From Gis and Bim straight to Cim. Practical application in the urban area of Porto

SVILUPPO ENERGETICO SOSTENIBILE

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CIM, BIM, GIS, urban microclimate, thermal comfort, 3D model, simulation

A RESEARCH WORK

"To manage the relationship between climate change and human health it is imperative to collect data".

T. A. Sirakova-FEUP

Until now, urban planning has relied mainly on **Geographical Information Systems** (**GIS**). Although GIS involves the consideration of raster, vectors, points and polygons with related information, it usually does not have data about the material of each building structure or urban public space and the availability of materials is limited. **Building Information Modelling** (**BIM**), on the other hand, is specialized in dealing with the construction process and management of the lifecycle of individual buildings. **City Information Modelling** (**CIM**) is a new concept whose objective is to integrate all aspect of the urban systems into one environment by representing the interactions between public and private spaces. CIM theoretical methodology grounds on the interoperability between GIS, BIM and the capacity to create unified standards to bridge between them. **In the present case, a CIM model has been achieved with the use of both GIS and BIM models for creating a software tool focused on the thermal comfort of public spaces.** Devoted to supporting the decision-making process in the field of urban planning, this tool takes into consideration the geometry of the urban area and the interaction between weather conditions and built environment to simulate the consequences the new intervention will have on the public space. Moreover, it can be used to study different environmental scenarios in the urban environment and demonstrate how changes in the physical environment can: lead to rise/fall in surface temperature; modify outdoor comfort conditions; affect human behaviour and health.

Goals

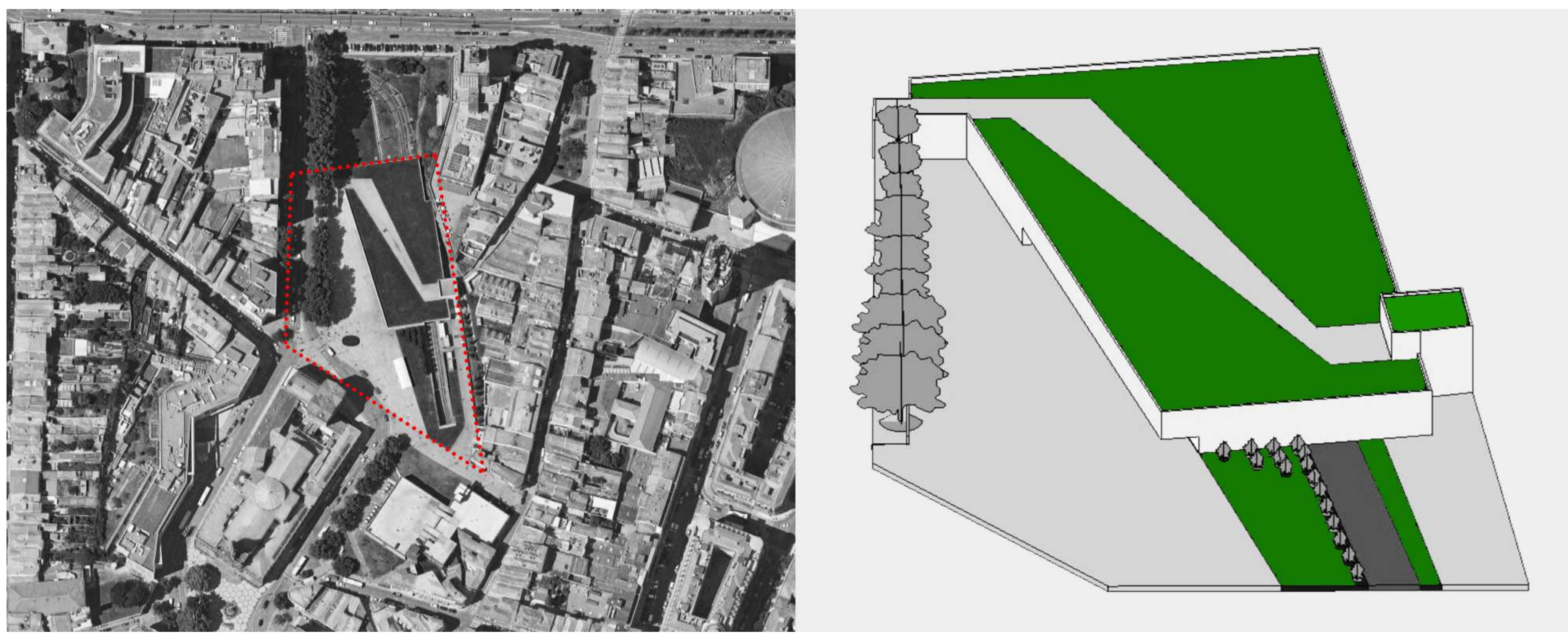
Specific research objectives are:

