

# Cloud-based room-centric daylight simulation application for environment design: a case study using the BIM model of TU Delft architecture faculty



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Building Technology

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Secondary mentor: Dr. Eleonora Brembilla  
Delegate Examiner: Manuela Triggianese

## 1. INTRODUCTION

- 1. Introduction
- 2. Background & Related Work
- 3. Research Question

## 2. METHODS

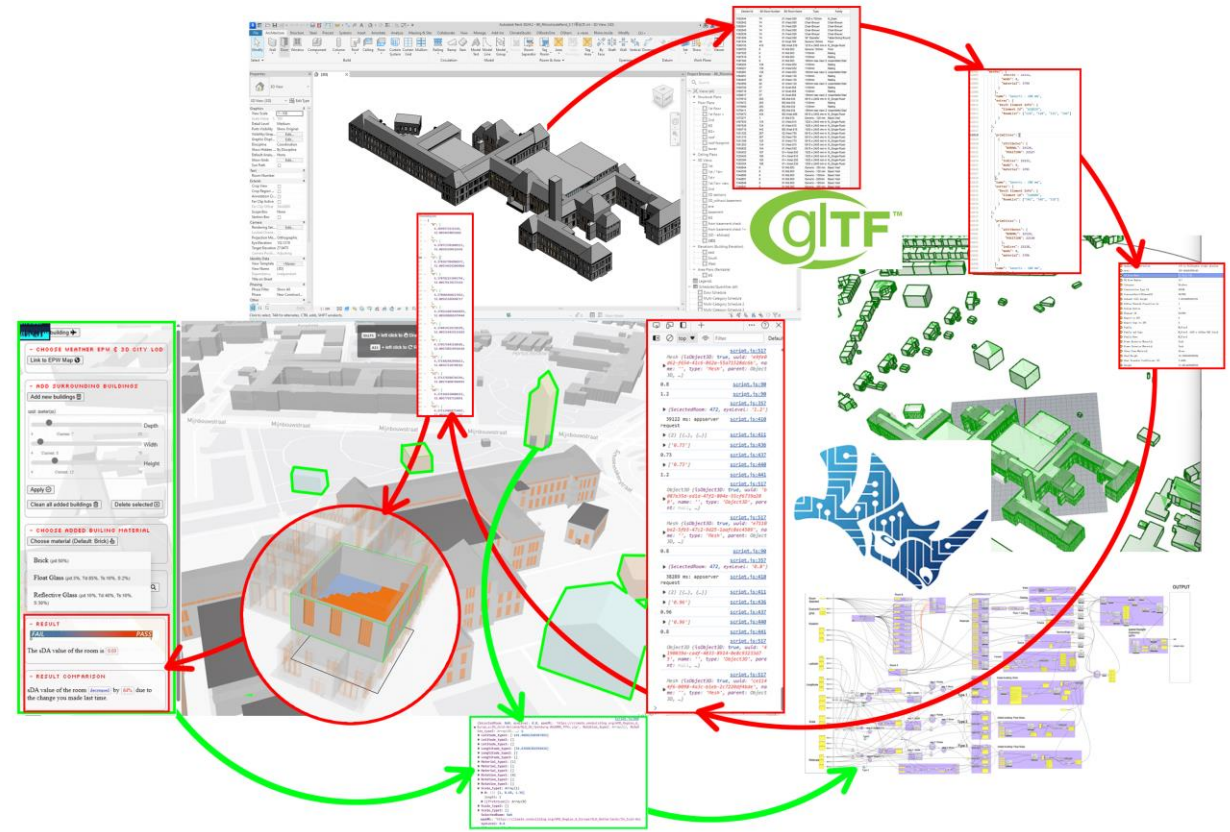
- 4. Methodology
- Settings & Data preparation
- 5. Implementation

## 3. RESULT

- Demo
- 6. Results

## 4. CONCLUSION

- 7. Conclusion
- 8. Future work

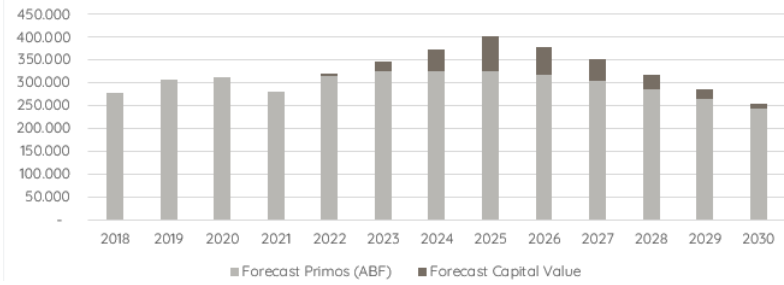


# 1

## INTRODUCTION

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Development and forecast housing shortage the Netherlands  
In numbers of homes. Source: Primos, 2018-2022 and forecast by Capital Value



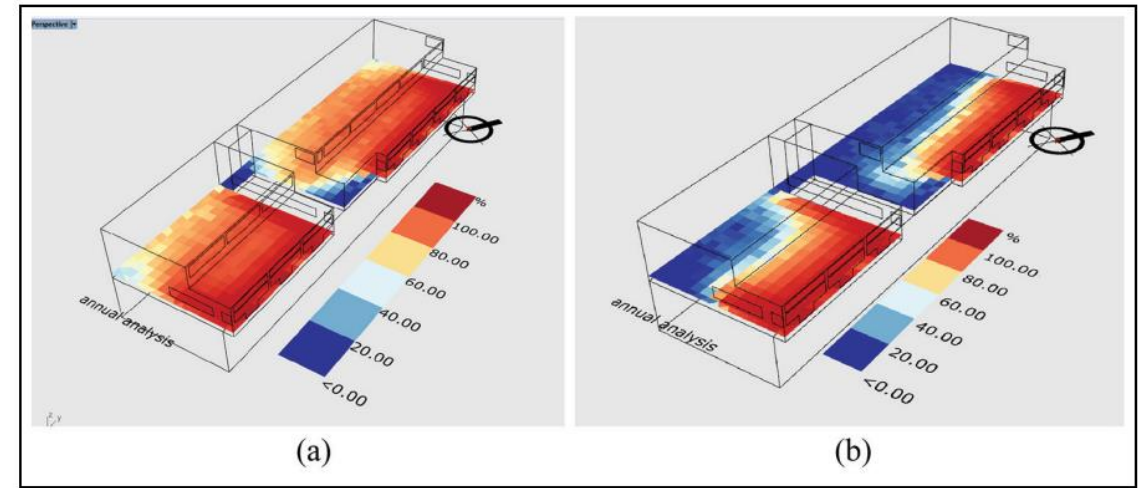
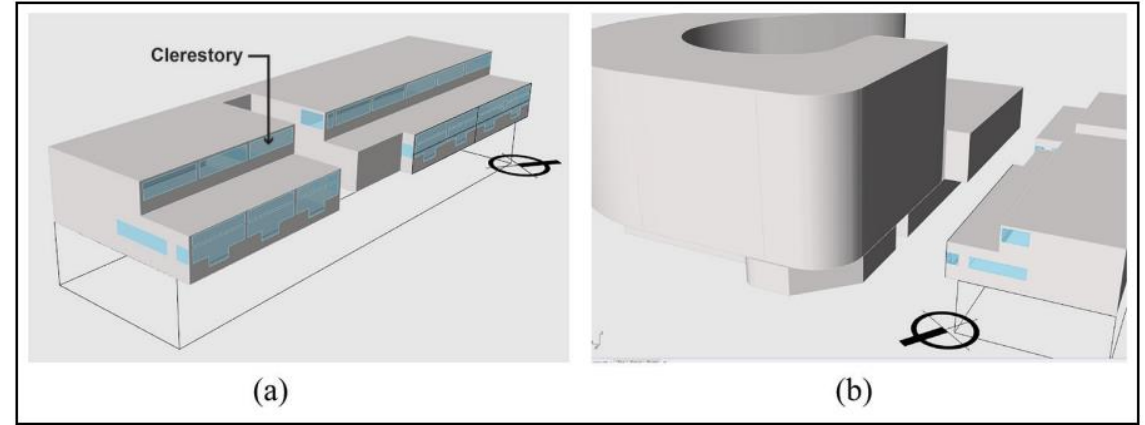
Housing shortage in the Netherlands Pascoe, R. (2022)



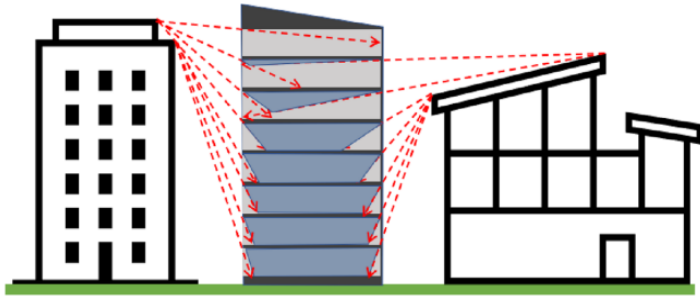
New building under construction Pascoe, R. (2023)

before

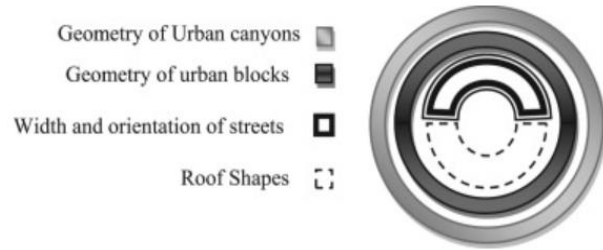
after



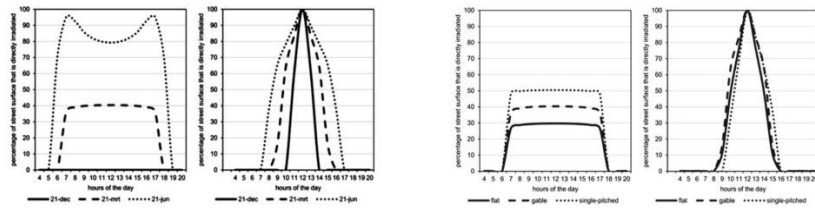
Daylight Autonomy for Architecture Building without new building(a) and with new building(b). (Rajus et al., 2022)



Obstruction angle (OA)'s impact on indoor daylight



Hierarchy of the factors affecting the amount and quality of solar radiation (Nasrollahi & Shokri, 2016)

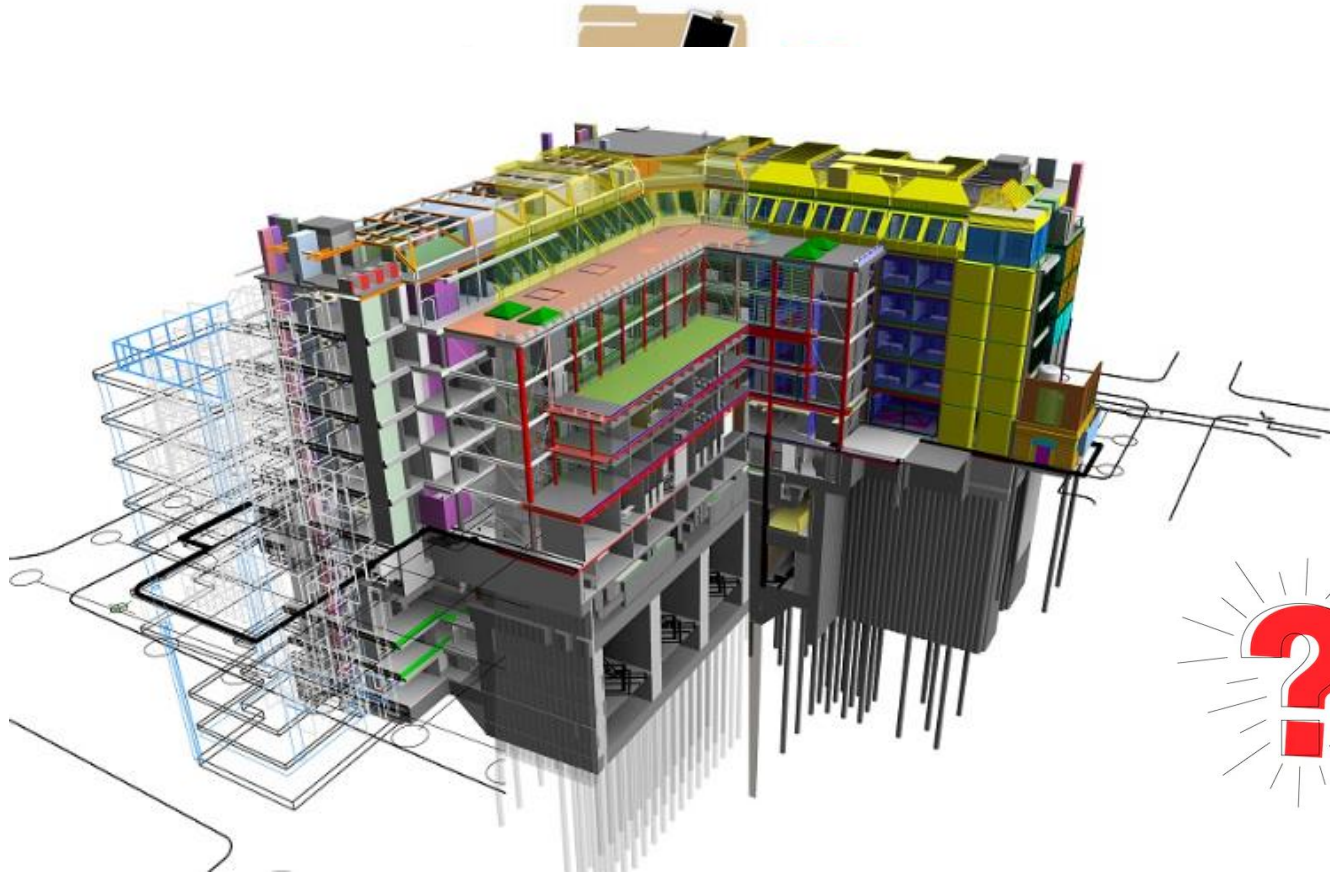


Influence of street direction (left two) and influence of roof shape (right two), both with east-west street(left) and north-south(right). (Van Esch et al., 2012)



Simulation on existing building after change the surroundings on urban scale





Building Information Modelling (BIM)  
Daylight simulation tools with Radiance Embedded (Radiance, n.d.)



According to a survey of satisfaction Fernandez-Antolin's group (2020-2022) with 170 people working in architecture field,

- ❑ complexity of use
- ❑ large amount of data entry
- ❑ a poor interface



Wanted:

- ❑ User-friendly
- ❑ Less data entry, automated workflow
- ❑ Nice integration with other tools

# 1. Introduction – Revit or Rhino?

Third-party plugin / app ~~Not supported~~ ? Not sure

## What is BIM?



### AppServer

A node.js app and API for remote solving Grasshopper definitions on Rhino.Compute

- ✓ node.js
- ✓ Express.js
- ✓ REST API
- ✓ caching
- ✓ open source
- ✓ ...

<https://github.com/mcneel/compute.rhino3d.appserver>

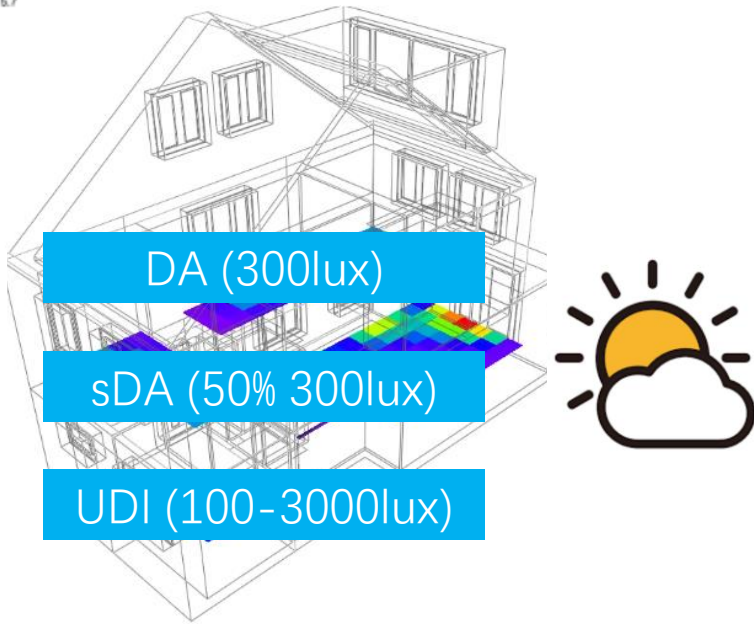


Revit or Rhino ?

### Climate-Based Daylight Modeling CBDM Standard



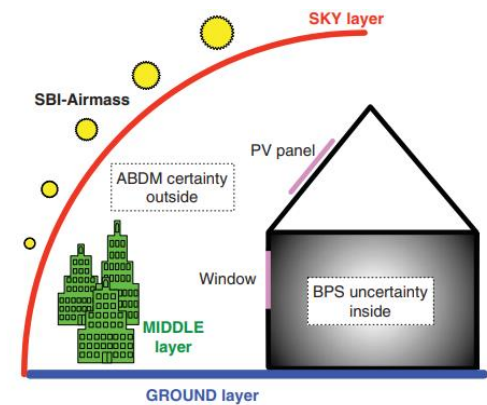
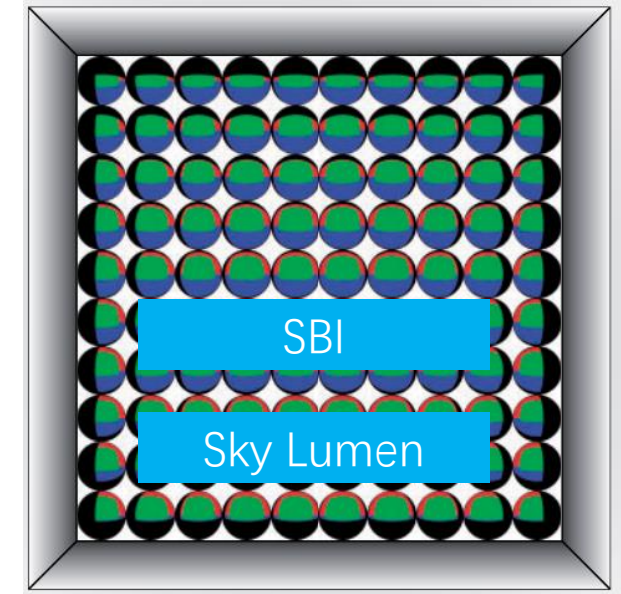
365 days



DA (300lux)  
sDA (50% 300lux)  
UDI (100-3000lux)



### Aperture-Based Daylight Modeling ABDM Method



EN 17037

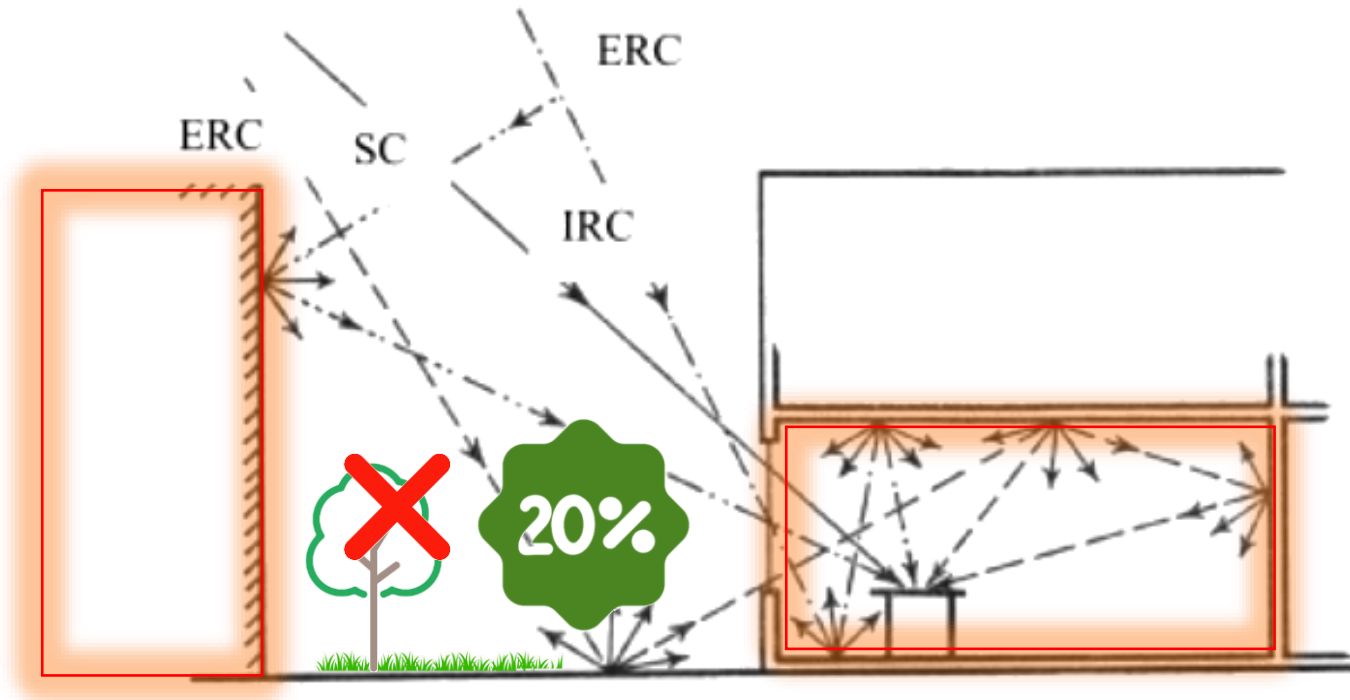


WELL™

BREEAM®



3DBAG by tudelft3d + 3DGI

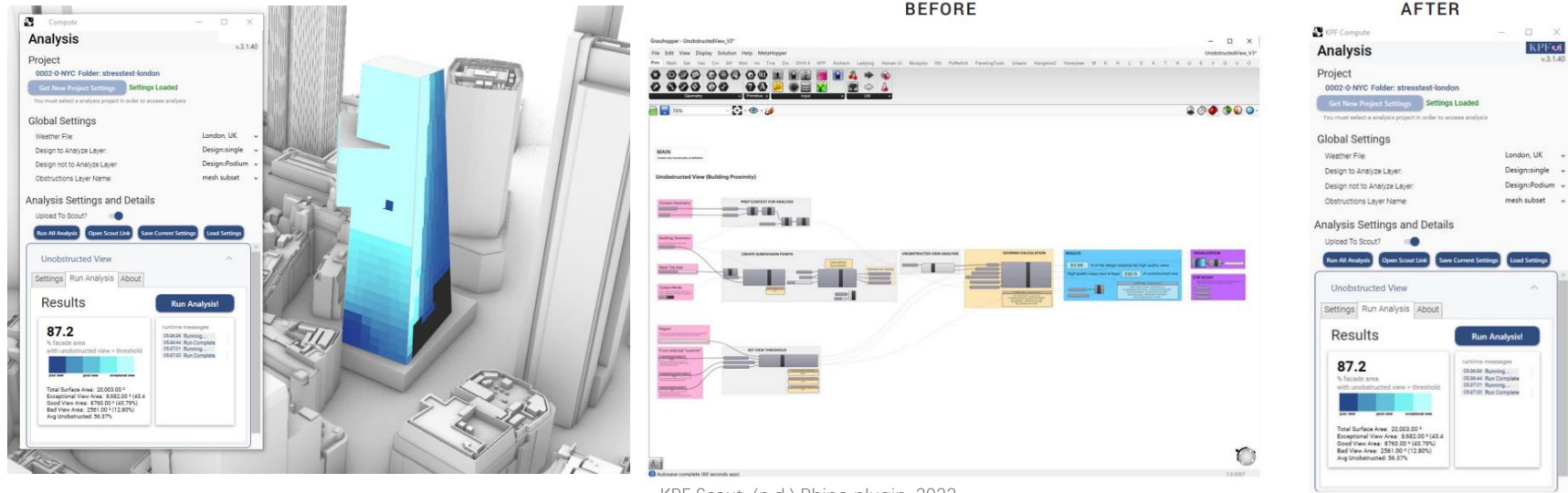


Different ways of daylight penetration into the building: Directly from the sky. Direct reflection from an external barrier. Reflection from the floor and ceiling. Reflection from the ground, ceiling and the walls. (Nasrollahi & Shokri, 2016)

Illuminance level
 = 
 SC
 + 
 ERC
 + 
 IRC

Static City Model
BIM

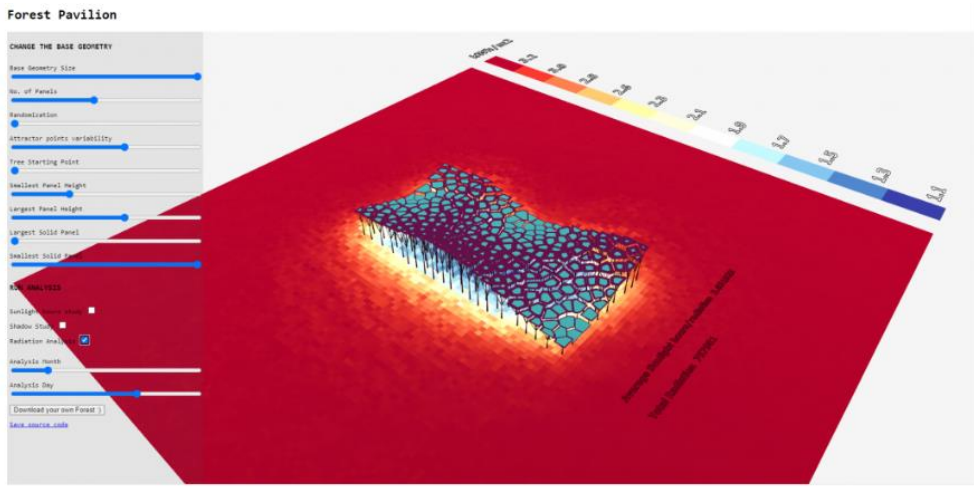
Added New Building



KPF Scout. (n.d.) Rhino plugin, 2022



Arup InForm. (n.d.)



