



expedition

part of the Useful Simple Trust

PAS 2080 Accelerator Project

Final Report

June 2021

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HS2 i3P

Transport Research
and Innovation
Board (TRIB)

Executive Summary

Purpose

The infrastructure sector is facing a significant decarbonisation challenge. The purpose of this project was to identify how to accelerate the adoption of the PAS 2080 Carbon Management in Infrastructure standard.

A key objective of this study was to ensure that we recognise, support and coordinate with related carbon management activities that are happening across the sector.

Methodology

We have adopted a strategic planning model to structure our work and address the PAS 2080 adoption challenge. The approach involved these key activities:

1. undertake diagnosis;
2. establish guiding principles; and
3. identify actions.

An i3P PAS 2080 Community of Practice was established with representatives from major infrastructure clients and the supply chain, to support the analysis and validate the findings.

Diagnosis

Key finding: For most organisations, the balance between the pros and cons precludes adoption of PAS 2080. Without a stronger driver in the form of either a client or government requirement, it is unlikely that we will see widespread and rapid adoption of PAS 2080.

Additional findings from the diagnosis include:

- Within the infrastructure sector there is inadequate awareness of PAS 2080 and what is necessary for its implementation.
- Currently, organisations adopt PAS 2080 either because clients require it (note this is rare), or to gain a competitive advantage.
- PAS 2080 is perceived as likely to increase costs without increasing revenue. In the current low margin environment, this is highly problematic.
- Carbon management and change management capabilities are often lacking in the infrastructure sector. This is particularly important for clients given their role in stimulating PAS 2080 adoption through project and programme requirements.
- There are many different types of organisations in the sector with different scales, drivers, ownership structures etc. As a result, their motivation and capability to embark on a carbon management and PAS 2080 change process are different.

Executive Summary

Guiding principles

Based on the findings from the diagnosis, four 'guiding principles' shaped the development of key actions:

1. Focus on tipping the balance so that the drivers (pros) of adoption outweigh the barriers (cons).
2. Focus on carbon leadership particularly with infrastructure clients, but also within supply chain companies.
3. Focus on developing sector and organisational carbon management maturity.
4. Respond to the organisational ecosystem.

Actions

The 5 key actions to accelerate adoption of PAS 2080 are:

1. Galvanise infrastructure clients to adopt PAS 2080.
2. Build whole life carbon management and PAS 2080 awareness across the sector.
3. Develop the evidence base to encourage PAS 2080 adoption in the supply chain.
4. Ensure the sector can access the necessary capabilities to improve their approach to carbon management.
5. Drive down the costs of implementing carbon-focused change.

For each of the actions we have identified: key activities, alignment requirements with other industry carbon management workstreams, and stakeholders (Appendix B).

Recommendations

The three immediate recommendations arising from this study are to:

1. Formally share the findings of this study with key organisations and groups working on infrastructure decarbonisation and specifically: ICE's 'The Carbon Project' which is revising PAS 2080, the Infrastructure Client Group (ICG) Carbon Working Group, the Supply Chain Sustainability School, UKGBC and the Carbon Literacy Project.
2. Engage with Infrastructure Clients to discuss the findings in relation to Client behaviours and advocate for both stronger leadership around adoption of PAS 2080 and carbon management more generally. This could be through the TRIB Board and ICG for example.
3. Bearing in mind TRIBs original interest in developing pilot studies, they may wish to fund a programme to develop the evidence base to encourage PAS 2080 adoption in the supply chain.

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Version	Date	Reason for Issue	Authors	Reviewers
1.0	21/5/21	Final draft for review	Ed McCann Kell Jones	Jo Dobson
1.1	30/6/21	Final version	Ed McCann Kell Jones	Jo Dobson

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0 \ Introduction

Purpose of the study

The infrastructure sector is facing a significant decarbonisation challenge.

The PAS 2080 Carbon Management in Infrastructure standard was launched in 2016 with the aim to improve the management of carbon across the lifecycle, and lead to emissions reductions across the infrastructure sector.

However, recent studies by TRIB and the i3P identified that PAS 2080 is not being widely applied yet.

Accelerating the adoption of PAS 2080 is one of 20 opportunities identified in the i3P Zero Carbon World Strategy as being critical to moving towards a 'Zero Carbon World'.

Expedition Engineering was appointed by the Transport Research Innovation Board (TRIB), HS2, Network Rail and the Infrastructure Industry Innovation Partnership (i3P) **to explore how to accelerate the adoption of PAS 2080.**

An i3P PAS 2080 Community of Practice was established with representatives from major infrastructure clients and the supply chain, to support the analysis and validate the findings. See page 34 for the members of the Community of Practice.

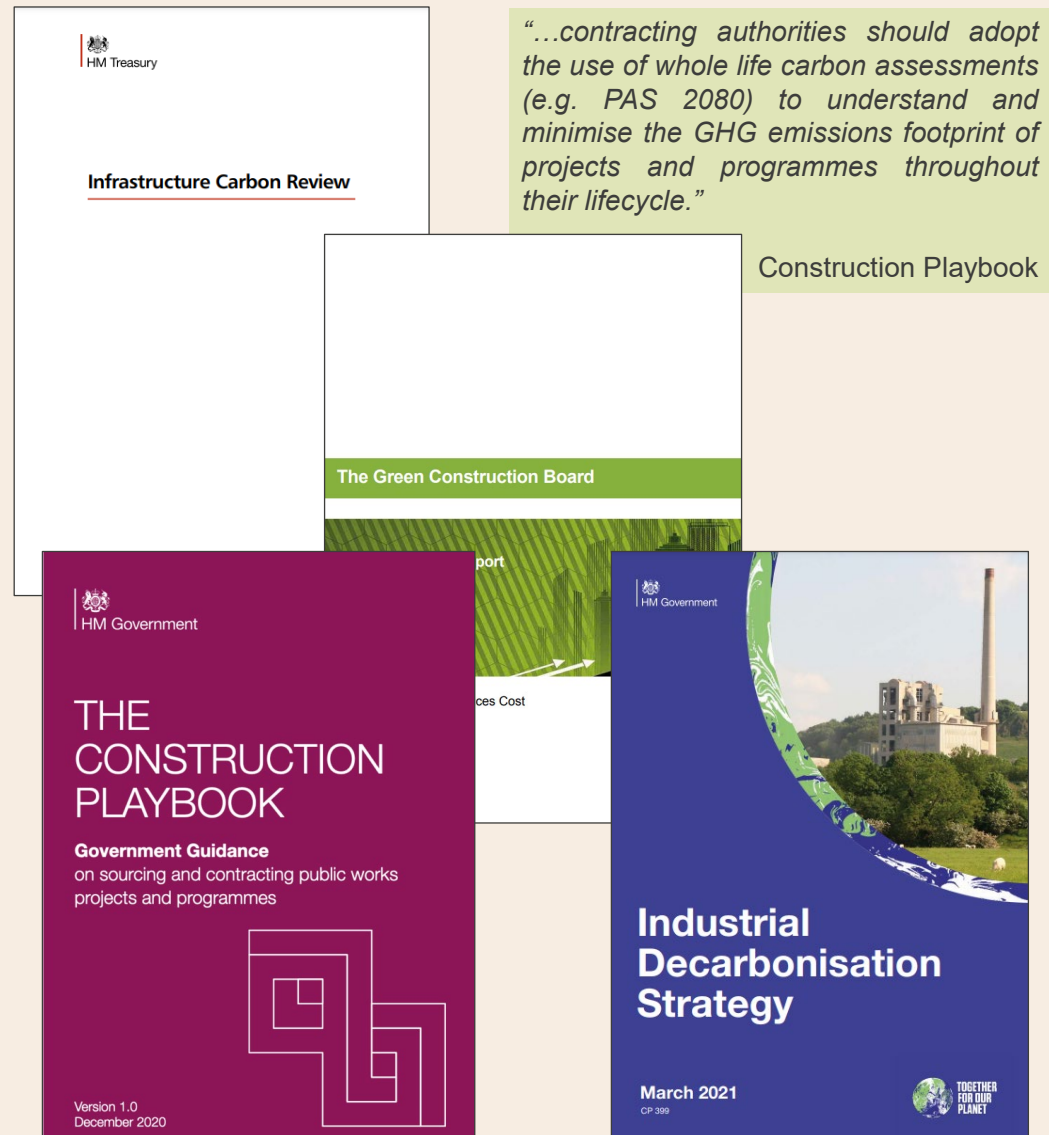
The study took place from March – May 2021.

