Overcoming Adoption Barriers of Next Generation Processing Technologies in Ceramics and Glass Industries

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Project Team

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Background

More than 75% of materials used in the society come from the foundation industries

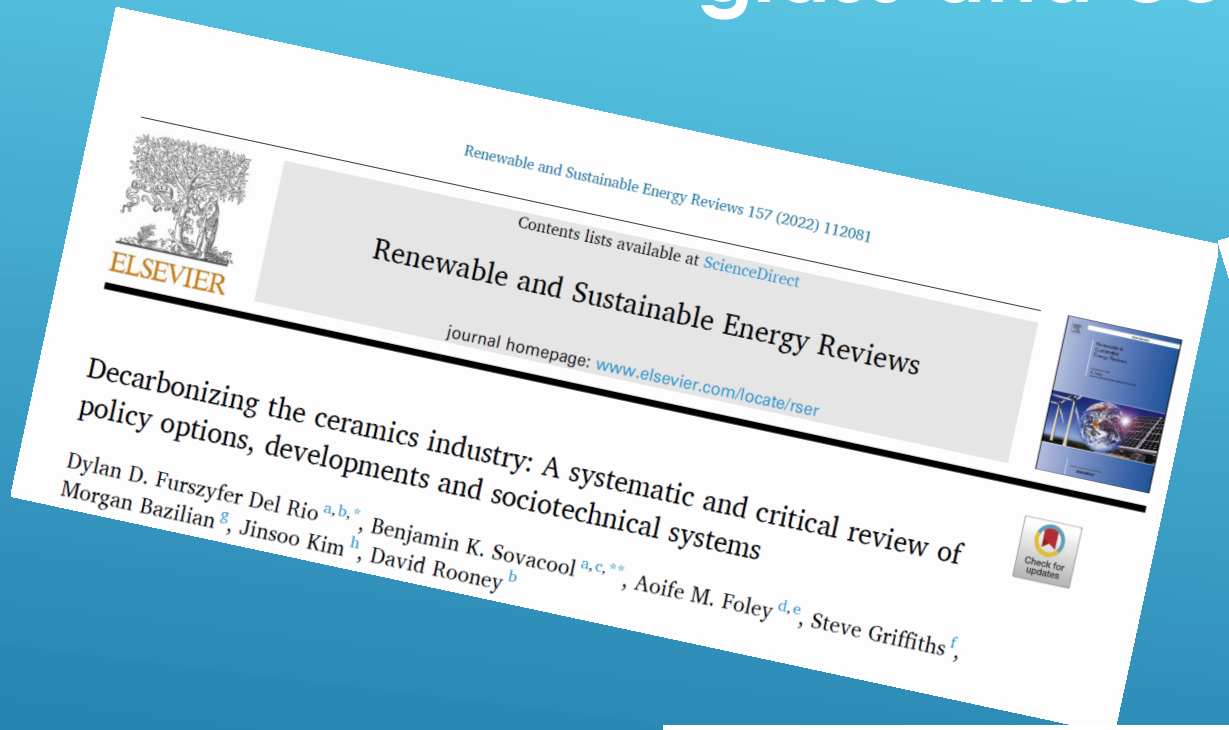
≈ 28Mt of materials annually

≈ 10% of UK's CO_2 emissions

Ceramics Sector consumes ≈ 4.7 TWh energy annually; emits1.2Mt CO_2-eq in 2012

Glass Sector consumes ≈ 9 GWh energy annually; emits 2.2Mt CO_2-eq in 2012

Previous research efforts towards decarbonising the glass and ceramics sectors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Decarbonizing the ceramics industry: A systematic and critical review of policy options, developments and sociotechnical systems
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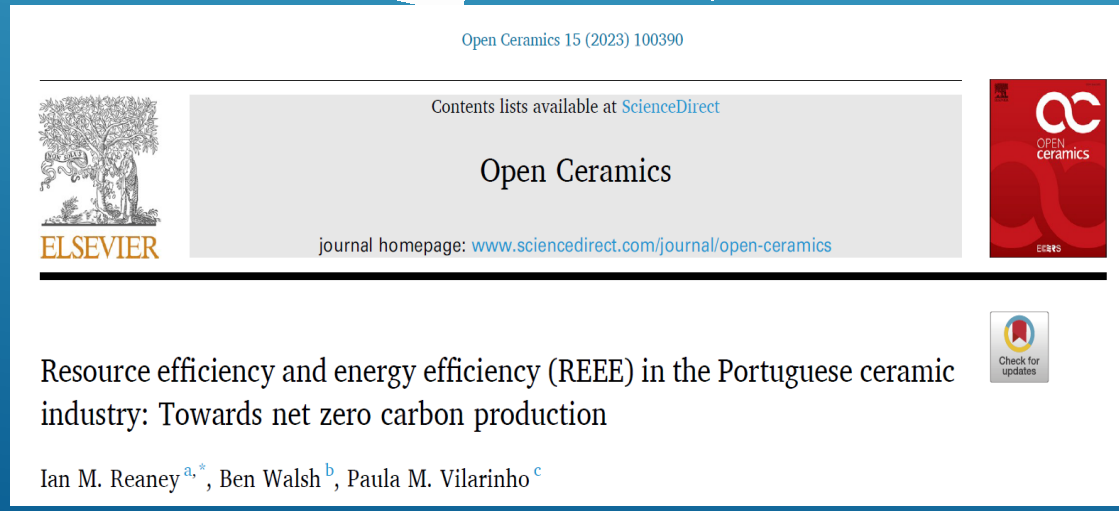
Open Ceramics 15 (2023) 100390
Contents lists available at ScienceDirect
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journal homepage: www.sciencedirect.com/journal/open-ceramics
Resource efficiency and energy efficiency (REEE) in the Portuguese ceramic industry: Towards net zero carbon production