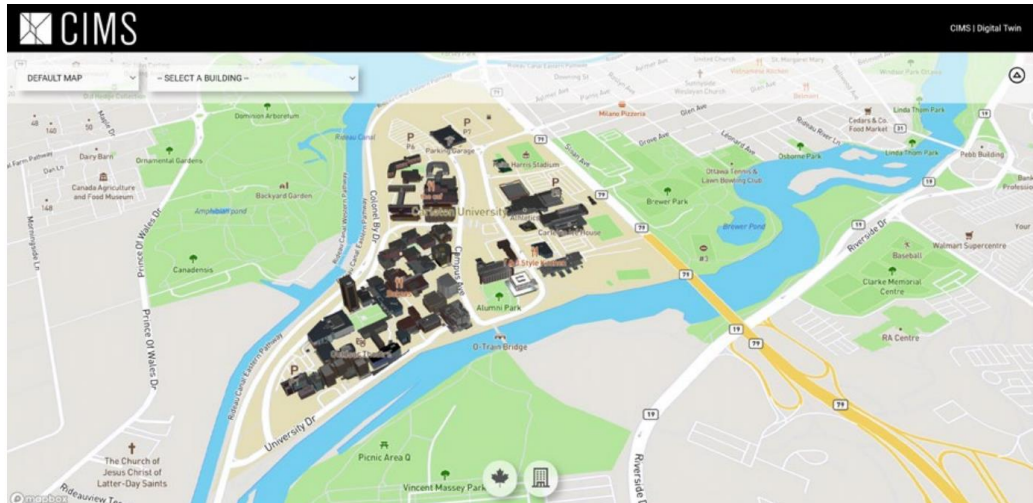
IAAC MaCAD track student projects (Ingrassia, M, 2021)



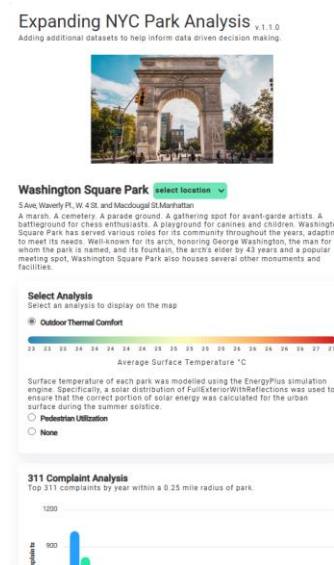
View Revit models inside Mapbox using Autodesk Forge (Wallabyway, 2019)



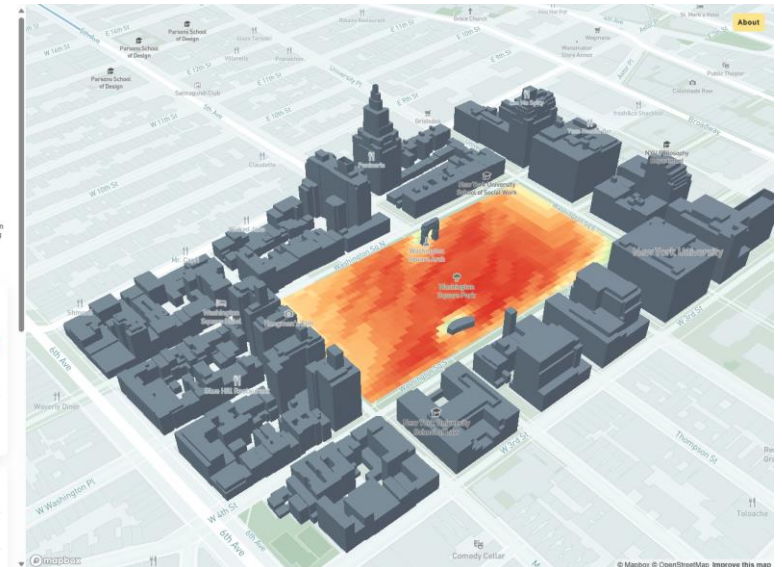
Place BIM model everywhere in Mapbox, reading IFC properties by clicking elements before placing. (Helenkwok, 2023)



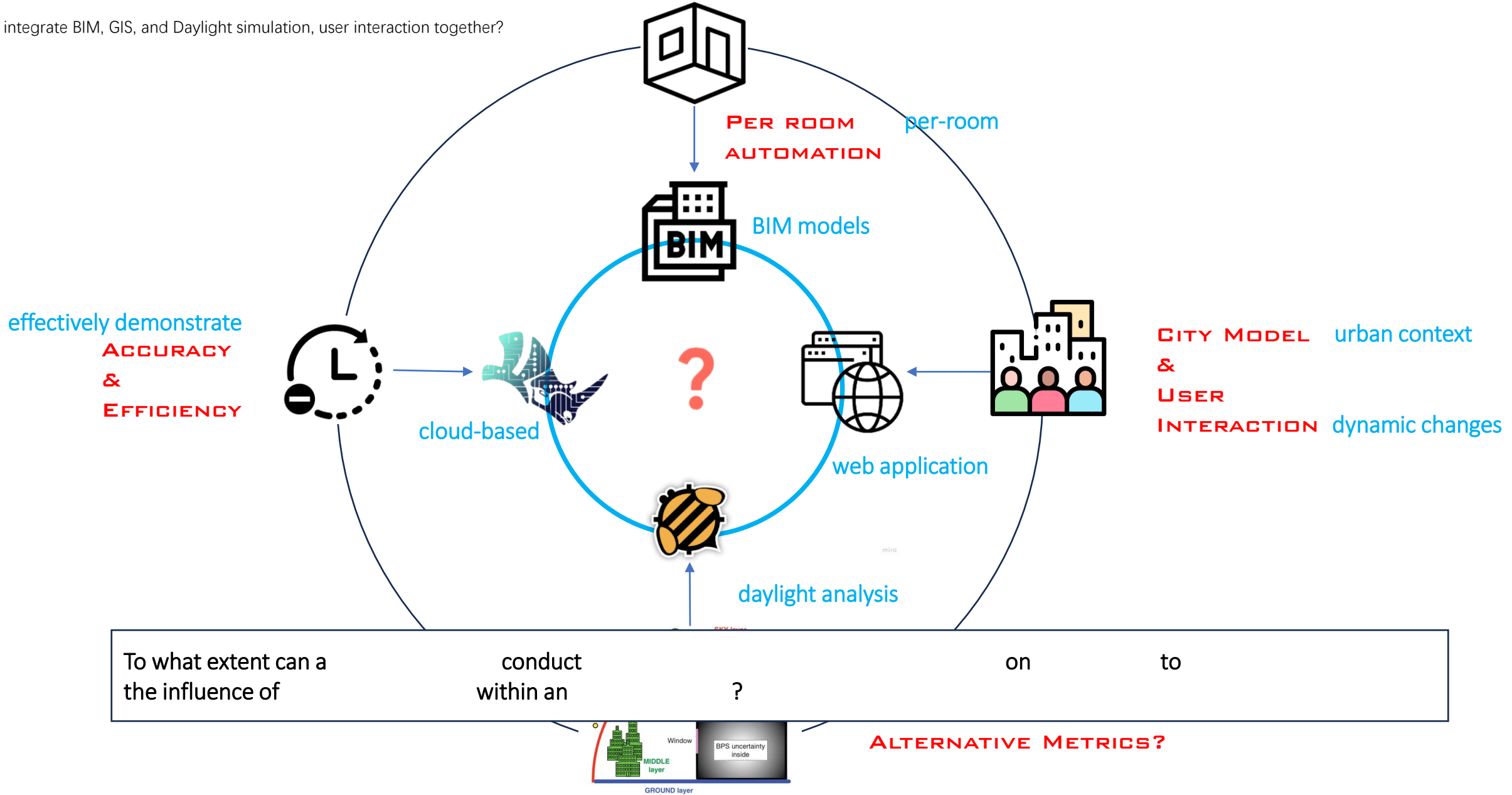
CDC BIM campus digital twin WebGL browser (CIMS lab, 2023)



NYC park analysis tool using Rhino, Vue.js, Mapbox.gl, apex-charts, Three.js, and Tailwind CSS (Pachuca, 2021)



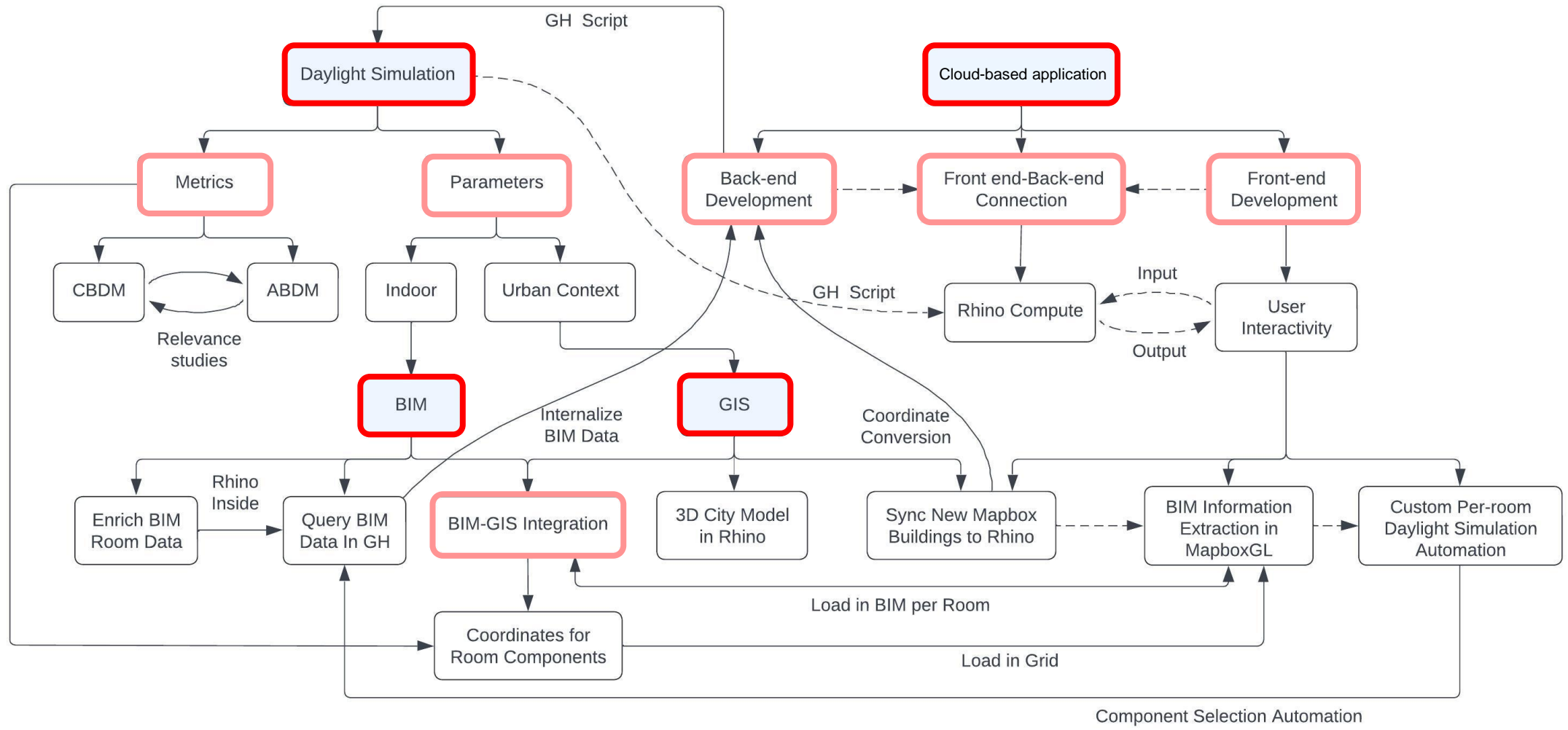
How to integrate BIM, GIS, and Daylight simulation, user interaction together?

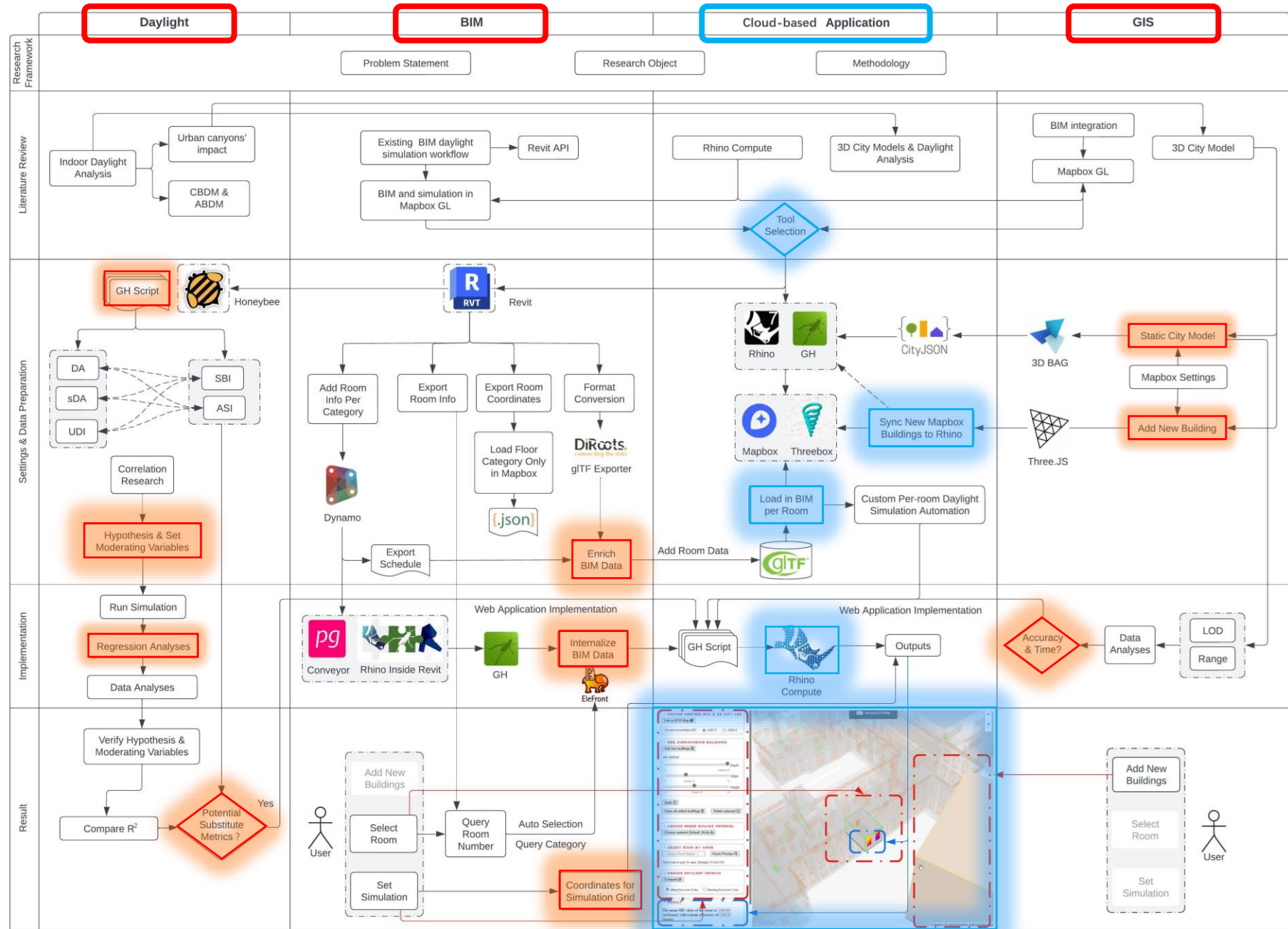


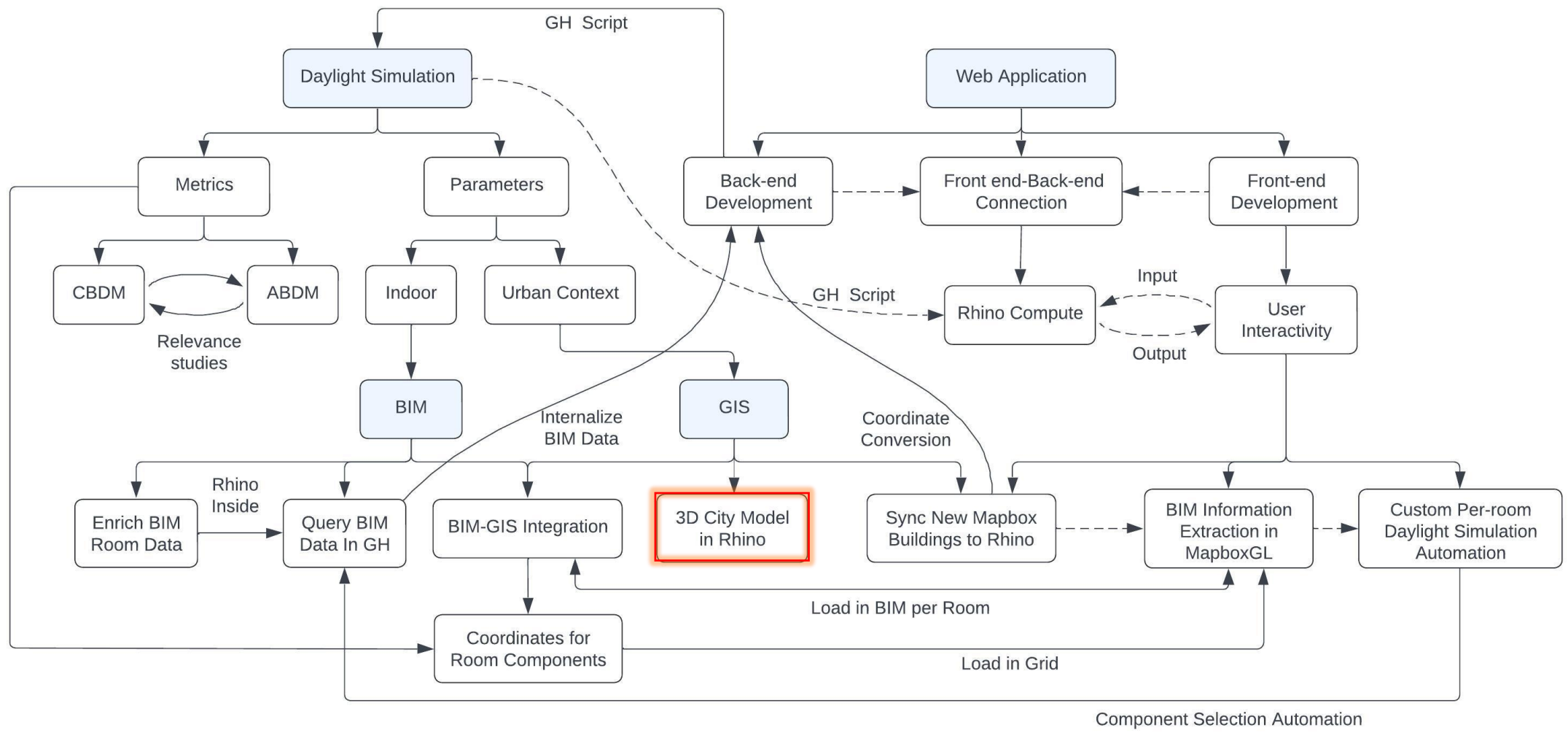
# 2

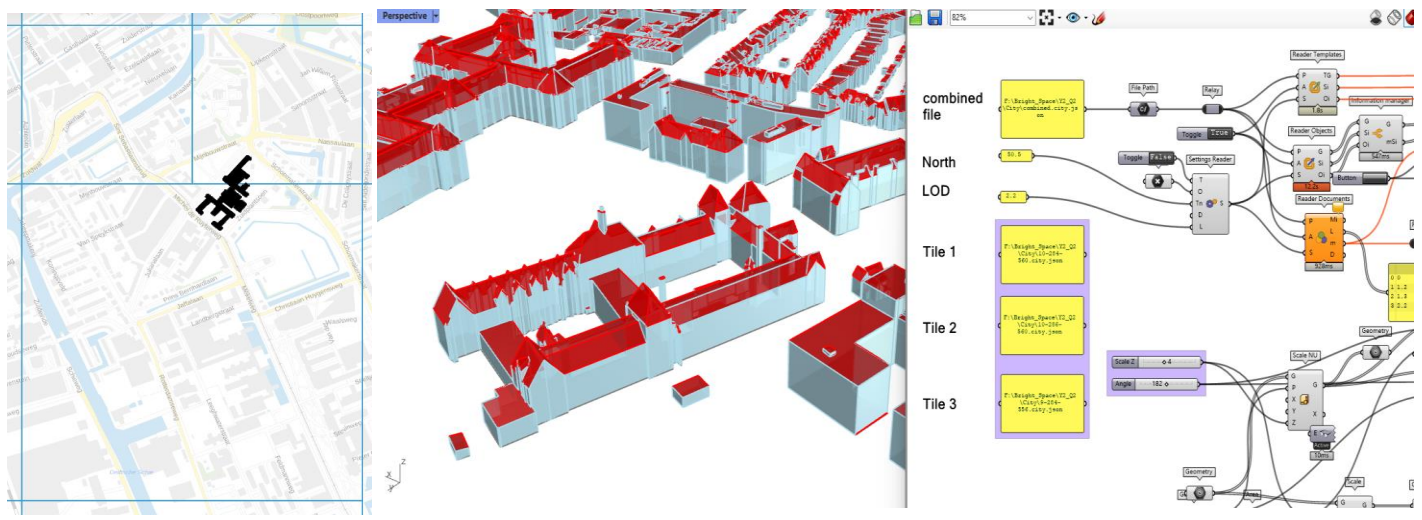
## METHODS

- 4. Methodology
  - ⚙️ Settings & Data preparation
- 5. Implementation

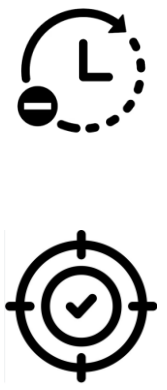
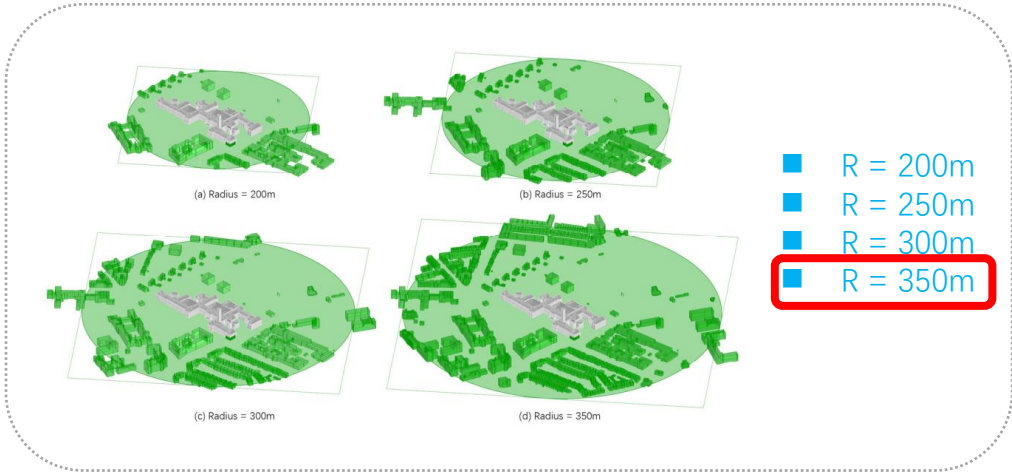
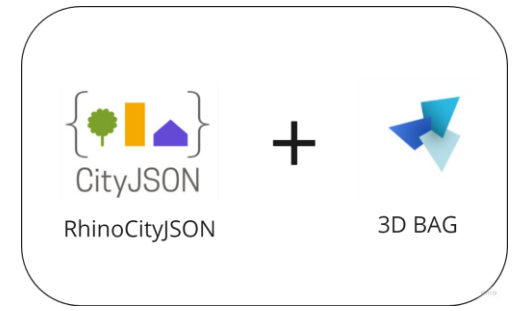








