

Multi-objective environmental assessment for affordable housing – predictive and generative approaches for early design optimization.



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IDEAS TO IMPACT

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Research motivation

Recent research has focused on optimizing sustainable and affordable housing design through multi-objective approaches. Studies have explored evolutionary and generative techniques to enhance conceptual design, addressing form-finding, spatial programming, and performance-based optimization¹.

Hypothesis

A generative tool can assist architects in early design stages of affordable housing design by suggesting layout and envelope solutions with the optimized relation between costs and environmental impact

Why affordable housing?

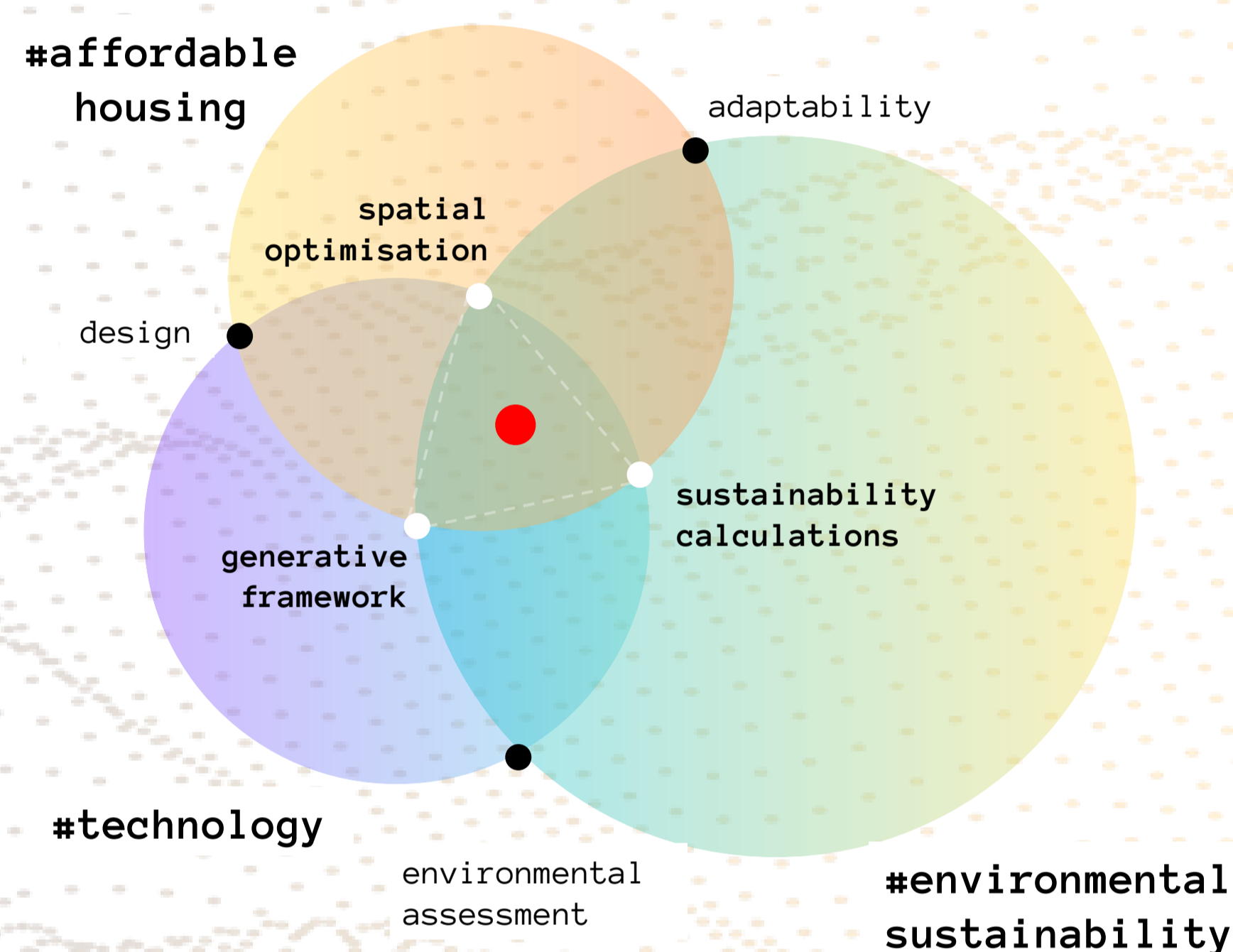
Research in affordable housing is crucial due to its wide-ranging impacts on individuals, communities, and urban development. As housing needs vary significantly across localities, local-level research is increasingly important for tailoring effective policies and programs².

