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Towards a just heat transition in the building sector: A study on social indicators of sustainability

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ABSTRACT

Heating in UK buildings is dominated by fossil fuels as the main energy source, representing over 80% of the household energy consumption and 79% of the carbon emissions. Therefore, heat decarbonisation in this sector should be accelerated in order to achieve the 2050 net zero carbon targets. However, there is still a great deal of uncertainty regarding the social impacts of heat decarbonisation strategies on households and the communities. The multiplicity of social criteria and inconsistency of their measuring methods complicate the assessment of social sustainability in the energy systems, leading to less incorporation of the social factors in design and decision-making processes. Therefore, identifying a set of indicators that represent the social performance of energy systems is an essential for conducting a holistic sustainability assessment. In this research, a methodological process is established primarily aimed to identify, select, and prioritise a representative set of indicators that can reflect the social sustainability of the heating transition in the building industry. The research accounts for a qualitative survey and judgments of experts to determine the indicators and their importance weights thus reducing the subjectivity and uncertainties of the process. The result is a social sustainability assessment framework that will enable decision-makers to evaluate the transition pathways, select the best alternatives, and monitor their performance, by analysing social indicators in conjunction with other sustainability parameters.

Video to this article can be found online at https://doi.org/10.1016/j.sctalk.2022.100092.

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Figures and tables

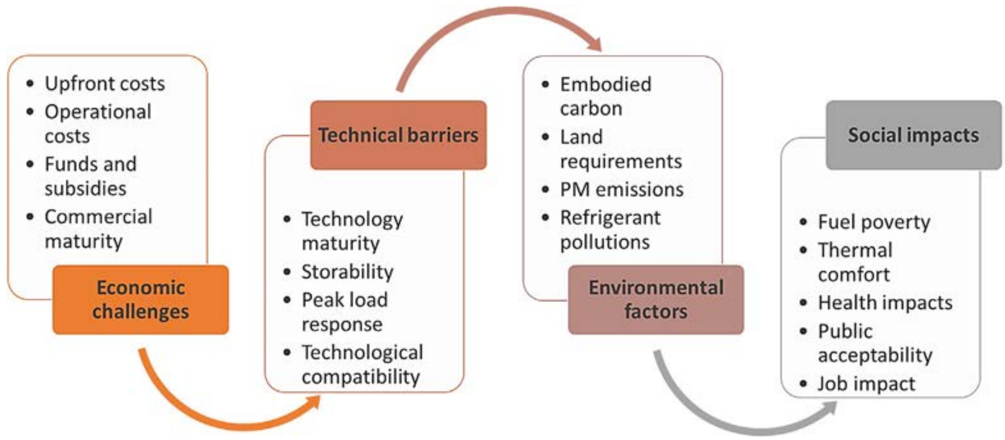

Fig. 1. Challenges of heat decarbonisation: Sustainable heat transitions involve more than a simple shift to less carbon-intensive technologies. They are tied up with several economic, technical, environmental, and social challenges that have the potential to negatively impact upon the wellbeing of people and communities if end-user needs are not carefully considered.

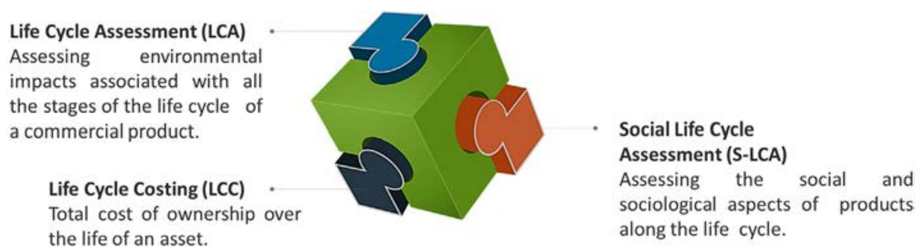

Fig. 2. Sustainability assessment: Sustainability assessments integrates the three dimensions of sustainability in a comprehensive framework.