- **clarify what is CIM**, what has been done and what are the future potentials and challenges;
- **explore the possibility of using BIM environment** for creating new tool for urban planning;
- **create a tool for estimating mean radiant temperature** based on surface temperature;
- **validate the tool**: creating a 3D model of a chosen part of the city, take measurements and compare the estimates to the real values;
- **simulate different scenarios** and see how diverse materials and colours can change thermal comfort and health condition of the public space
- **suggest future work** for optimization of the tool The validation of this tool uses Trindade Metro Station in Porto, Portugal as Case Study. The choice of this location relates to its insertion in the city centre, the surrounding built environment, the function of the area and the geometry, with two levels with different materials. The upper level is mainly a large green area with the insertion of other materials on the elevator, crossing path and end walls, and the lower level, which includes granite, concrete and glass. The case study will permit to study the tool response to estimate different surface temperatures and in consequence to predict mean radiant temperature for Citizen. During the validation process, surface temperature measurements were conducted and later compared with the tool output. The results show that the tool represents correctly the expected increase or decrease in surface temperature.

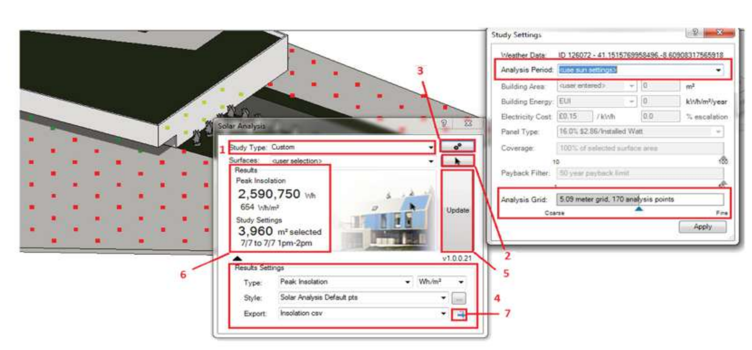
This model was designed to serve as a bridge between traditional and the foreseen digital urban planning in order to create conditions for the more sustainable urban environment and enhancing the quality of life, as it provides valuable information for the decision process by municipalities. The listed methodological steps seek to find a new way of looking at urban planning, using new tools to support technical and political decisions, regarding changes to the built environment, intended to be more sustainable, using the most suitable construction materials and reducing the need to fix unexpected mistakes, considering the final purpose of the interventions. This is not only a tool for aiding the decision-making process in urban planning but also a tool to qualify urban public spaces, guarantee user comfort and healthy arrangements in public space.

APPLICATION

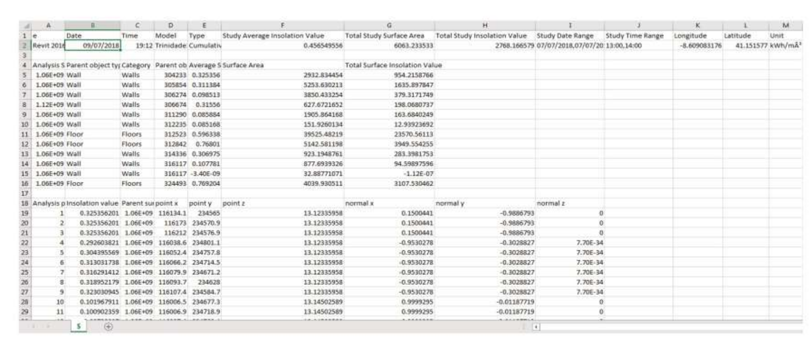
"Source: FEUP, Facultade de Engenharia Universidade do Porto - 2018"