PAS 2080

PAS 2080 has been developed to enable effective and efficient carbon management on infrastructure programmes. The intended direct and indirect benefits for organisations working in the infrastructure sector include:

- Reduced carbon emissions
- Demonstration of commitment to meeting government and industry goals around carbon
- Development of the carbon reporting and management capabilities required for a zero carbon world
- Identifying, measuring and monitoring carbon risks
- Building a carbon-focused and innovative culture
- Enhanced environmental reputation
- Collaboration across the supply chain
- Increased competitiveness in the UK, and an early advantage in global markets

Expedition



Alignment with other sector initiatives

Several organisations have been looking at the challenges of carbon management in infrastructure, and some have started to develop responses to accelerate the transition.

A key objective of this study is to ensure that we recognise, support and coordinate with these related activities.

The Green Construction Board

Good progress but not fast enough

The Infrastructure Carbon Review was published in November 2013 with the call to action 'cut carbon, save cost'. Seven years on, and with the

Carbon Reduction Code of Practice

Carbon Reduction Code for use by clients, consultants, contractors and supply chain members across all sectors of the built environment

This draft Carbon Reduction Code was developed by the Achieving Net Zero Cross-Industry Working Group convened by CSC. It is a first step to facilitate action towards reducing carbon emissions (CO₂e) related to design, construction, maintenance and operation of built assets. It is not intended to replace PAS 2080 (or equivalent standards), which provides a common framework for all infrastructure sectors and value chain members on how to manage whole life carbon when delivering infrastructure assets and programmes of work.

Carbon reduction is more likely to happen when all organisations within a value chain are committed to working together to reduce their footprint and save costs. Collaboration is the key to success, and with alignment across all parties, the Working Group is confident in progressing towards the net zero carbon objective.

This will need to be delivered within and alongside the wider, coordinated system of systems needed to support a vibrant industry and

SUPPLY CHAIN SUSTAINABILITY

SCHOL

i3P

ciria

Is our carbon wallet empty?

The embodied carbon of the National Infrastructure Pipeline

A workpackage from the Net Zero Infrastructure Industry Coalition

ice Institution of Civil Engineers

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HOME ABOUT ICE

Infrastructure Client Group

The Infrastructure Client Group (ICG) brings together the UK's most progressive economic infrastructure clients in partnership with government and industry.

ice Institution of Civil Engineers

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HOME KNOWLEDGE AND RESOURCES

The Carbon Project

Towards Net Zero for Infrastructure

UNIVERSITY OF CAMBRIDGE

Study at Cambridge About the University Research at Cambridge Quick links

Cambridge Centre for Smart Infrastructure and Construction

Transforming infrastructure through smarter information

Methodology

Desktop Study

Extensive review of approx. 70 documents from academia, industry bodies and individual organisations.

Expert Interviews

9 semi-structured interviews with industry professionals having direct responsibility for carbon innovation in their organisation.

Industry Survey

Online questionnaire survey with stakeholder community which had 38 detailed responses.

Roundtables

Community of Practice Roundtables on 19th April to validate findings and 13th May to discuss and agree recommended actions

The development of a strategy to: Accelerate adoption of PAS 2080

PAS 2080 is an important component in the UK Strategy to address the climate challenge as set out below:

- Level 1 Challenge – Mitigate the effects of climate change
- Level 2 Challenge – Decarbonise infrastructure
- Level 3 Challenge – Implement effective carbon management in infrastructure
- Level 4 Challenge – Accelerate adoption of PAS 2080

We have adopted a strategic planning model¹ to structure our work and address the PAS 2080 adoption challenge. The approach involves these key activities:

- 1. Undertake diagnosis**
- 2. Establish guiding principles**
- 3. Identify actions**

The results of our work are set out in the following sections.

(1) *'Good Strategy/Bad Strategy: The Difference and Why It Matters'*, Richard Rumelt

1 \ Diagnosis

The development of a strategy to: Accelerate adoption of PAS 2080

To structure our diagnosis and to gain different perspectives on the situation we have used two models or “lenses”:

A) The lens of organisational maturity

B) The lens of organisational change

We have chosen these two models based on previous work looking at infrastructure systems and the observation that it is typically necessary both to explore both “system structure, or state” and “process”.

The results of our analysis are summarised in the following slides.

Results of Diagnosis A:

Through the lens of organisational maturity

Organisational maturity

- This section explores organisations' maturity in relation to carbon management and PAS 2080. We obtained information using a combination of desk studies, interviews, roundtable discussions and an online survey.
- The survey sought to establish current levels of maturity using Expedition's organisational maturity model as a framework, which assesses maturity against seven key themes, as shown adjacent.
- The survey was open for just over 2 weeks from 19th March to 6th April.
- 38 survey responses were fully completed, with responses from 24 different companies.
- Summary findings follow, and detailed commentary is included in Appendix A.

Attitudes

Materials and products

Organisational structures

Equipment

Skills

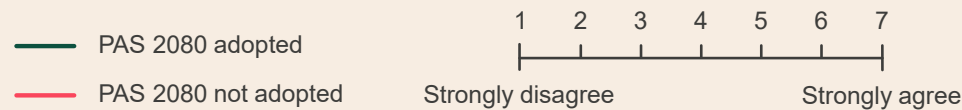
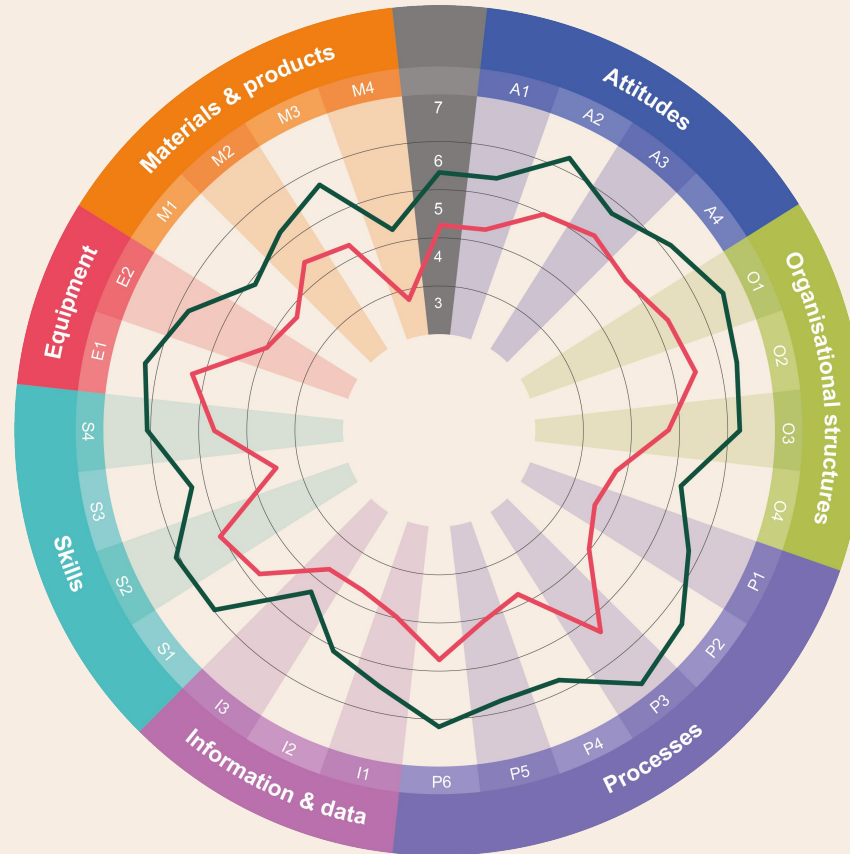
Processes

Information and Data

The organisational maturity framework

PAS 2080 adopters have higher levels of carbon maturity across all themes

Materials and products In your organisation...
M1...there are well established processes for challenging materials, designs and specifications for their carbon content
M2...opportunities for reducing material use are implemented
M3...processes are in place to ensure that carbon reductions are implemented on projects
M4...enough is done to improve the carbon effectiveness of designs and to ensure their adoption
Equipment In your organisation...
E1...you have access to relevant carbon calculation tools
E2...you have good access to a complete lifecycle analysis database
Skills In your organisation...
S1...you have access to relevant carbon calculation tools
S2...you know how to set appropriate carbon reduction targets
S3...carbon management skills are embedded in across the organisation
S4...you have the ability to develop and implement low carbon designs
Information and Data In your organisation...
I1...general practice guidance, technical standards, etc. are adequate to enable carbon to be reduced
I2...project-related systems and processes provide the carbon information and data to support efficient and reliable decision making at all stages of the project.
I3...there is an effective exchange of information about carbon-focused innovations from within the sector and from other relevant sectors.