Ian M. Reaney [a,*], Ben Walsh [b], Paula M. Vilarinho [c]

Research focus

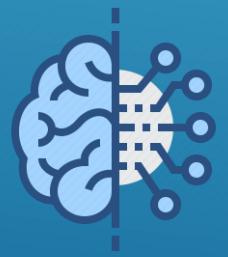
Next Generation Processing Technologies (NGPTs)

New technologies that provide high energy efficiency and process intensification supported by transformative digital technologies (e.g., AI/ML, digital twin, IoT, 3-D printing, cloud computing etc)

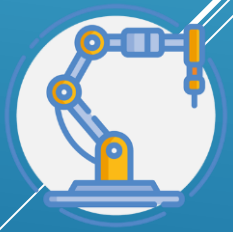
What role can NGPTs play towards decarbonising the ceramics and glass sector?

Industrial Internet of Things

Cloud Computing



Artificial Intelligence / Machine Learning



Robotics

The role of Next Generation Processing Technologies (NGPTs)

Digital Technologies

- Cloud Computing
- Industrial Internet of Things
- Smart Tags for Track & Trace
- Digital Twins
- Artificial Intelligence / Machine Learning
- Robotics
- Additive Manufacturing
- Augmented Reality

Potential Benefits

- Process optimisation
- Real-time monitoring
- Enhanced information sharing
- Identification of inefficiencies
- Waste reduction
- Energy consumption reduction
- Improved resource efficiency

Research Question

What are the barriers to the adoption of NGPTs in the ceramics and glass sector, and how can they be overcome?