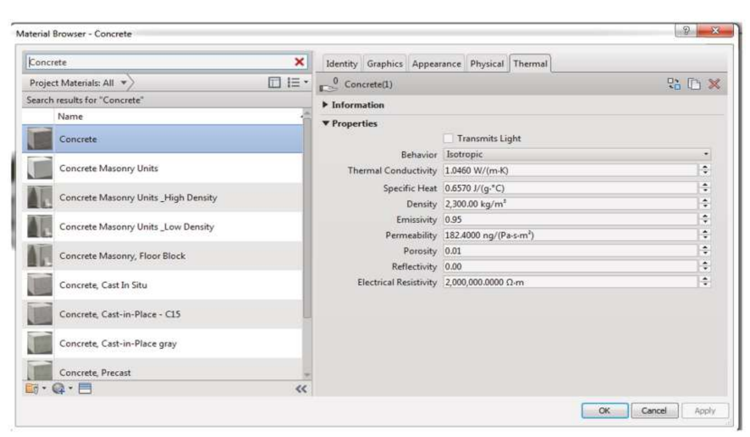
Portugal_Porto_Metro Station Trindade: Real life scenario (Google Maps) vs. simplified 3D model



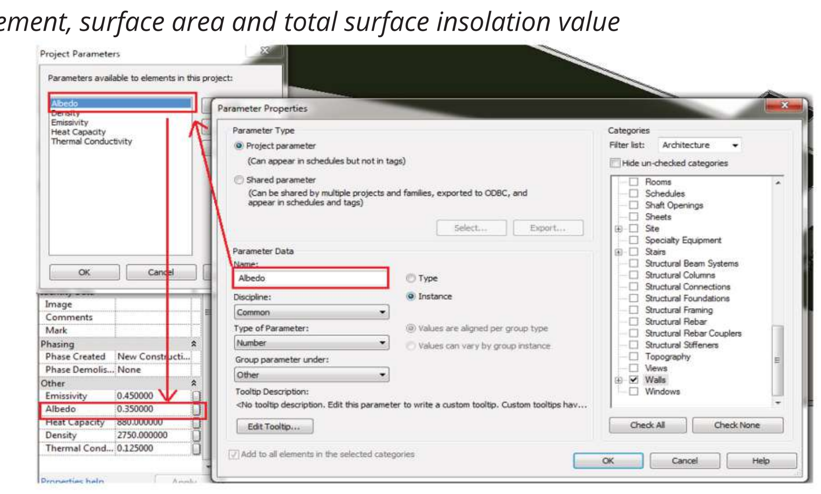
Configuring Solar Analysis Menu



Element, surface area and total surface insolation value



Thermal properties of the materials in Revit



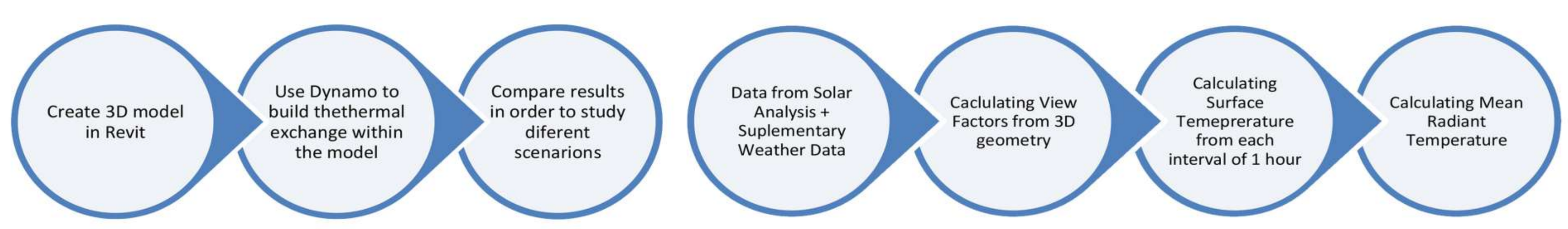
Revit Project Parameters Menu

	Soil (w/Grass)	Granite	Granite Cobblestone	Concrete
Albedo (0-1)	0.25	0.35	0.35	0.55
Density (kg/m³)	1200	2750	2750	2200
Emissivity (0-1)	0.96	0.45	0.45	0.85
Heat Capacity (J/kgK)	800	790	790	880
Thermal Conductivity (W/mK)	0.25	1.8	1.8	2