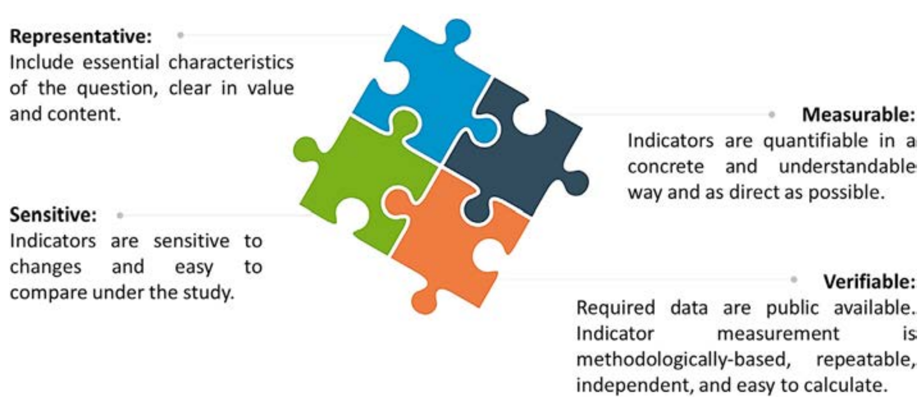

Fig. 3. Requirements for sustainability indicators: Based on these requirements, sustainability indicators will be able to quantify, analyse, and communicate complex sustainability information in a simple way through systematic, precise, consistent, and transparent measures.

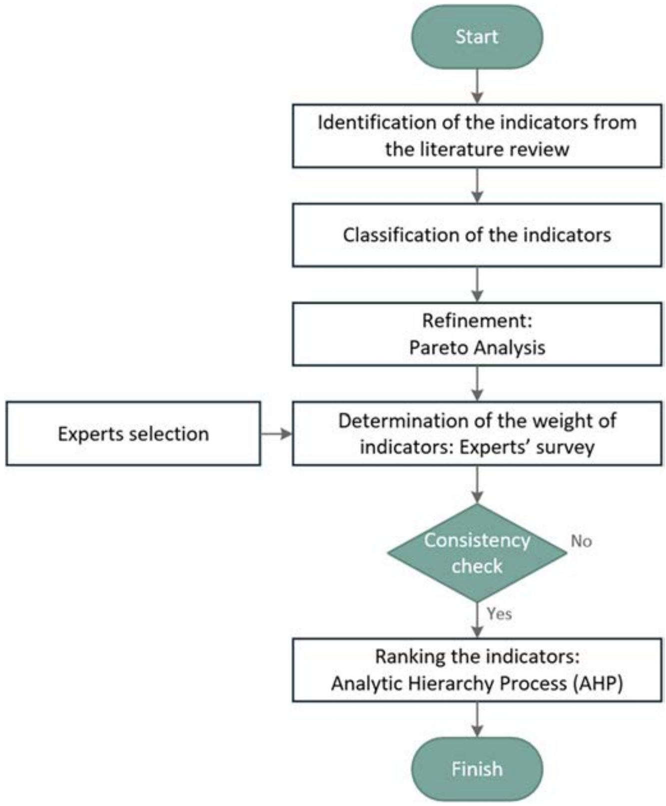

Fig. 4. Methodology stages: A methodological process is established, consisting of five stages to identify, select, and prioritise a representative set of sustainability indicators for heating transition.