Load 3D BAG cityJSON models in GH

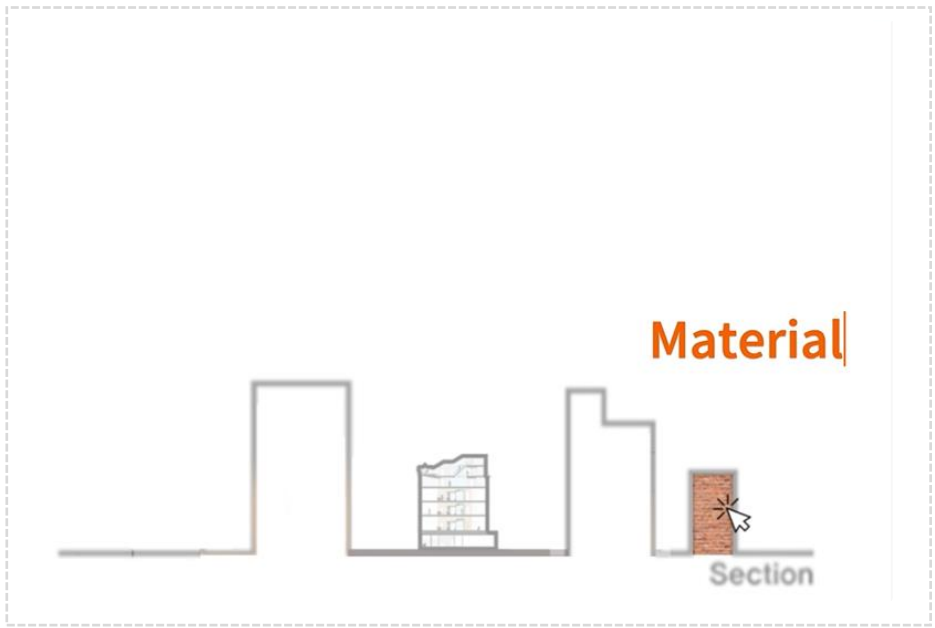


STATIC CITY MODEL IN GH



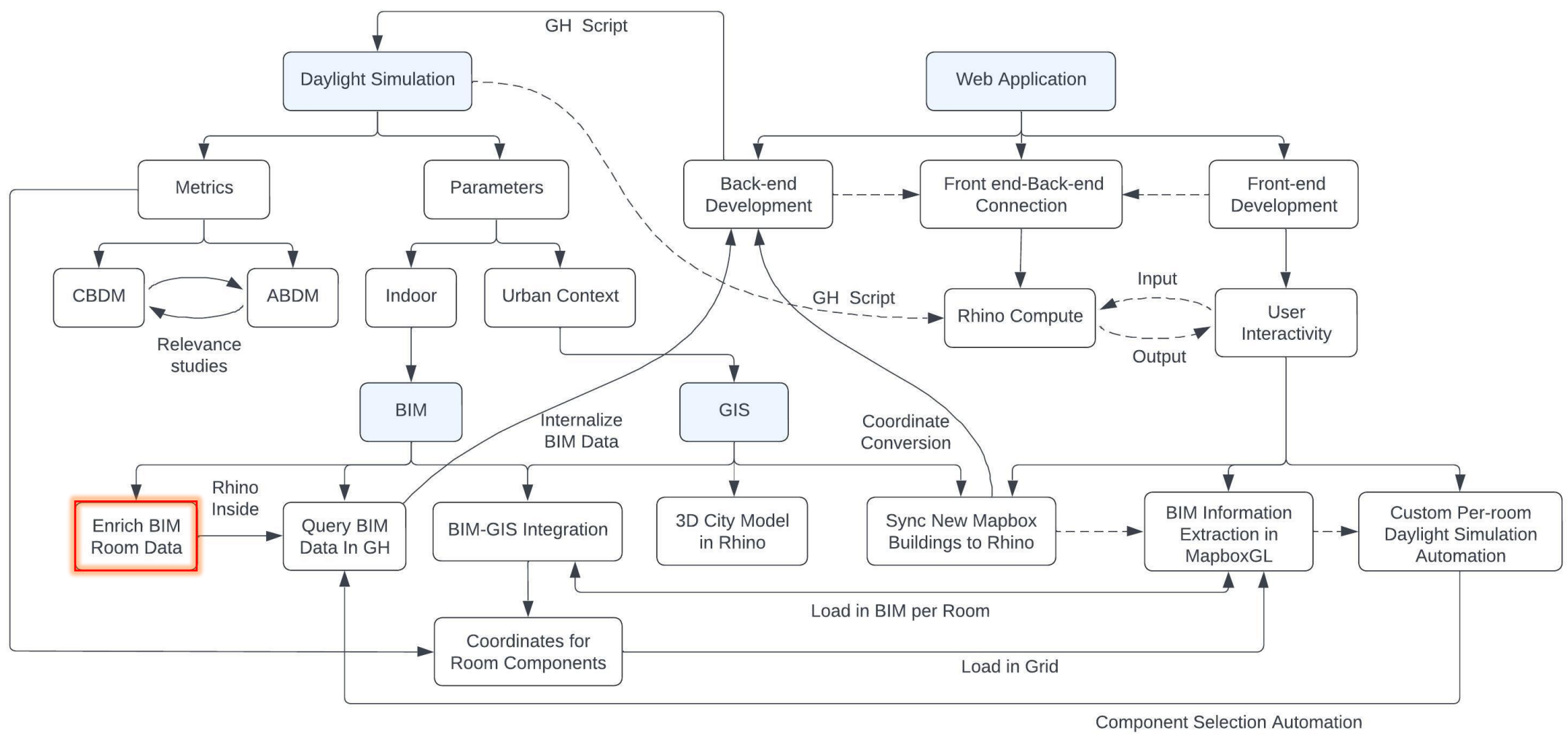
CREATE ATTRIBUTES

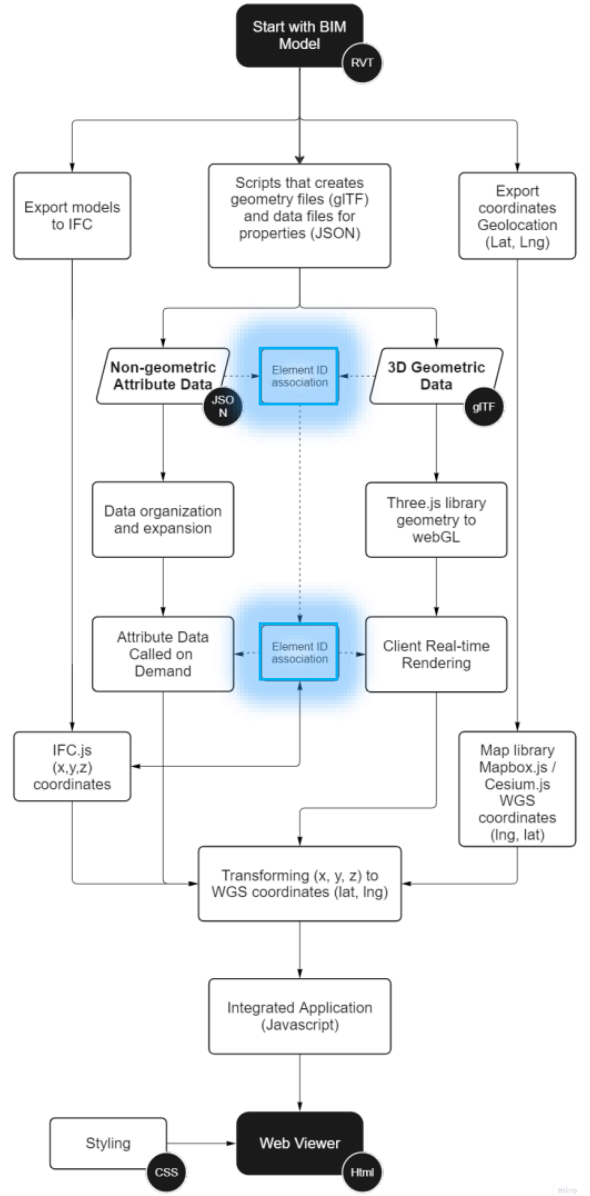
USER-ADDED BUILDINGS



BIM







Basic Wall  
Generic - 740mm

Walls (1) Edit Type

Related to Mass

Cross-Section Definition  
Cross-Section Vertical

Text

Room Number

Structural

Structural

Structural Usa... Non-bearing

Dimensions

Length 29.1876

Area 109.801 m<sup>2</sup>

Volume 81.246 m<sup>3</sup>

Identity Data

Image

Comments

Mark

Phasing

Phase Created New Construct...

Phase Demoli... None

IFC Parameters

Export to IFC By Type

Export to IFC As

IFC Predefine...

IfcGUID 1vt1r3IUf7Ggn...

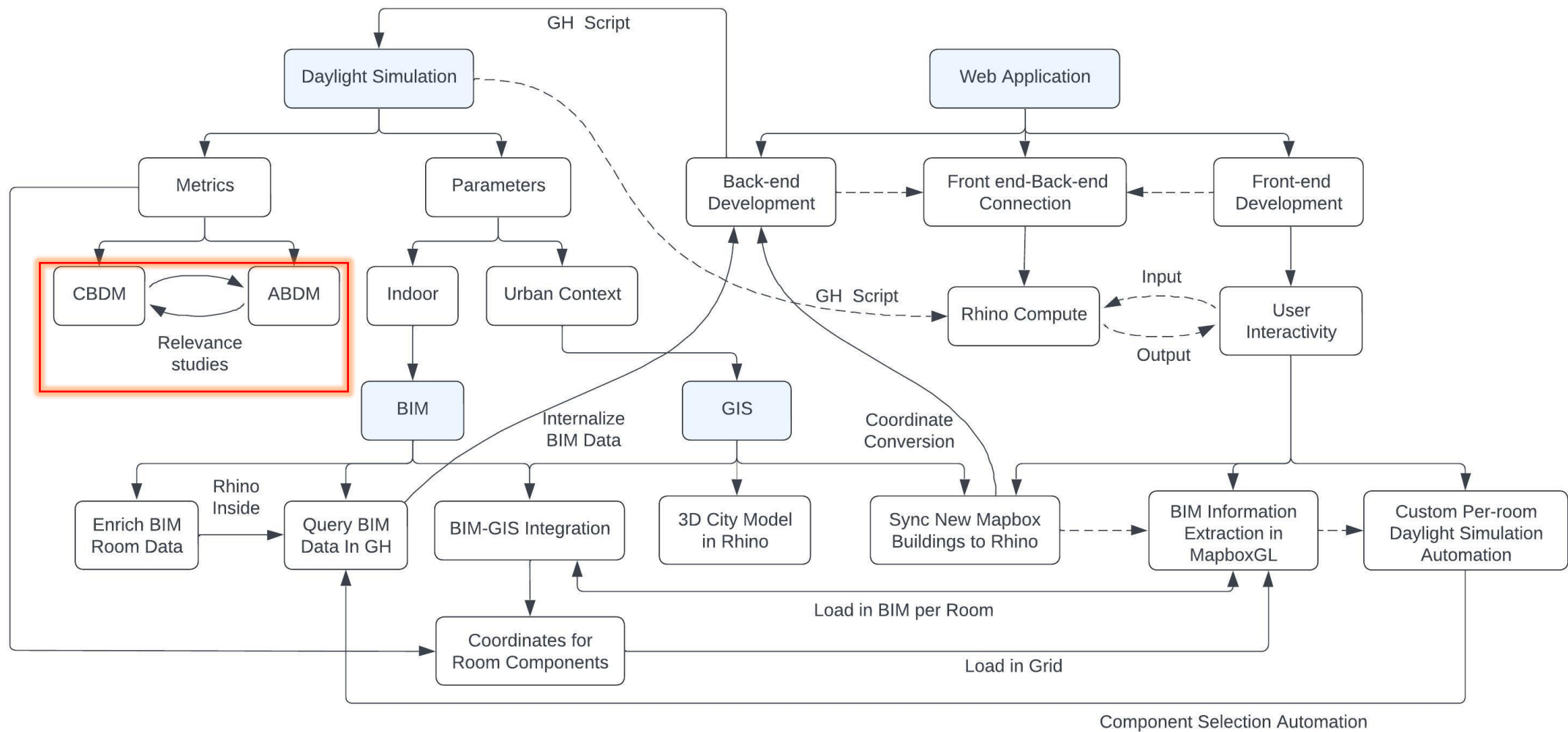
Other

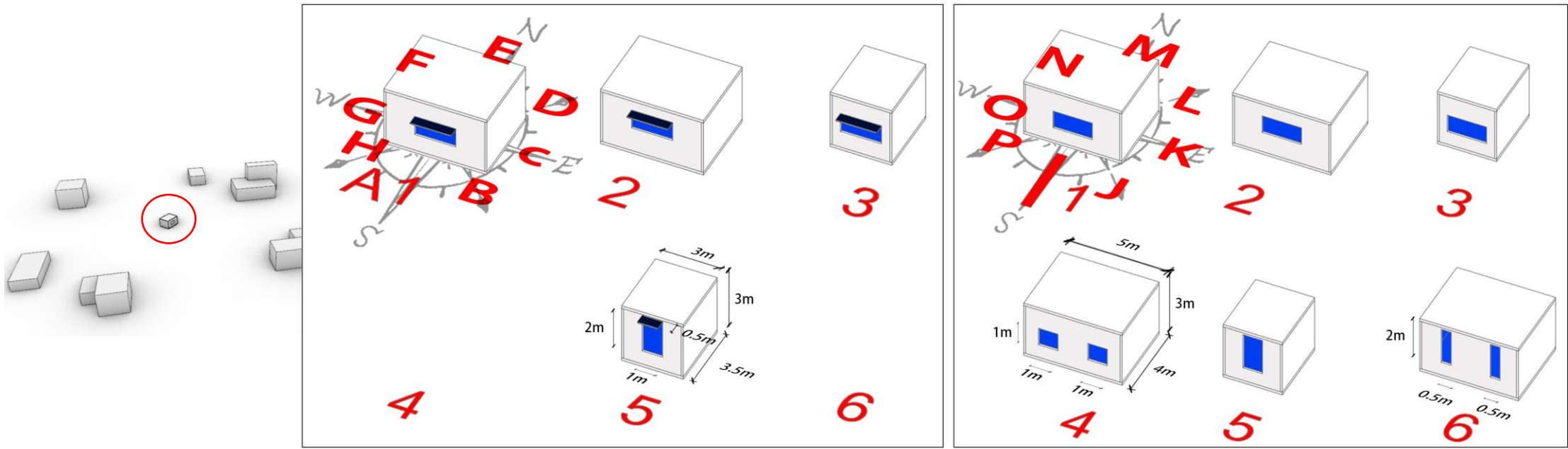
Element Id	1614994
RoomA	38
RoomB	39
RoomC	40
RoomD	46
RoomE	56
RoomF	57
RoomG	161
RoomH	169
RoomI	346
RoomJ	357
RoomK	724



WebGL based interactive application workflow - BIM / GIS (Yan, Z et al., 2023.)

TAG ROOM INFO PER CATEGORY

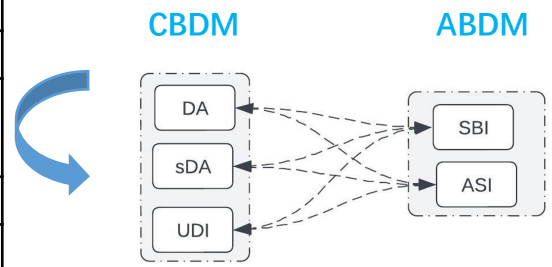


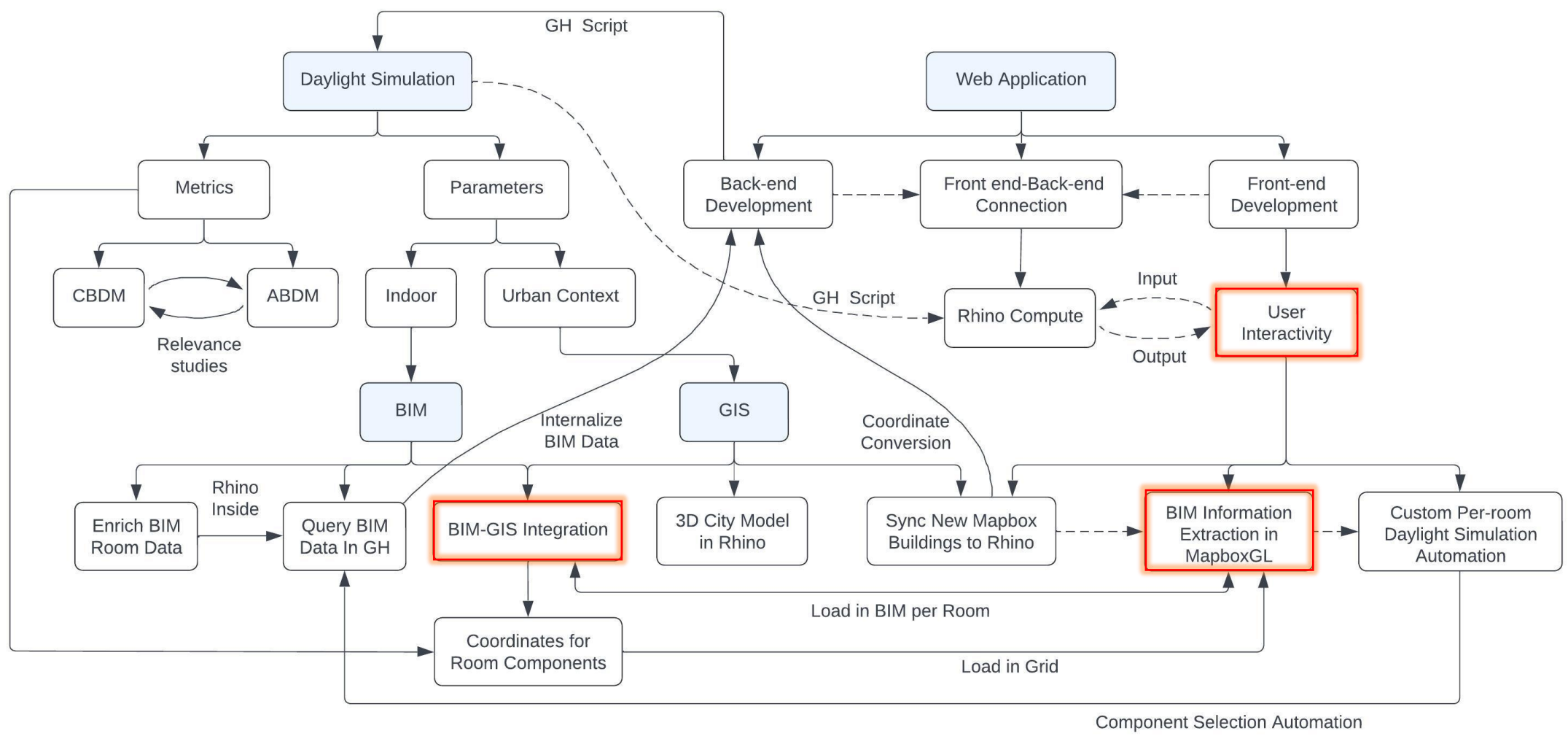


(a) with shading

(b) without shading

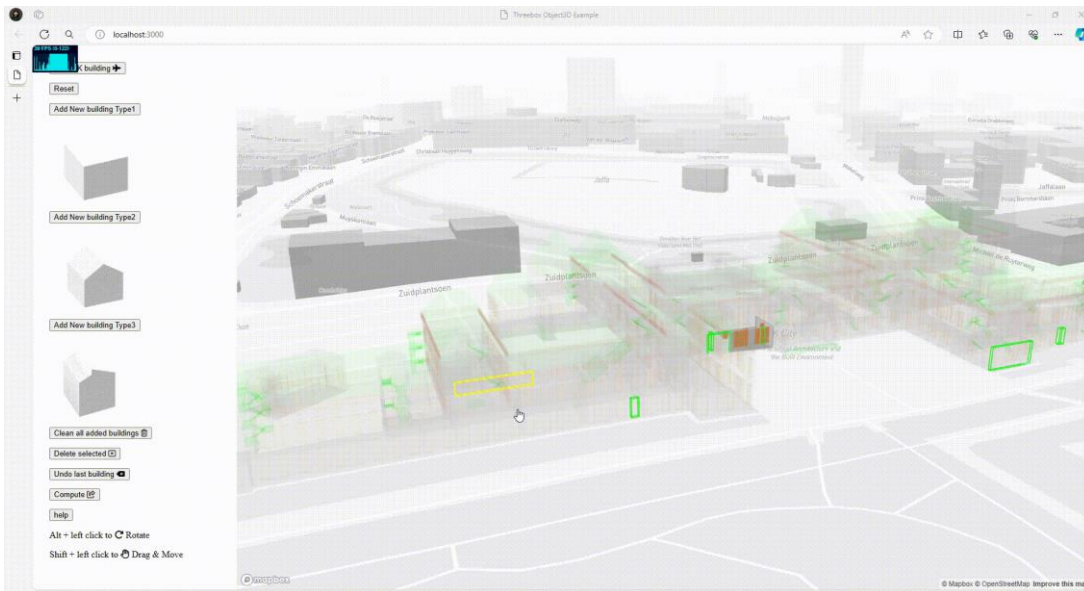
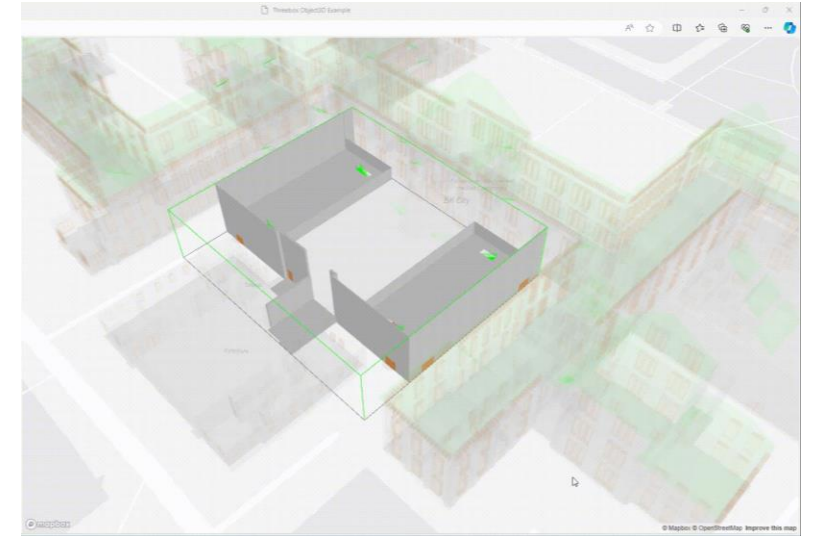
Comparison of	First Compare object	Second Compare object	Moderating variables to be validated
1 vs 2	0.9m	1.4m	height of window sills
1 vs 3	3m x 3.5m	5m x 4m	room's layout
3 vs 5	portrait window	landscape window	portrait and landscape window orientations
1 vs 4	single window	two separate windows	distribution type of windows
4 vs 6	1m x 1m	0.5m x 1.5m	shape of combined windows
A-H vs I-P	with shading	without shading	presence or absence of shading
A, B, H, I, J, P vs D, E, F, L, M, N	facing South	facing North	orientation of windows



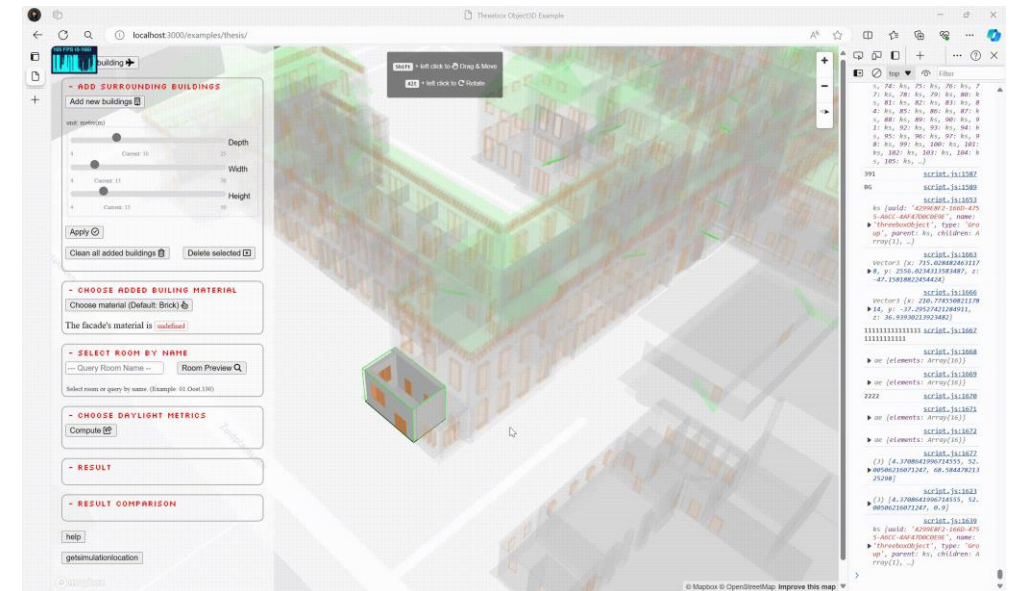


	Load in as a whole	Load in per BIM element	Load in per room way 1	Load in per room way 2	Load in per room way 2 (duplicate of multiple tag elements)
Element	1	7520	477	477	477
Time	10s	10+ min	1min	35s	48s
Interaction	-	++	+	+	+
Accuracy	-	++	+	+	++

