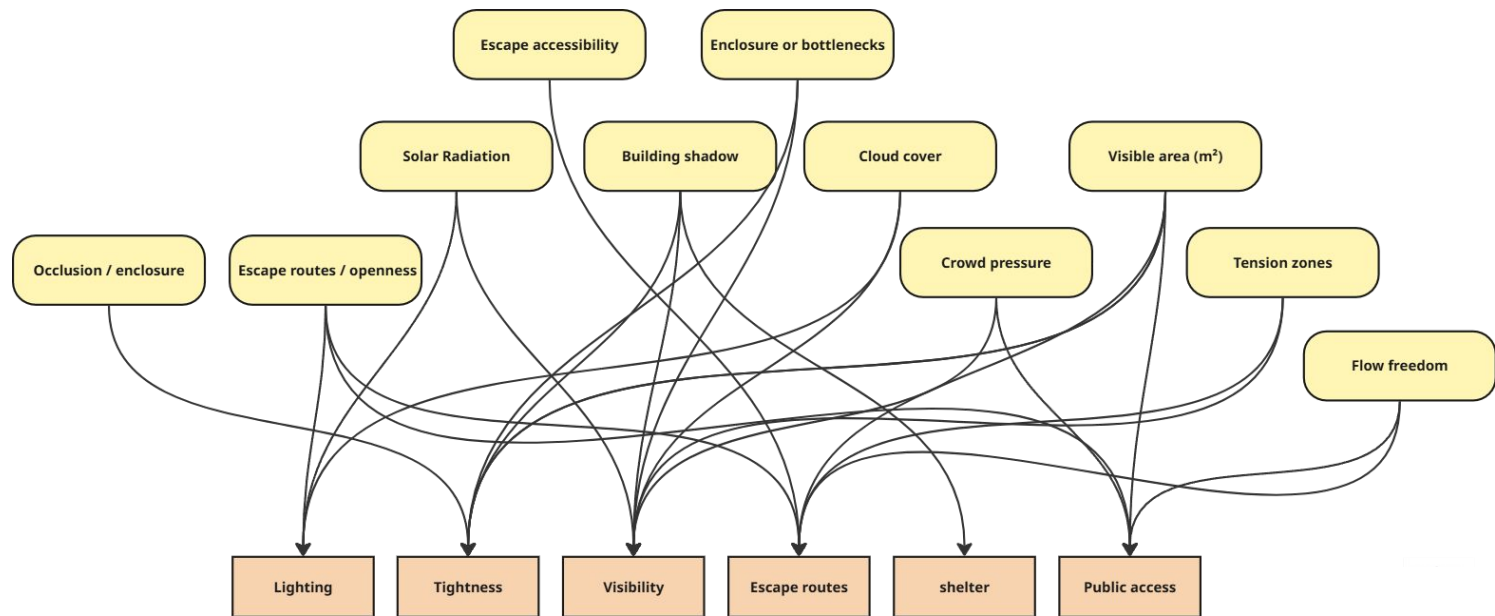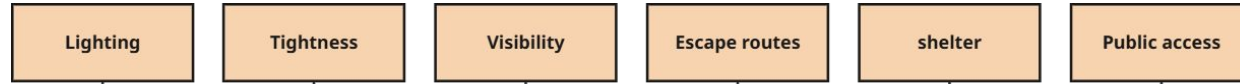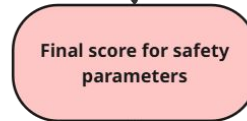
NYC safety index according to NYC open data

$$S1 = 1 - \frac{\text{Total Complaints} - \min}{\max - \min} \qquad S2 = 1 - \frac{\text{Felony Count} - \min}{\max - \min}$$

Parameters chosen to generate the final score

Score generated purely using the nyc dataset

S1 – Complaint Density

Measures how many total crime complaints were reported in a precinct. Fewer complaints = higher safety.

S2 – Felony Rate

Tracks how many crimes were classified as felonies (serious crimes). Fewer felonies = higher safety.