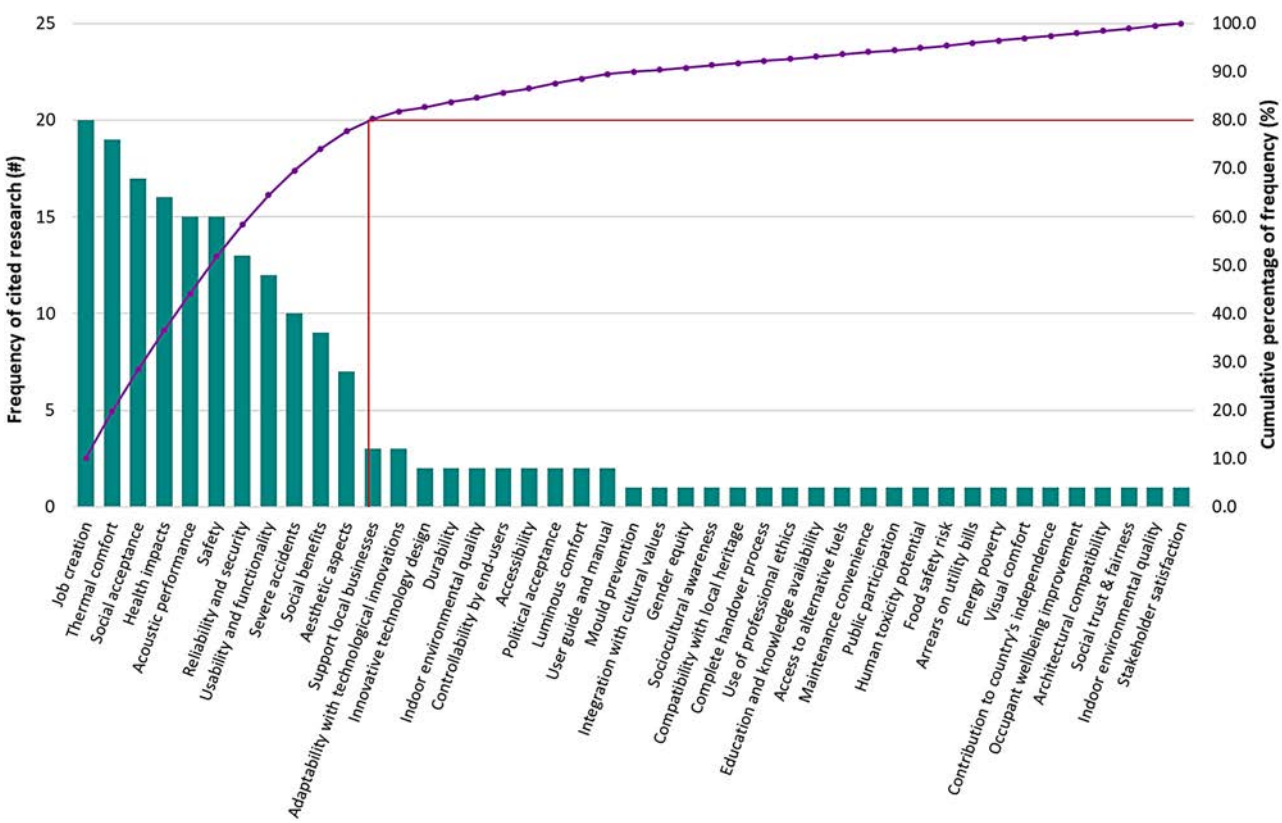

Fig. 5. Pareto chart: Pareto chart is drawn for the identified social indicators. The indicators are divided into two parts through a red line that cuts the cumulative percentage graph at 80%. The indicators with less than or equal to 80% cumulative frequency are considered vital and are proceeded to the next stage.

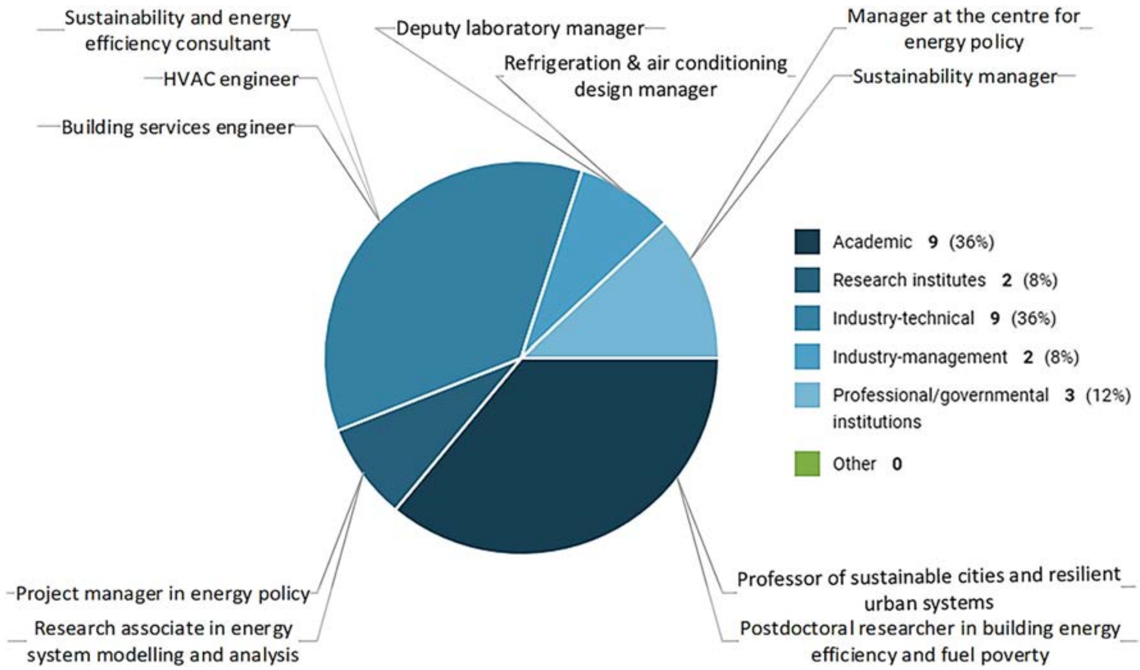

Fig. 6. Expert participants: The survey is completed by 25 certified experts from different sectors. This figure illustrates participants from academia and industry-technical build the biggest share of participants (36%). Around 12% were from professional/governmental institutions. Industry managers and research institutes share the same number of participants (8%).