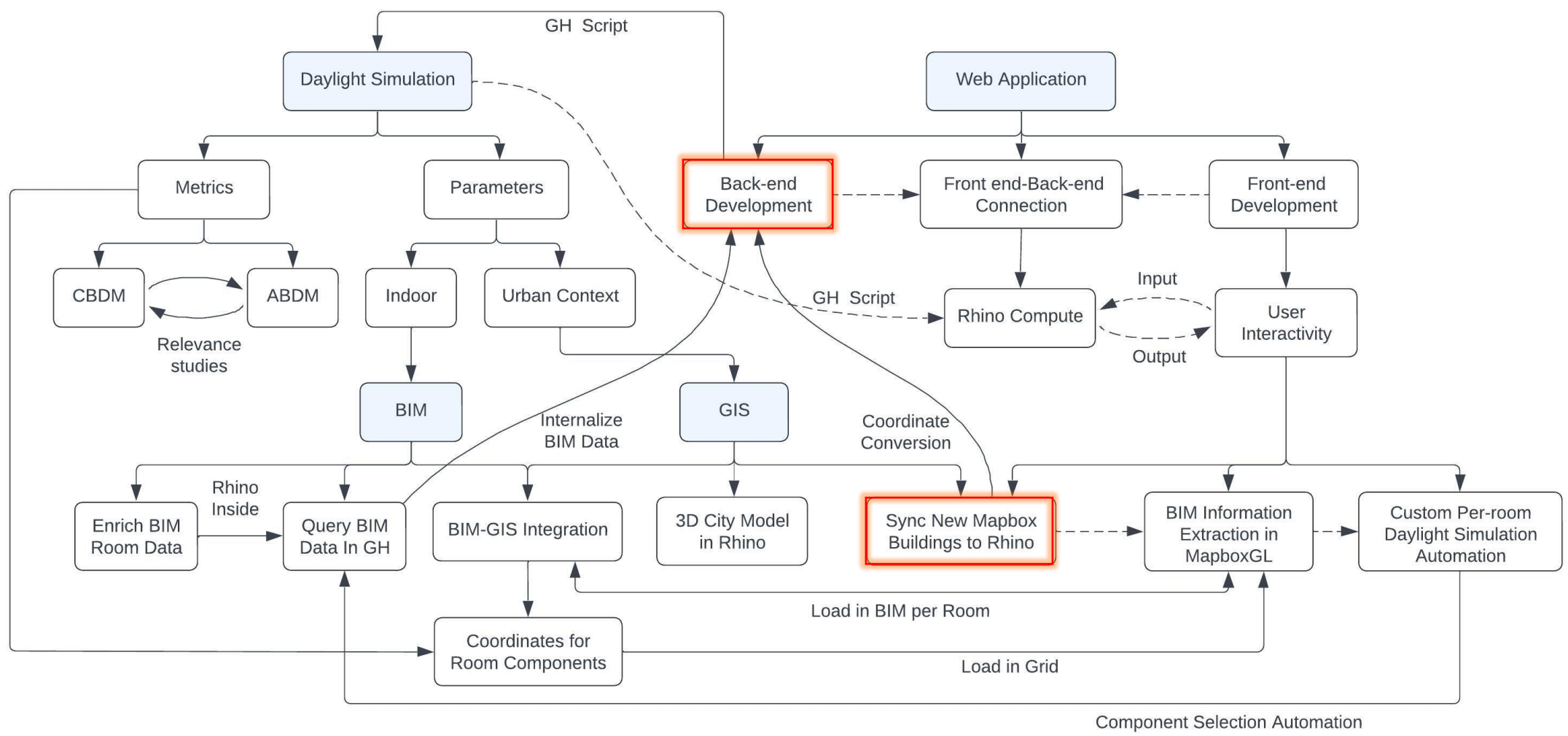
Comparison of different load in methods



Load in per **element**



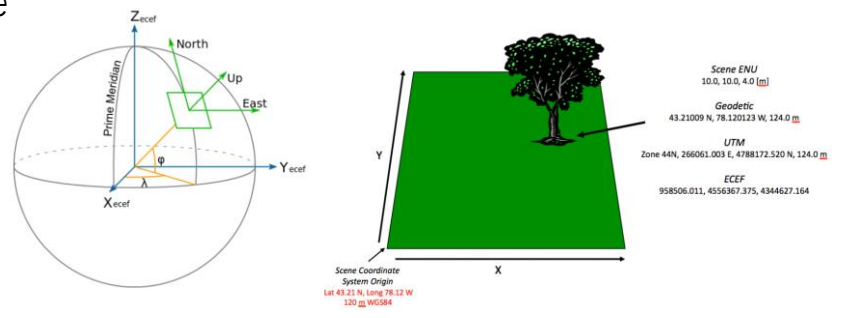
Load in per **room**



- Classify by material to build HB Shade
- Avoid empty inputs

- Synchronize - reproduce

- ▣ Duplicate
- ▣ Scale
- ▣ Move
- ▣ Rotate



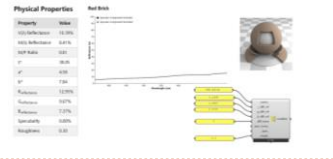
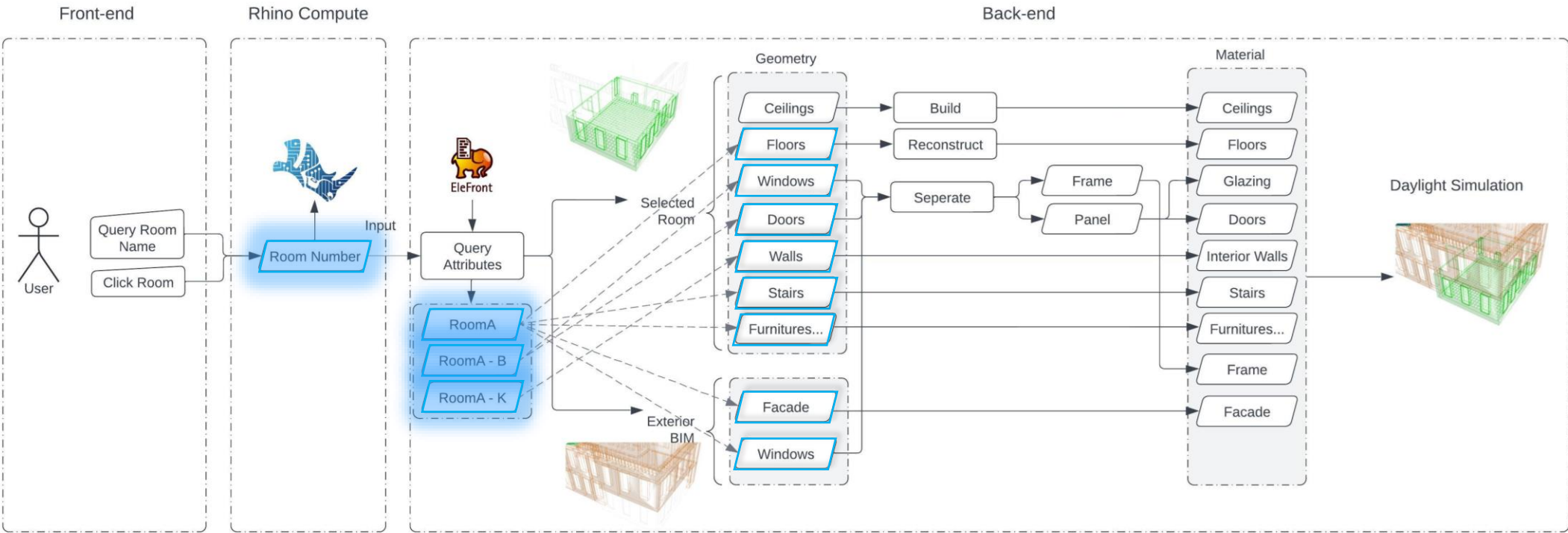
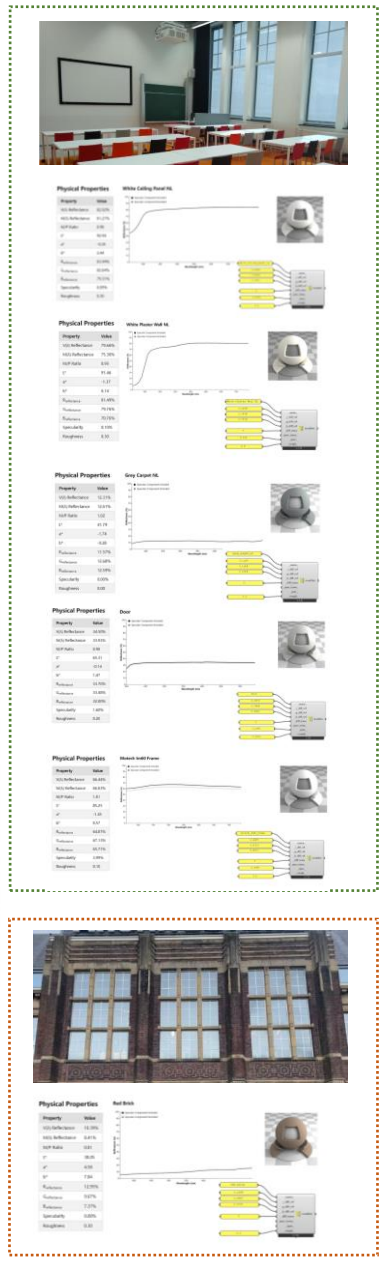
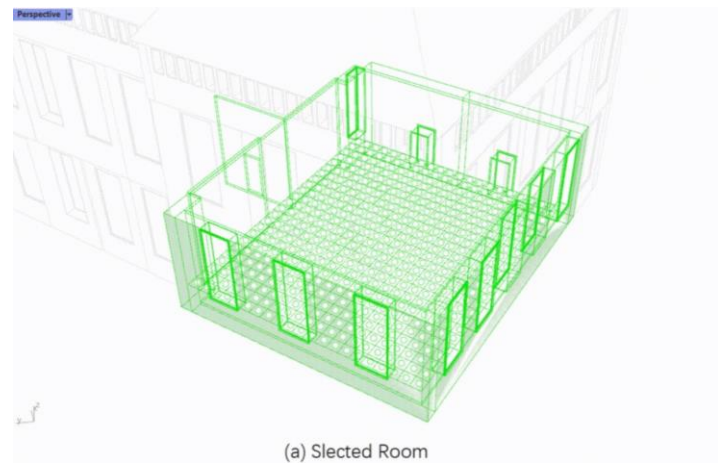
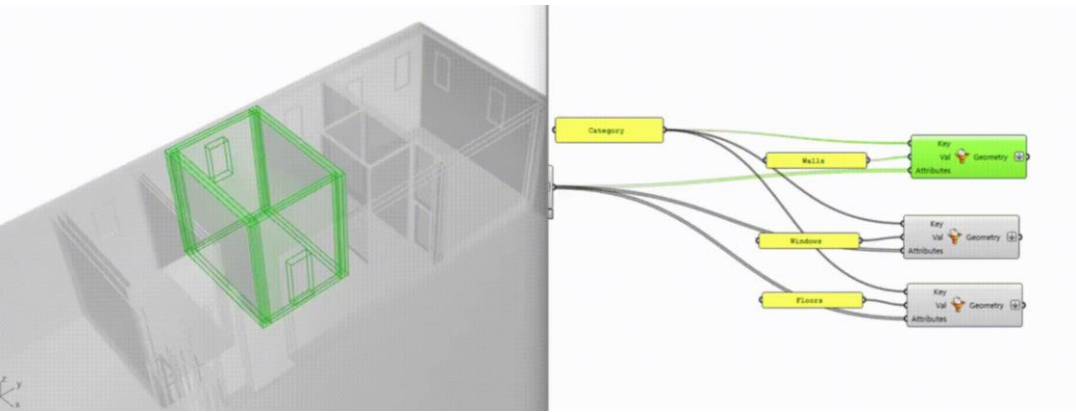
Relationships between Geodetic, ECEF and Scene ENU coordinate systems. (Wikipedia, 2010)

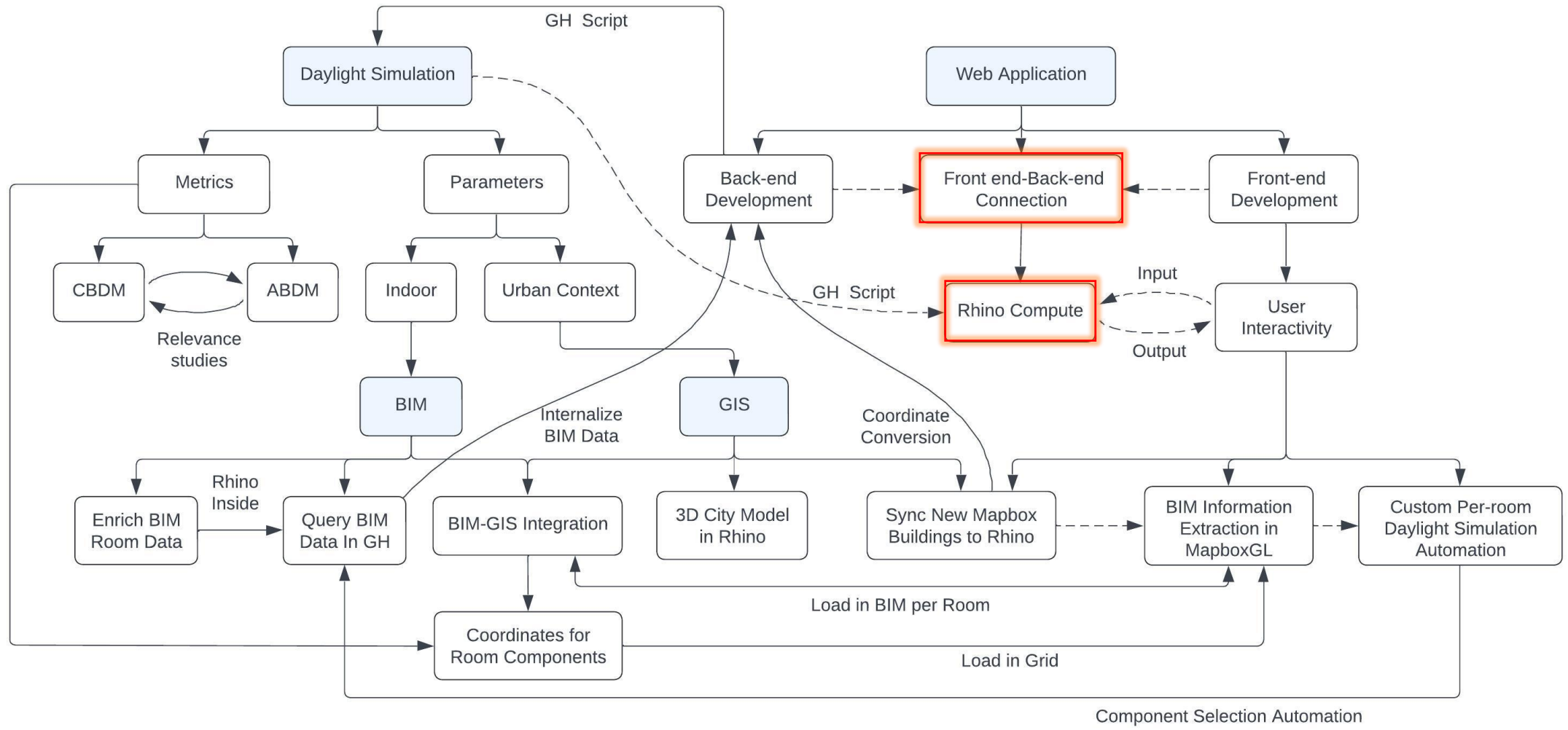
Material	Display in the application	Results
Float Glass		Material 1 Energy Assembly: 63.1%
Brick		Material 2 Energy Assembly: 65.2%
Reflective Glass		Material 3 Energy Assembly: 68.7%

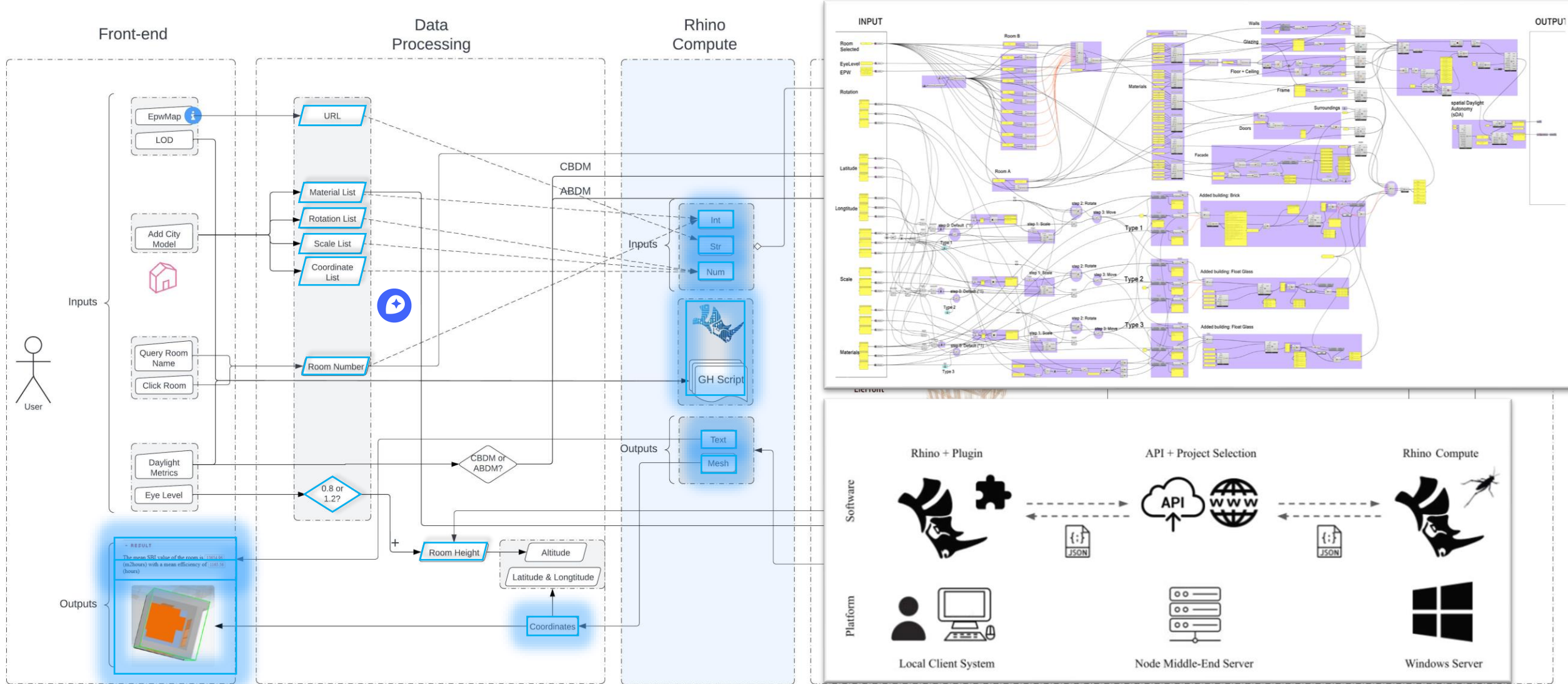
3 material settings



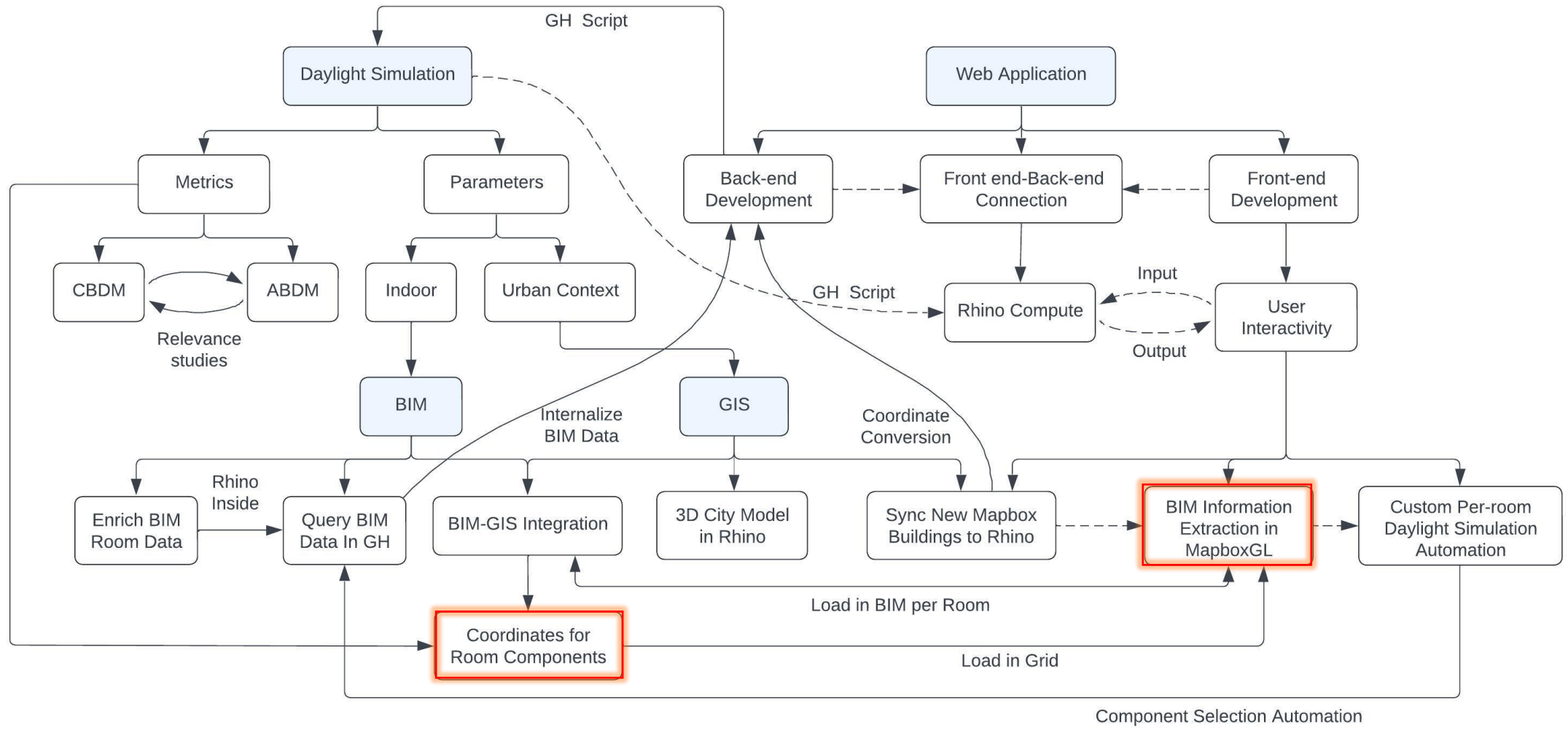




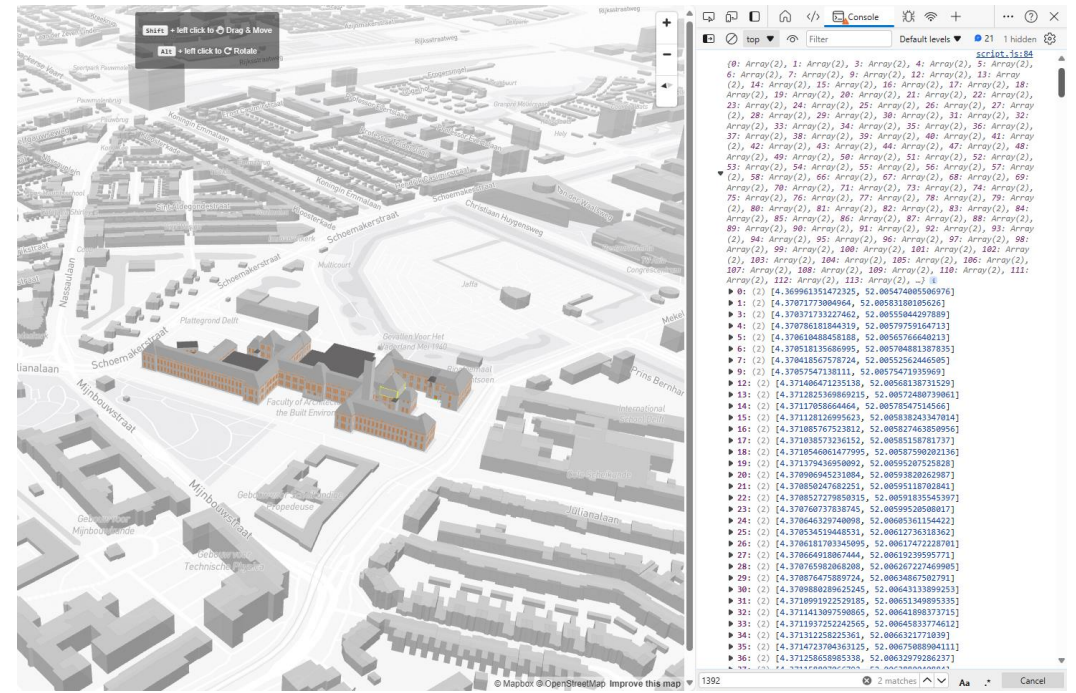
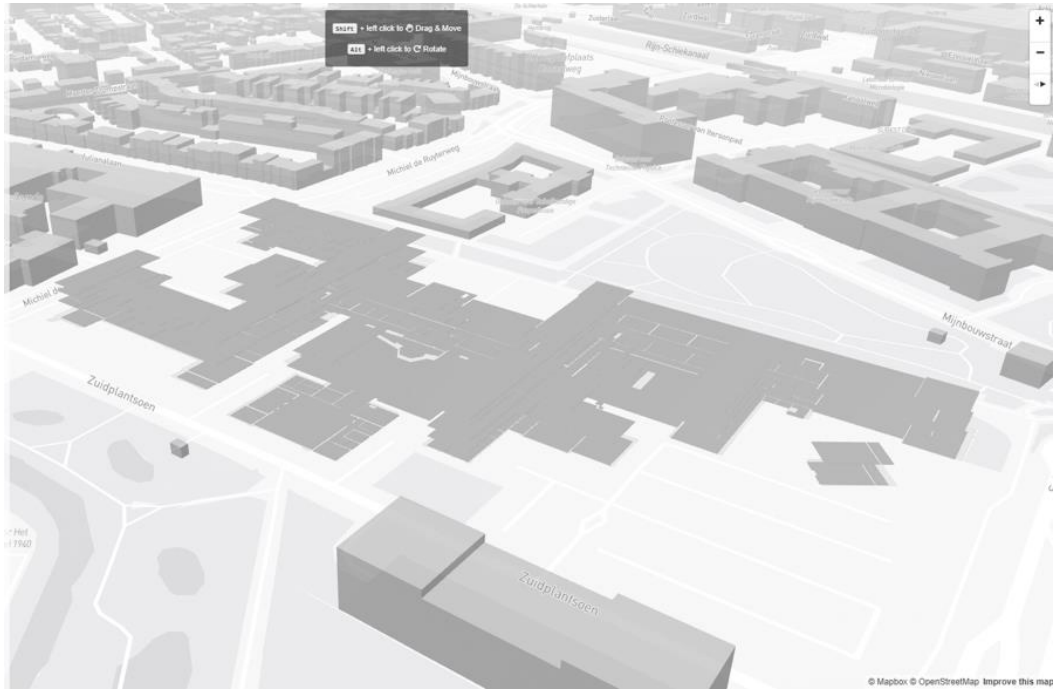
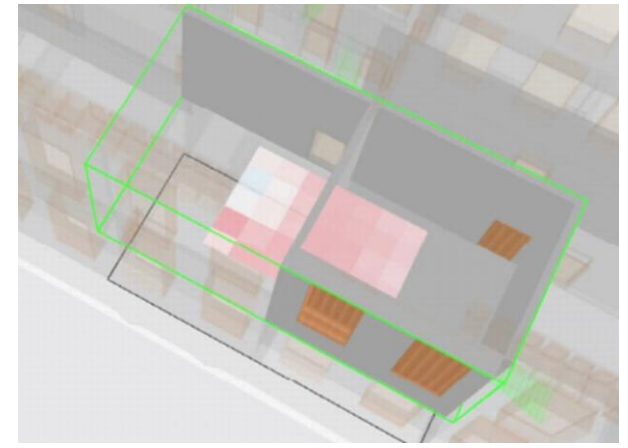