Attitudes: Individuals in your organisation...
A1...are rewarded for considering carbon in their decision-making
A2...are motivated to reduce the carbon impacts on infrastructure projects
A3...are motivated to reduce carbon in their organisations (e.g. offices, business travel)
A4...have effective attitudes to carbon-based innovation
Organisational structures, relationships and culture...
O1 Your organisation's leadership has a strong focus on carbon management
O2 Your organisation promotes a culture that supports carbon reduction in their own operations (e.g. offices, business travel etc)
O3 Your organisation promotes a culture that supports carbon reduction during design and construction of projects
O4 The commercial relationships between the client and the supply chain support and encourage carbon reductions
Processes In your organisation...
P1...carbon management processes are well defined and understood.
P2...there is a well-defined carbon baseline
P3...there are challenging carbon reduction targets
P4...carbon management is embedded in our project appraisal processes
P5...there are effective carbon-focused continuous improvement processes
P6...there is a carbon-focused innovation pipeline in place

Key Conclusions

Attitudes & culture

Leadership is imperative

- Some organisations are adopting carbon management unilaterally under strong internal carbon leadership.
- Even with PAS 2080, constructors are often unable to effect change due to client disinterest.
- Clients need to lead through establishing requirements for the supply chain.
- All firms – including SMEs – need clear and consistent leadership & messaging around carbon if carbon management is to be successful.

Equipment, tools & data

A lack of consistency creates uncertainty and waste

- 19 unique supplier companies report using a carbon calculator, maintained in-house. This represents significant duplication (wasted effort) across the sector and will make comparison of results very difficult.
- Companies are developing their own approaches to carbon management and measurement to gain competitive advantage. This leads to inconsistencies in carbon baselines, targets and outcomes.
- Companies are suspected of 'gaming' project baselines, by including out of date and overly conservative specifications (e.g. assuming 100% OPC content in concrete baseline). Clients risk accusations of greenwashing and not delivering on targets.
- Supply chain maturity is being assessed through firm-specific PQQ processes, creating unhelpful variation in data required from the supply chain.

Key Conclusions

Knowledge, skills, processes and systems **Carbon management needs to be more embedded**

- Carbon management processes are neither well-defined nor understood in PAS 2080 non-adopters.
- Carbon targets (e.g. “net zero”, “80% reduction”) are largely in place in respondent companies.
- Corporate carbon baselines are less well-understood. As a result, staff may struggle to measure progress or assess what represents a good outcome.
- Project carbon targets must be realistic and deliverable within the aspirations and limitations of projects and programmes.
- To achieve carbon goals, there is a need to embed and enact carbon management in practise and to move beyond “tick-box” compliance.
- Some firms are beginning to embed carbon decision-making in their own in gateway processes, but these are not widespread.
- There is a widely held view among study participants that the SME supply chain have limited awareness and knowledge of PAS 2080 and carbon management more generally.
- Supply chain carbon capability development is being encouraged by some firms through their PQQs, with a focus on key suppliers.

Results of Diagnosis B:

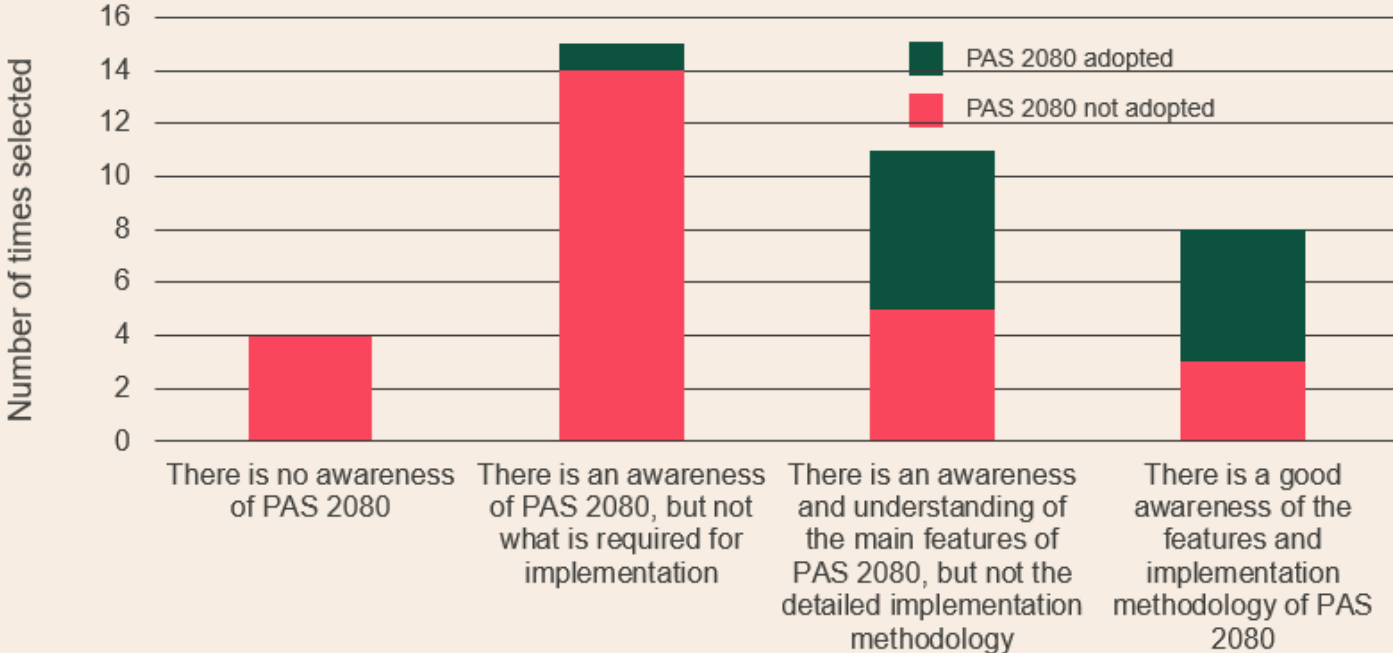
Through the lens of organisational change

Generic Organisational Change Process



Awareness

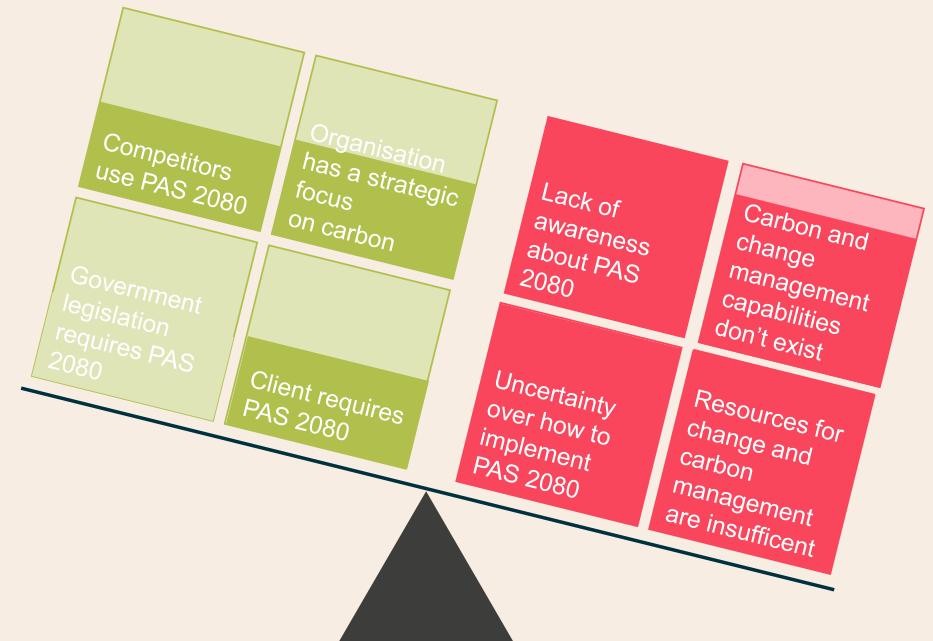
- Respondents observe that there is inadequate awareness of PAS 2080 and what needs to be done to implement it in organisations.
- This supports anecdotal evidence that we have from conversations with industry leaders that awareness across the sector of PAS 2080 and carbon management is low.