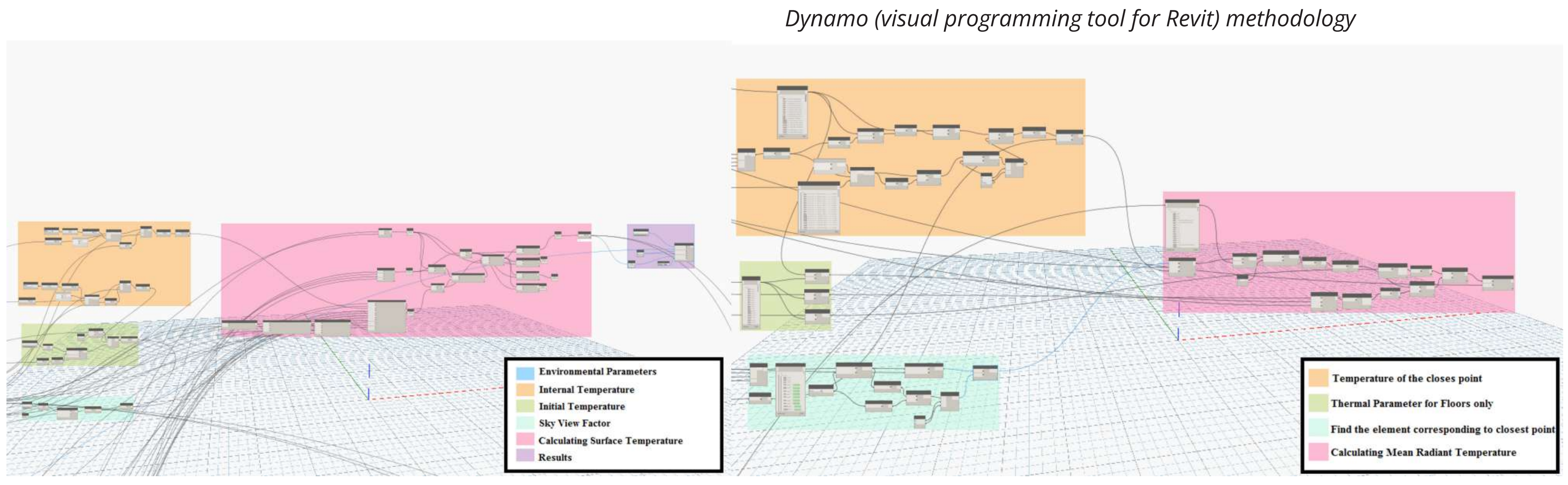
Thermal properties of the materials

	Asphalt (*black*)	Painted pavement (*white*)	Green Area
Albedo (0-1)	0.10	1	0.25
Density (kg/m³)	2400	-	1600
Emissivity (0-1)	0.96	-	0.96
Heat Capacity (J/kgK)	920	-	800
Thermal Conductivity (W/mK)	0.75	-	0.25