S3 – Violent Crime Presence

Looks at high-severity offenses like rape, robbery, and assault. Fewer violent crimes = higher safety.

S4 – Crime Completion Rate

Measures how many crimes were completed vs. attempted. More prevented/attempted crimes = higher safety.

precinct	total_complaints	felony_complaints	violent_complaints	completed_crimes	s1	s2	s3	s4	safety_score
1	4484	1315	215	4441	0.516907675	0.551372273	0.800419973	0.516419253	6.1
5	2871	1064	241	2835	0.696329255	0.639690359	0.773249739	0.697031039	7.1
6	2825	900	167	2792	0.701446051	0.6973962	0.850574713	0.701866847	7.5
7	2376	694	216	2345	0.751390434	0.769880366	0.799373041	0.752136752	7.7
9	2716	837	203	2689	0.713570634	0.719563688	0.812957158	0.713450292	7.4
10	2077	709	175	2052	0.784649611	0.764602393	0.842215256	0.785087719	8
13	4210	1245	311	4165	0.547385984	0.576002815	0.700104493	0.54745839	6
14	8094	2569	610	7980	0.115350389	0.110133709	0.387669801	0.118421053	2
17	1673	531	100	1654	0.829588432	0.827234342	0.920585162	0.829847054	8.6
18	5241	1765	385	5201	0.432703003	0.393033075	0.622779519	0.430949168	4.8
19	4058	1412	240	4011	0.56429366	0.517241379	0.774294671	0.564777328	6.2
20	2129	657	112	2105	0.778865406	0.782899367	0.908045977	0.779127305	8.2
22	141	40	24	141	1	1	1	1	10
23	3333	1030	404	3271	0.644938821	0.651653765	0.60292581	0.647998201	6.3
24	2658	730	190	2623	0.720022247	0.75721323	0.826541275	0.720872695	7.6
25	3289	1045	314	3248	0.649833148	0.646375792	0.696969697	0.650584795	6.6
26	1635	501	177	1607	0.83381535	0.837790289	0.840125392	0.835132704	8.4
28	2832	780	228	2796	0.700667408	0.739619986	0.786833856	0.701417004	7.4
30	2272	627	174	2254	0.762958843	0.793455313	0.843260188	0.76237067	7.9
32	3627	1058	443	3578	0.612235818	0.641801548	0.562173459	0.613472785	6
33	2503	903	238	2468	0.737263626	0.696340605	0.776384535	0.738304094	7.4
34	3845	1321	341	3798	0.587986652	0.549261084	0.668756531	0.588731444	6
40	8547	2737	981	8396	0.064961068	0.051020408	0	0.071637427	0.4
41	4100	1339	584	4044	0.559621802	0.542927516	0.414838036	0.561066127	5.1
42	5129	1662	686	5040	0.44516129	0.429275158	0.308254963	0.449055331	4
43	6244	2207	738	6156	0.321134594	0.237508797	0.253918495	0.323549258	2.8
44	7267	2312	883	7192	0.207341491	0.200562984	0.102403344	0.207040036	1.7
45	3854	1377	394	3796	0.586985539	0.52955665	0.613375131	0.588956365	5.8
46	5703	1947	732	5622	0.38131257	0.328993666	0.260188088	0.383603239	3.3
47	6680	2532	916	6593	0.272636263	0.123152709	0.067920585	0.274403959	1.7
48	5252	1663	708	5197	0.431479422	0.428923293	0.285266458	0.43139901	3.9
49	4455	1634	497	4358	0.520133482	0.439127375	0.505747126	0.525753486	5
50	2824	919	213	2785	0.701557286	0.690710767	0.802507837	0.702654071	7.3
52	5372	1942	784	5286	0.418131257	0.330752991	0.20585162	0.421390013	3.3
60	4230	1166	363	4193	0.54516129	0.603800141	0.645768025	0.544309492	5.9
61	3163	1114	253	3137	0.663848721	0.622097115	0.760710554	0.663067926	6.8
62	3441	1001	250	3421	0.632925473	0.661857847	0.76384535	0.631129105	6.8
63	2513	729	154	2486	0.736151279	0.757565095	0.86415883	0.736279802	7.8
66	2560	823	205	2522	0.730923248	0.724489796	0.810867294	0.732231219	7.5
67	5960	2003	603	5877	0.35272525	0.309289233	0.394984326	0.354925776	3.5
68	2427	695	155	2406	0.745717464	0.769528501	0.863113898	0.745276653	7.9
69	2090	662	194	2065	0.78320356	0.781140042	0.822361546	0.783625731	7.9
70	3769	1284	485	3716	0.596440489	0.552280084	0.518286311	0.597953216	5.6
71	2816	872	288	2795	0.702447164	0.707248417	0.724137931	0.701529465	7.1
72	2834	846	245	2814	0.700444939	0.716396904	0.76907001	0.699392713	7.2