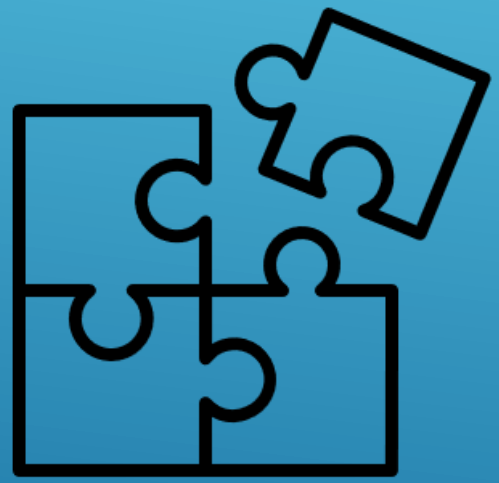
Research Approach

Critical Literature Review

Initial identification of relevant technologies and barriers for the decarbonisation of the glass and ceramics industries.

Stakeholder Interviews

Expert interviews to validate and further complement the findings from the critical literature review.



Interpretive Structural Modelling

Analysis of workshop discussion data for identification of barriers interactions.

Stakeholder Consultation Workshop

In-depth discussion on barriers to digital technology adoption for the decarbonisation of the glass and ceramics industries.

16 Barriers to digital technology adoption for the Ceramics and Glass Industries

Critical Literature Review & Stakeholder Interviews

Organisational Barriers	
B1	Unclear Value Proposition
B2	Resistance to Change
B3	Prioritisation of Short-Term Goals
B4	Risks Associated with Investment Failure

External & Regulatory Barriers	
B9	Regulatory Complexity
B10	Lack of Inter-Organisational Collaboration
B11	Lack of Regulatory Support
B12	Lack of Cross-Sector Collaboration
B13	Lack of Intra-Sector Collaboration

Operational & Technological Barriers	
B5	Integration with Existing Technologies and Infrastructure
B6	Data Privacy and Security
B7	Operational Complexity
B8	Operational Disruptions due to Technology Adoption

Resource Constraints	
B14	Workforce Availability and Skills
B15	High Costs
B16	Technological Limitations

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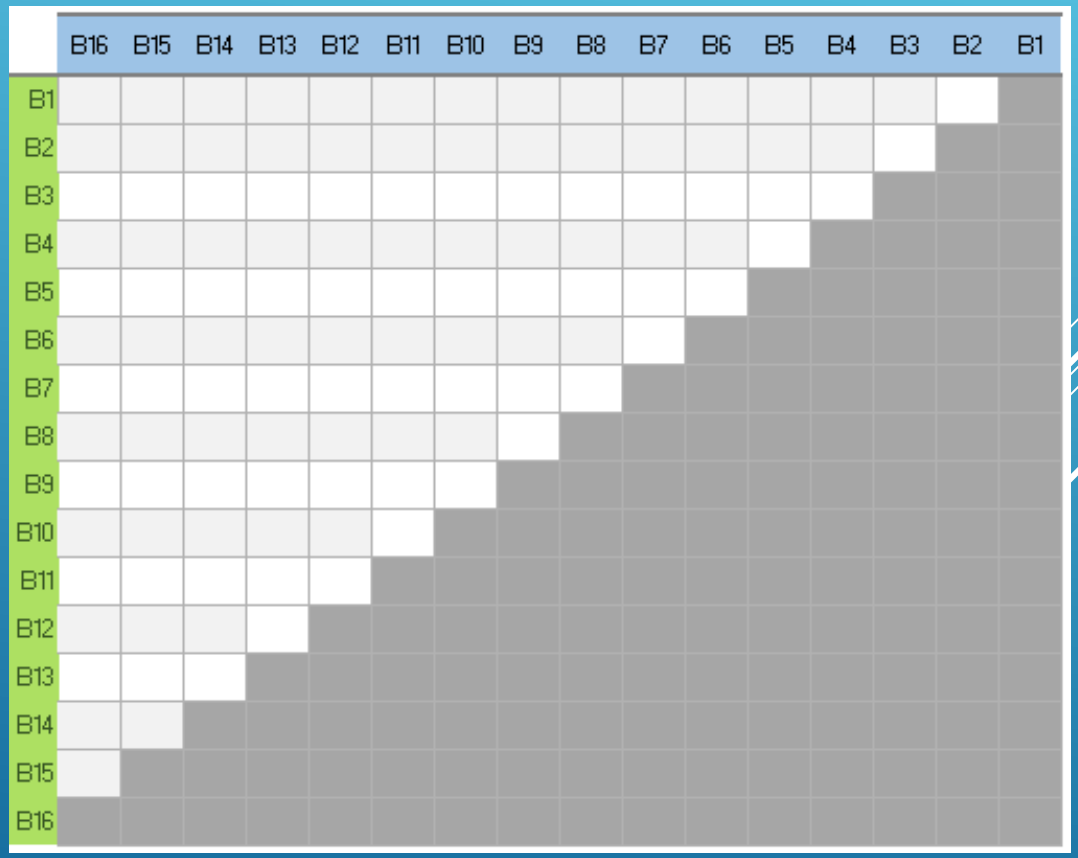
Contextual understanding and interaction of barriers: interpretive structural modelling (ISM)

