

# eurac research

## Occupant Behaviour Modelling and Building Performance Simulations

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# Agenda

- Context
- Motivation
- Objectives
- Occupant behaviour research field
- Research gap
- Integrating occupant behaviour modelling
- Conclusions

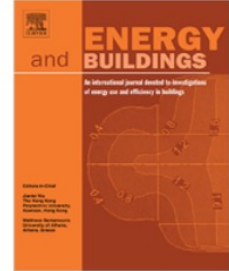


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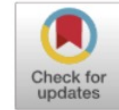


# Towards integrating occupant behaviour modelling in simulation-aided building design: Reasons, challenges and solutions

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<https://doi.org/10.1016/j.enbuild.2021.111498>

# Motivation

## Building Performance Gap:

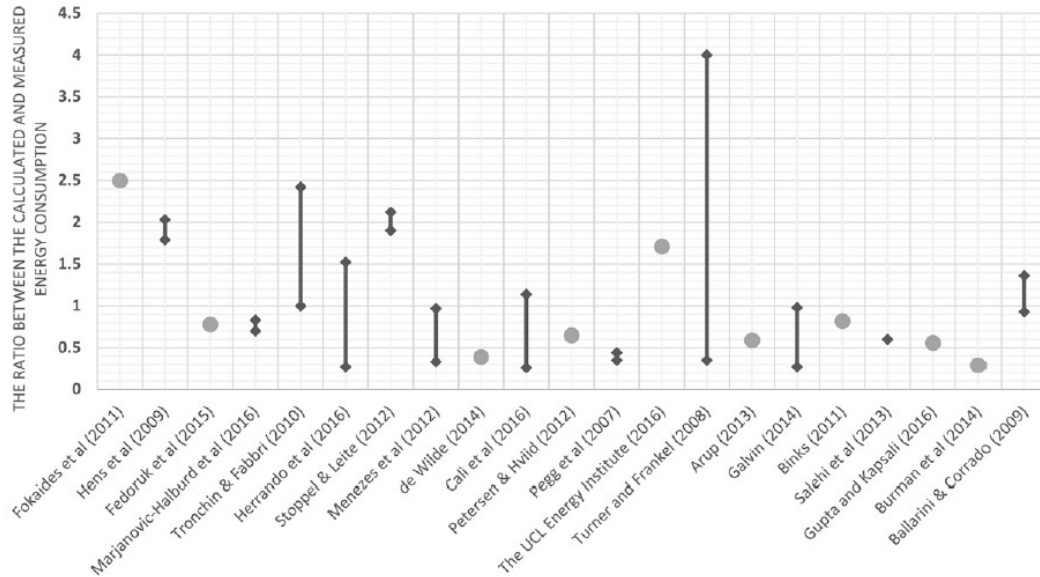
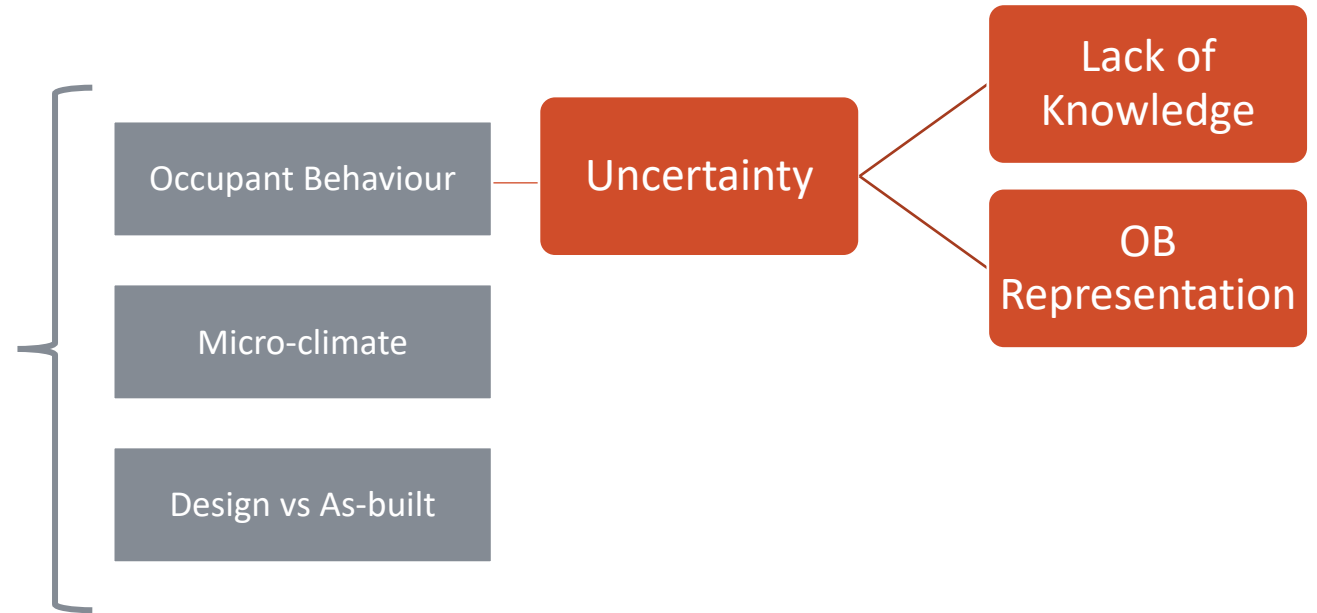


