

# Data-driven sustainability assessment for affordable housing in Portugal



**Aydan Aghabayli**  
aydan.aghabayli@gmail.com

Supervisor: José Nuno Beirão<sup>1</sup>  
1. CIAUD, Faculdade de Arquitectura, Universidade de Lisboa

MIT Portugal 2023 Annual Conference

## ABSTRACT

The urge of reverting climate change has made sustainability assessment a mandatory requirement within the AEC industry. The adoption of sustainable parameters by housing design becomes inevitable. However, in affordable housing, the investment in sustainability is quite restricted due to the highly constrained budget limitations. Furthermore, Lifecycle assessment (LCA) adds difficulties to many conceptual aspects of affordable housing because by definition it considers sustainability over the entire lifecycle of the building (from construction to operation, maintenance, demolition, and materials reuse or recycling). Digitalization in the AEC industry and the use of the data in digital format creates opportunities for collection and analysis of data that may help LCA and provide information on which solutions provide better sustainability performance, hence guiding design towards more optimized solutions. This research aims at using Data-driven techniques including machine learning and based on BIM models develop tools for optimizing design decisions that improve LCA results.

KEYWORDS: Sustainability, Affordable Housing, Lifecycle Assessment, Digitalization

## OBJECTIVES

**Main Objective:** To establish a computer-aided workflow for the optimization of Lifecycle assessment in affordable housing designs by resorting to BIM models and using integrated data-driven and machine learning techniques.

**Objective 2:** To obtain a knowledge base of the contemporary and traditional sustainability parameters for housing design, its LCA, and their relations to affordable housing; including results taken from the comparative analysis of paradigmatic case studies.

**Objective 3:** To define an optimisation formula or fitness function balancing sustainability and affordability criteria.

**Objective 4:** To identify what BIM model parameters can be optimized for the given objectives and collect useful data to improve our knowledge base.

**Objective 5:** To present an accessible open-source data-driven approach for sustainability assessment to be used for affordable housing validation based on our knowledge base (at TRL4)..

**Objective 6:** To provide a framework (tools and methods) to be used by designers at early design stages for automatic Lifecycle assessment of affordable housing using BIM data models.

## RESEARCH QUESTIONS

**Main Question:** Is it possible to optimize results on sustainability assessment applied to affordable housing design by using a data-driven approach?

**Q2:** What are the most impacting decisions and parameters on housing sustainability and affordability?

**Q3:** What are the relations between those parameters and how can this relation be optimised using data-driven solutions?

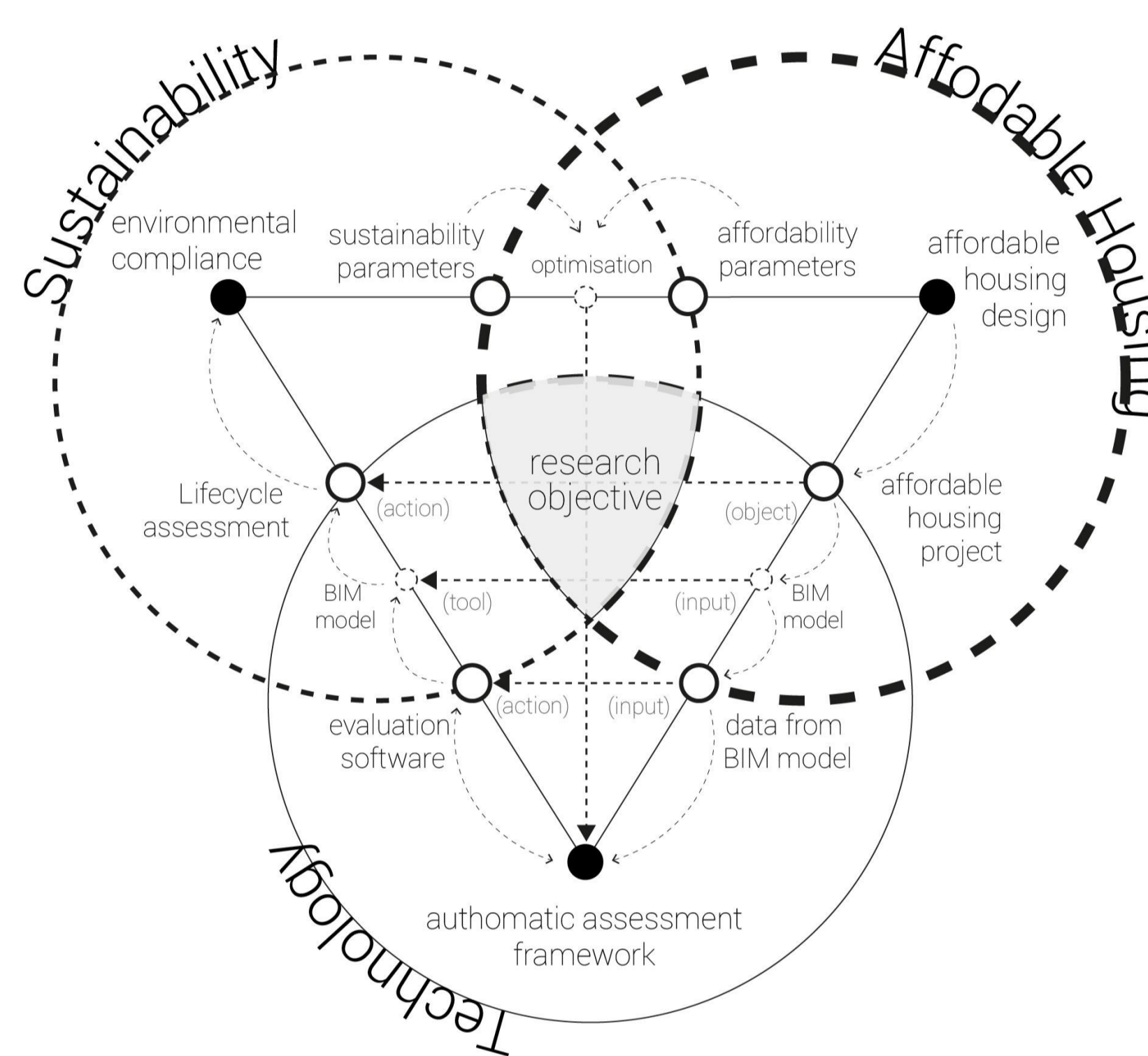
**Q4:** How can the use of BIM models facilitate the process of evaluation, optimization and obtaining knowledge for sustainability?