The cons and pros balance.....

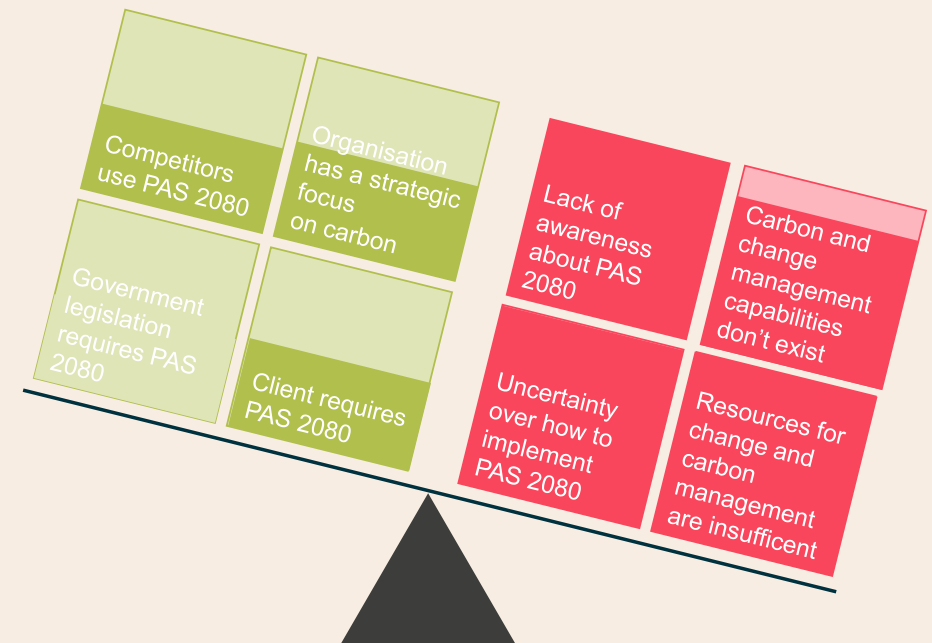
For most organisations, the balance between the cons and pros precludes adoption of PAS 2080.

- Currently organisations adopt PAS 2080 either because (rarely) clients require it, or to gain some kind of competitive advantage in winning work.
- Usually a competitive focus on carbon is associated with a shift in corporate strategy towards addressing carbon-related risks.
- In pursuit of competitive advantage, organisations develop bespoke organisational processes and data sets. This creates complexity, duplication, confusion and waste in supply chains.
- Competitive advantage also restricts rather than encourages data sharing which leads to duplication and waste in effort.
- Many organisations see carbon management as a disruptive change which doesn't easily integrate with their existing ISO systems (90001, 14001, 45001).



The cons and pros balance.....

- There is considerable uncertainty about how to adopt PAS 2080.
- Carbon management and change management capabilities are often lacking in the infrastructure sector. This is particularly important for clients given their role in stimulating PAS 2080 adoption through project and programme requirements.
- Some organisational leaders expressed ambivalence about the value of such accredited process systems. The benefits of accreditation to some organisations, beyond fulfilling a pre-qualification requirement, are not apparent.
- PAS 2080 is perceived as likely to increase costs without increasing revenue. In the current low margin environment, this is highly problematic.
- Without a stronger driver in the form of either a client or government requirement it is unlikely that we will see widespread and rapid adoption of PAS 2080.



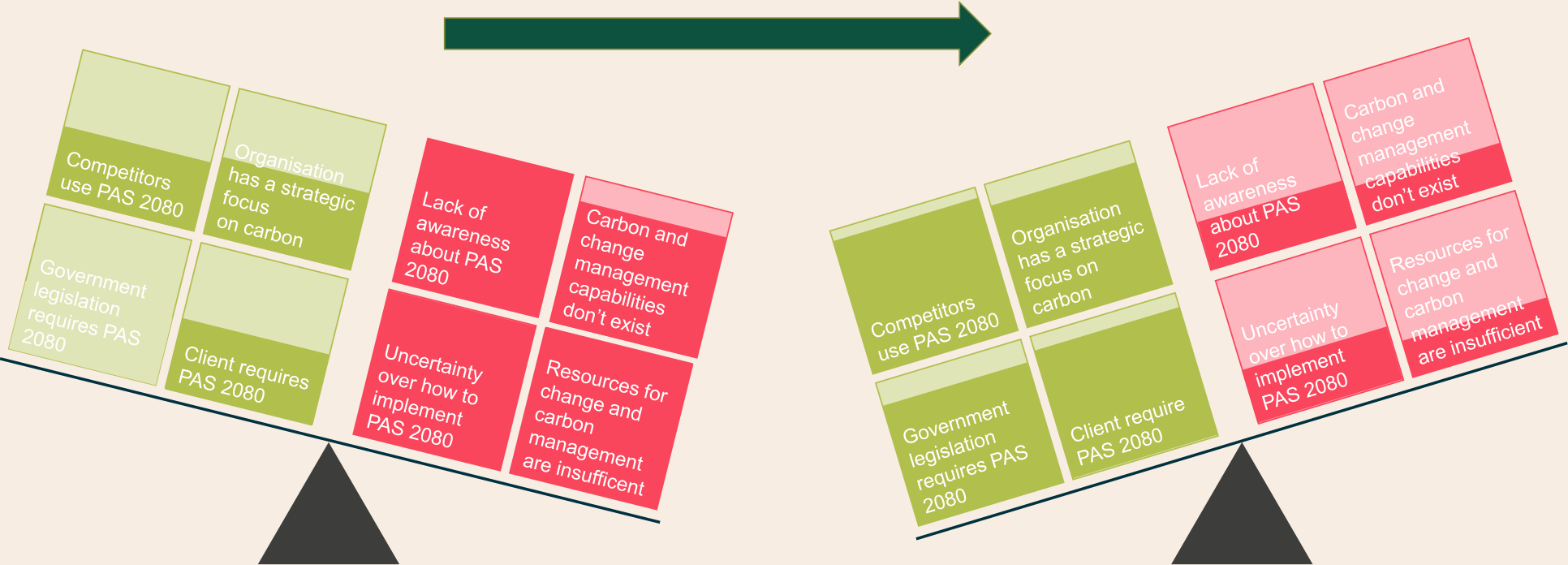
“We are doing it on this project because it is a requirement, but [we are] unsure of the demonstrable benefit elsewhere”

2 \ Guiding Principles

Based on the findings from the diagnosis, this section sets out four 'guiding principles' to guide the development of coherent actions.

Guiding Principle 1

Focus on tipping the balance so that the drivers (pros) of adoption outweigh the barriers (cons)



Guiding Principle 2

Focus on carbon leadership particularly with infrastructure clients, but also within supply chain companies.

- Strong client leadership is essential to drive PAS 2080 adoption
- Each organisation in the value chain needs clear and consistent leadership around carbon if carbon management is to be successful.

“...it should be emphasised that strong client leadership and commitment is essential both to legitimise collaborative contracting models and to achieve more fundamental behavioural change within collaborative projects and alliance schemes.”