Table 1

Indicators set: A total of 12 indicators are shortlisted through the two rounds of refinement. The indicators' measurement unit and direction of impact are also given in the table.

Social Indicator	Measurement Unit	Description	Impact on Sustainability
Fuel poverty	%	Risk of exposure to fuel poverty using LIHC indicator	−
Thermal comfort	%	Percentage of hours in thermal comfort using PMV indicator	+
Health impacts	£	Activity damage cost for each technology over the lifecycle	−
Employment impact	Job/GWh	Number of employees hired over 12 months per unit of heat produced	+
Social acceptance	%	Public preference for the utilisation of the technology	+
Safety	Injuries/GWh	Occupational accident risk and public hazards over life cycle	−
Aesthetics and visual impact	%	Perceived visual connection with the surrounding landscape	−
Usability and functionality	%	Extent to which the system is understandable, simple in use and adjustable	+
Reliability of and security	%	Percentage of the equivalent available hours to the statistical hours	+
Acoustic performance	dB	Airborne exterior sound insulation	−
Social benefits	%	Level of compatibility with cultural and local heritage values	+
Severe accidents	#/GWh	Number of severe accidents per unit of heat produced	−

Table 2

Indicators' priority: The identified indicators are ranked based on their importance weight, obtained using the AHP method. Global weights in the table refer to the overall weights of indicators with respect to the goal of sustainability. The local weights refer to weights of indicators with respect the goal of social sustainability.

Social Indicator	Local Weight	Global Weight
Health impacts	20.25%	5.48%
Fuel poverty	13.45%	3.64%
Thermal comfort	12.80%	3.46%
Safety	10.80%	2.92%
Employment impact	9.13%	2.47%
Reliability and security	8.12%	2.20%
Usability and functionality	6.36%	1.72%
Social acceptance	5.84%	1.58%
Acoustic performance	5.04%	1.36%
Aesthetics and visual impact	3.38%	0.91%
Severe accidents	3.10%	0.84%
Social benefits	2.21%	0.60%

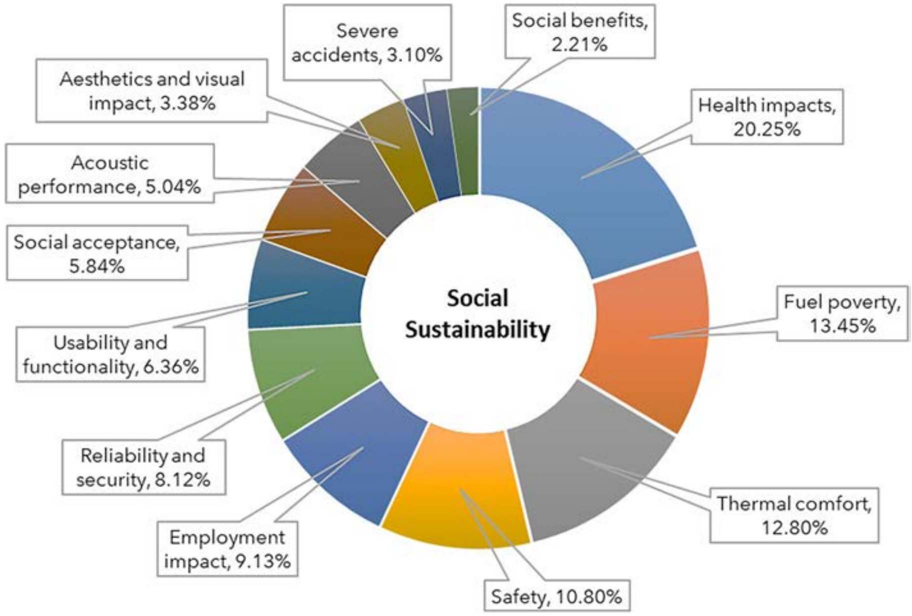

Fig. 7. Constituents of social sustainability: Figure recaps the results of the research in a pie chart illustrating the constituents of social sustainability and their importance weight concerning the heating transition in the building sector. Using these indicator set, social sustainability can be incorporated into design and design-making processes.

CRediT author statement

Mohammad Hosein Abbasi: Conceptualization, Data curation, Formal analysis, Investigation, Visualization, Writing - original draft.

Badr Abdullah: Supervision, Resources, Writing - review & editing.

Raúl Castaño-Rosa: Supervision, Formal analysis, Writing - review & editing.

Muhammad Waseem Ahmad: Supervision, Formal analysis, Writing - review & editing.

Ali Rostami: Supervision, Methodology, Writing - review & editing.