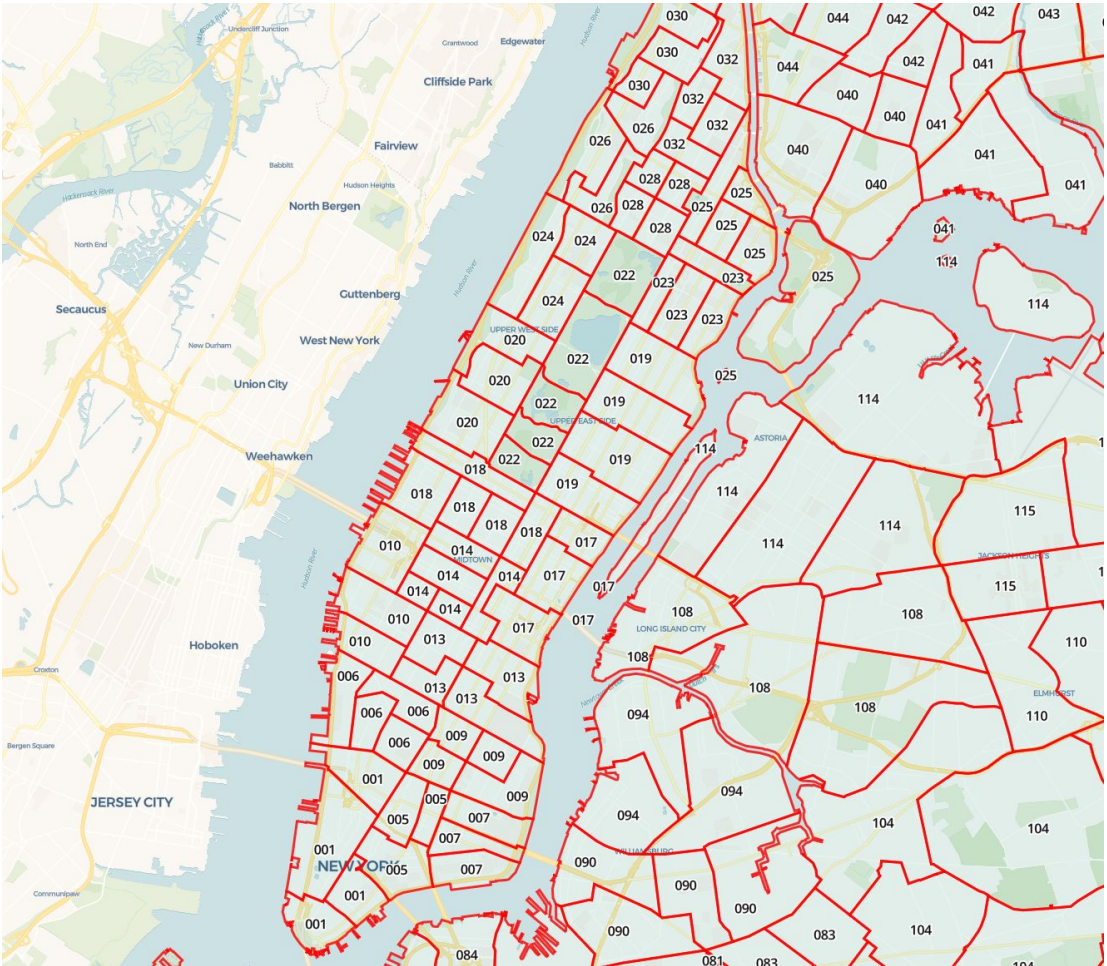$$S3 = 1 - \frac{\text{Violent Crime Count} - \min}{\max - \min}$$