(Kadefors et al., 2019)

“Clients should ultimately own and drive reductions in GHG emissions”

(CITT research programme)

Guiding Principle 3

Focus on developing sector and organisational carbon management maturity

No carbon management systems in place



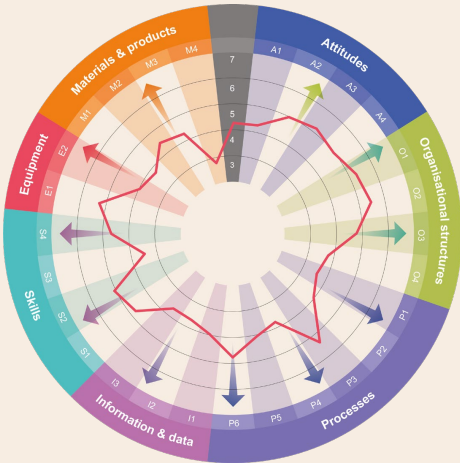
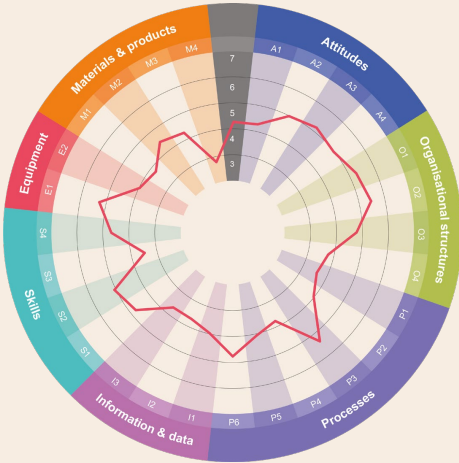
Carbon management systems in place



Accredited management systems in place



PAS 2080



Guiding Principle 4

Respond to the organisational ecosystem

- There are many different types of organisations in the sector with different scales, drivers, ownership structures etc.
- As a result, their motivation and capability to embark on a carbon management and PAS 2080 change process are different.
- With a large majority of project spend being with SMEs, engaging these organisations in carbon management should be a key priority.
- Interventions need to recognise the varied nature of the infrastructure supply chain ecosystem

3 \ Actions

This section sets out an action plan for accelerating the adoption of PAS 2080.

Key Actions

The 5 key actions to accelerate adoption of PAS 2080 identified through this study are:

1. Galvanise infrastructure clients to adopt PAS 2080
2. Build whole life carbon management and PAS 2080 awareness across the sector
3. Develop the evidence base to encourage PAS 2080 adoption in the supply chain
4. Ensure the sector can access the necessary capabilities to improve their approach to carbon management
5. Drive down the costs of implementing carbon-focused change

We developed 20 specific activities grouped under these 5 key action headings. We shared these actions and activities with the COP who confirmed that they were **necessary and sufficient** to accelerate the adoption of PAS 2080.

Many of these activities are already being implemented by others working on the infrastructure decarbonisation challenge. In the second roundtable we focused on discussing the 20 activities, identifying related activity in the sector and key stakeholders as well as identifying organisations and individuals who could contribute to the delivery of the activities.

The following pages set out the 20 activities, and the output of the second roundtable is presented in Appendix B

Activities

Ref	Action 1: Galvanise infrastructure clients to adopt PAS 2080
1.1	Infrastructure clients to commit to adopting PAS 2080 on their projects and programmes and prepare a roadmap for getting accredited.
1.2	Identify and support advocates of PAS 2080 within ICG, TRIB, GCB, and professional institutions. Provide collateral for them to influence their peers.
1.3	Encourage the industry C-suite and funding organisations to make significant vocal & formal commitments to carbon reduction pathways.
1.4	COP to coordinate with ongoing sector PAS 2080-related activities to ensure there is a clear, single message to organisational leadership across the sector.

Ref	Action 2: Build whole life carbon management & PAS 2080 awareness across the sector
2.1	Work with the Carbon Literacy Project to embed whole lifecycle carbon management principles and a PAS 2080 overview into their standard training programme for the construction sector. Develop standard curriculum for infrastructure.
2.2	Infrastructure clients and funders to proactively communicate their project and organisational carbon roadmaps with their whole value chain.
2.3	Infrastructure clients and funders to establish their supply chain's current carbon management maturity through PQQ processes.
2.4	Institutions to invest in a coordinated communications campaign when the PAS 2080 refresh is launched, to raise awareness of the importance of carbon management and the direction of travel.

Ref	Action 3: Develop the evidence base to encourage PAS 2080 adoption in the supply chain
3.1	Identify and implement PAS 2080 pilot studies to demonstrate what it takes to implement and to gather evidence on benefits.
3.2	Develop case examples that demonstrate the financial pros and cons of adopting PAS 2080 and opportunities to maximise ROI at each step of the journey (the business case)
3.3	Provide detailed case studies and guidance on PAS 2080 implementation and benefits for different organisation types.

Activities

Ref	Action 4: Ensure the sector can access the necessary capabilities to improve their approach to carbon management
4.1	Establish a comprehensive, co-ordinated and highly effective carbon skills development programme.
4.2	Develop a common methodology to help organisations baseline their current carbon maturity levels.
4.3	Identify / establish an appropriate sector framework for developing a carbon reduction roadmap, baselines, targets.
4.4	Develop a network of carbon mentors willing to work with the SME community to advance their carbon maturity.
4.5	Identify / develop a common sector specific carbon procurement PQQ to support clients in achieving their desired carbon outcomes.

Ref	Action 5: Drive down the costs of implementing carbon-focused change
5.1	Encourage the sector to collaborate to standardise carbon data sets, tools and assumptions to avoid duplication of effort.
5.2	Develop carbon management implementation guidance for different organisation types, showing integration with existing (ISO/BS) systems & processes.
5.3	Develop and publish standard clauses relating to carbon management for tenders and standard supplier questionnaires (e.g. Achilles) for the supply chain.
5.4	These standard clauses should accommodate and reflect the variety of current levels of carbon maturity, and will provide a clear improvement trajectory for the value chain to work towards to mitigate the risks of loss of work.

4\ Recommendations

This section sets out key recommendations for accelerating the adoption of PAS 2080.

Recommendations

1. Formally share the findings of this study with key organisations and groups working on infrastructure decarbonisation and specifically: ICE's The Carbon Project, the ICG Carbon Working Group, the Supply Chain Sustainability School, UKGBC and the Carbon Literacy Project.
2. Engage with Infrastructure Clients to discuss the findings in relation to Client behaviours and advocate for both stronger leadership around adoption of PAS 2080 and carbon management more generally. This could be through the TRIB Board and ICG for example.
3. Bearing in mind TRIBs original interest in developing pilot studies, TRIB may wish to fund a programme to address Action 3 – see Table below.

Ref	Develop the evidence base to encourage PAS 2080 adoption in the supply chain
3.1	Identify and implement PAS 2080 pilot studies to demonstrate what it takes to implement and to gather evidence on benefits.
3.2	Develop case examples that demonstrate the financial pros and cons of adopting PAS 2080 and opportunities to maximise ROI at each step of the journey (the business case).
3.3	Provide detailed case studies and guidance on PAS 2080 implementation and benefits for different organisation types.

Contributors

The project team would like to thank the i3P PAS 2080 Community of Practice and interviewees for supporting this study.

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- Kat Ibbotson – Environment Agency
- Graham Edgell – Morgan Sindall
- Kiro Tamer - Keltbray
- Chris Hayes - Skanska
- David Jackson- Sweco
- Sarah Jolliffe – BAM Nuttall
- Kim Yates – Mott MacDonald
- Ian Kirkaldy – Independent
- Conor McCone – Skanska
- Ruth Finlayson – Skanska

Appendix A

Detailed findings from the
desktop review and survey

Desktop review

The desktop study was undertaken to establish the current state of play relating to PAS 2080 adoption and carbon management more generally in the sector.

The study reviewed approximately 70 texts including:

- Academic papers
- Doctoral theses
- Academic & industry presentations
- Reports from
 - The OECD
 - Professional institutions
 - Governmental and non-governmental bodies
 - Industry bodies
- Trade press articles
- Organisational reports, statements and roadmaps

The study was used to inform the structure and content of the survey. The findings are incorporated with the results of the survey and interviews in the slides that follow.



Survey

A PAS 2080 survey was conducted between 19th March and 2nd April 2021.