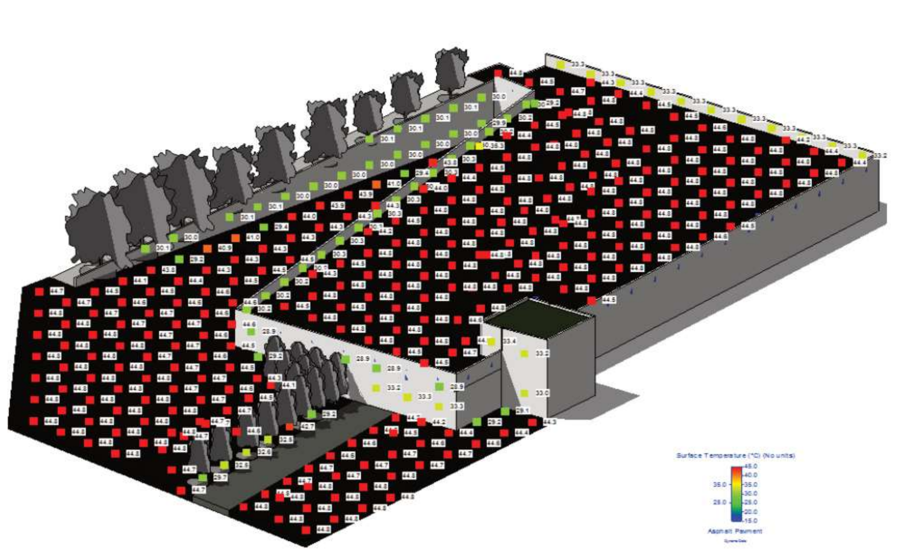
Thermal properties of the new materials



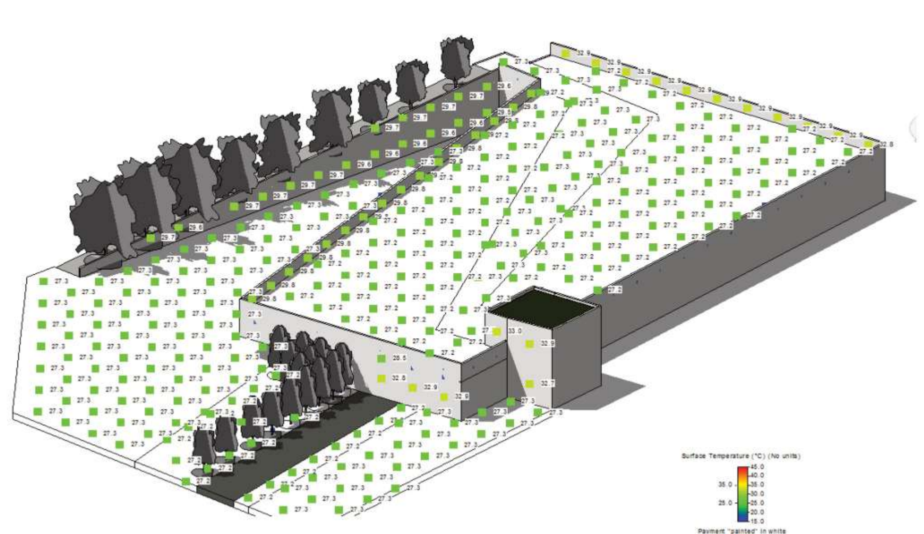
Dynamo (visual programming tool for Revit) methodology



Dynamo algorithm for Surface Temperature and Mean radiant Temperature

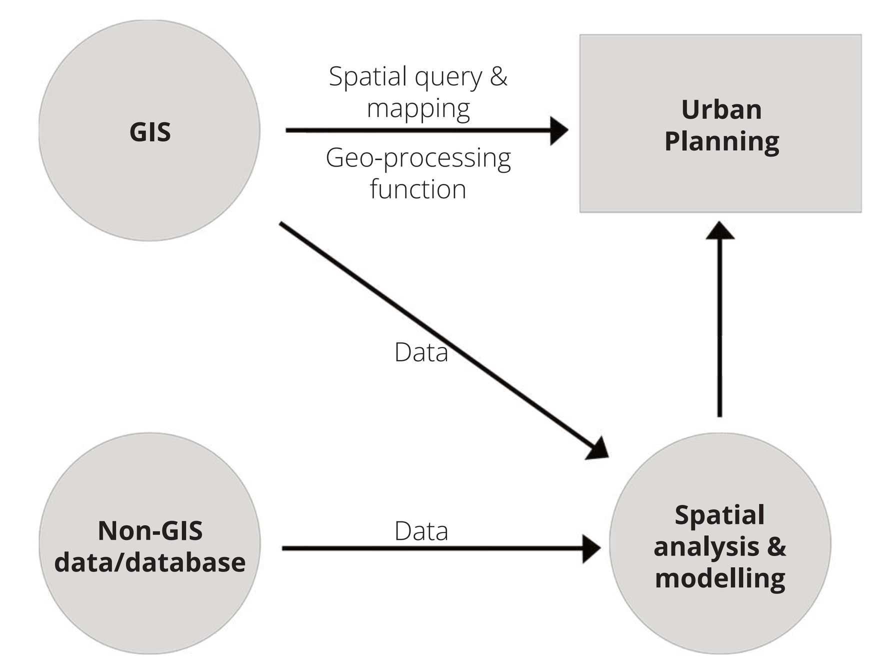


Increase in surface temperature (asphalt pavement)

