Developing an empirically based agent-based model to support local transitions

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Background and Research Questions

Background:

→ Significance of sustainable technologies (e.g. hydrogen) in achieving sustainability goals

→ Low adoption rates despite potential benefits

Research questions:

→ **What are the most important factors for the adoption of sustainable technologies?**

→ **What is the joined impact of these factors?**

→ **How to accelerate the adoption of sustainable technologies?**

Approaches From Different Disciplines

	Environmental Psychology	Transition Studies
Insights:	Factors influencing individual sustainable technology adoption behaviour of e.g., electric vehicles or PV **(micro level)**	Diffusion of innovations on the system level **(macro level)**
Methods:	• Self-reports • Experiments • Field studies • Etc.	• System analysis • Simulations (Agent-based modelling) • Exploration of scenarios
Limitations:	• Static • Limited insights on what happens after the adoption behaviour	• Assumption of the rational actor in simulations (homo economicus) • Low psychological (or social) reliability

Interdisciplinary Approach

→ Integrating findings from the literature on sustainable technology adoption into an agent-based model

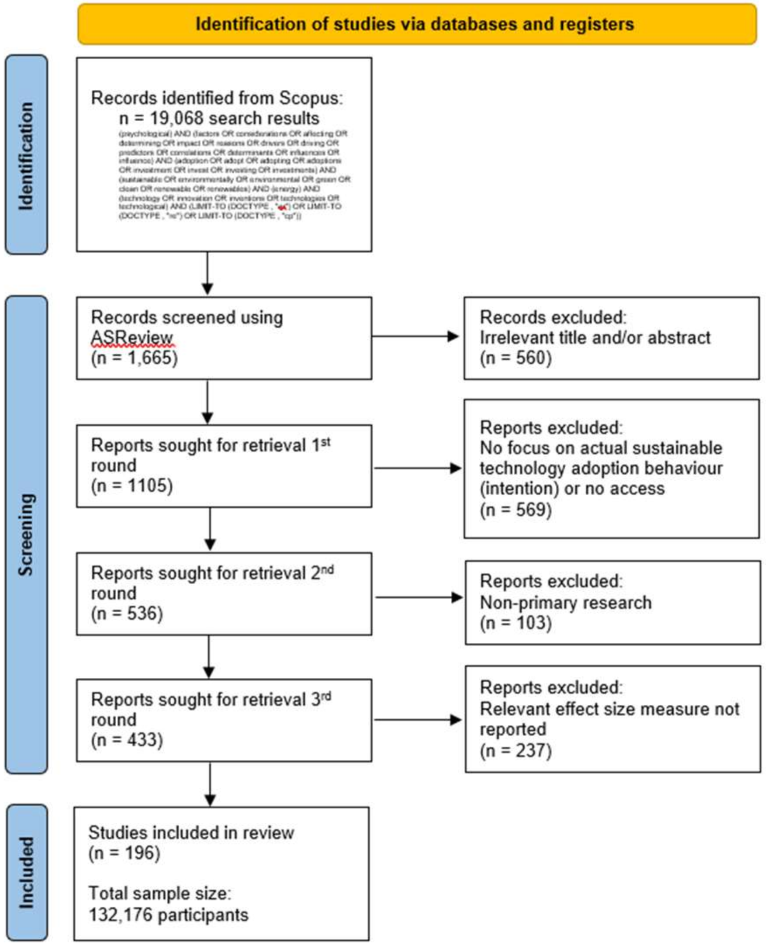
Aim:

→ Addressing the complexity of interrelated social and technical phenomena and heterogeneous social actors