The survey explored:

- Carbon management maturity
- Motivation to implement change
- Barriers to adopting PAS 2080

The survey was completed by representatives from:

Clients

- EDF
- Environment Agency*
- Highways England
- HS2*
- Network Rail
- Severn Trent
- + a water industry representative*

Designers

- Arup
- Expedition
- Mott McDonald
- Sweco*
- WSP

Contractors

- Balfour Beatty Vinci (HS2)
- BAM Nuttall
- Costain
- EKFB (HS2)
- Ferrovial Construction
- Graham
- Jacobs
- Keltbray*
- Mace Dragados JV
- Morgan Sindall
- SCS
- Skanska*

PAS 2080 Study

Emergent findings

- Infrastructure projects are delivered by Project Based Organisations (PBOs).
- These businesses have a core organisational function, and peripheral groups that work on delivering to specific client and project requirements.
- The PAS requires organisations to address **both** core organisational processes and project aspects.
- Few organisations have PAS 2080 accreditation.
- The majority of those that have are linked to a strong client who requires it (HS2, Anglian).
- Many other firms have adopted organisation-level carbon targets, carbon management processes (e.g. SBTi, Carbon Trust).
- Many firms deliver asset-based carbon-related services independently from their organisational objectives.
- Carbon is often seen as a specialist, bolt-on activity provided when clients ask for it.

Challenges on the *asset delivery* side that may limit PAS 2080 adoption

Organisation

- Setting a baseline (unique assets, takes time, effort)
- Mix of approaches available to pursue
- Setting targets (arbitrary). What does 'good' look like?
- A lack of clarity in Green Public Procurement requirements
- Getting the procurement right to incentivise suppliers (see Kadefors et al., 2019 for a summary of options)

Supply chain

- Existence of incentivisation mechanisms (client, regulations etc)
- Capability, knowledge, awareness etc. development takes time
- Inconsistent application of tools, standards
- Collaboration & competition
- Knowledge (& data) sharing is perceived to undermine competitive advantage

PAS 2080 Study

Challenges on the *organisational* side that limit PAS 2080 adoption

Implementing and integrating carbon accounting is a fundamental change to organisations' processes, systems and decision-making.

Skanska's organisational implementation took 6 months

- *"It's a change to the way the whole business works".*
- *"... there is no denying that the [net-zero] objective is unprecedented and will require all [of our] processes to change."*
- *"This is actually really difficult isn't it? How do we do it?"*

"Truly addressing the climate emergency challenge requires a culture that **puts carbon at the forefront of every business decision**. For the majority of businesses not founded explicitly upon social or environmental purpose, **achieving the level of change needed may require considerable business transformation.**"

Mace 2020 Carbon Survey

Barriers to implementation

- The “barriers to ... ” literature in construction has a long history.
- Gieseckam et al, (2014) summarised and categorised the reported barriers to the uptake of lower ‘carbon’ materials, technologies and practices.
- Jackson and Kaesehage, (2019) reported 126 barriers relating to the implementation of carbon management practices.
- The practical and cultural challenges identified in the Infrastructure Carbon Review still stand.

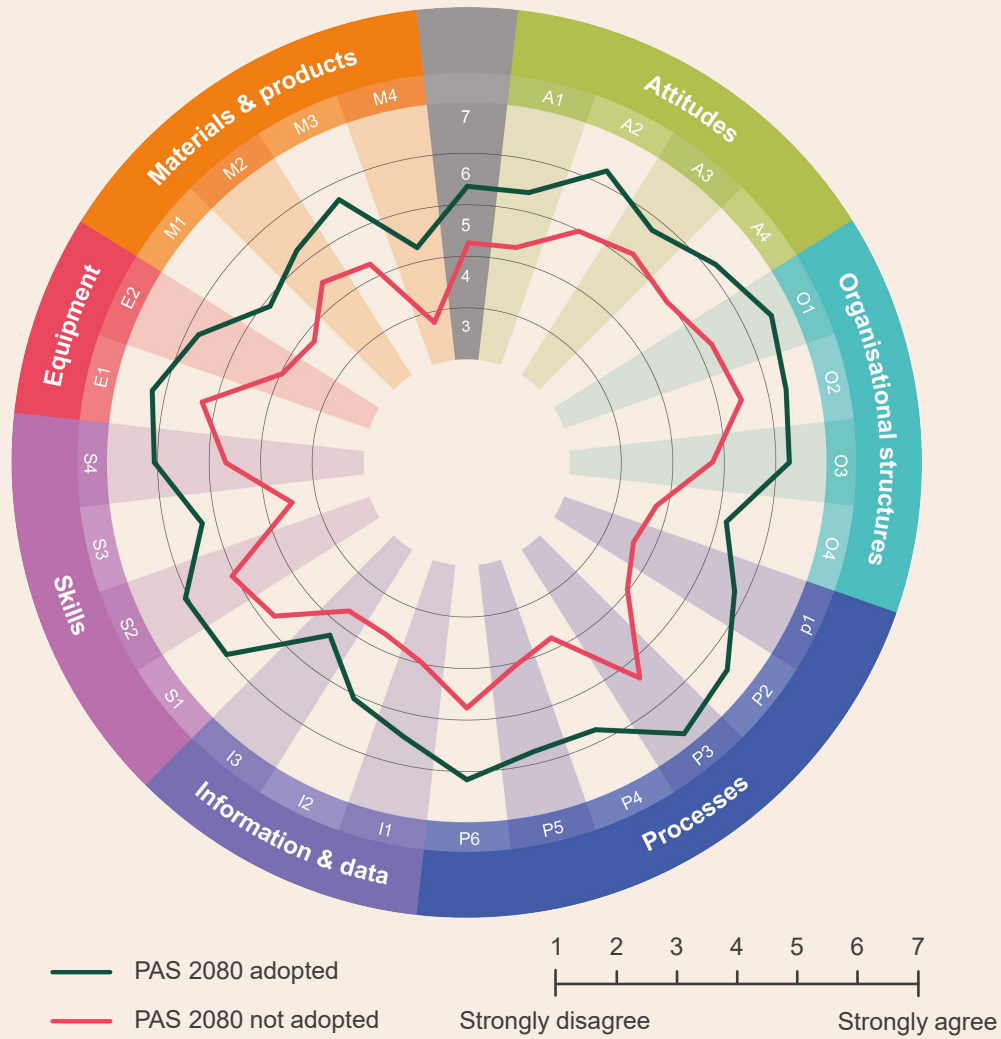
Common barriers to the uptake of lower embodied carbon materials, technologies and practices in the construction industry.

Institutional and Habitual	Economic	Technical and Performance-related	Knowledge and Perceptions
Institutional culture and established practice promotes preferred material palette Focussed training and recruitment results in departmental lock in to familiar materials Time constraints incentivise familiar ‘copy-paste’ designs Lack of established advocacy groups Lack of effective marketing from producers Lack of user–producer relationships Influence of industry trends Habitual specification and historic practice of individual practitioners Viewed as outwith responsibility or remit of any individual High level of design inconvenience	High cost of new products Market externalises cost of embedded emissions Uncertainty premium placed on novel options High transaction costs of additional professional training and research Money sunk in existing materials (in terms of training, establishing relations with supply chains, etc.) Lower design:fee ratio because of increased detailing Insufficient comparative information on costs Unwillingness to accept risk Project financing incompatible with time constraints Anticipated increase in lead times Small industries producing alternatives cannot compete against established industries’ economies of scale	Lack of established standards, design guides and tools, and standardised details Lack of material performance data Lack of full-scale demonstration projects Policy and regulatory limitations and restrictions Lack of confidence in contractor ability and availability of skilled labour prevents inclusion in design Shortage of specialist skills prevents installation Insufficiently developed supply chains Local availability of materials and technologies	Lack of awareness and practical knowledge of alternatives amongst practitioners Lack of client knowledge of alternatives Negative perceptions amongst practitioners based on past experiences Negative perceptions held by clients Insufficient fit with the culture of the clients/inhabitants Perceived unreliability or risk of new alternatives Perceived concerns about material sourcing prevent selection Policy uncertainty Regarded as low priority and other considerations take precedence

Barriers Identified by the Green Construction Board:

- Novelty, risk and liability
- Competing business priorities
- Time and cost to implement and investigate alternatives

Using a carbon innovation carbon maturity model as a frame for the diagnosis



Materials and products In your organisation...

M1...there are well established processes for challenging materials, designs and specifications for their carbon content

M2...opportunities for reducing material use are implemented

M3...processes are in place to ensure that carbon reductions are implemented on projects

M4...enough is done to improve the carbon effectiveness of designs and to ensure their adoption

Equipment In your organisation...

E1...you have access to relevant carbon calculation tools

E2...you have good access to a complete lifecycle analysis database

Skills In your organisation...