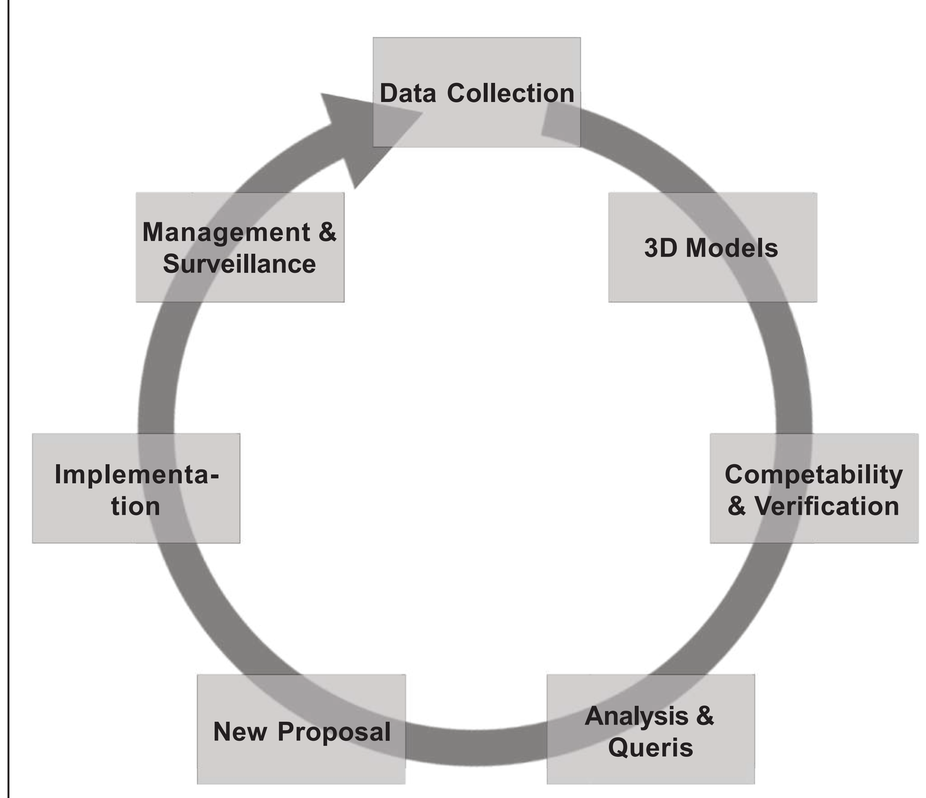


Decrease in surface temperature (white painting)