Figure 1. The reported ratios between the calculated energy consumption and the measured energy consumption of the 21 research works reviewed.

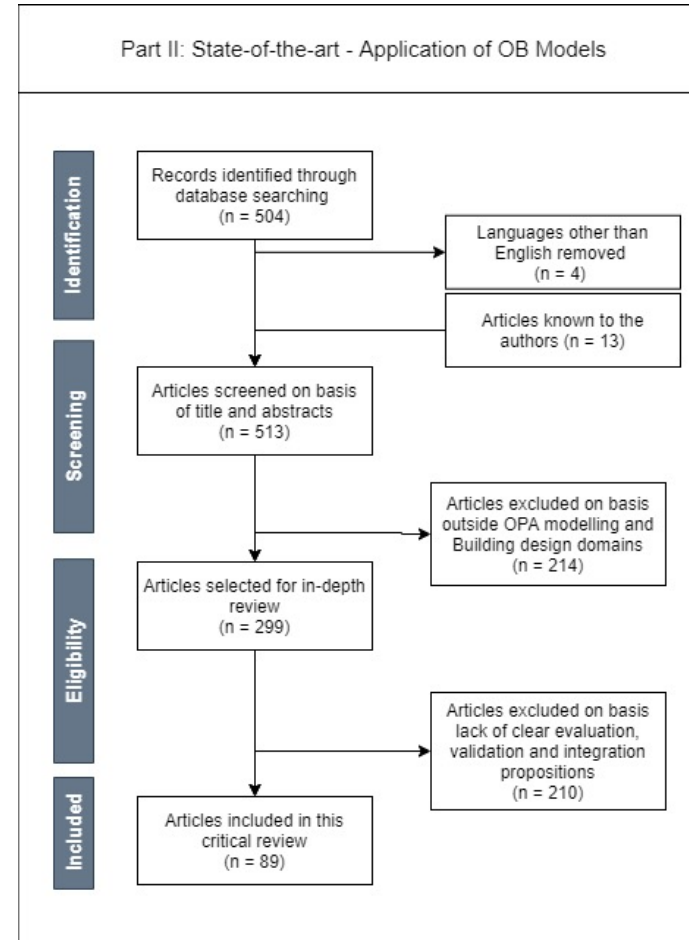
### ■ Main Causes:



# Objectives & Methodology

Critical review to answer:

1. What is the added value of considering more advanced OB models in the simulation-aided building design process?
2. How to choose the most appropriate OB modelling approach and model depending on the design purpose?
3. How can advanced OB models be integrated into BPS accessible and useful for supporting the decision-making process?