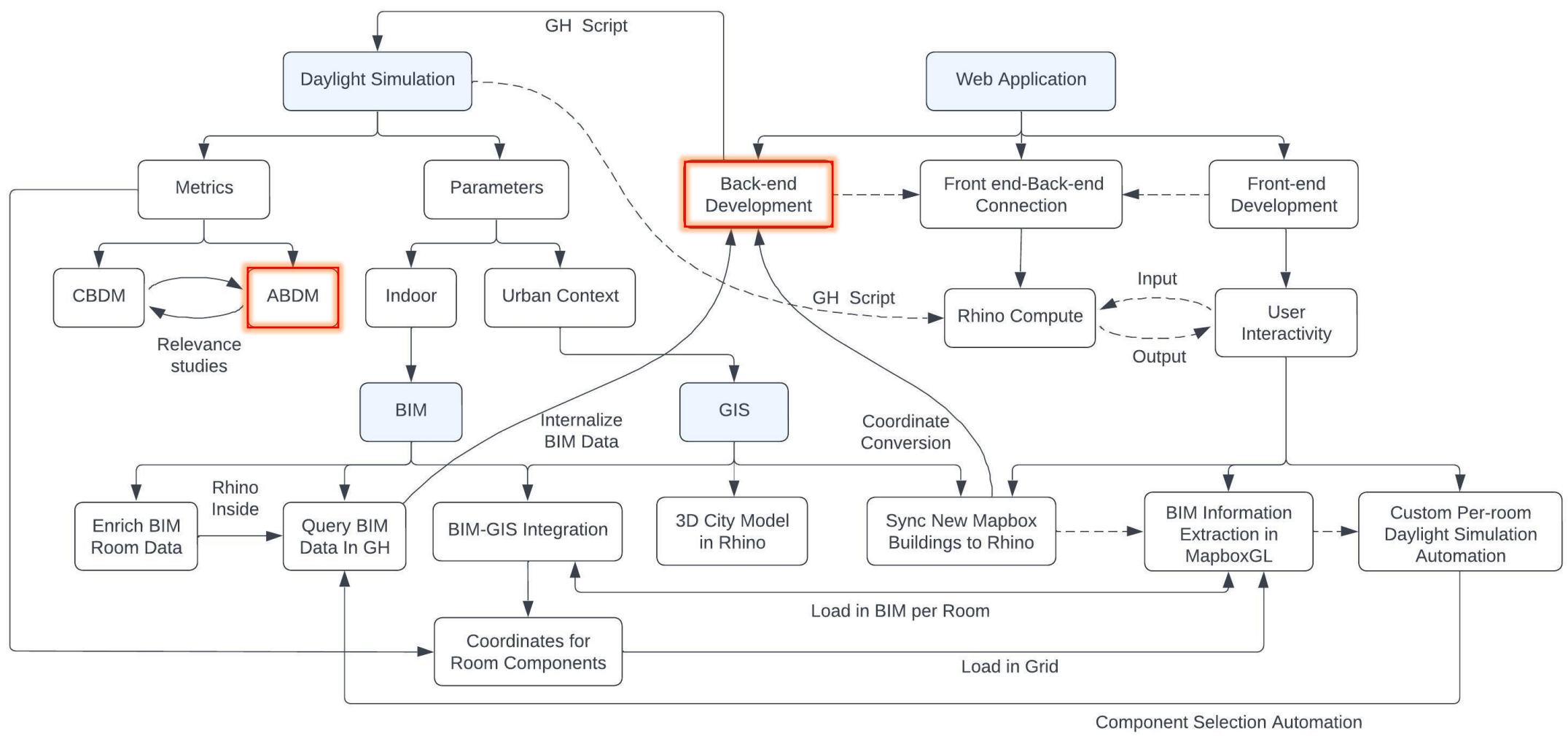
# Get Coordinates for simulation grid

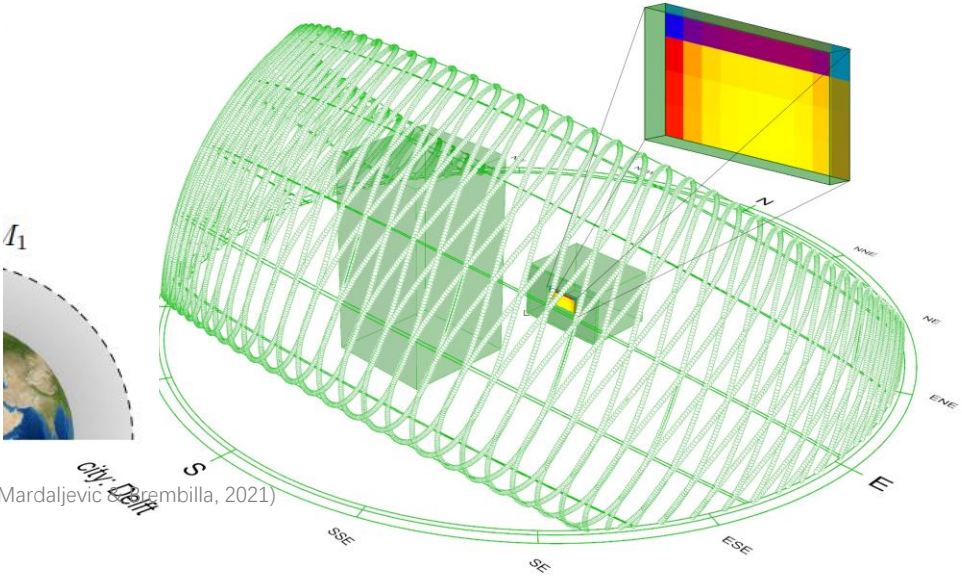
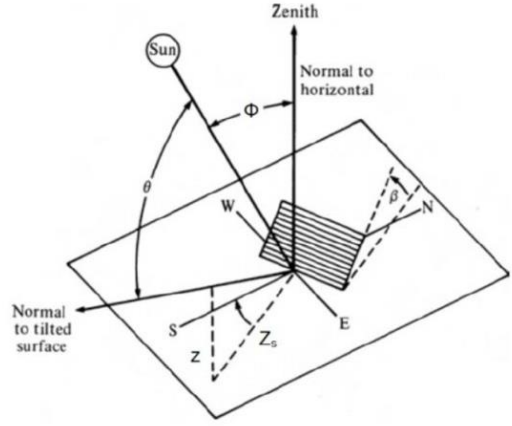
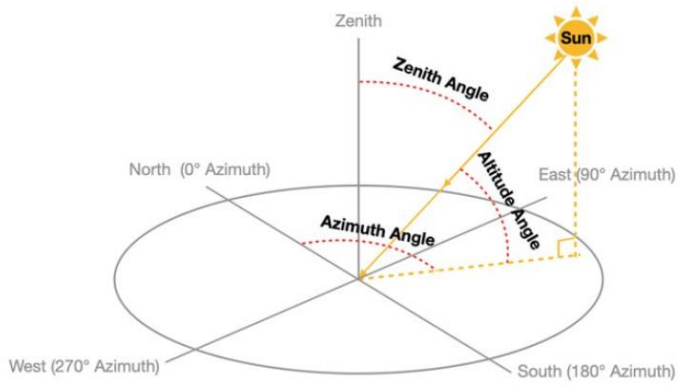
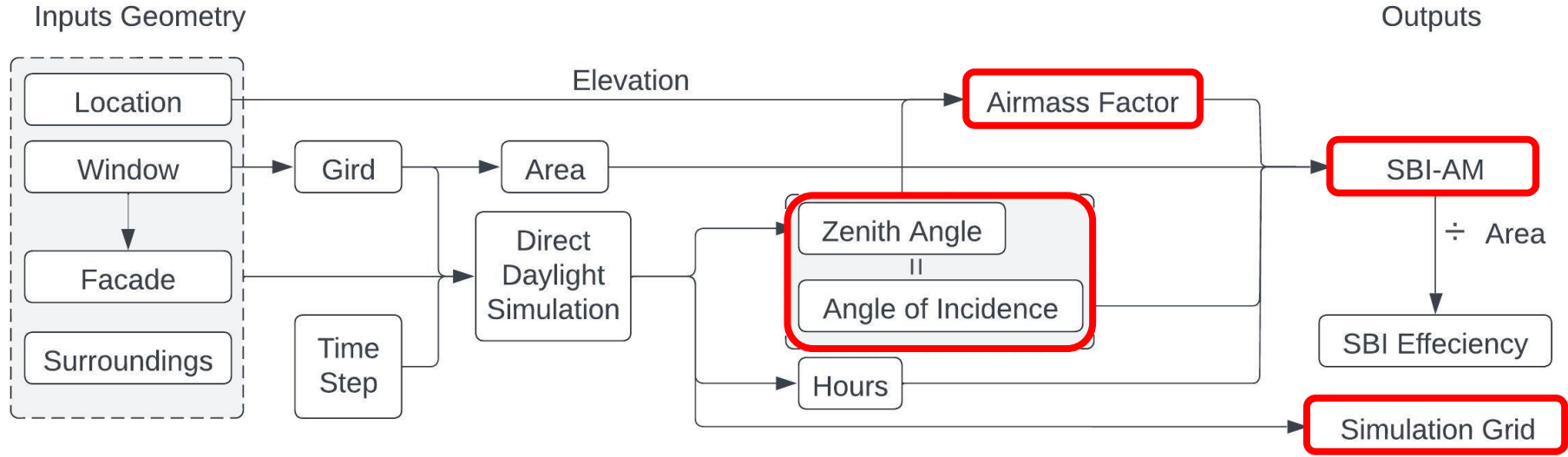


Get Coordinates for simulation grid

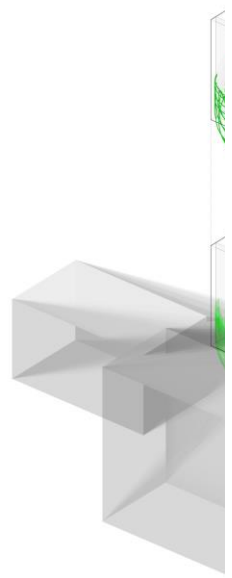
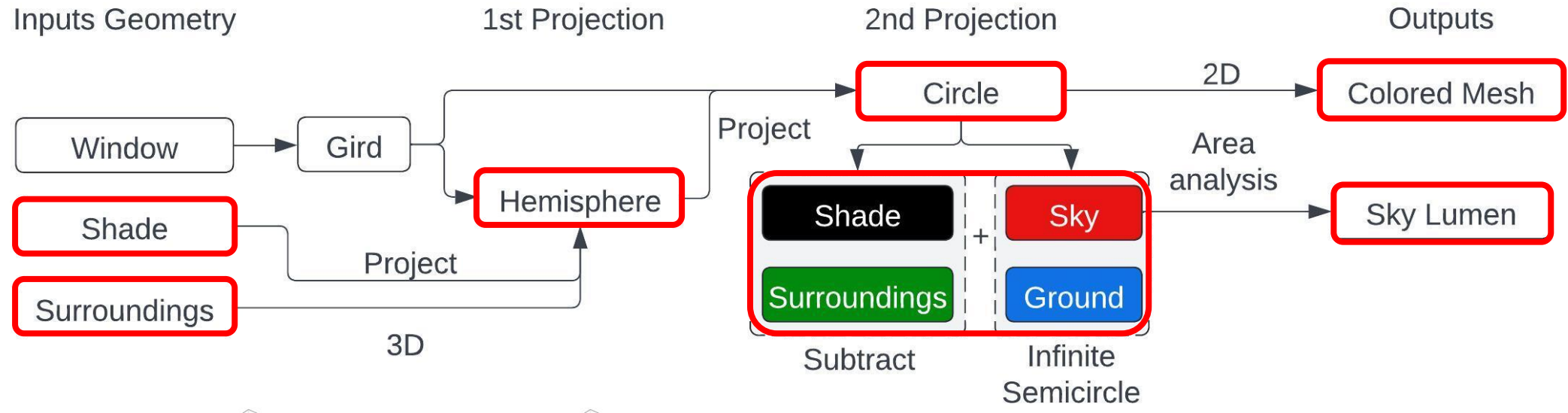


Load floors to get JSON coordinates then parse in JS object for BIM building

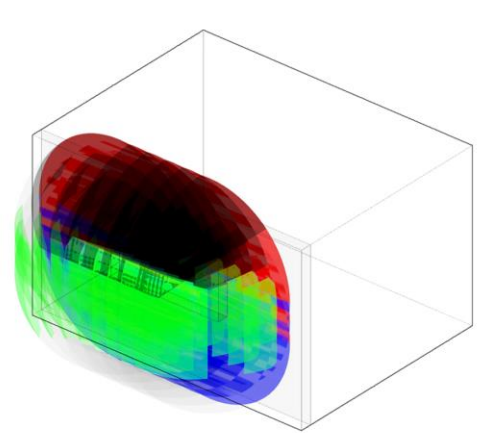




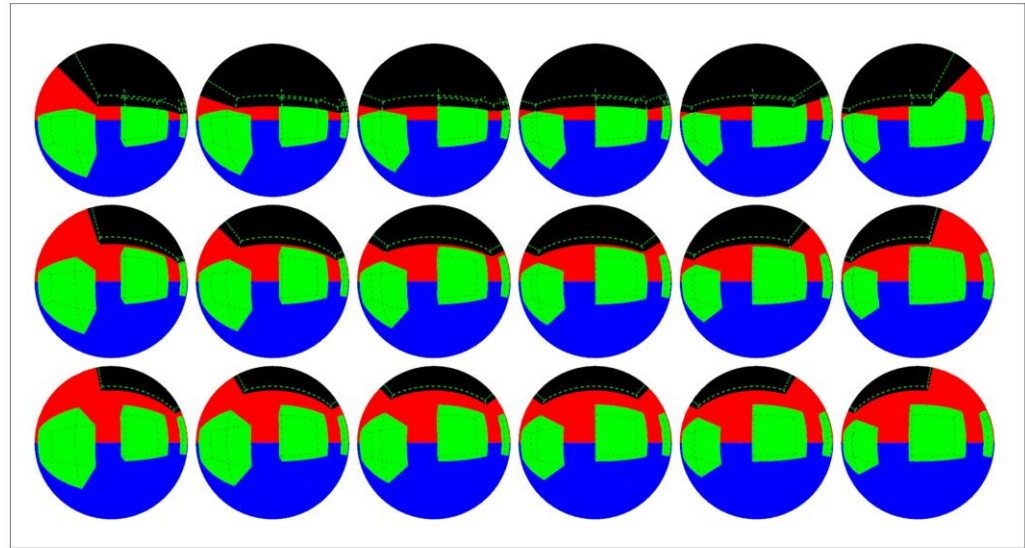
(a) correlation between altitude angle, zenith angle and angle of incidence  
(b) Airmass (AM) as a function of solar zenith angle  $\theta_z$  (Mardaljevic & Gramaglia, 2021)



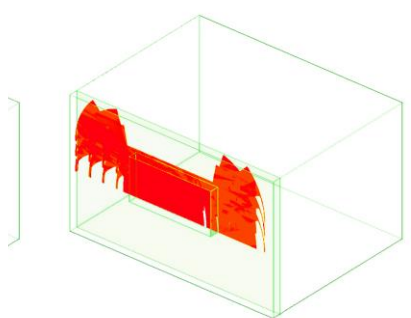
(a) p



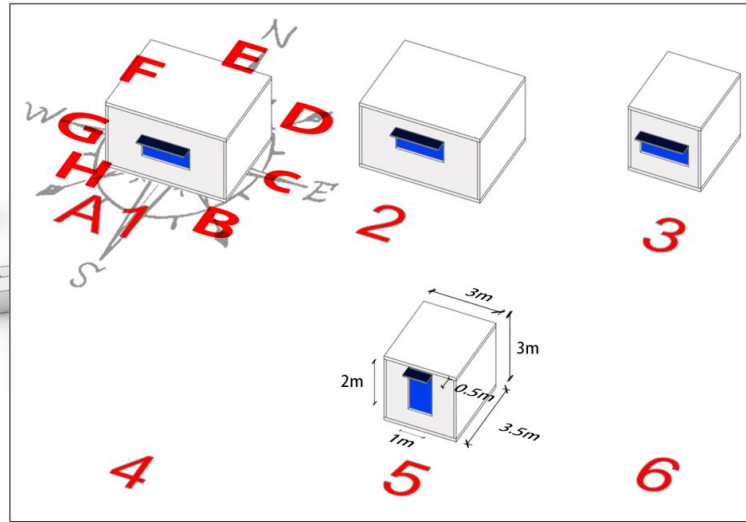
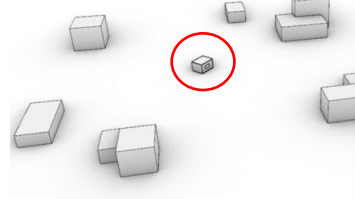
(a) 1st Projection



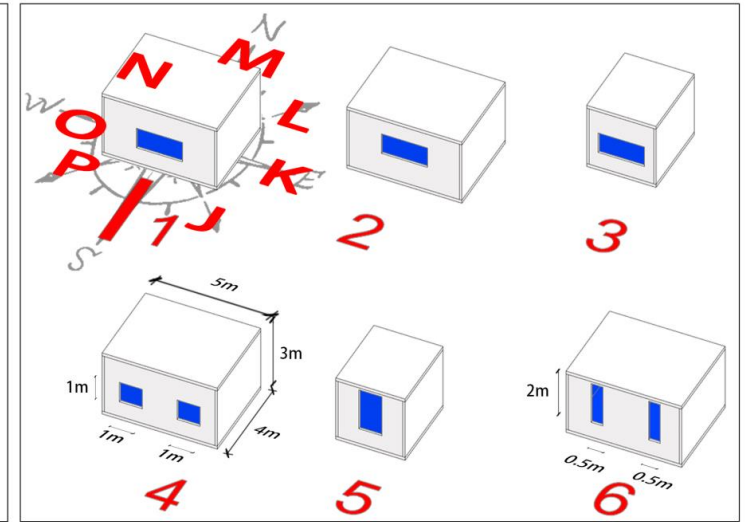
(b) 2nd Projection



Nr.	Name	SBL-AM	View-Numbers	DA [°]	sDA [°]	UD [°]
1	A1	3692.701137	241.7962001	29.704583	20	67.97175
2	A2	3600.177862	2476.422144	27.786633	114.1667	66.026
3	A3	3692.365756	2529.02294	55.186621	60.7143	77.32
4	AS	62.76.4476	3232.661164	60.934266	65.7143	77.07375
5	B1	3693.370491	255.4904343	27.64425	15	63.646063
6	BP	3625.655492	2956.023293	26.01	17.5	61.521
7	R1	3697.2939	2564.43695	49.381429	42.6671	74.557321
8	RE	5553.990673	3258.680182	53.3	53.5714	75.223363
9	C1	27.44.509117	251.4914103	17.339417	10.8333	56.53
10	C2	27.04.052641	2460.436493	13.717167	0	53.722063
11	C3	27.44.736745	251.5161673	33.912143	26.5714	73.672321
12	CS	4036.134627	3221.581564	37.616398	26.7657	75.0425
13	D1	17.00.11771	2509.912592	6.272167	6.667	50.39725
14	DE	1681.599193	2471.367655	3.671167	0	46.306633
15	DS	17.05.306527	2511.442021	21.080179	17.6671	71.566571
16	DS	2530.753	3218.953007	24.035	116.0714	74.030179
17	E1	1382.136212	2429.602675	5.926633	6.667	45.270667
18	E2	1389.217142	2397.154131	0.763633	0	42.69625
19	E3	1367.450762	2432.95662	16.372143	16.0714	60.801964
20	ES	1621.556198	3139.186572	17.590306	12.5	72.457143
21	F1	1636.909376	2457.661975	6.744063	6.667	50.326333
22	F2	1612.64529	2422.715219	3.839633	0	47.75625
23	F3	1636.755359	2461.508546	21.630693	19.6429	71.517321
24	FS	2546.020057	3165.535454	24.18125	19.6429	73.973363
25	GI	27.61.591635	2493.001576	17.682167	10.8333	56.614333
26	G2	27.27.156764	2453.52046	13.186083	0	55.951063
27	G3	27.59.022954	2493.324961	36.4575	26.5714	74.936607
28	G6	4063.676103	3193.13077	39.259036	26.5714	76.301766
29	H1	37.30.651666	2542.136246	26.516633	15.8333	66.081917
30	H2	3673.702141	2496.136623	23.722633	6.333	63.79075
31	H3	37.29.16304	2542.604427	49.671429	46.4266	76.766929
32	H6	5589.25722	3242.016466	54.603929	56.9266	77.410663
33	I1	59.76.526412	3633.106971	44.270417	31.667	72.619167
34	I2	60.04.50226	32791.91762	43.5257	35.8333	72.41625
35	I3	59.79.602559	3633.614732	67.25179	96.4266	77.120206
36	I4	59.68.502222	3628.581669	46.605	44.1667	74.319917
37	I5	62.76.4476	3616.401559	65.156214	92.6671	77.160663
38	I6	62.76.4476	3663.324743	45.422333	40	74.466333
39	J1	52.93.186464	3667.479976	39.551167	25.8333	69.446417
40	J2	53.14.536747	3681.735673	37.49125	23.333	66.6795
41	J3	52.79.467203	3666.091344	60.265179	76.7657	76.643363
42	J4	52.67.216536	3650.619785	42.264167	32.5	70.667
43	J5	55.53.990673	367.406052	57.360714	69.6429	76.613929
44	J6	55.53.990674	3673.412472	36.453683	23.333	69.921333
45	K1	3650.619915	361.619193	26.6625	14.1667	66.42725
46	K2	3664.195082	3760.204211	22.659333	5.6333	64.389417
47	K3	3630.536921	3619.636996	46.326179	39.2657	77.900714
48	K4	3646.746056	3611.603662	27.2525	11.6333	66.534667
49	K5	4036.134627	3636.650102	42.509036	32.1429	76.414464
50	K6	4036.134628	3635.606447	22.97475	6.667	64.46375
51	L1	23.34.276721	3612.721995	14.11267	12.037	61.996
52	L2	23.37.686301	3771.206429	10.366	0.6333	59.567417
53	L3	23.32.906642	3612.620429	33.68929	32.1429	76.734643
54	L4	23.16.332224	3606.551229	14.666	11.3333	62.298333
55	L5	25.30.753006	3627.049666	29.283398	23.2143	76.389107
56	L6	25.30.753006	3626.751567	9.176917	3.3333	56.9695
57	M1	1689.250663	3734.473076	10.346917	11.6667	66.056663
58	M2	1697.996967	3697.566946	5.663633	0.6333	57.136167
59	M3	1699.459296	3766.463134	27.71125	30.3671	76.091071
60	M4	1691.934442	3693.40371	130.00063	11.33333	59.475063
61	M5	1621.56293	3753.509914	20.2755	21.4266	75.036214
62	M6	1621.56298	3751.551323	4.539917	3.3333	56.306633
63	N1	24.74.263752	3762.5541	14.423917	13.333	61.905063
64	N2	24.62.104174	3722.690736	10.681917	2.5	60.346417
65	N3	24.74.410343	3764.577417	34.677321	33.9266	76.736367
66	N4	24.66.226178	3756.13742	15.167633	1.5	62.597917
67	N5	25.46.020057	3779.694156	30.002143	26.7657	76.466536
68	N6	25.46.020056	3778.145607	9.429667	3.3333	60.192417
69	O1	3667.107446	3794.643756	26.34775	17.5	67.4765
70	O2	3689.120015	3752.496472	22.97725	10	66.167063
71	O3	3667.076599	3794.690416	46.579416	46.4266	76.943929
72	O4	3666.113	3766.786227	26.076667	11.63333	69.111917
73	O5	4063.676103	3666.175579	44.582143	41.6714	77.706036
74	O6	4063.676102	3607.860661	23.14125	6.6667	67.407667
75	P1	53.53.651041	3616.350433	36.794667	25.8333	71.603
76	P2	53.74.321441	3769.939036	37.067417	23.3333	70.97063
77	P3	53.52.745379	3666.477565	62.016929	71.4266	77.724464
78	P4	53.36.51915	3612.057619	41.292167	34.1667	73.1755
79	P5	55.89.257222	3667.746813	59.452657	76.7657	77.631429
80	P6	55.89.257222	3666.597647	36.9155	24.1667	72.7765