$$S4 = 1 - \frac{\text{Completed Crimes} - \min}{\max - \min}$$

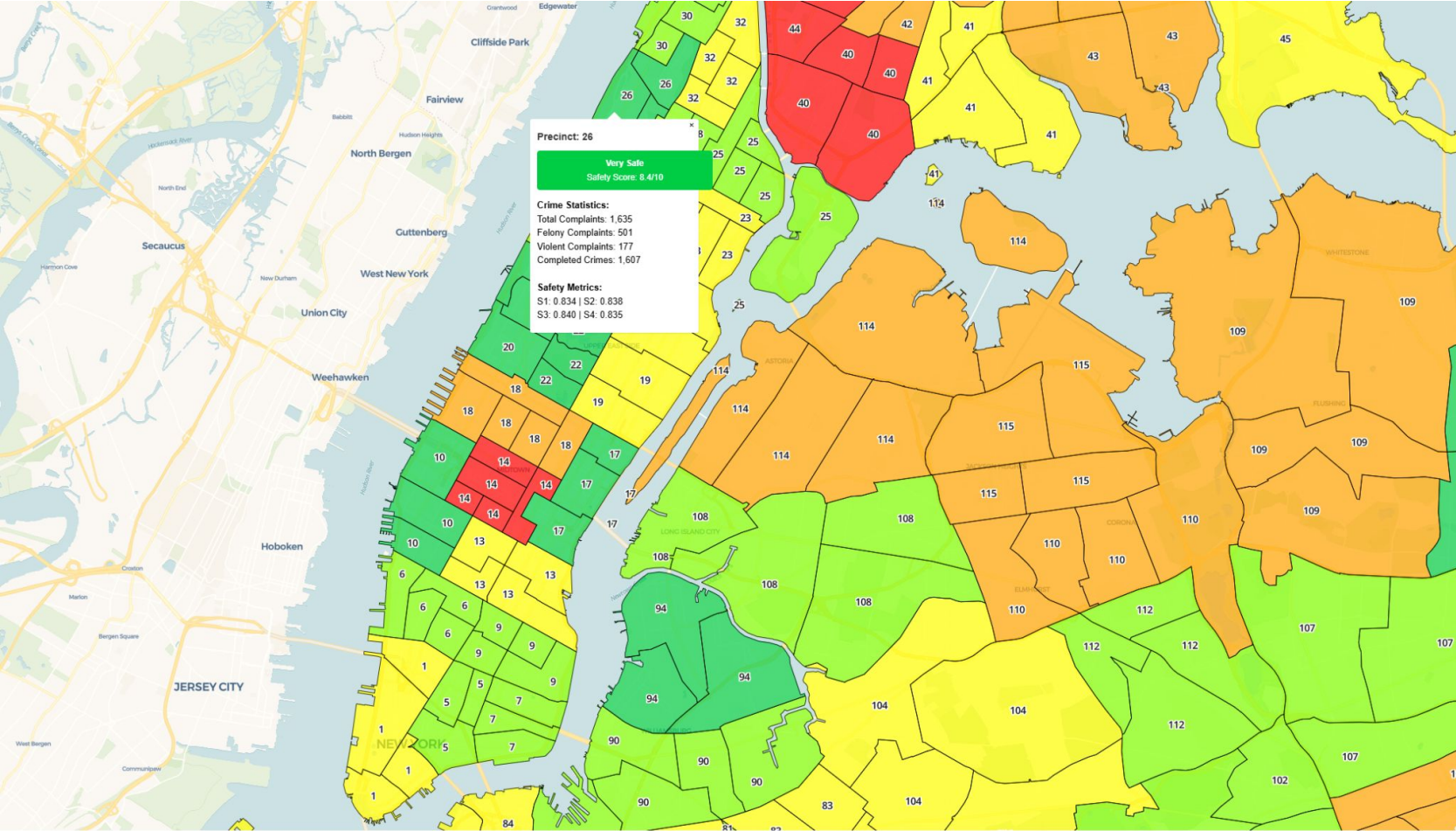$$\text{Safety Score} = (S1 \times 0.25) + (S2 \times 0.25) + (S3 \times 0.30) + (S4 \times 0.20)$$