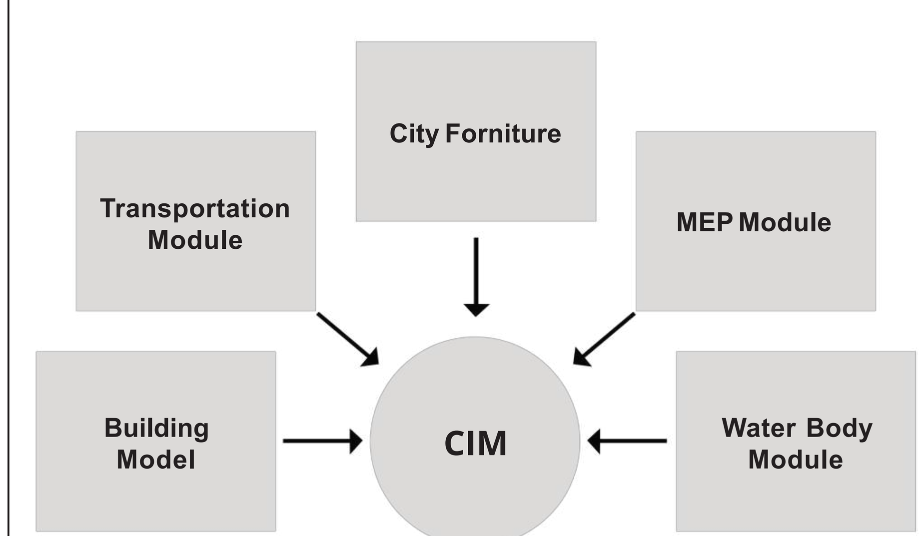
PROCESS



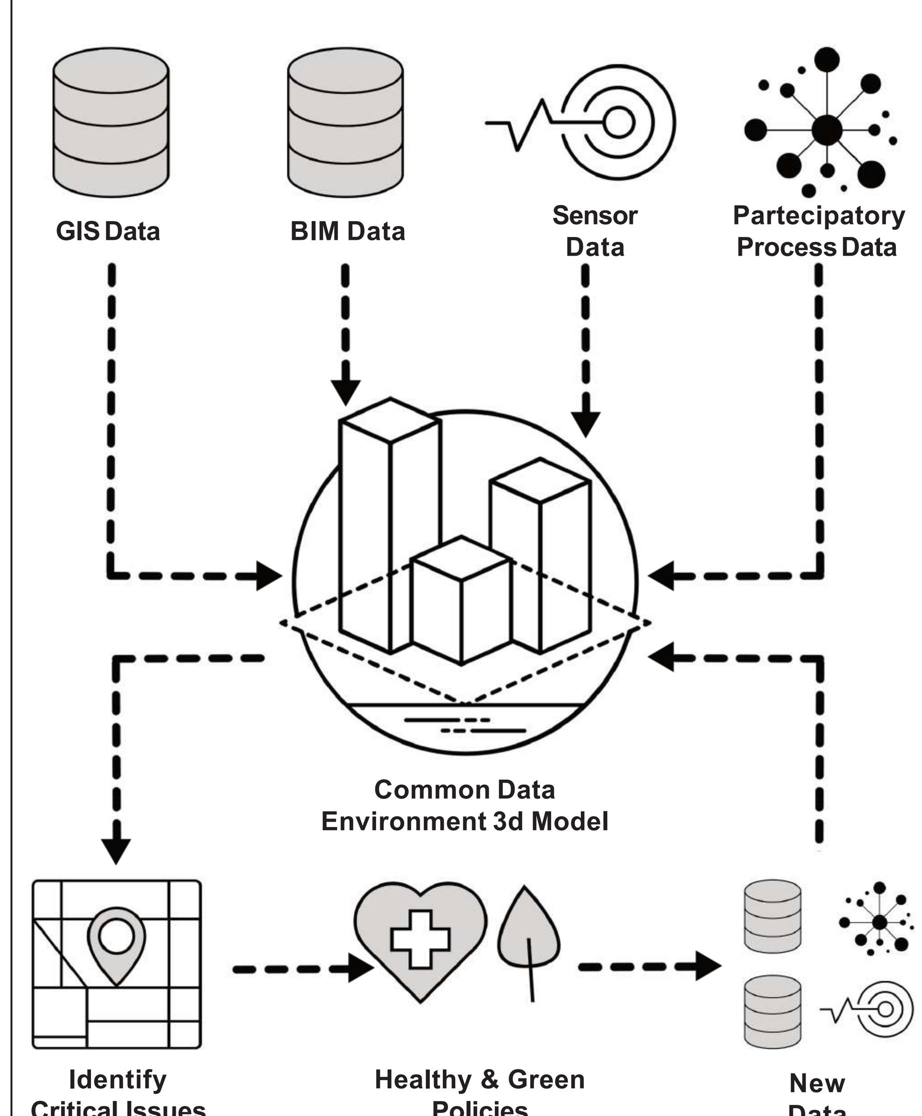
GIS and Urban Planning



Methodology of CIM



Sub-models of CIM



Best practice for Informed Urban Planning