**Q5:** To what extent can Machine Learning to help us identify a fitness function by establishing a balance between sustainability and affordability for sustainability and affordability optimization?

## EXPECTED RESULTS

It is expected that this research will increase the quality of affordable housing by ensuring the minimisation of its environmental impact, assessing the use of materials, energy consumption, reusability and waste production among other parameters. The contribution of the research to increasing the comfort of living in affordable houses for the end-users is also among the key goals, which are part of the SDGs developed by the UN.

## VENN DIAGRAM



## FLOWCHAT OF ANALYTIC AND GENERATIVE PHASES

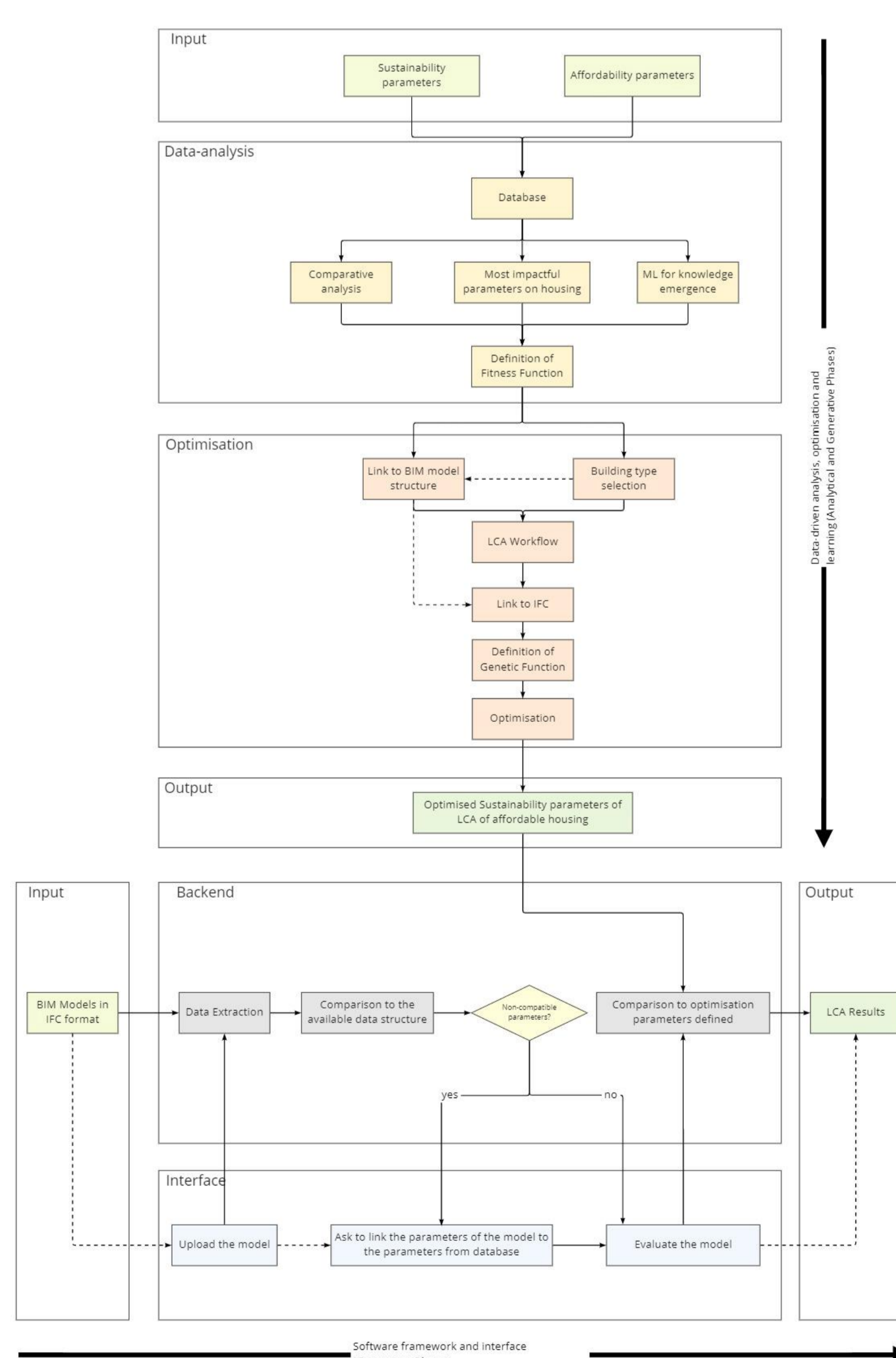
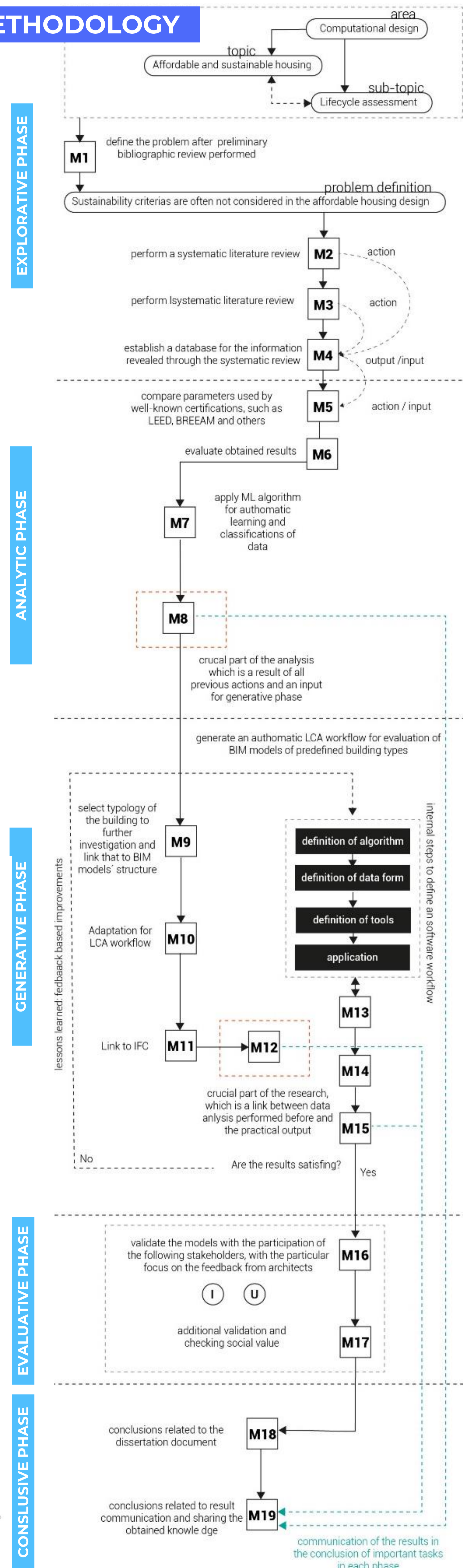


Figure 2. Flowchart representing simplified structure of the analytical and generative phases of the dissertation

## METHODOLOGY



Funded by:



under the Doctoral Grant 2022 MPP2030-FCT | Sustainable Cities