# OB research field

## 1. Investigation:

- Data collection techniques & sensing technologies
- Privacy and ethic issues

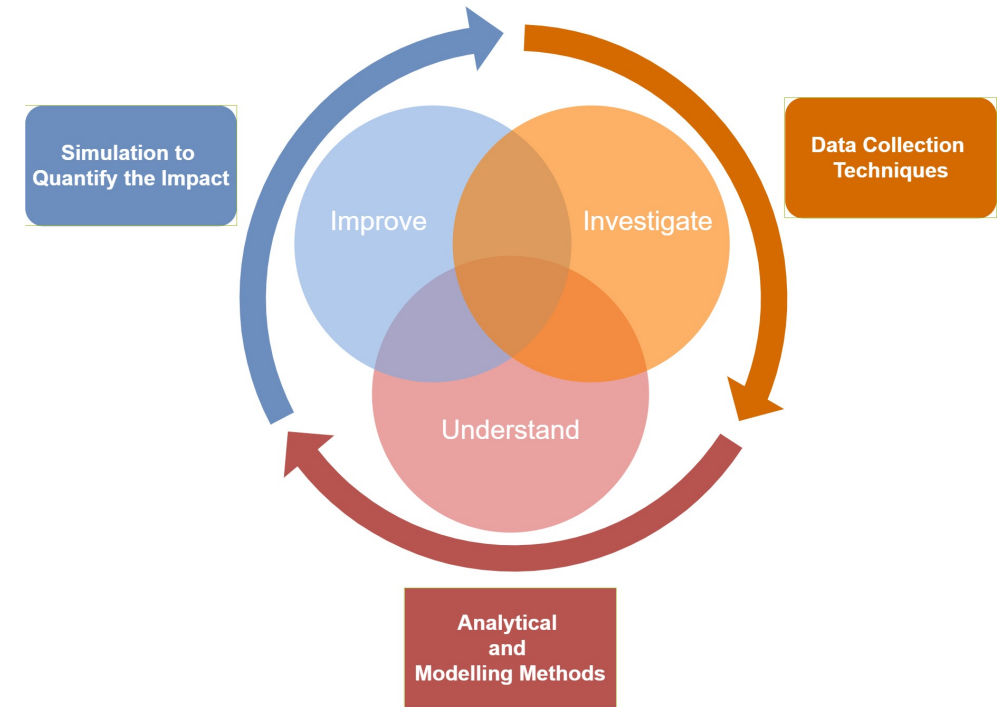
## 2. Understanding:

- DNAS Ontology: Drivers – Needs – Actions – Systems
- Drivers motivating OB behaviour
- OB is influenced by: environmental, time-related, contextual, physiological, psychological, social, and random factors
- Occupant Behaviour (OB): Presence, Adaptive, Non-adaptive
- OB models (300+)