$$\text{Final Score} = \text{Safety Score} \times 10 \quad \text{(Rounded to 1 decimal)}$$

NYC safety index according to NYC open data

NYC safety index according to NYC open data

Precinct: 26

Very Safe
Safety Score: 8.4/10

Crime Statistics:
Total Complaints: 1,635
Felony Complaints: 501
Violent Complaints: 177
Completed Crimes: 1,607

Safety Metrics:
S1: 0.834 | S2: 0.838
S3: 0.840 | S4: 0.835

We add perception weightage and see how the safety index changes for some of the areas. The ones that I have simulated using grasshopper and then finally added to the web map.

Parameters chosen to generate the final score

Additional parameters

Parameter weightage input

precinct	total_complaints	felony_complaints	violent_complaints	completed_crimes	s1	s2	s3	s4	safety_sc	lighting	tightness	visibility	escape_routes	shelter	public_access	perceived_safety_score	perceived_safety_source
1	4484	1315	215	4441	0.516907675	0.551372273	0.80041/973	0.516419253	6.								
5	2871	1064	241	2835	0.696329255	0.639690359	0.773249739	0.697031039	7.								
6	2825	900	167	2792	0.701446051	0.6973962	0.850574713	0.701866847	7.5								
7	2376	694	216	2345	0.751390434	0.769880366	0.799373041	0.752136752	7.7								
9	2716	837	203	2689	0.713570634	0.719563688	0.812957158	0.713450292	7.4								
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13	4210	1245	311	4165	0.547385984	0.576002815	0.700104493	0.54745839	6								
14	8094	2569	610	7980	0.115350389	0.110133709	0.387669801	0.118421053									
17	1673	531	100	1654	0.829588432	0.827234342	0.920585162	0.829847054	8.								
18	5241	1765	385	5201	0.432703003	0.393033075	0.622779519	0.430949168	4.8								
19	4058	1412	240	4011	0.56429366	0.517241379	0.774294671	0.564777328	6.								
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22	141	40	24	141	1	1	1	1	10								
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24	2658	730	190	2623	0.720022247	0.75721323	0.826541275	0.720872695	7.0	0.85	0.3	0.9	0.8	0.7	1	0.76	Grasshopper
25	3289	1045	314	3248	0.649833148	0.646375792	0.696969697	0.650584795	6.6								
26	1635	501	177	1607	0.83381535	0.837790289	0.840125392	0.835132704	8.4	0.9	0.2	0.95	0.9	0.75	0.95	0.84	Grasshopper
28	2832	780	228	2796	0.700667408	0.739619986	0.786833856	0.701417004	7.4	0.75	0.4	0.85	0.7	0.65	0.8	0.73	Grasshopper
30	2272	627	174	2254	0.762958843	0.793455313	0.843260188	0.76237067	7.9								
32	3627	1058	443	3578	0.612235818	0.641801548	0.562173459	0.613472785	6	0.65	0.6	0.7	0.5	0.55	0.75	0.63	Grasshopper
33	2503	903	238	2468	0.737263626	0.696340605	0.776384535	0.738304094	7.4								
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50	2824	919	213	2785	0.701557286	0.690710767	0.802507837	0.702654071	7.3								
52	5372	1942	784	5286	0.418131257	0.330752991	0.20585162	0.421390013	3.3								
60	4230	1166	363	4193	0.54516129	0.603800141	0.645768025	0.544309492	5.9								
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62	3441	1001	250	3421	0.632925473	0.661857847	0.76384535	0.631129105	6.8								
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66	2560	823	205	2522	0.730923248	0.724489796	0.810867294	0.732231219	7.5								
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68	2427	695	155	2406	0.745717464	0.769528501	0.863113898	0.745276653	7.9								