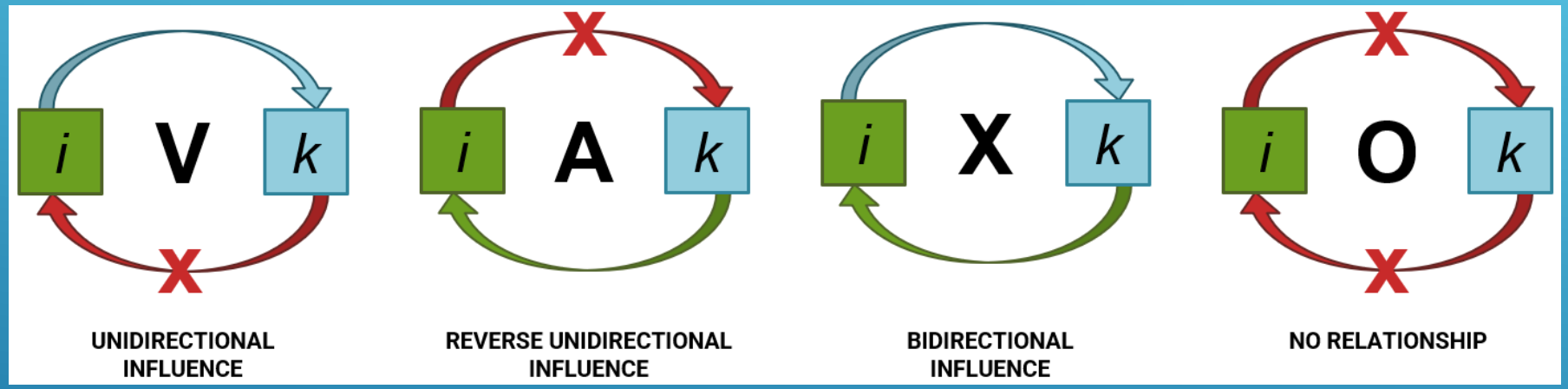
Contextualisation of Barriers and Consensus Building

		Agree or Disagree on its significance?
Unclear Value Proposition	B1	
Resistance to Change	B2	
Prioritisation of Short-Term Goals	B3	
Risks Associated with Investment Failure	B4	
Integration with Existing Technologies and Infrastructure	B5	
Data Privacy and Security	B6	
Operational Complexity	B7	
Operational Disruptions due to Technology Adoption	B8	
Regulatory Complexity	B9	
Lack of Inter-Organisational Collaboration	B10	
Lack of Regulatory Support	B11	
Lack of Cross-Sector Collaboration	B12	
Lack of Intra-Sector Collaboration	B13	
Workforce Availability and Skills	B14	
High Costs	B15	
Technological Limitations	B16	
	-	