Why technology?

Increase in use of BIM can enhance energy efficiency, reduce life cycle costs, and improve sustainability performance³.

Implementing optimization criteria in housing projects can lead to cost reduction, with initial costs decreasing by 16–45% after applying affordability criteria, while mandatory sustainability criteria add less than 4% to costs⁴.

Venn diagram



Why sustainable assessment?

Construction industry is responsible for **37%** of global energy-related carbon emissions.

where **3/4** is for operational energy and **1/4** is for embodied carbon.

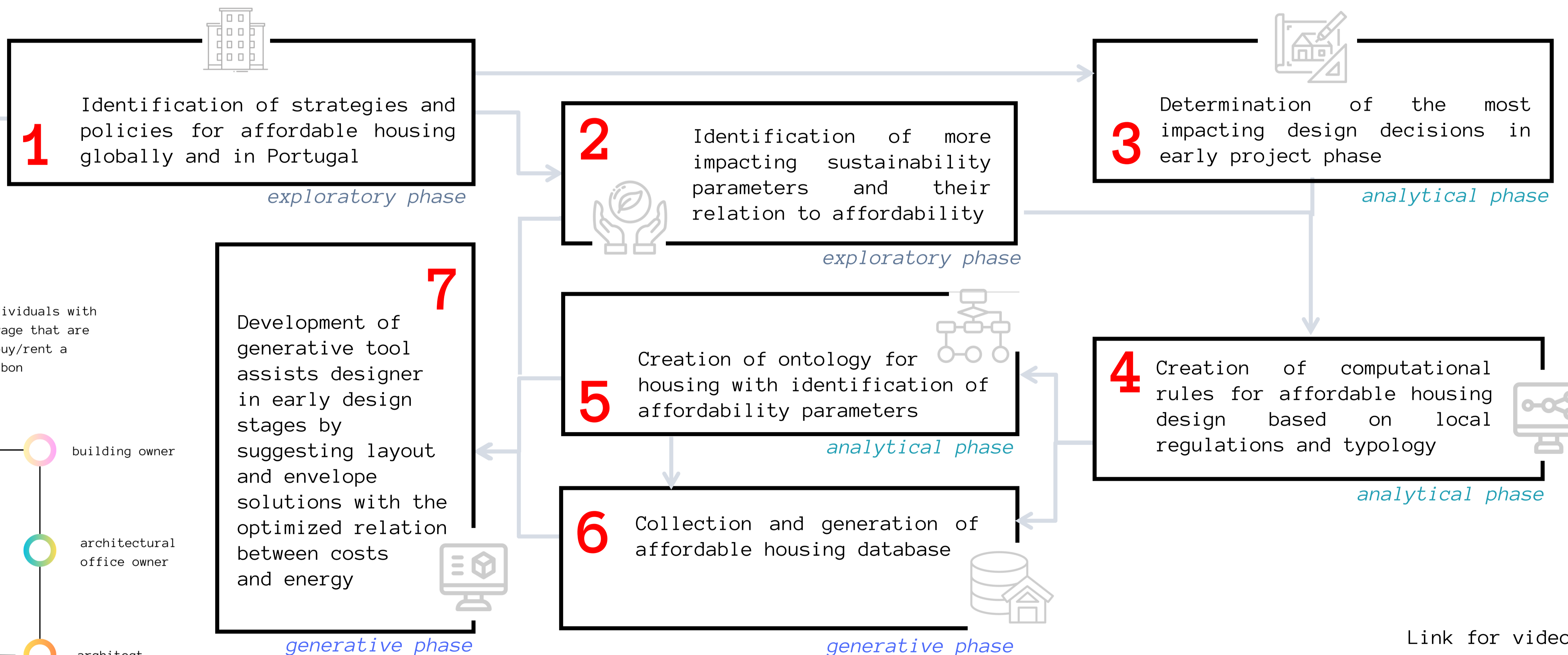
Housing is responsible for **17–20%** of global energy-related carbon emissions which is a sizable fraction of the total AEC-related emission⁵.

Effective practices for sustainable affordable housing include lean construction methods, energy-efficient designs, and supportive government policies⁶.