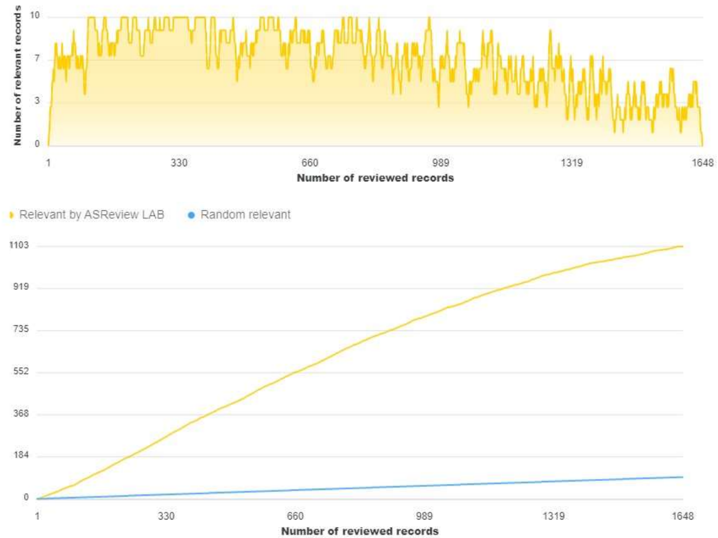
→ Understanding sustainable technology adoption at the micro and macro level (emergent behaviour)

Methodology: Systematic Literature Review

PRISMA Flow Diagram



ASReview:



PRISMA Flow Diagram adapted from: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

Key Findings

Psychological Factors

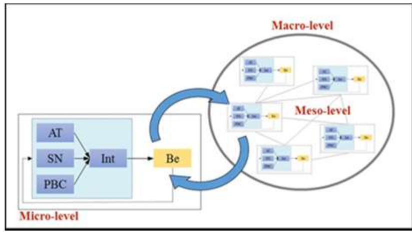
Factor	No. of Studies	No. of Part.	Mean r *	Std. Deviation
Subjective norm	125	104,689	0.480	0.156
Attitude	113	87,246	**0.570**	0.167
Environ. concern	77	55,324	0.456	0.137
PBC	75	65,687	**0.535**	0.176
Personal norm	53	47,103	**0.596**	0.164
Perceived benefits	48	25,989	0.440	0.193
Perceived ease of use	43	24,356	0.426	0.171
Techn. knowledge	40	22,965	0.407	0.178
Perceived costs	39	24,543	- 0.311	0.223

* Mean of the Pearson Correlation Coefficient;

Key Findings

Differences in Technologies

	Technologies					
	Alternative-Fuel Vehicles (n = 99)		Energy-Efficient Appliances (n = 51)		Renewable Energy Technologies (n = 46)	
Factor	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Subjective norm	0.569	0.149	0.429	0.133	0.407	0.123
Attitude	0.657	0.143	0.484	0.167	0.505	0.124
Environ. concern	0.480	0.122	0.397	0.151	0.439	0.149
PBC	0.617	0.137	0.486	0.164	0.417	0.171
Personal norm	0.636	0.152	0.476	0.139	0.465	0.122
Perceived benefits	0.457	0.214	0.375	0.137	0.468	0.195
PEU	0.498	0.152	0.369	0.124	0.347	0.179
Techn. knowledge	0.408	0.214	0.428	0.150	0.362	0.155
Perceived costs	- 0.348	0.186	- 0.120	0.121	- 0.284	0.262



From: Scalco et al. (2018)

Integration Into Agent-Based Models

The next steps:

→ Understand interrelatedness between factors:
- How do perceived benefits and costs influence attitude?
- How does technological knowledge influence ease of use?

→ Formalisation:
- Define attributes to each agent (empirically): Attitudes, PBC and personal norms (e.g., -1 to 1)
- Define within-agent behaviours:
  - Attitude updates: Social interactions or technological advancements
  - Tech. knowledge: Likely to increase over time
- Determine adoption threshold

→ Model interactions:
- Attitude diffusion through social networks (convergence or divergence?)
- Normative influence: Agents with strong personal norms exert social pressure

Thank you!

Any ideas for further analysis?

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Merging Variables for Better Comparability

- A few Examples