Jeff Cullen: Supervision, Writing - review & editing.

Data availability

Data will be made available on request.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Further reading

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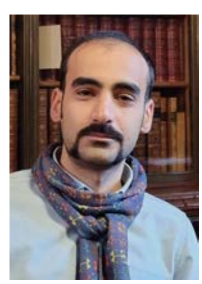
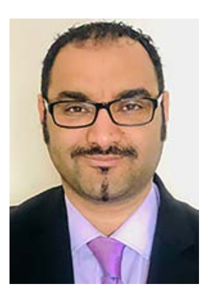


Mohammad Hosein Abbasi is an interdisciplinary energy researcher, started his career as an energy engineer, before being immersed in the energy research within the wider context of sustainability. After being graduated in the Master of Energy Engineering, he has worked for almost 7 years in building energy services and the energy-environment startup ecosystem. Hosein then started his PhD in 2019 to pursue his interest in exploring the intersectionalities of social sustainability and energy transitions in the building sector. In this project, he has particularly investigated the interconnections between social factors of heat decarbonisation, e.g. fuel poverty, thermal comfort, health impacts, public acceptability, safety, etc., with the economic and environmental factors and their role in delivering a just and sustainable transition.



Dr. Badr Abdullah is the Programme Leader of Architectural Engineering & Building Services Engineering at the School Civil Engineering and Built Environment. Badr is also a Reader in Sensor Applications. He leads the Building Engineering and Construction Practise Research Theme in the Faculty of Engineering and Technology. Badr has extensive research interests spanning a wide range of unique applied science and technologies for the design and development of sensors to suit a wide range of industries such as built environment, energy, oil/gas, environmental monitoring, manufacturing and healthcare.

Dr. Raúl Castaño-Rosa is an interdisciplinary building engineer with over 6 years of experience in the non-academic and academic sector where he has played a key role in teaching, researching, mentoring and exchanging knowledge on sustainability, resilience, buildings, innovative solutions and people's quality of life. He is currently working as a postdoctoral researcher (Affordable and Resilient Housing) at Tampere University, ASUTUT research group, where he is actively involved internationally in different European projects. Additionally, he is Research Field Coordinator of the Resilient Community strategy in the SMART-ER programme of the ECIU University. His main area of research and interest is on how to support more resilient communities with people at the core of the process. This includes other subtopics like Energy poverty; Climate Emergency; Post-Occupancy Evaluation (POE); Building Management System (BMS); Home Energy Management System (HEMS).

Dr. Muhammad Waseem Ahmad is a Senior Lecturer in Building Services and Architectural Engineering at Liverpool John Moores University. His research interests lie in the broader field of smart and sustainable buildings, districts, and cities. As an interdisciplinary academic, his work links energy (building and district energy systems, smart grids, and renewable energy), digital architecture (parametric design and digital twins), and environment (sustainable building design). He has completed a number of nationally and internationally funded research projects. In his recently completed research projects, the research focus was on improving the understanding of the interactions between users, individual buildings (EU-PERFORMER)/districts (EU-PENTAGON) and energy systems, as well as on the development of resource-efficient and resilient built environment. He has also served as the technical coordinator of (EU-PENTAGON) project as well.

Dr. Ali Rostami is the Programme Leader in Quantity Surveying in the School of Built Environment, Liverpool John Moores University. He is a full member of APM – the Chartered body for the project profession, and a chartered Civil Engineer. Before coming to LJMU, he held a Lecturer position in Built Environment in the School of Computing and Engineering at the University of West London, and a senior researcher position in Project Risk Management at the University of Wolverhampton. Prior to his academic career, he has worked for almost 10 years as a project manager in the oil, gas and petrochemical construction industry in the Middle East. He was responsible for the project management of various large-scale international projects. During his professional career, he covered the whole life cycle of projects from the initial feasibility study to the final handover and implementation.

Dr. Jeff Cullen obtained a PhD at University of Liverpool, School of Electrical Engineering and Electronics, in 2000 entitled 'Optical Techniques for Industrial Automated Applications'. His post-doctoral research career began at Liverpool working on industrial facing projects in the Automotive and Microwave fields. All of these projects had an underpinning theme of energy usage. In 2005 he joined Liverpool John Moores University as a founding member of the RF and Microwave group under Prof. Ahmed Al-Shammaa. He continued research related to energy in projects as varied as investigating the performance of fridges for the leisure industry through to microwave systems to provide a novel way of heating for both domestic and industrial uses. Jeff has been involved with multiple projects regarding sensors, sustainability and monitoring and characterising new and novel products that are brought to the university through the industrial outreach programs in the faculty.