Customize Safety Weightage

Precinct Number: 100

Lighting: 1

Tightness: 1

Visibility: 1

Escape Routes: 1

Shelter: 1

Public Access: 1

Apply Custom Weights

Find Precinct

A crowd based data sourcing platform for assessing perceived urban safety

Grasshopper Weighted Calculations

Precinct 24
Lighting: 0.85 × 0.8 = 0.680   Tightness: 0.3 × 1 = 0.300
Visibility: 0.9 × 0.9 = 0.810   Escape Routes: 0.8 × 1 = 0.800
Shelter: 0.7 × 0.7 = 0.490   Public Access: 1 × 1 = 1.000

Weighted Sum: 4.080 ÷ Total Weights: 5.4 = Average: 0.756
Final Score: 7.6/10 | Original Score: 7.6/10

Precinct 26
Lighting: 0.9 × 0.8 = 0.720   Tightness: 0.2 × 1 = 0.200
Visibility: 0.95 × 0.9 = 0.855   Escape Routes: 0.9 × 1 = 0.900
Shelter: 0.75 × 0.7 = 0.525   Public Access: 0.95 × 1 = 0.950

Weighted Sum: 4.150 ÷ Total Weights: 5.4 = Average: 0.769
Final Score: 7.7/10 | Original Score: 8.4/10

Precinct 28
Lighting: 0.75 × 0.8 = 0.600   Tightness: 0.4 × 1 = 0.400
Visibility: 0.85 × 0.9 = 0.765   Escape Routes: 0.7 × 1 = 0.700
Shelter: 0.65 × 0.7 = 0.455   Public Access: 0.8 × 1 = 0.800

Weighted Sum: 3.720 ÷ Total Weights: 5.4 = Average: 0.689
Final Score: 6.9/10 | Original Score: 7.3/10

Precinct 32
Lighting: 0.65 × 0.8 = 0.520   Tightness: 0.6 × 1 = 0.600
Visibility: 0.7 × 0.9 = 0.630   Escape Routes: 0.5 × 1 = 0.500
Shelter: 0.55 × 0.7 = 0.385   Public Access: 0.75 × 1 = 0.750

Weighted Sum: 3.385 ÷ Total Weights: 5.4 = Average: 0.627
Final Score: 6.3/10 | Original Score: 6.3/10

Customize Safety Weightage

Precinct Number: e.g. 14
Lighting: 0.8
Tightness: 1
Visibility: 0.9
Escape Routes: 1
Shelter: 0.7
Public Access: 1

[Apply Custom Weights]
[Find Precinct]

Grasshopper Weighted Calculations

Precinct 24
Lighting: 0.85 × 0.8 = 0.680   Tightness: 0.3 × 1 = 0.300
Visibility: 0.9 × 0.9 = 0.810   Escape Routes: 0.8 × 1 = 0.800
Shelter: 0.7 × 0.7 = 0.490   Public Access: 1 × 1 = 1.000

Weighted Sum: 4.080 ÷ Total Weights: 5.4 = Average: 0.756
Final Score: 7.6/10 | Original Score: 7.6/10

Precinct 26
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Weighted Sum: 4.150 ÷ Total Weights: 5.4 = Average: 0.769
Final Score: 7.7/10 | Original Score: 8.4/10

Precinct 28
Lighting: 0.75 × 0.8 = 0.600   Tightness: 0.4 × 1 = 0.400
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Weighted Sum: 3.720 ÷ Total Weights: 5.4 = Average: 0.689
Final Score: 6.9/10 | Original Score: 7.3/10

NYC Safety Index (2025 Crime Data)