## 3. Improving:

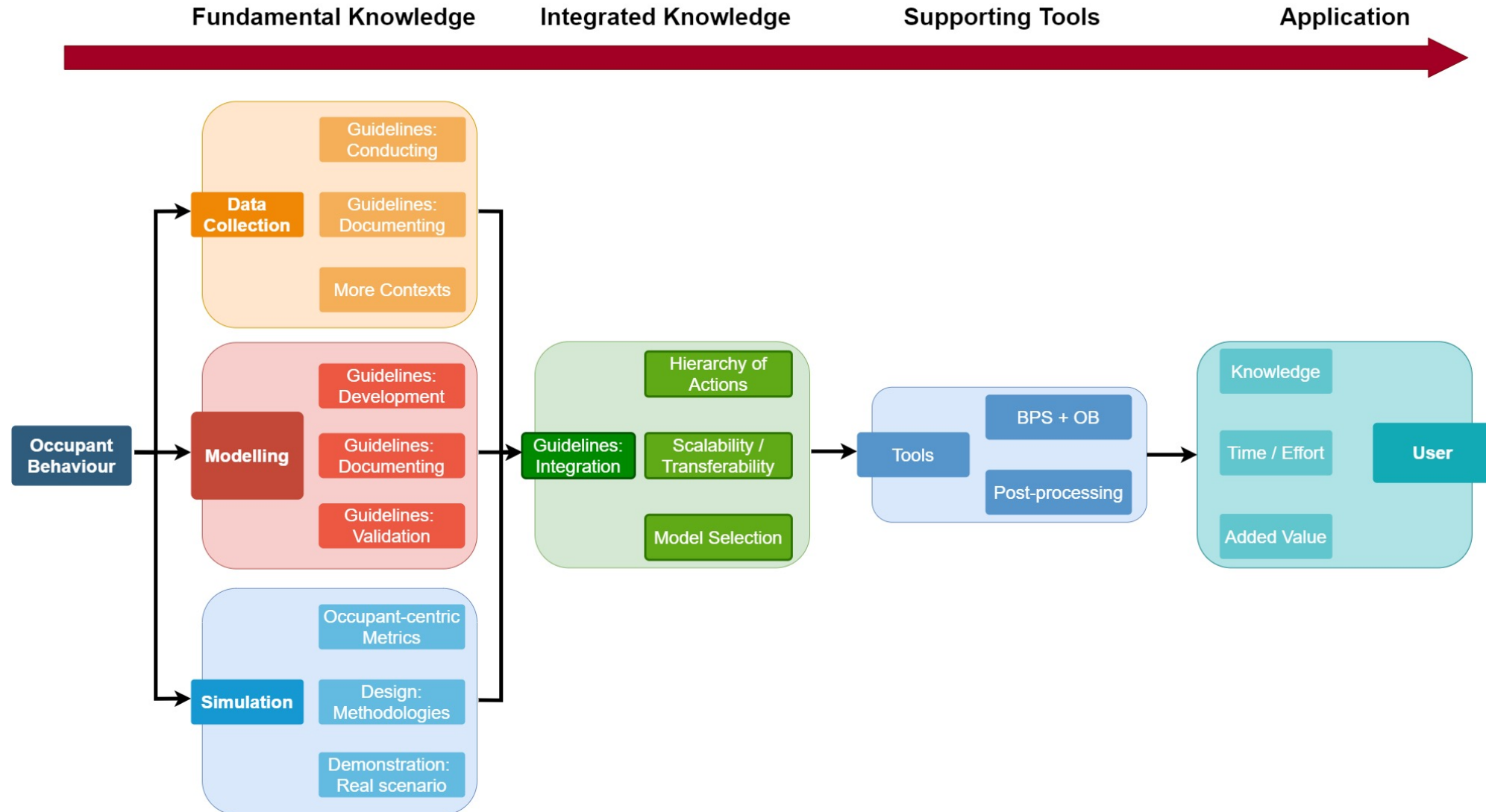
- Integration of OB models with BPS tools: e.g., co-simulation
- Occupant-centric design and & operation: metrics
- Design strategies: e.g., probabilistic design

## Human-building interaction research loop



Adapted from: Hong, T., Taylor-Lange, S. C. S. C., D'Oca, S., Yan, D. Da, & Corngati, S. P. S. P. (2016). Advances in research and applications of energy-related occupant behavior in buildings. *Energy and Buildings*, 116, 694–702. <https://doi.org/10.1016/j.enbuild.2015.11.052>

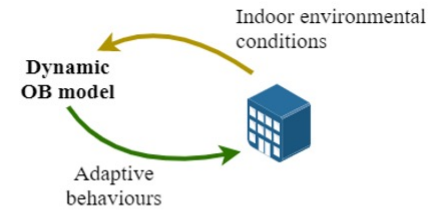
# Gap between OB research and building design practice



# Added Value

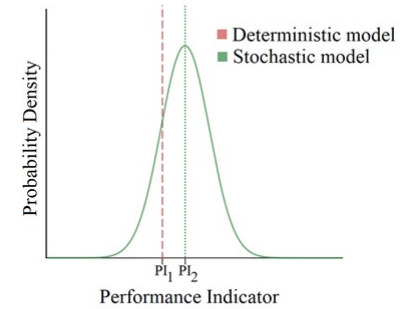
Two-way human-building interaction

Assessing how design alternatives influence adaptive behaviours to maximise comfort while reducing energy consumption