S1...you have access to relevant carbon calculation tools

S2...you know how to set appropriate carbon reduction targets

S3...carbon management skills are embedded in across the organisation

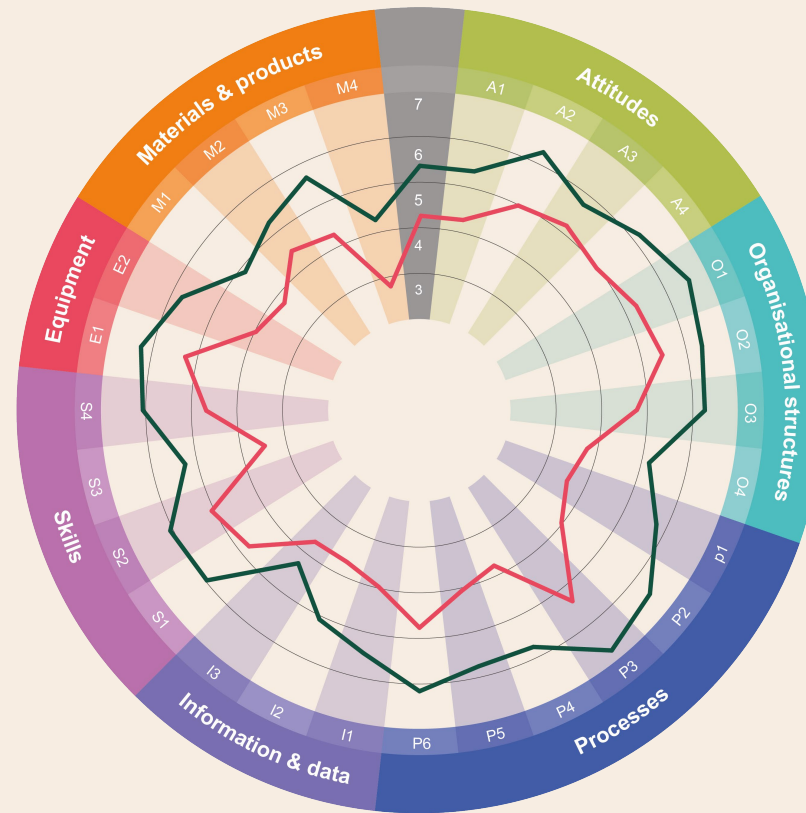
S4...you have the ability to develop and implement low carbon designs

Information and Data In your organisation...

I1...general practice guidance, technical standards, etc. are adequate to enable carbon to be reduced

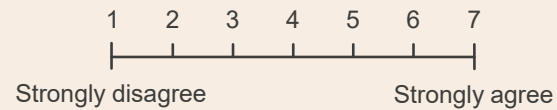
I2...project-related systems and processes provide the carbon information and data to support efficient and reliable decision making at all stages of the project.

I3...there is an effective exchange of information about carbon-focused innovations from within the sector and from other relevant sectors.



— PAS 2080 adopted

— PAS 2080 not adopted



Attitudes: Individuals in your organisation...

A1...are rewarded for considering carbon in their decision-making

A2...are motivated to reduce the carbon impacts on infrastructure projects

A3...are motivated to reduce carbon in their organisations (e.g. offices, business travel)

A4...have effective attitudes to carbon-based innovation

Organisational structures, relationships and culture...

O1 Your organisation's leadership has a strong focus on carbon management

O2 Your organisation promotes a culture that supports carbon reduction in their own operations (e.g. offices, business travel etc)

O3 Your organisation promotes a culture that supports carbon reduction during design and construction of projects

O4 The commercial relationships between the client and the supply chain support and encourage carbon reductions

Processes In your organisation...

P1...carbon management processes are well defined and understood.

P2...there is a well-defined carbon baseline

P3...there are challenging carbon reduction targets

P4...carbon management is embedded in our project appraisal processes

P5...there are effective carbon-focused continuous improvement processes

P6...there is a carbon-focused innovation pipeline in place

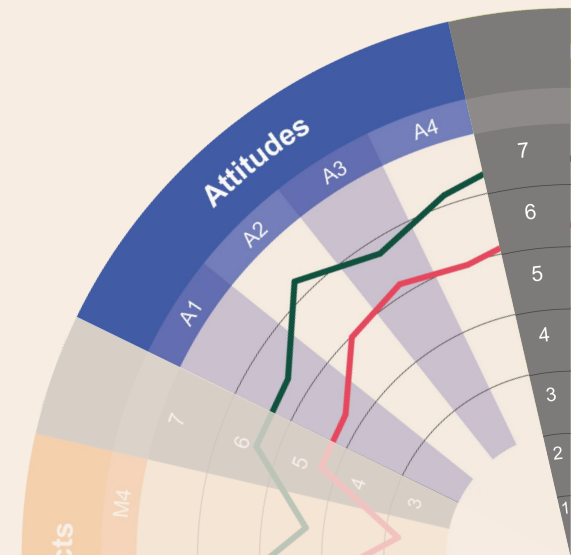
Attitudes

- In PAS adopting companies, individuals are more likely to have an effective attitude to carbon-based innovation, and be motivated to reduce carbon impacts in their organisation and on projects.

This may be reflected in the increased likelihood of reward for considering carbon in their decisions.

- Leadership was a strong theme in the interviews, with those organisations adopting PAS 2080 and carbon management processes being driven to do so by their organisation's leadership.
- Service providers feel their Scope 1 & Scope 2 emissions are largely under control, and that the material suppliers will need to deliver on their roadmaps.

Attitudes: Individuals in your organisation...	
A1	Are rewarded for considering carbon in their decision-making
A2	Are motivated to reduce the carbon impacts on infrastructure projects
A3	Are motivated to reduce carbon in their organisations (e.g. offices, business travel)
A4	Have effective attitudes to carbon-based innovation



Attitudes

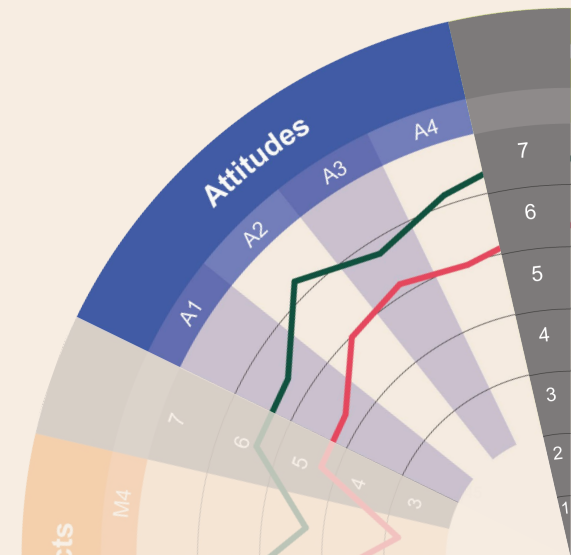
- But... motivations for carbon management vary.

“We are doing it on this project because it is a requirement, but [we are] unsure of the demonstrable benefit elsewhere”

“Carbon management (and how widespread it is) often depends on the attitudes and behaviours of individuals i.e. whether they are really pushing it, following through, showing leadership (or not) etc.”

Attitudes: Individuals in your organisation...

A1	Are rewarded for considering carbon in their decision-making
A2	Are motivated to reduce the carbon impacts on infrastructure projects
A3	Are motivated to reduce carbon in their organisations (e.g. offices, business travel)
A4	Have effective attitudes to carbon-based innovation



Organisational structures, relationships and culture

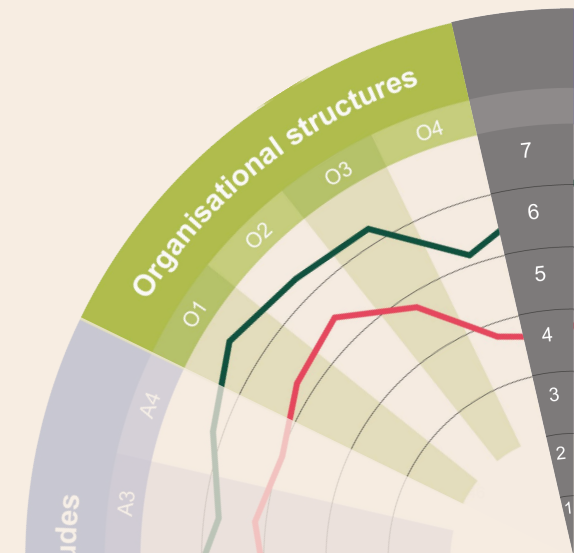
- The survey highlighted the challenges in developing commercial arrangements between clients and their suppliers which promote carbon reduction.