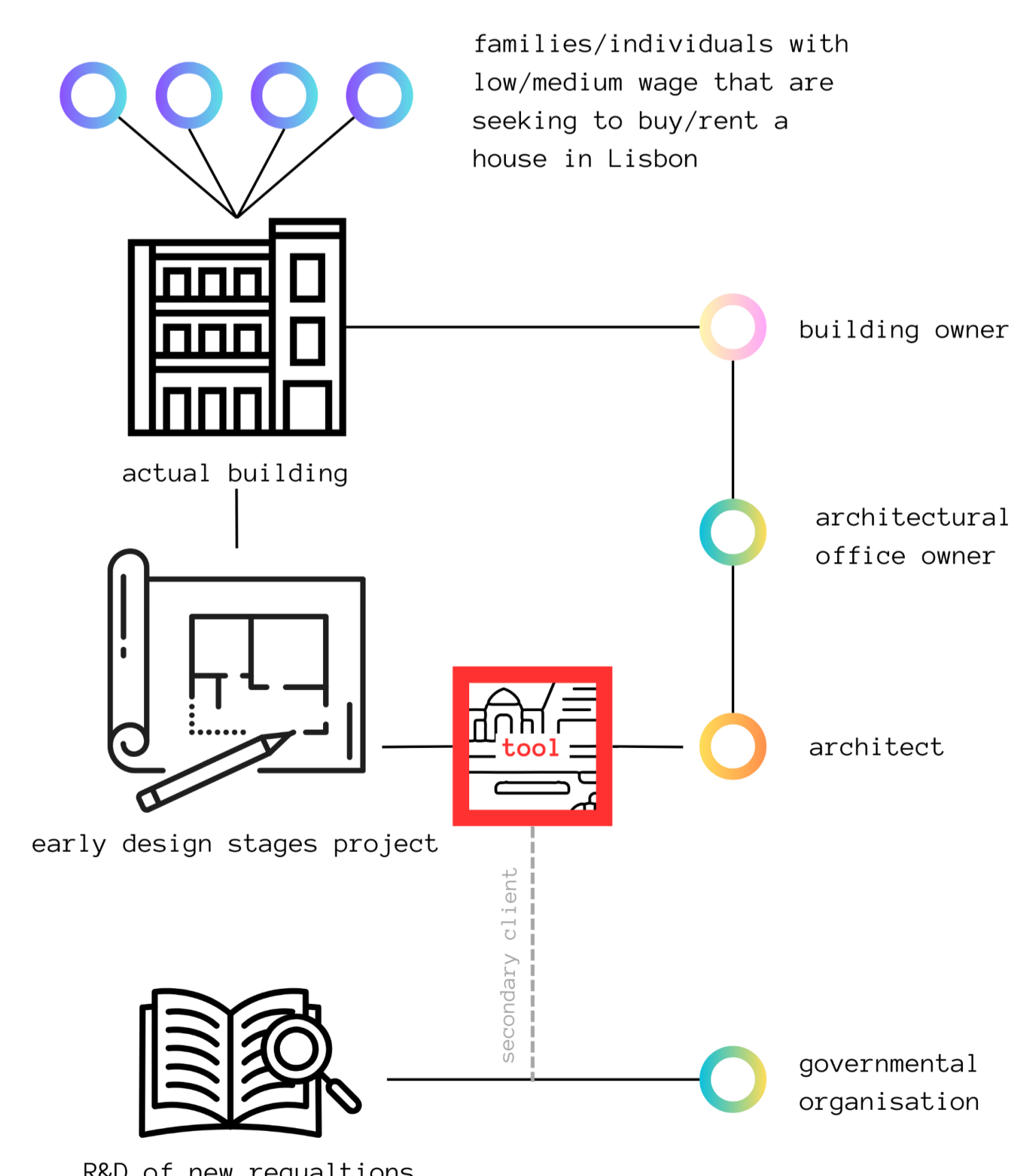
Research objectives

- i. contributing to the knowledge of sustainability assessment in the AEC industry, with a particular focus on the affordable housing concept, presenting a framework for data-driven analyses, and optimization providing an open-source software for evaluation;
- ii. defining the existing policies, design methods and tools for affordable housing design;
- iii. defining an optimization formula or fitness function balancing sustainability and affordability criteria.
- iv. presenting an accessible open-source data-driven approach for sustainability assessment to be used for affordable housing validation based on our knowledge base

Methodology



Tool framework



Expected results

The research aims to provide in-depth insights into affordable housing strategies and policies, ultimately producing a guideline to support these efforts. The practical outcome of the research will be the development of a tool that supports architects in the initial design phases, enabling them to optimize the balance between affordability and sustainability.

Link for video and references



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