Interactions Among Barriers



ISM Matrix Situations



I: Interpretive
S: Structural
M: Modelling

Interpretive Structural Modelling: data collection

		Agree or Disagree on its significance?	
Unclear Value Proposition	B1	Agree	*
Resistance to Change	B2	Agree	*
Prioritisation of Short-Term Goals	B3	Agree	
Risks Associated with Investment Failure	B4	Agree	*
Integration with Existing Technologies and Infrastructure	B5	Agree	
Data Privacy and Security	B6	Agree	*
Operational Complexity	B7	Agree	*
Operational Disruptions due to Technology Adoption	B8	Agree	
Regulatory Complexity	B9	Agree	
Lack of Supply Chain Collaboration	B10	Agree	*
Lack of Regulatory Support	B11	Agree	
Lack of Cross-Sector Collaboration	B12	Agree	*
Lack of Intra-Sector (Competitors) Collaboration	B13	Agree	
Workforce Availability and Skills	B14	Agree	
High Costs	B15	Agree	
Technological Limitations	B16	Agree	

Barrier i		B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
Unclear Value Proposition	B1																
Resistance to Change	B2																
Prioritisation of Short-Term Goals	B3																
Risks Associated with Investment Failure	B4																
Integration with Existing Technologies and Infrastructure	B5																
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High Costs	B15																
Technological Limitations	B16																

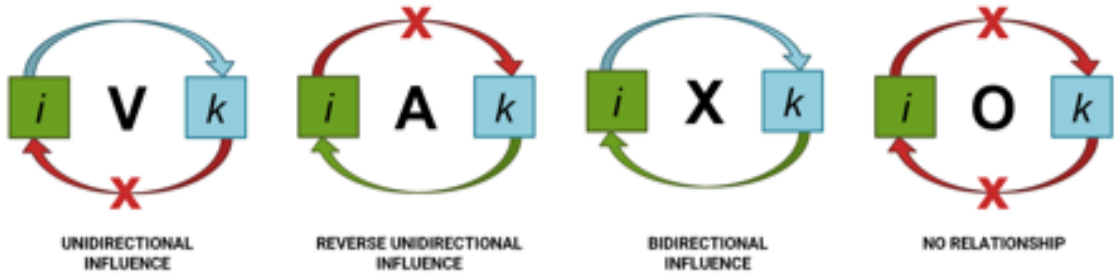
Mapping out the interrelationships among the 16 barriers using ISM

Steps for the Activity:

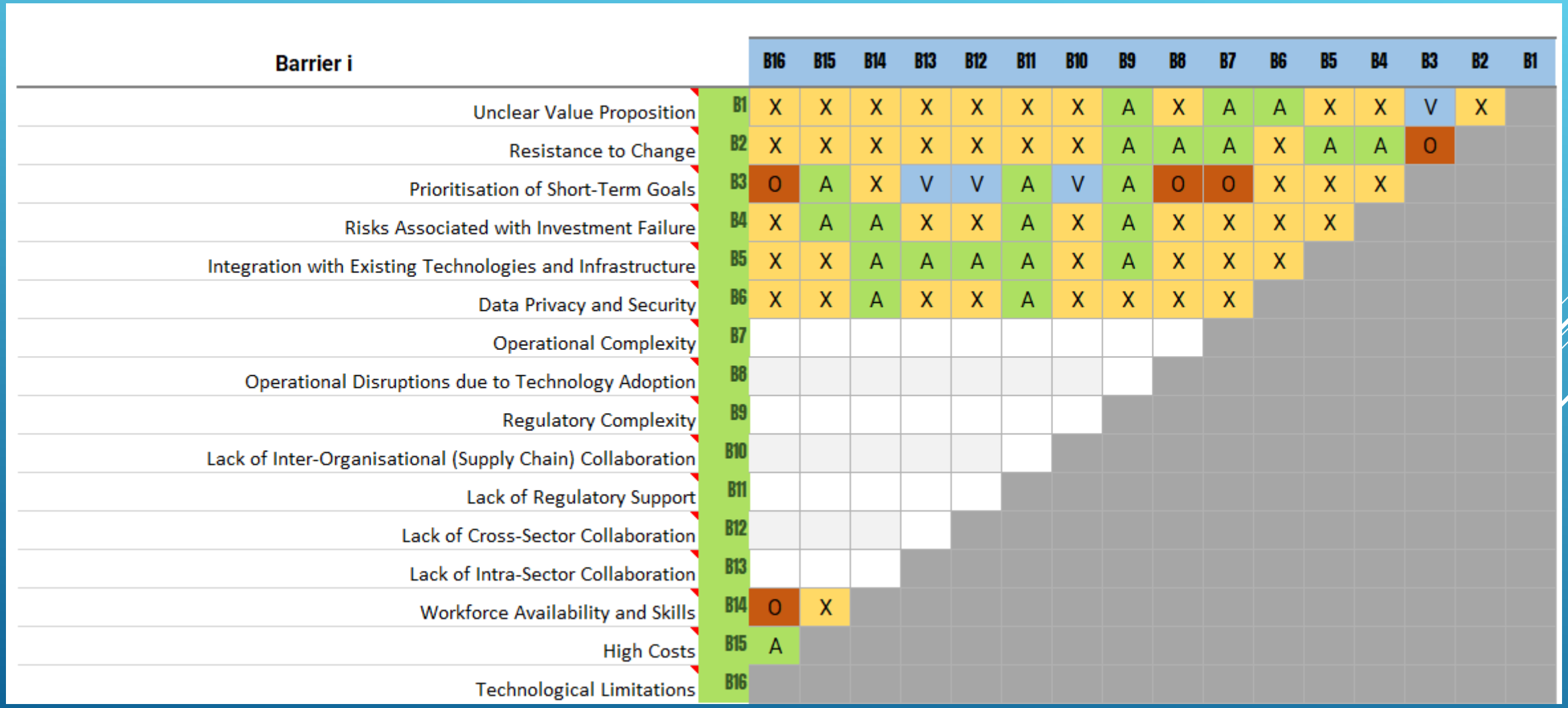
- Review each pair of barriers and decide the type of relationship based on the definitions provided.
- Record your assessment in the ISM matrix by marking V, A, X, or O in the corresponding cell.
- Ensure every pair of barriers is evaluated and the matrix is completed.

Remember:

- Think critically about the nature of the influence between each pair of barriers.
- Discuss with your group to reach consensus before marking your decision.
- If there is any uncertainty, re-examine the barriers' definitions and context.



ISM data collection (yet to be completed)



Barrier i		B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
Unclear Value Proposition	B1	X	X	X	X	X	X	X	A	X	A	A	X	X	V	X	
Resistance to Change	B2	X	X	X	X	X	X	X	A	A	A	X	A	A	O		
Prioritisation of Short-Term Goals	B3	O	A	X	V	V	A	V	A	O	O	X	X	X			
Risks Associated with Investment Failure	B4	X	A	A	X	X	A	X	A	X	X	X	X				
Integration with Existing Technologies and Infrastructure	B5	X	X	A	A	A	A	X	A	X	X	X					
Data Privacy and Security	B6	X	X	A	X	X	A	X	X	X	X						
Operational Complexity	B7																
Operational Disruptions due to Technology Adoption	B8																
Regulatory Complexity	B9																
Lack of Inter-Organisational (Supply Chain) Collaboration	B10																
Lack of Regulatory Support	B11																
Lack of Cross-Sector Collaboration	B12																
Lack of Intra-Sector Collaboration	B13																
Workforce Availability and Skills	B14	O	X														
High Costs	B15	A															
Technological Limitations	B16																

NEXT STEPS

- Complete the ISM table
- Carry out post workshop interviews
- Complete ISM modelling
- Use ISM output to inform strategies to overcome barriers
- Publish output: Practitioner Report and Academic Journal Article

THANK YOU!

Funders

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Engineering and Physical Sciences Research Council

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