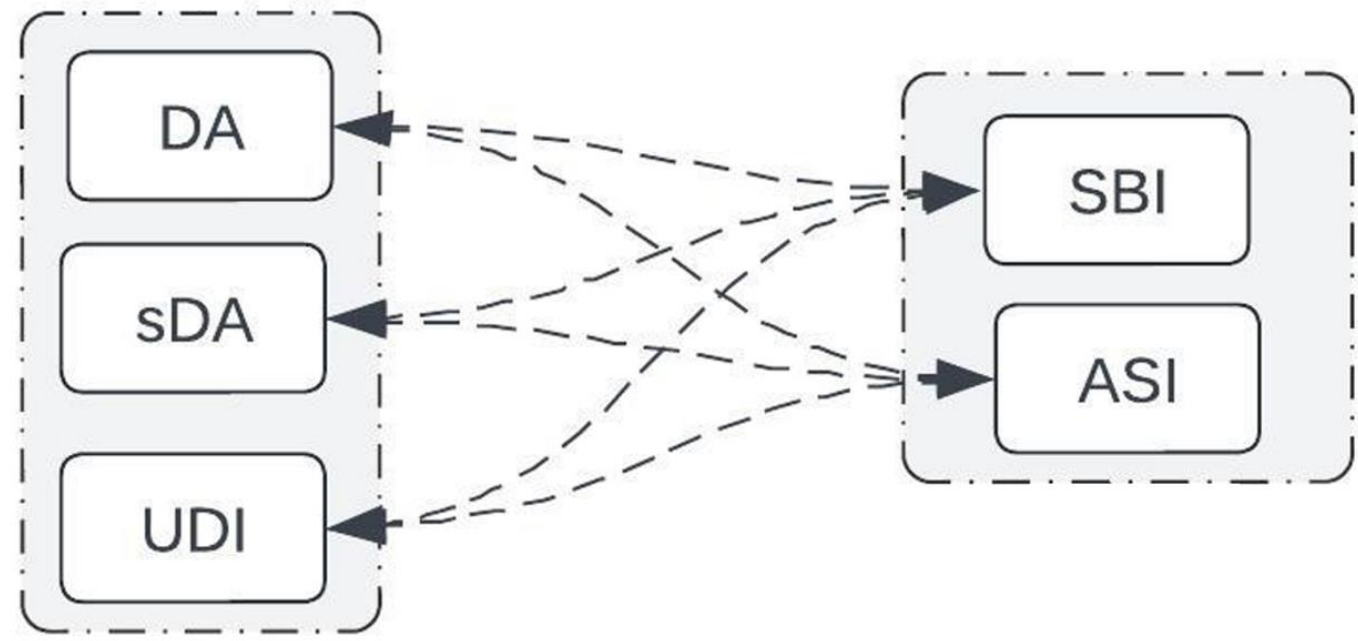
(a) with shading

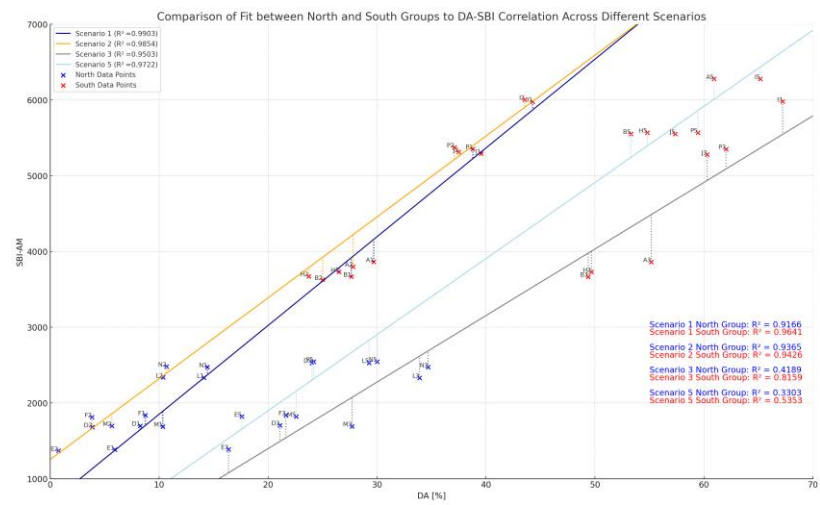
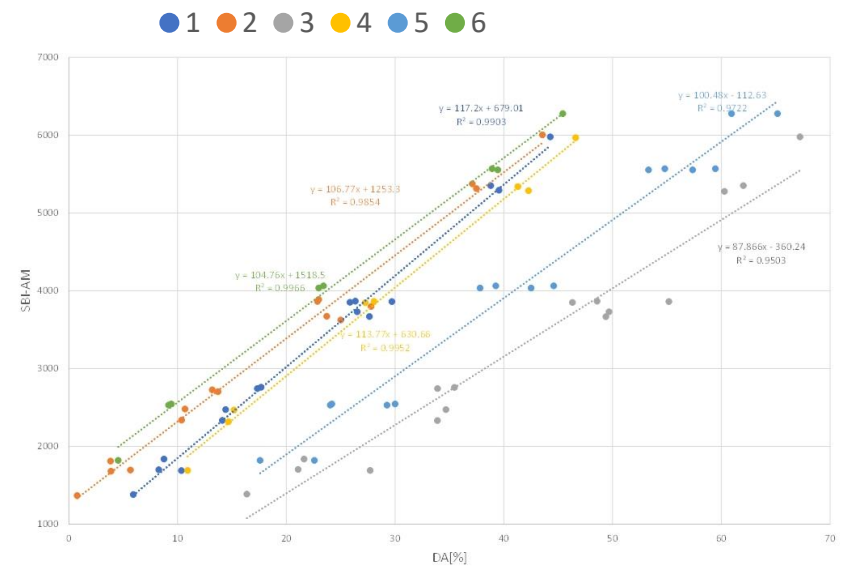


(b) without shading

**CBDM Metrics**

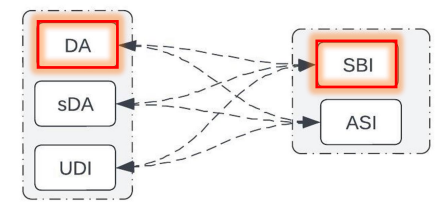
**ABDM Metrics**

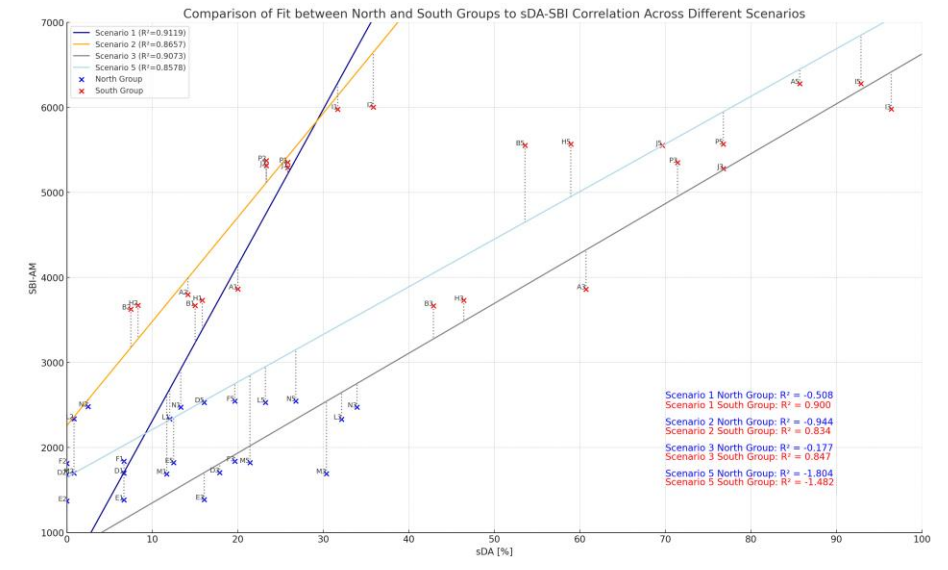
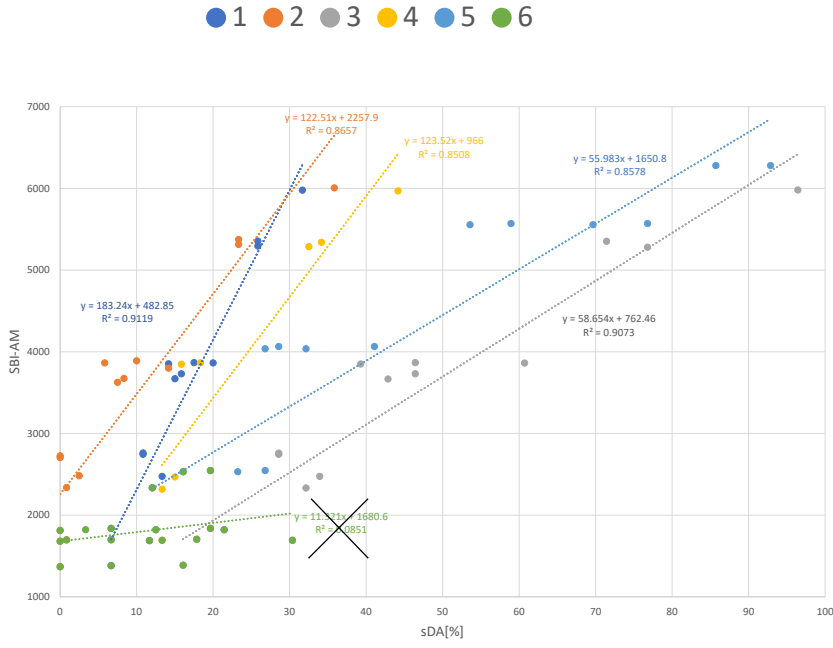




**Analysis:**

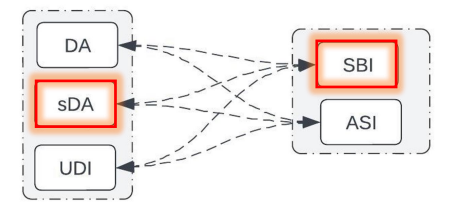
- Overall very strong correlation
- South better fitting than North
- Greatest impact moderating variable : Geometric features of rooms



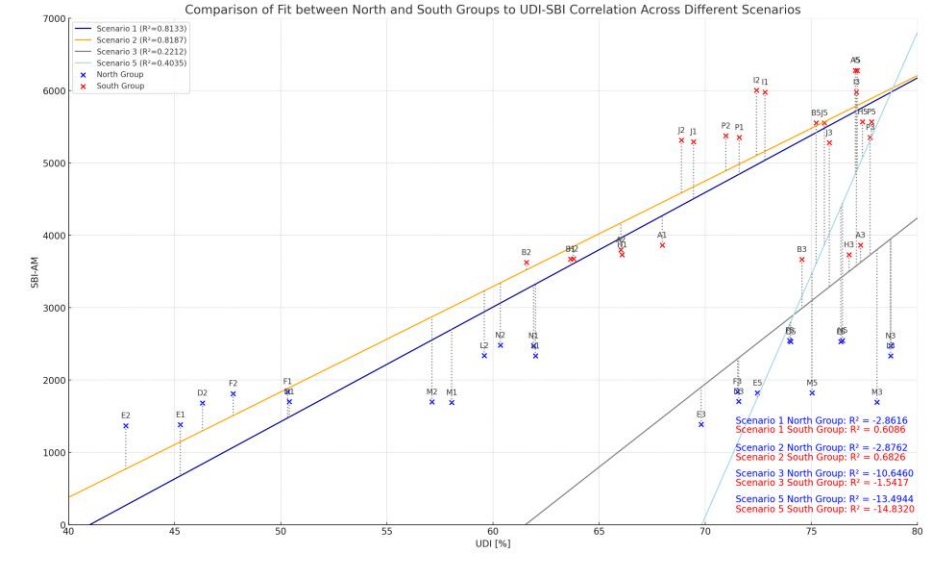
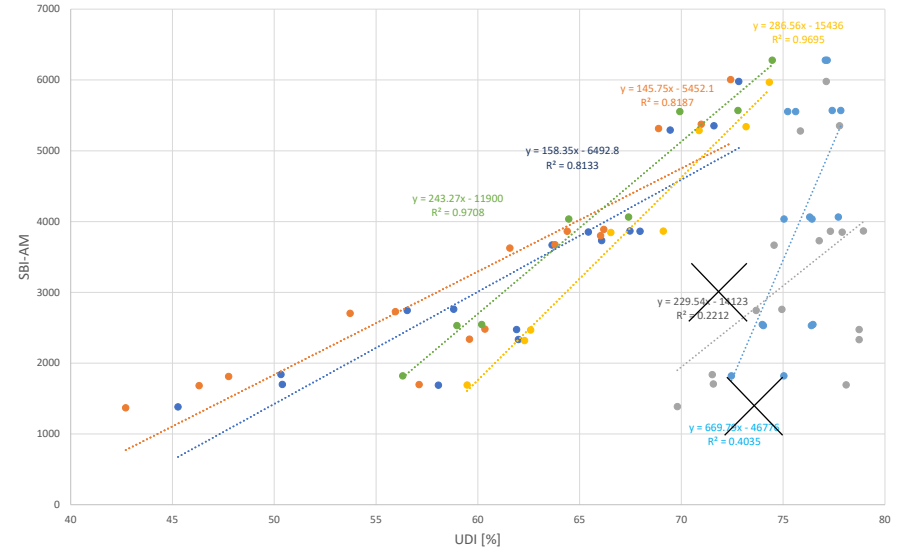


**Analysis:**

- Overall strong correlation, 1 exception
- South better fitting than North
- Greatest impact moderating variable : Geometric features of rooms

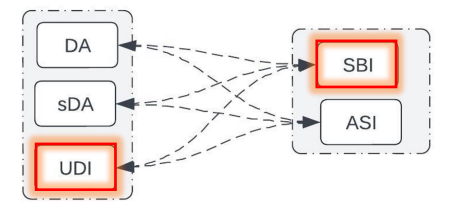


1 2 3 4 5 6

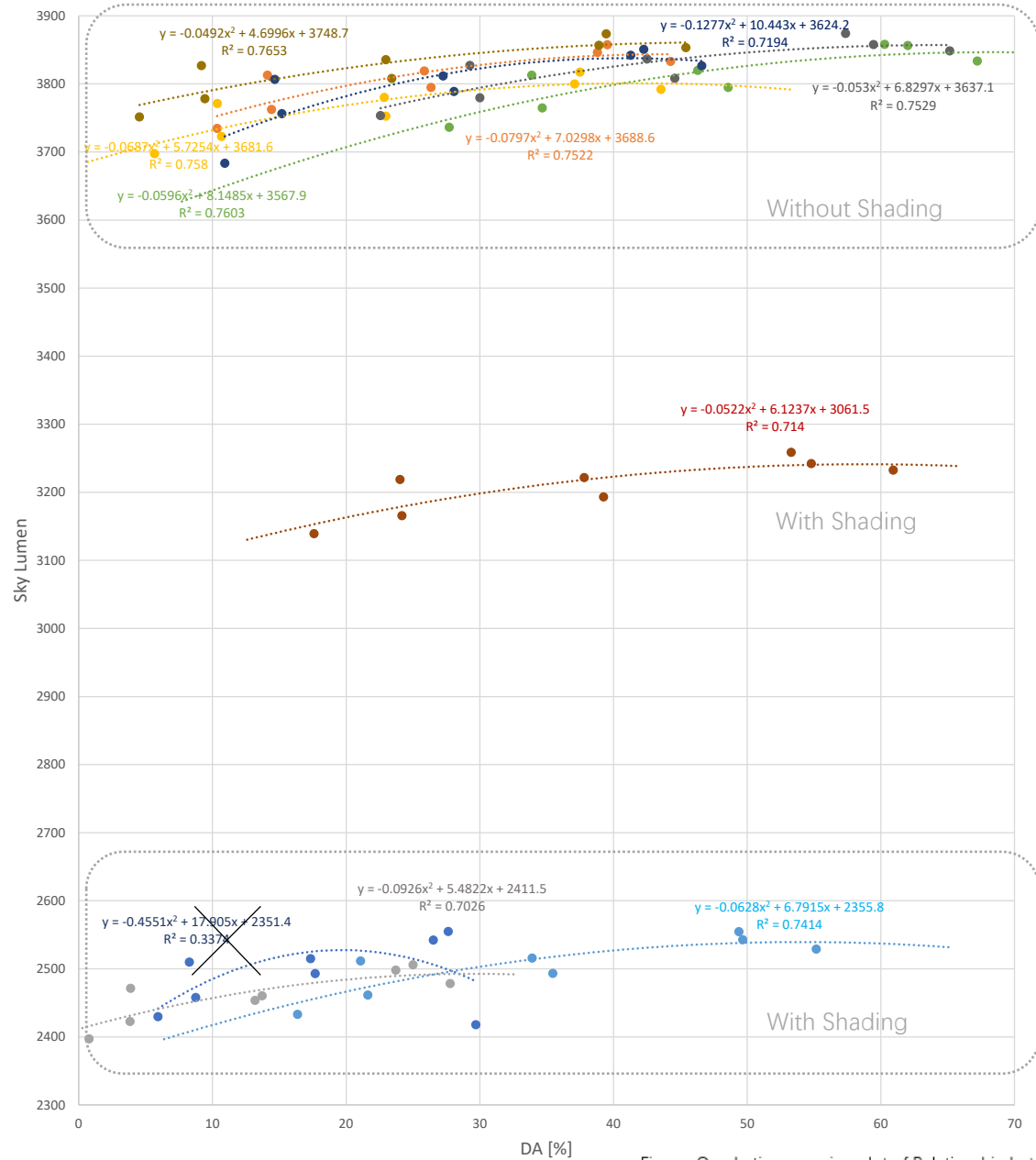


**Analysis:**

- Overall strong correlation, 2 exceptions
- South better fitting than North



# 8. Data analysis : DA – Sky Lumen



- 1 with shading ● 1 without shading ● 2 with shading ● 2 without shading ● 3 with shading
- 3 without shading ● 4 without shading ● 5 with shading ● 5 without shading ● 6 without shading

**Analysis:**

- Overall good correlation
- Greatest impact moderating variable : **Shading condition**

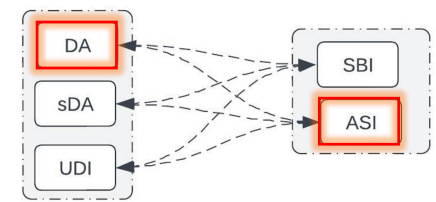
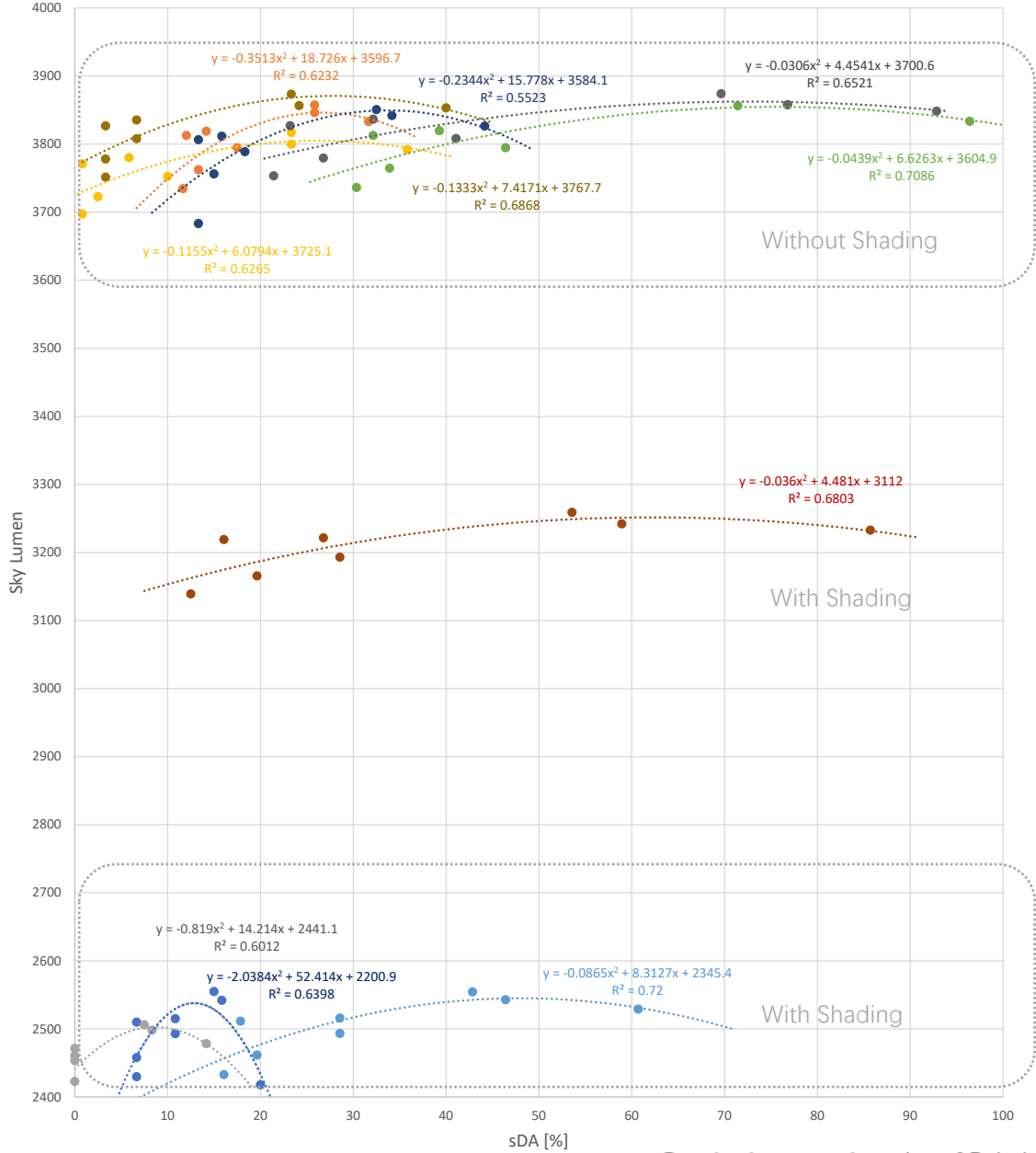


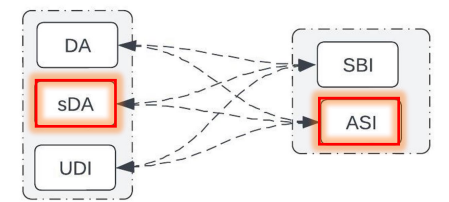
Figure: Quadratic regression plot of Relationship between DA and Sky Lumen



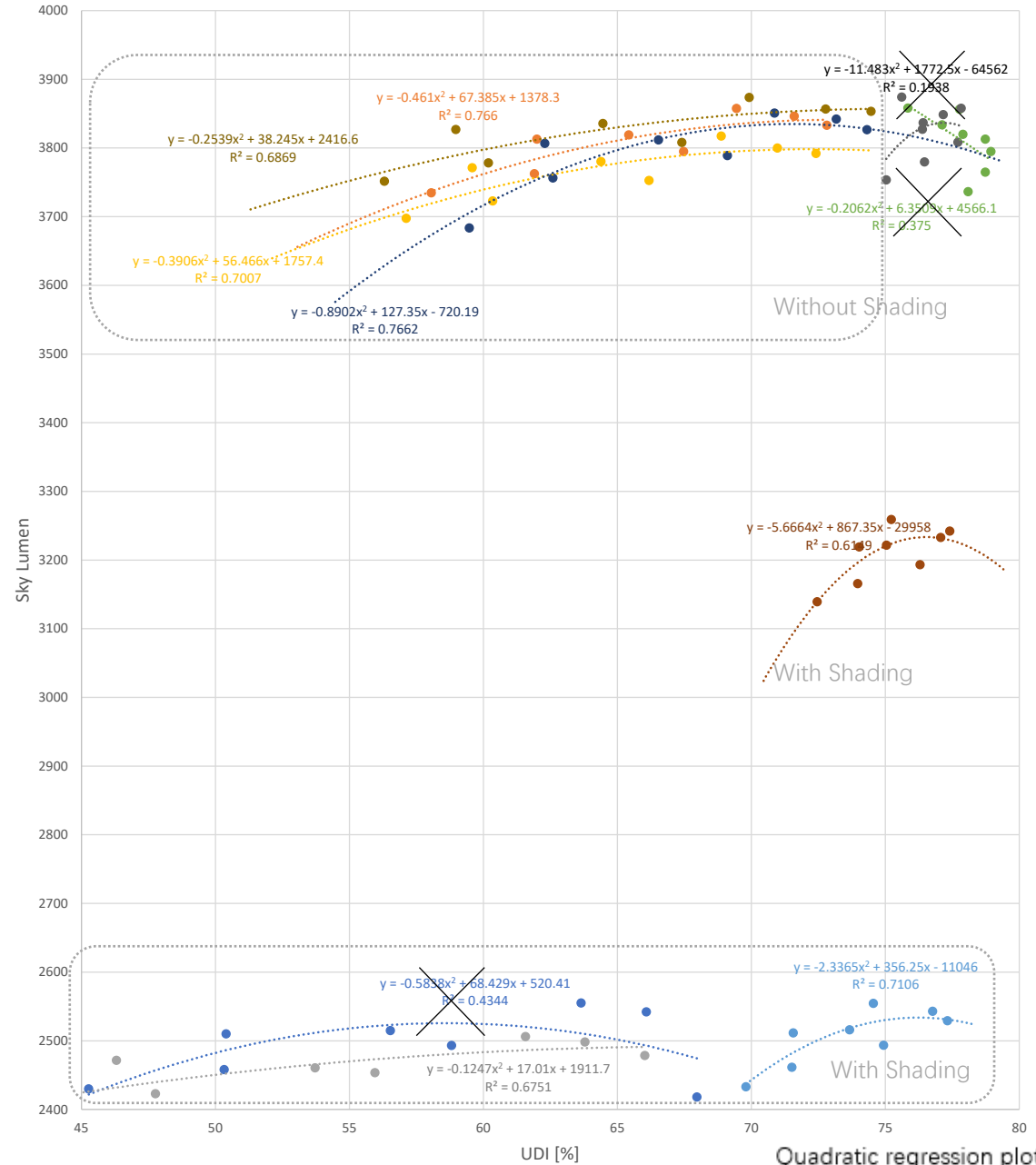
- 1 with shading ● 1 without shading ● 2 with shading ● 2 without shading ● 3 with shading
- 3 without shading ● 4 without shading ● 5 with shading ● 5 without shading ● 6 without shading

**Analysis:**

- Overall good correlation
- Greatest impact moderating variable : **Shading condition**



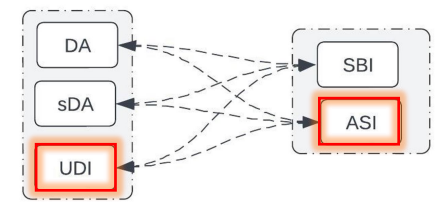
Quadratic regression plot of Relationship between sDA and Sky Lumen<sup>el</sup>