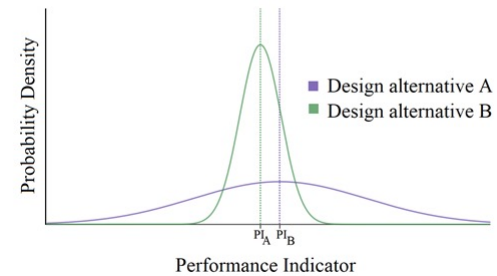
Uncertainty in PI

Estimating what is the range or expected value of the building performance considering occupants diversity - e.g., Probability distribution of PI



Robustness against OB

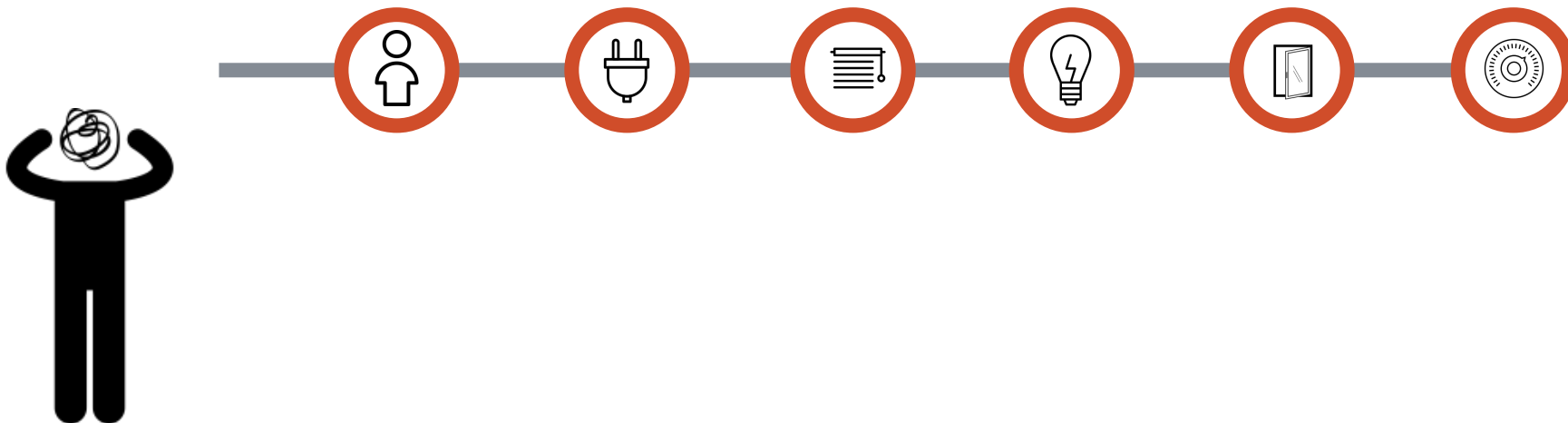
Assessing what is the impact of the OB on the performance of different design alternatives





# Influential OB

- Balance between accuracy and complexity
- The impact of the OB is case- and context-specific and that defining general guidelines is impossible
- Identifying the most relevant aspects of the OB needs to be an integral step of the BPS procedure.
- Sensitivity analysis (SA) and uncertainty analysis (UA)
- Need for screening methods



# Choosing the OB Modelling approach



## Purpose of Simulation

- Building Life Cycle
- KPI
- Spatial resolution
- Temporal Resolution



## Physical destination

- Building Use
- Building Systems
- Control Strategies



## Occupant's characteristics

- Cultural
- Psychological
- Socio-economic

# Conclusions

- Developing generalized OB models is virtually impossible
- Practitioners could implement OB models for:
  - understanding how the diversity of the occupants influences the building performance
  - predicting the probability distribution of performance indicators
  - design a building that promotes energy-efficient behaviours and is more robust to the impact of the OB.
- OB is case- and context specific – Need for a fit-for-purpose approach
- Standard schedules: Review and Update - Proposing a variety of standard schedules that represent different OB scenarios tailored to different building life cycle stages and simulation purposes
- Databases and tools required for identifying OB models in different contexts – For example Cultural-E Atlas

Thank You!



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