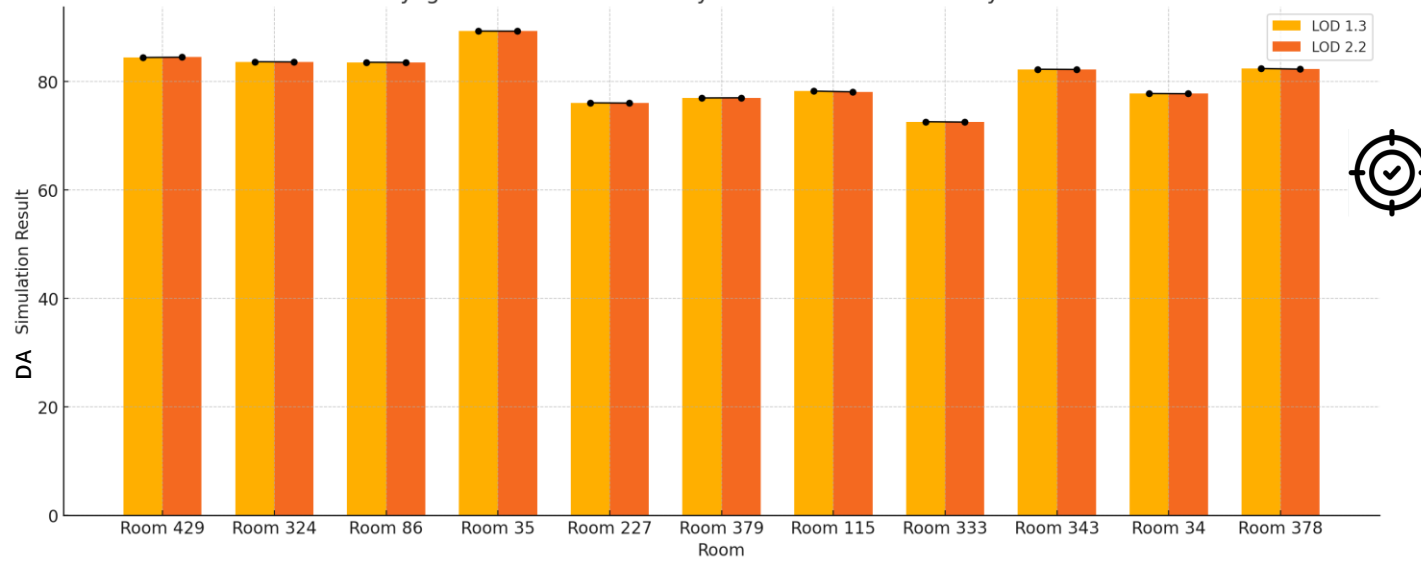
- 1 with shading    ● 1 without shading    ● 2 with shading    ● 2 without shading    ● 3 with shading
- 3 without shading    ● 4 without shading    ● 5 with shading    ● 5 without shading    ● 6 without shading

**Analysis:**

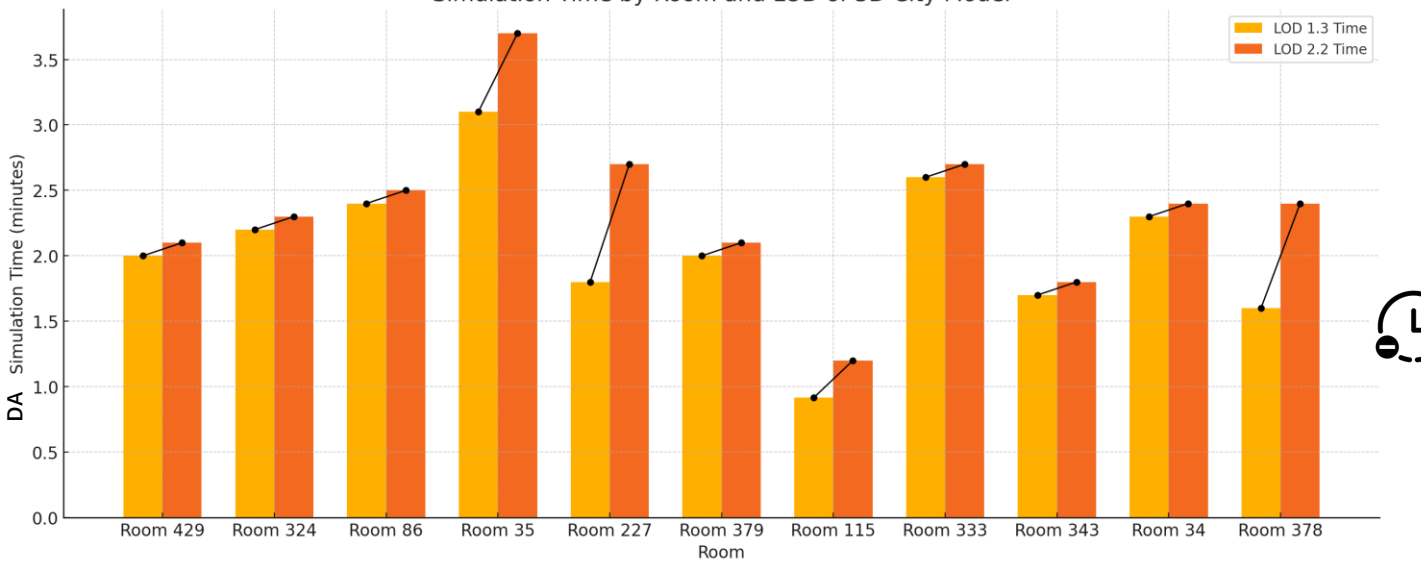
- Overall good correlation, 3 exceptions
- Greatest impact moderating variable : **Shading condition**



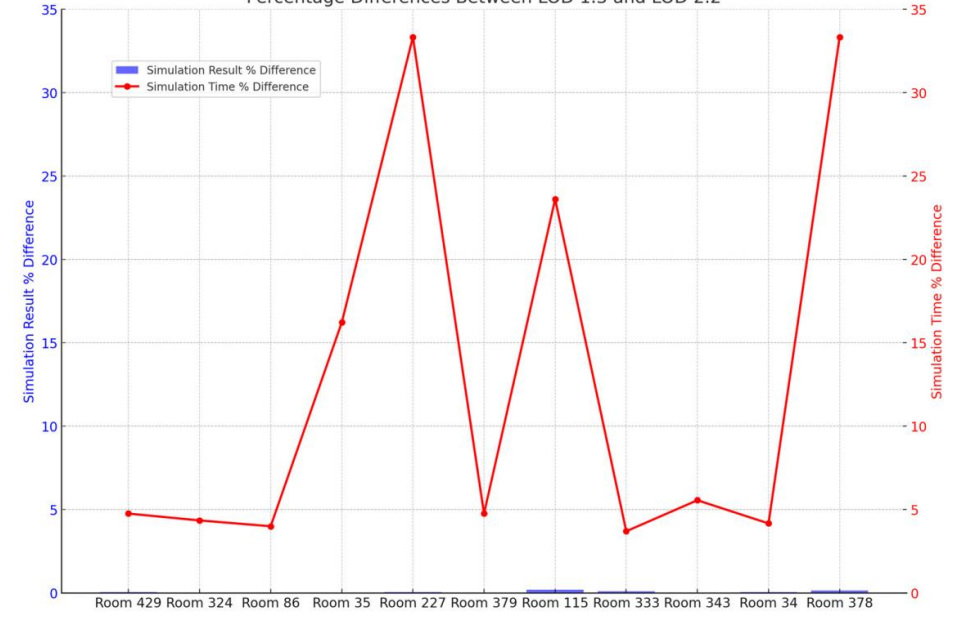
Daylight Simulation Results by Room and LOD of 3D City Model



Simulation Time by Room and LOD of 3D City Model

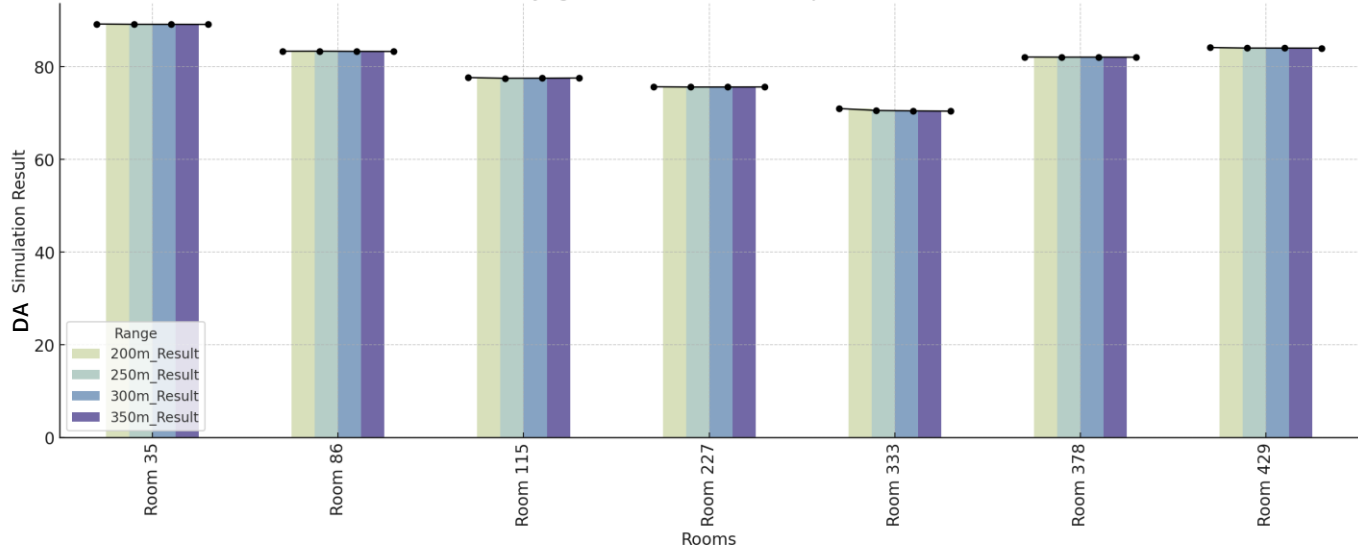


Percentage Differences Between LOD 1.3 and LOD 2.2

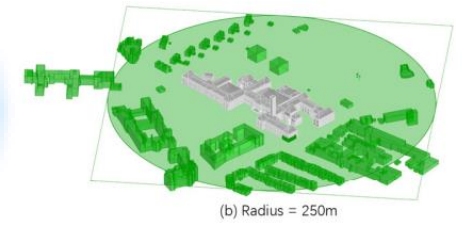
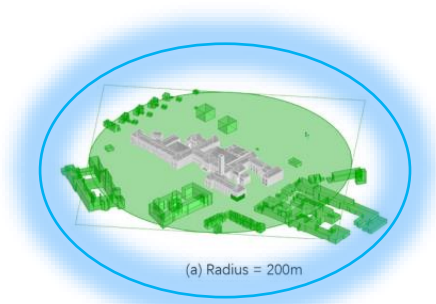
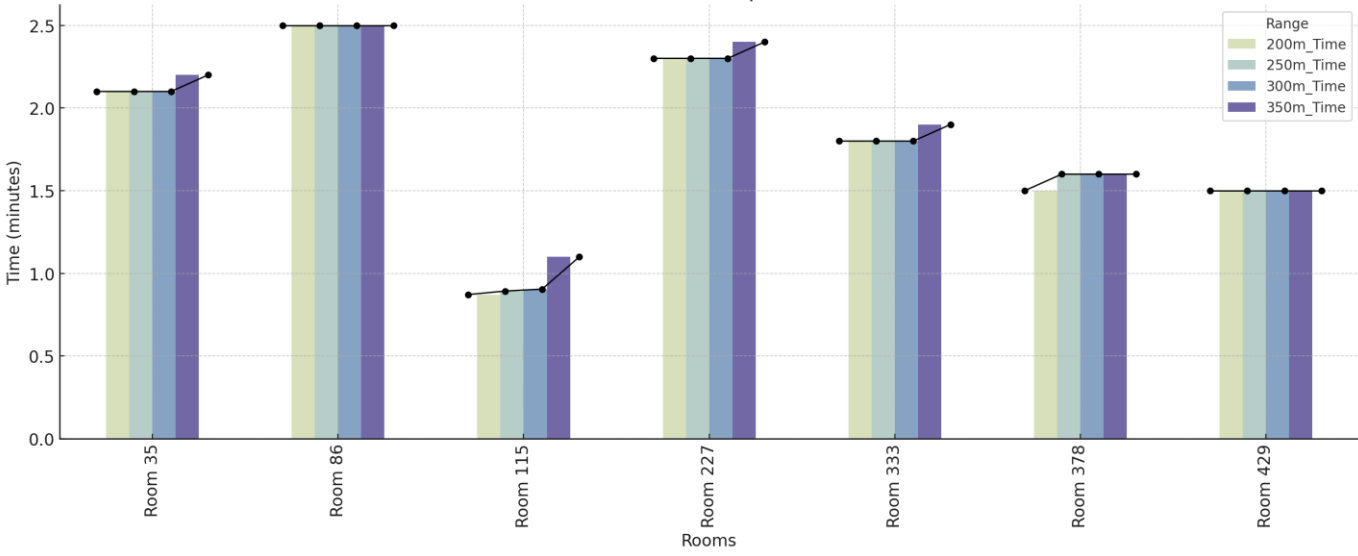


Choose surroundings LOD:  LOD1.3  LOD2.2

Daylight Simulation Results per Room



Simulation Time per Room



High-density area

LOD



Amsterdam

Radius



New York

Radius



BIM on different scale

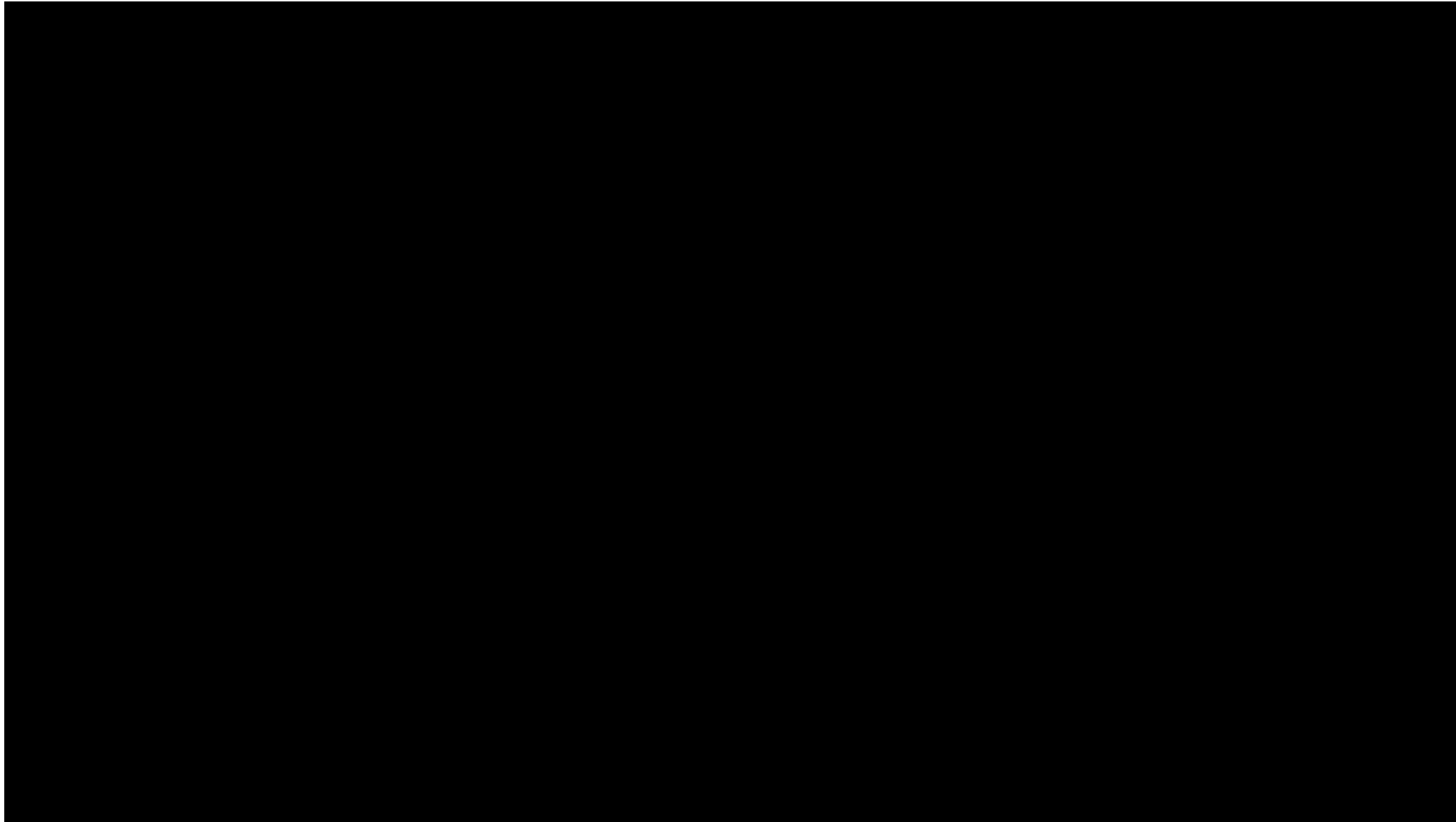
# 3

## RESULTS

 Demo  
6. Results



<https://www.youtube.com/watch?v=l1yJrKcFfYs>



Step 1

**- CHOOSE WEATHER EPW & 3D CITY LOD**

Link to EPW Map

Choose surroundings LOD:  LOD1.3  LOD2.2

Step 2

**ADD SURROUNDING BUILDINGS**

Add new buildings

unit: meter(m)

Depth:  Current: 25

Height:  Current: 25

Width:  Current: 25

Apply

Clean all added buildings Delete selected

Step 3

**- CHOOSE ADDED BUILDING MATERIAL**

Choose material (Default: Brick)

The facade's material is **Reflective glass**

Step 4

**- SELECT ROOM BY NAME**

Query Room Name Room Preview

Select room or query by name. (Example: 01.Oost.330)

Step 5

**- CHOOSE DAYLIGHT METRICS**

Compute

Desk Surface Level (0.8m)  Seated Eye Level (1.2m)

Step 6

**- RESULT**

On average, the selected room receives at least 300 lux daylight for **53.48%** of the occupied hours throughout the year, with a standard deviation of **23.41%** (DA)

**- RESULT COMPARISON**

This is the first time you run DA simulation on this room with the surface level height and LOD value you chose.

You should click a place on the map, right-click, and then select "Copy Link Address".

[Open EPW Map](#)

Add new buildings

Type 1

Choose material (Default: Brick)

Query Room Name Room Preview

Compute

Daylight Autonomy (DA)

Spacial Daylight Autonomy (sDA)

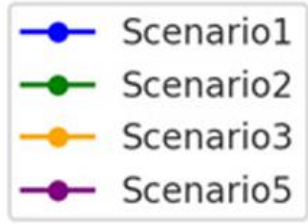
Useful Daylight Illuminance (UDI)

Sunlight Beam Index (SBI)

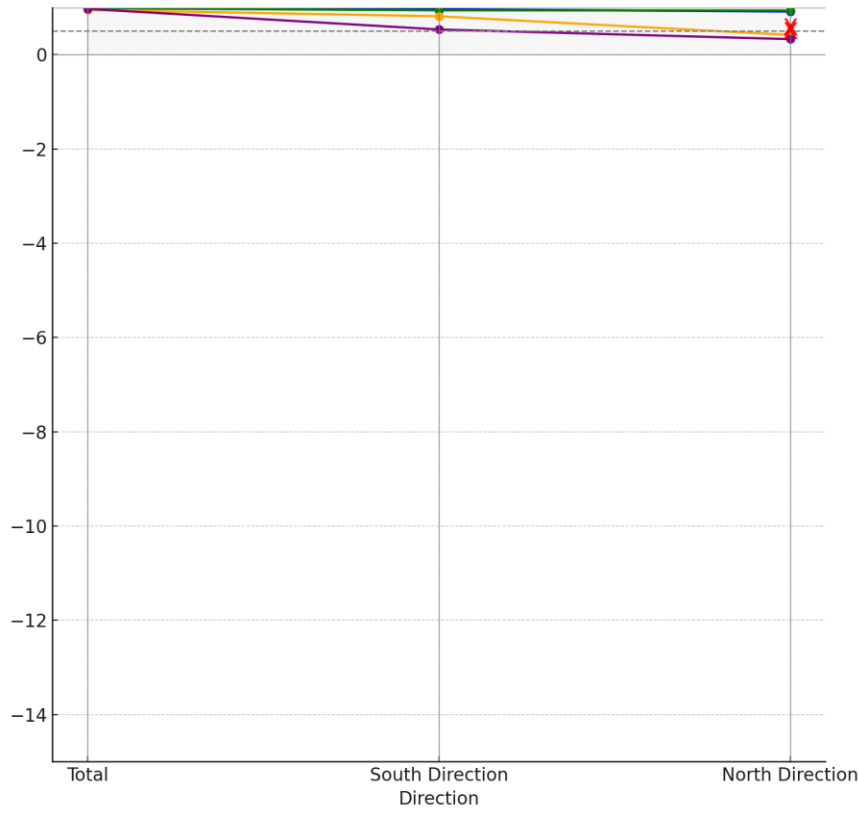
01.Mid.853

01.Mid.854

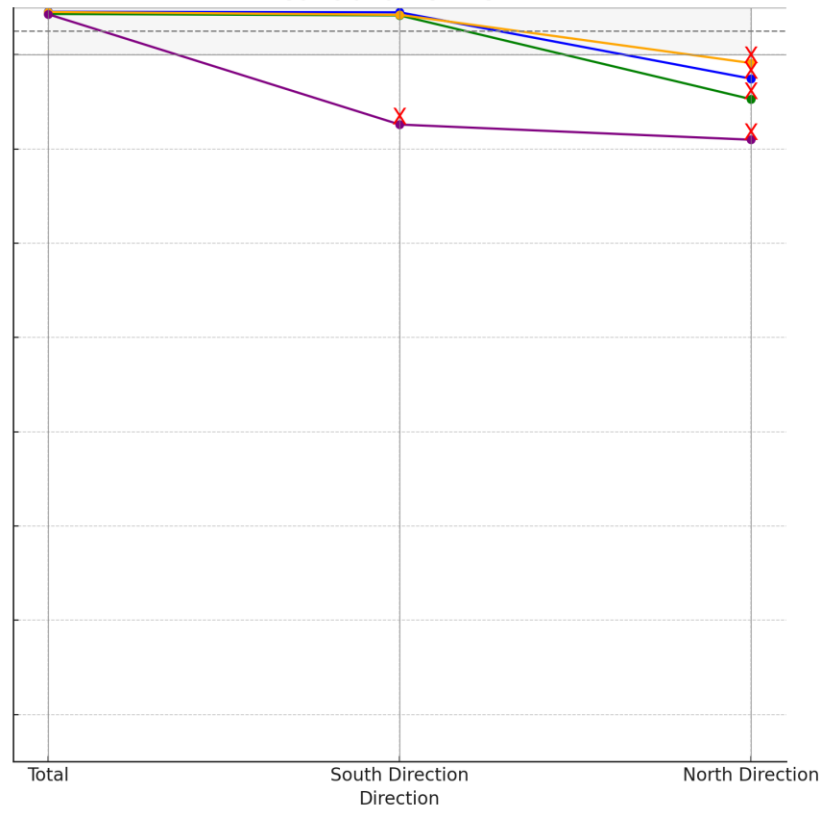
3D visualization of a building facade with a green-tinted window area. The interface includes a legend for "Desk Surface Level (0.8m)" and "Seated Eye Level (1.2m)". The map shows surrounding streets like Mijnbouwstraat and Poortlandplein.



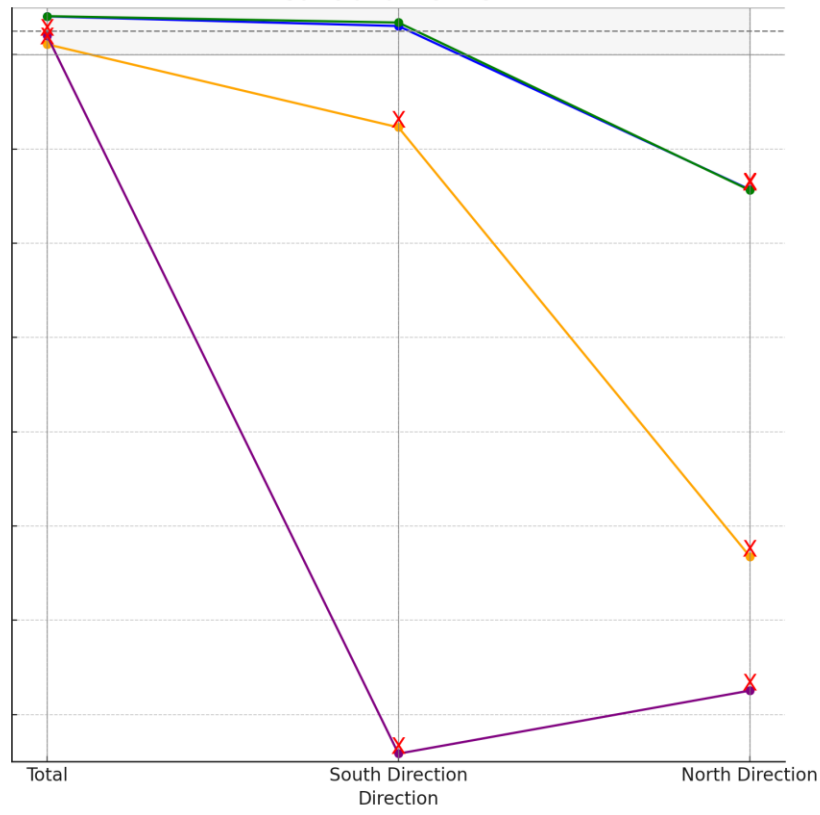
Correlation: DA-SBI

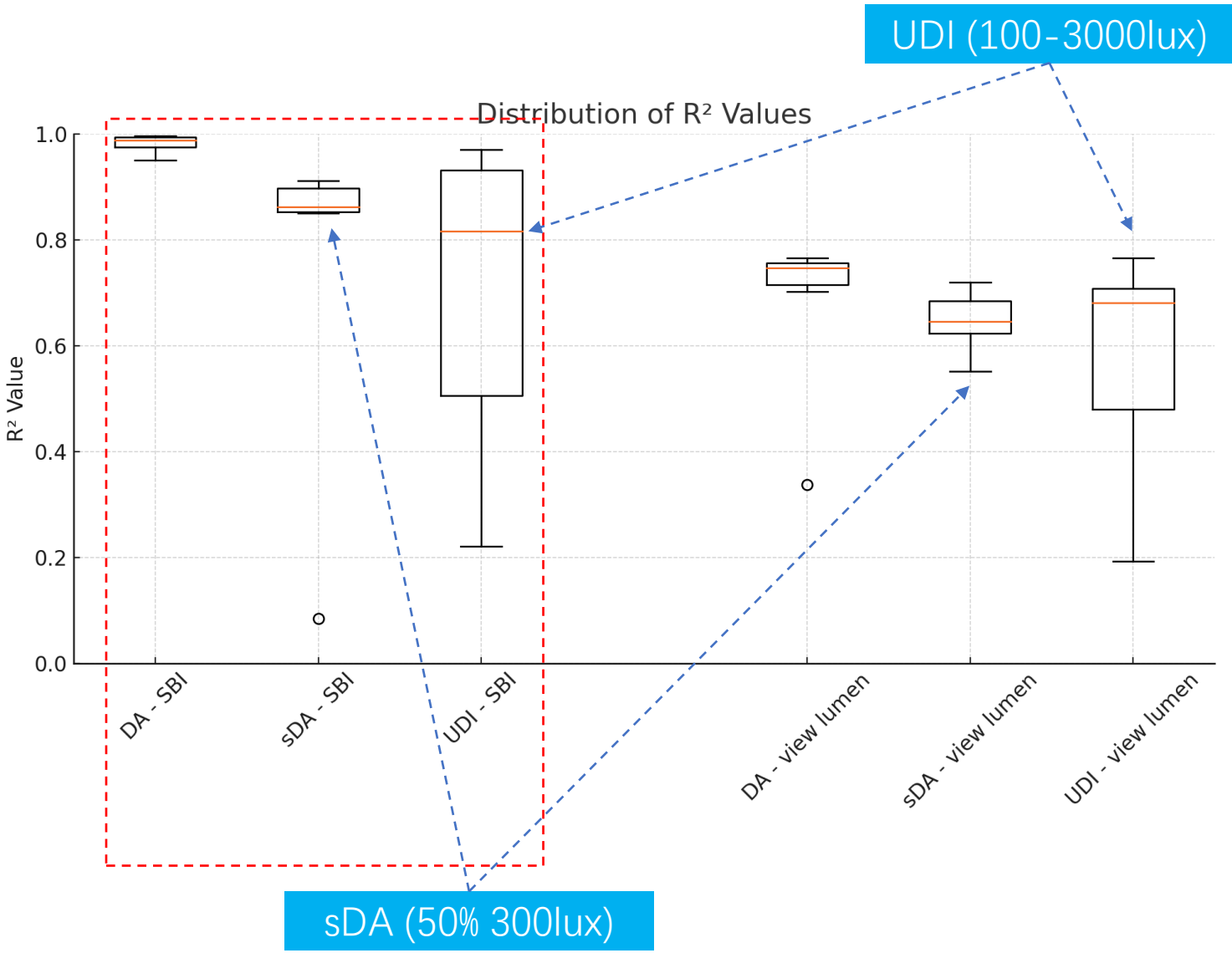


Correlation: sDA-SBI



Correlation: UDI-SBI





Conclusions:

- **SBI:** has strong correlation with traditional metrics : DA & sDA, UDI.
- **Outliers:** occasional lack of correlation in real-world scenarios (North)
- **Implementation:** influenced by all moderating variables

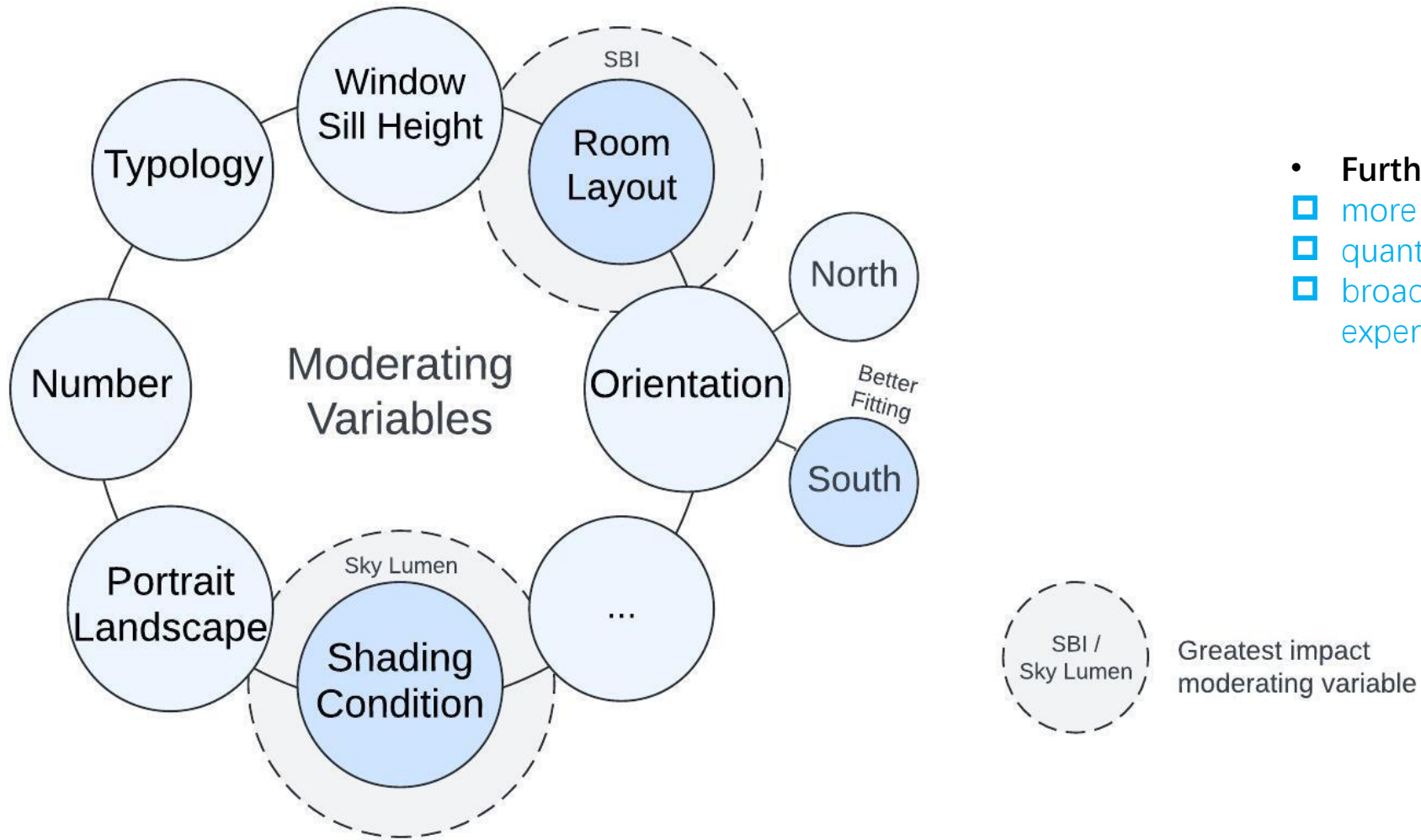
Compute

- Daylight Autonomy (DA)
- Spatial Daylight Autonomy (sDA)
- Useful Daylight Illuminance (UDI)
- Sunlight Beam Index (SBI)



Metrics	DA	sDA	UDI	SBI
Standard	CBDM	CBDM	CBDM	ABDM
GH Name	selectRoom_1_2(LOD).gh	selectRoom_2_2(LOD).gh	selectRoom_3_2(LOD).gh	selectRoom_4_2(LOD).gh
Innertree	{0;0}	{0;0;0}	{0;0}	{0;0}
response Json	<pre> (2) [{"-", "-"]}   0:     InnerTree: [{"0": Array(1)}]       ParamName: "MeshB64"       [[Prototype]]: Object     1:       InnerTree: [{"0": Array(3)}]         [{"0": {type: "System.String", data: "'85.018611'"}}]         [{"1": {type: "System.String", data: "'1.846954'"}}]         [{"2": {type: "System.String", data: "'3.411241'"}}]         length: 3         [[Prototype]]: Array(0)       [[Prototype]]: Object       ParamName: "Text"       length: 2       [[Prototype]]: Array(0)           </pre>	<pre> (2) [{"-", "-"]}   0:     InnerTree: [{"0": Array(1)}]       [{"0": {type: "System.String", data: "'RF3BQ8CgEBAAAA'"}}]       length: 1       [[Prototype]]: Array(0)       ParamName: "MeshB64"       [[Prototype]]: Object     1:       InnerTree: [{"0": Array(1)}]         [{"0": {type: "System.String", data: "'1'"}}]         length: 1         [[Prototype]]: Array(0)         ParamName: "Text"         length: 2         [[Prototype]]: Array(0)           </pre>	<pre> (2) [{"-", "-"]}   0:     InnerTree: [{"0": Array(1)}]       [{"0": {type: "System.String", data: "'RF3BQ8CgEBAAAA'"}}]       length: 1       [[Prototype]]: Array(0)       ParamName: "MeshB64"       [[Prototype]]: Object     1:       InnerTree: [{"0": Array(4)}]         [{"0": {type: "System.String", data: "'79.085833'"}}]         [{"1": {type: "System.String", data: "'7.752947'"}}]         [{"2": {type: "System.String", data: "'16.718611'"}}]         [{"3": {type: "System.String", data: "'4.194167'"}}]         length: 4         [[Prototype]]: Array(0)         ParamName: "Text"         length: 2         [[Prototype]]: Array(0)           </pre>	<pre> (2) [{"-", "-"]}   0:     InnerTree: [{"0": Array(1)}]       ParamName: "MeshB64"       [[Prototype]]: Object     1:       InnerTree: [{"0": Array(3)}]         [{"0": {type: "System.String", data: "'78.94'"}}]         [{"1": {type: "System.String", data: "'78.94'"}}]         [{"2": {type: "System.String", data: "'78.94'"}}]         length: 3         [[Prototype]]: Array(0)         ParamName: "Text"         length: 2         [[Prototype]]: Array(0)           </pre>
Coordinates Based on	Floor	Floor	Floor	Windows
Result Exempleon Application	<p><b>- RESULT</b></p> <p>On average, the selected room receives at least 300 lux daylight for <b>83.53%</b> of the occupied hours throughout the year, with a standard deviation of <b>3.37%</b> (DA)</p>	<p><b>- RESULT</b></p> <p><b>93%</b> of the area of the selected room receives at least 300 lux of natural daylight for at least 50% of the occupied hours throughout the year. (sDA)</p>	<p><b>- RESULT</b></p> <p>on average, <b>70.16%</b> of the time during occupied hours throughout the year, the illuminance levels within the room are between 100-3000lux. With a standard deviation of <b>13.60%</b>. Annually <b>24.97%</b> of the time it is too dark, and <b>4.87%</b> of the time it might cause glare. (UDI)</p>	<p><b>- RESULT</b></p> <p>The mean SBI value of the room is <b>78.94</b> (m2hours) with a mean efficiency of <b>7.80</b> (hours)</p>

(hours)




- **Further research:**
  - ▣ more moderating variables
  - ▣ quantitative relationship study
  - ▣ broader and more comprehensive experiments

# 4

## CONCLUSION

- 7. Conclusion
- 8. Future work

1. **3D city models** loaded in **Rhino** and **application** for simulation and interaction?

Front-end (Mapbox)	Connector (Rhino Compute)	Back-end (GH)
 Add new buildings (Settings)	Coordinates conversion	Sync to GH (Avoid empty input)
Static Extrusion Layer		3D BAG Static

2. How can **BIM** model be integrated into **Rhino** and **GIS platform** for automated **per- room daylight simulation** ?

Front-end (Mapbox)	Connector (Rhino Compute)	Back-end (GH)
Load BIM (glTF) per room	Dynamo + Rhino.inside.Revit	
 User interface + Select room	Input + GH script + Output (Settings)	4 Simulation Metrics Query attributes

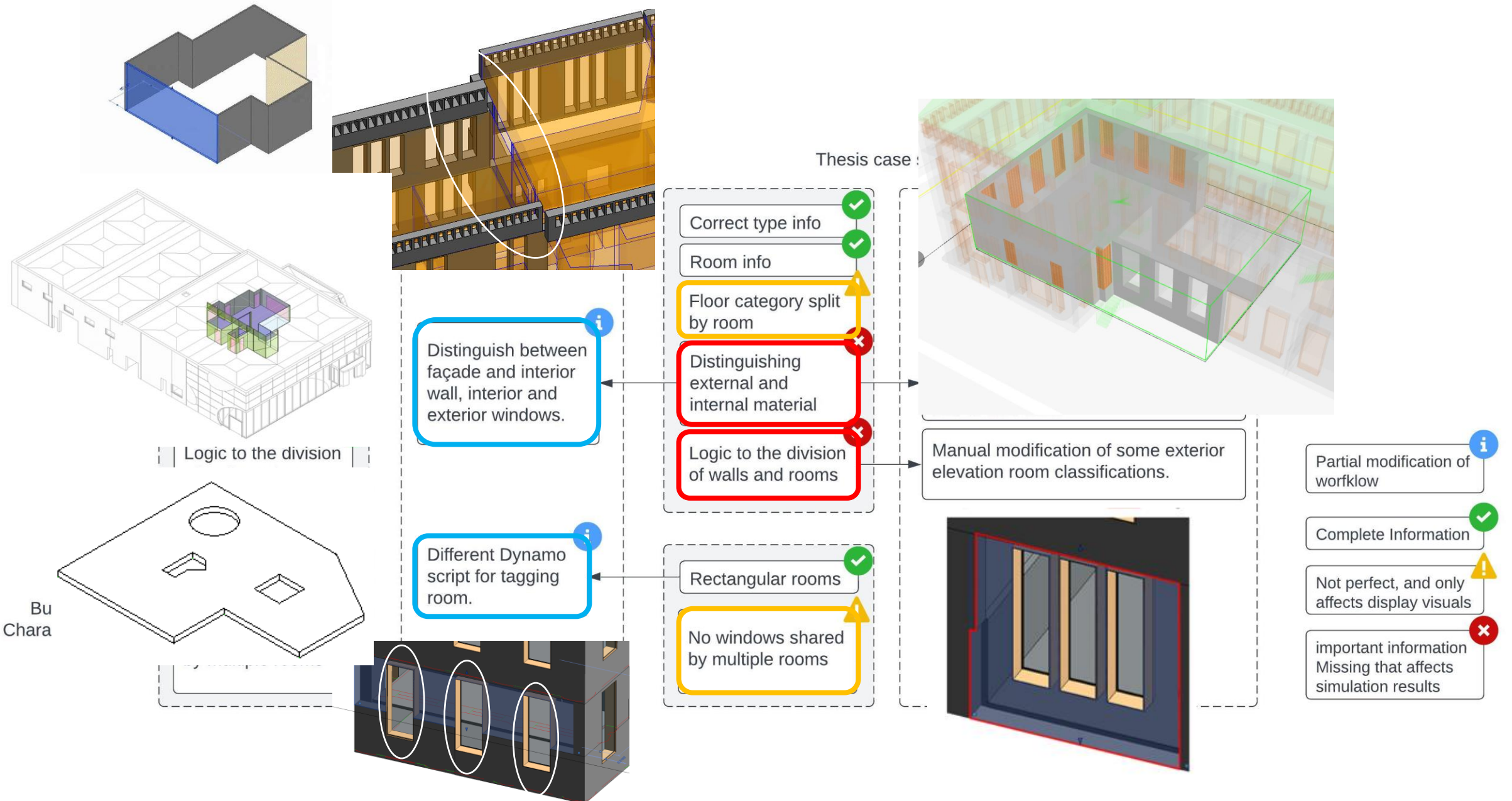
3. Implement **promising** new metrics (**SBI & sky-lumen**) on **application**?

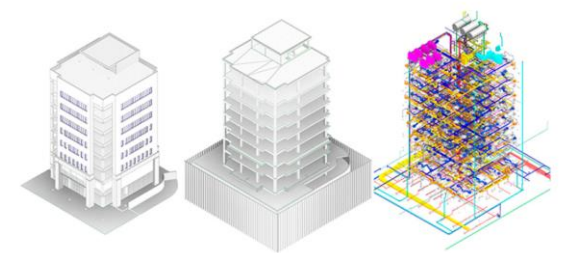
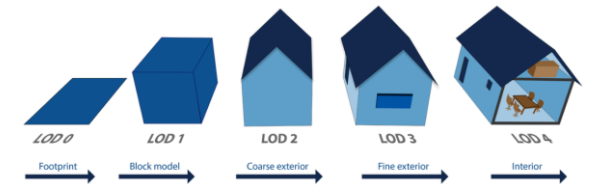
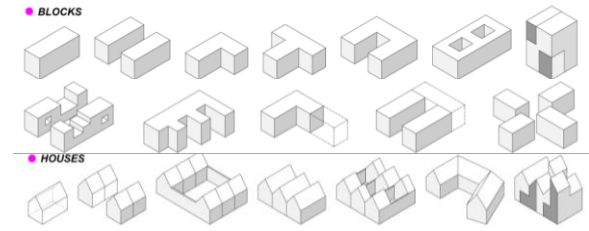
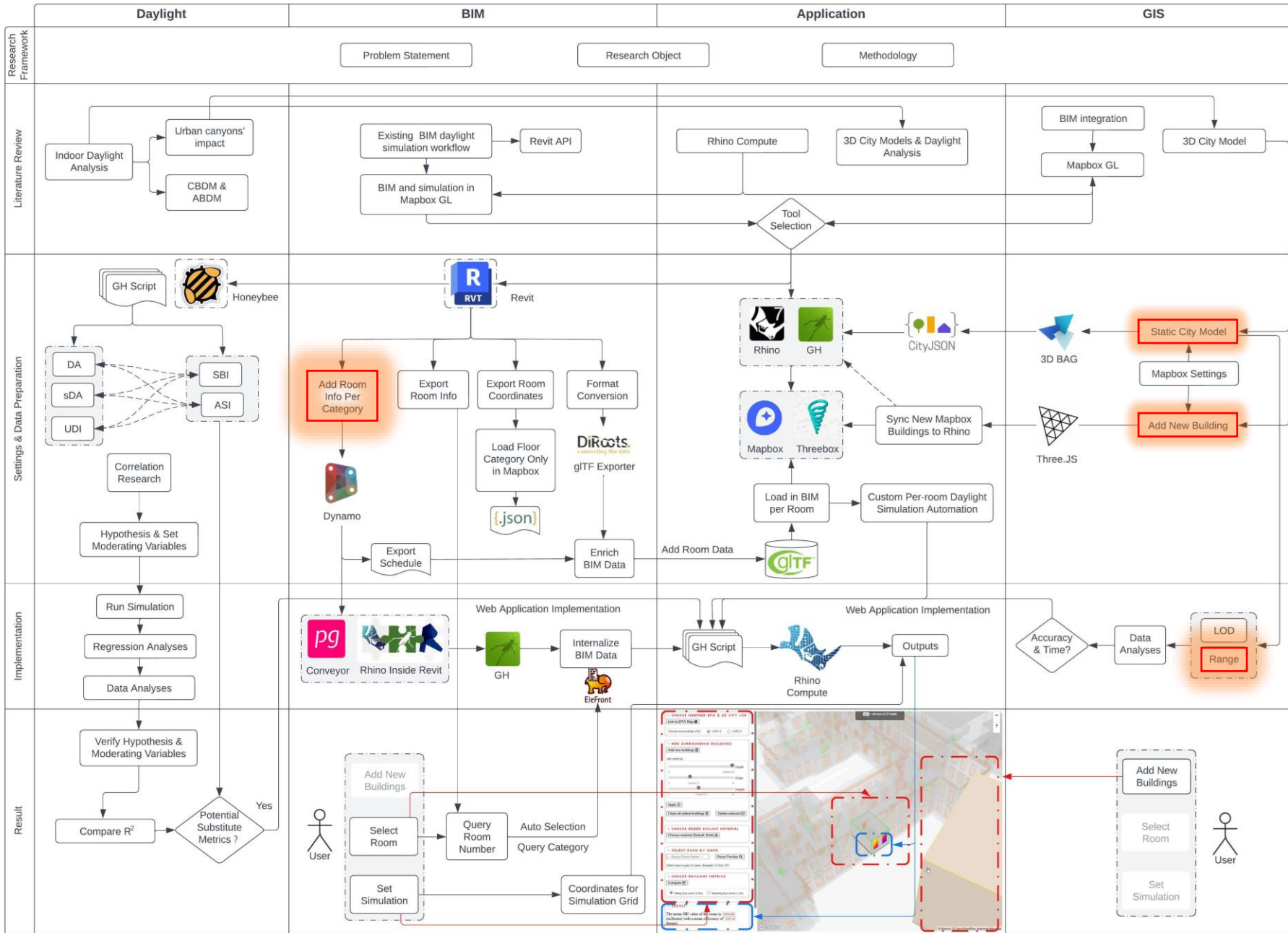
SBI - CBDM	Sky Lumen - CBDM	Conclusion
Linear relationship	Quadratic relationship	SBI has potential
North not applicable		SBI can't replace CBDM
Implementation: Window coordinates		

4. Impact of varying **LODs** in **3D city models** on accuracy and time, **workflow optimization**.

Radius	LOD	Conclusion
200m	1.3	Time > accuracy
		HB component, BIM load per room ...

**More than just an application ...**



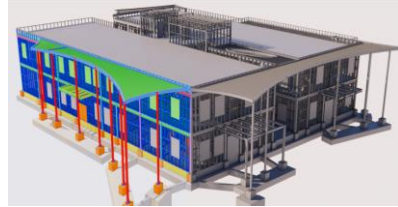




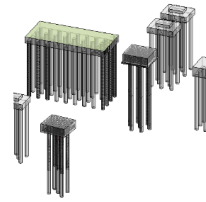
Building



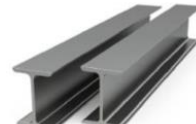
Room



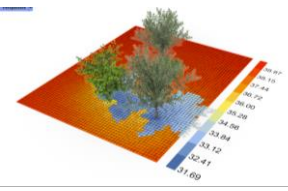
facade



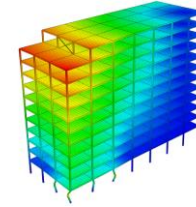
Category



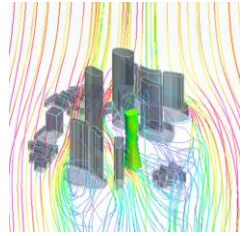
Element



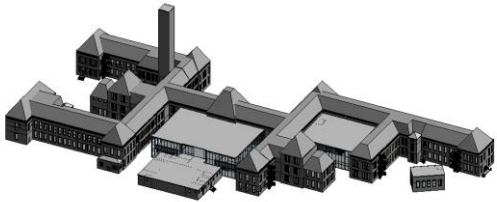
Daylight



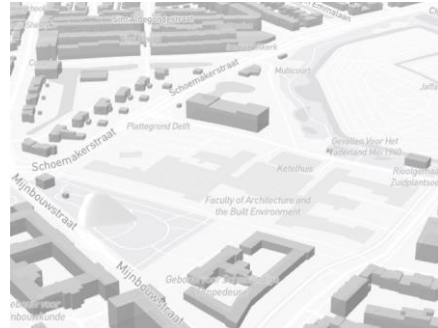
Structure



CFD ...



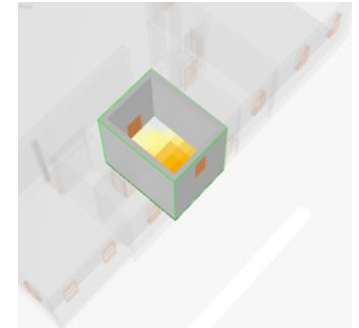
+



+



+

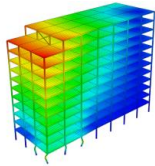


Mapbox

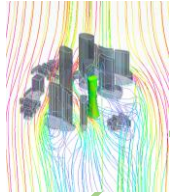


SCALE UP

Structure



CFD ...

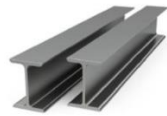


X

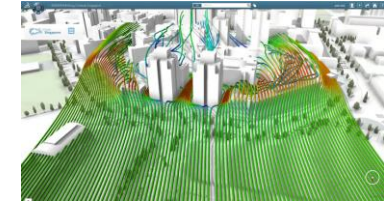
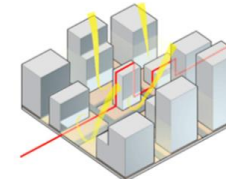
Category



Element



X



URBAN STUDY



CLIENT SELECTION

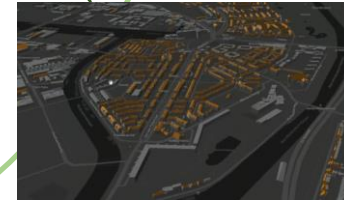
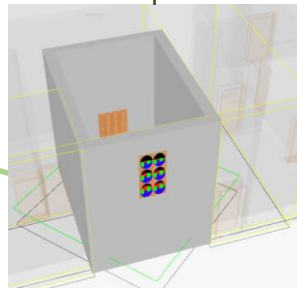


OPEN SOURCE DATA



USER EXPERIENCE

IMPLEMENT SKY LUMEN



3D TILE MAPBOX

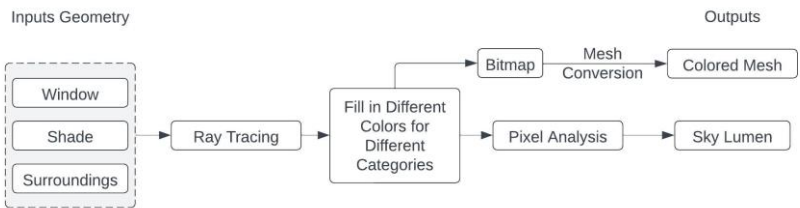
Project Progress

**Open GH File with Rhino.Inside for Unity**

NET (C#, etc.)  
Rhino3dm  
C#Python

Grasshopper definitions online  
2000+ geometric operations  
automatic file manipulation (Demosync)

Geometry as a Service



To what extent can a web application conduct per-room daylight analysis on BIM models to effectively demonstrate the influence of dynamic changes within an urban context?





MapboxGL



Rhino Compute



Rhino.inside.Revit



SBI



User Interface



# Thank you!