This suggests that the link between good carbon management and cost isn't yet fully appreciated in the sector (*"The value/benefit of PAS 2080 is yet to be established"*), and so the opportunity to financially incentivise carbon reductions is limited.

- Incremental material reductions on specifications will reduce material use... to a point. Where the goal is net zero emissions, there's a need to move beyond this carbon cost tipping point, requiring a different approach to design or materials. Beyond this point, increased costs are likely (Sweco).

Organisational structures, relationships and culture...

O1	Your organisation's leadership has a strong focus on carbon management
O2	Your organisation promotes a culture that supports carbon reduction in their own operations (e.g. offices, business travel etc)
O3	Your organisation promotes a culture that supports carbon reduction during design and construction of projects
O4	The commercial relationships between the client and the supply chain support and encourage carbon reductions

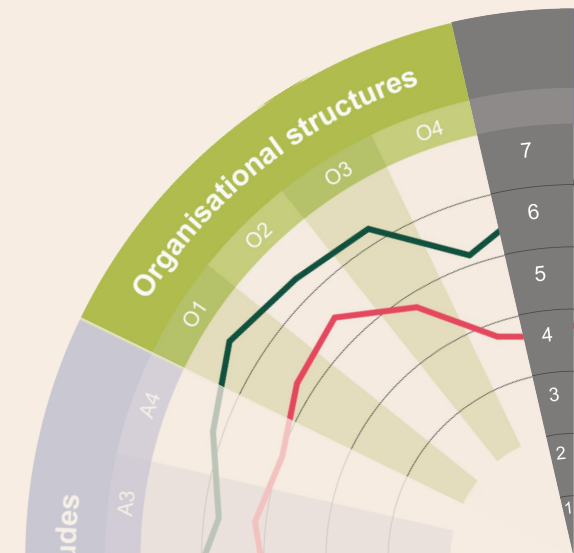


Organisational structures, relationships and culture

- Leadership's focus on carbon management was higher in those organisations that had adopted PAS 2080.
- Reducing scope 1 & 2 emissions is seen as (relatively) important in both adopters and non-adopters of PAS 2080. The carbon reduction culture doesn't necessarily extend to project delivery.
- Carbon management is in silos in some organisations. Organisations are trying to get it to become more mainstream by embedding it in gateway processes and supporting supply chain capability development.
- Value chains are not being offered a commercial carrot to implement carbon savings – pre-set budget envelopes don't allow for this (Tender carbon % are low).

Organisational structures, relationships and culture...

O1	Your organisation's leadership has a strong focus on carbon management
O2	Your organisation promotes a culture that supports carbon reduction in their own operations (e.g. offices, business travel etc)
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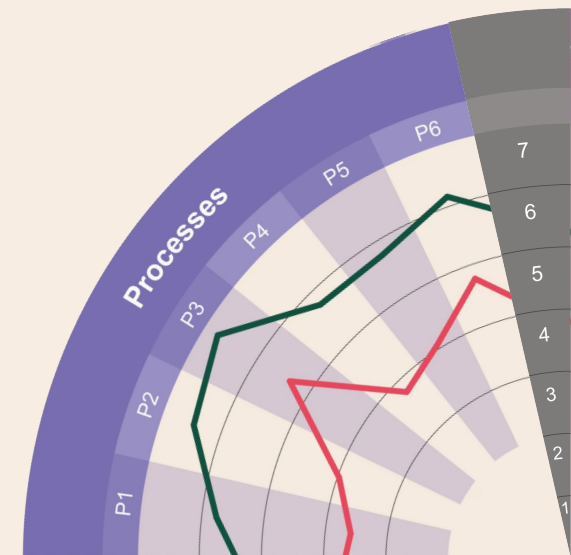


Processes

- Non-adopters report that they don't have project systems that deliver the data and information they need to support carbon-based decision-making.
- Carbon management processes are neither well-defined or understood in non-adopters.
- While carbon *targets* (e.g. "net zero") are largely in place in both adopters and non-adopters, the carbon *baseline* is less well-understood.
- This suggests that non-adopters may have exposure to carbon risks about which they are unaware. It also calls into question organisations' ability to meet the UK risk reporting requirements.

Processes in your organisation...

P1	Carbon management processes are well defined and understood
P2	There is a well-defined carbon baseline
P3	There are challenging carbon reduction targets
P4	Carbon management is embedded in our project appraisal processes
P5	There are effective carbon-focused continuous improvement processes
P6	There is a carbon-focused innovation pipeline in place

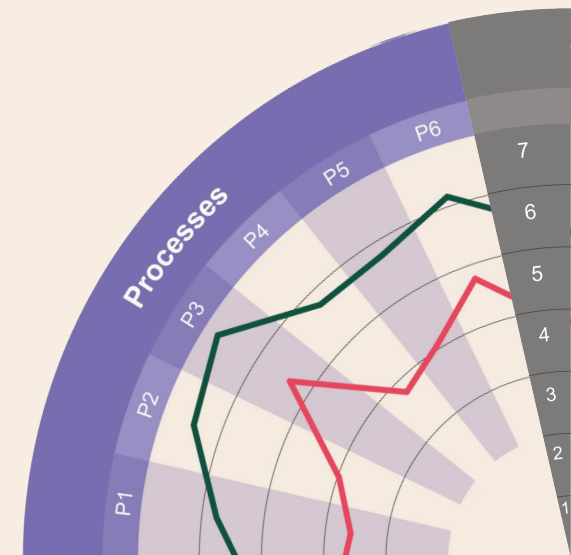


Processes

- Companies are suspected of ‘gaming’ project baselines, by including out of date and overly conservative specifications (e.g. 100% OPC content in concrete). There is little consistency across projects. Clients need to develop their competencies to address this.
- On the flip side, carbon targets need to be realistic, and deliverable within the confines of the cost and (pre-)specified material requirements.
- PAS 2080 encourages companies to implement effective carbon-focussed continuous improvement activities. Non-adopters do not have these.

Processes in your organisation...

P1	Carbon management processes are well defined and understood
P2	There is a well-defined carbon baseline
P3	There are challenging carbon reduction targets
P4	Carbon management is embedded in our project appraisal processes
P5	There are effective carbon-focused continuous improvement processes
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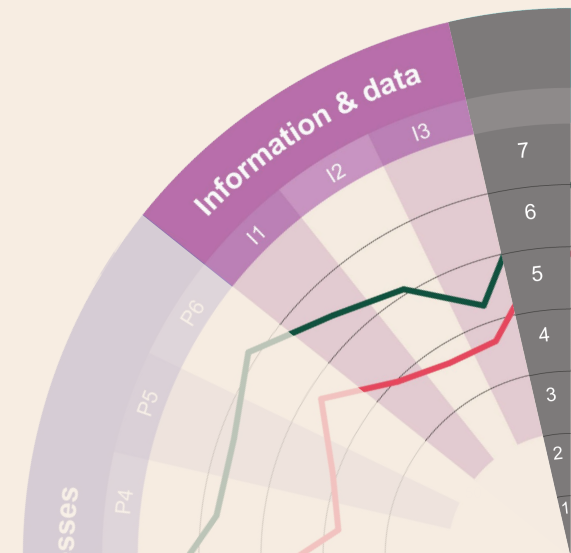


Information and data

- General practice guidance and technical standards are lacking in non-adopters, and while they are more available in adopters, there remains room for improvement.
- Data capture and maintenance across organisations is significant.
- The availability of lifecycle data was considerably lower in non-adopting companies.
- There are challenges in relation to carbon information exchange within and between sectors.
- One interviewee highlighted how data can be guarded as a USP, reducing integration in the wider organisation.

Information and data in your organisation...

I1	General practice guidance, technical standards, etc. are adequate to enable carbon to be reduced
I2	Project-related systems and processes provide the carbon information and data to support efficient and reliable decision making at all stages of the project
I3	General practice guidance, technical standards, etc. are adequate to enable carbon to be reduced



Skills

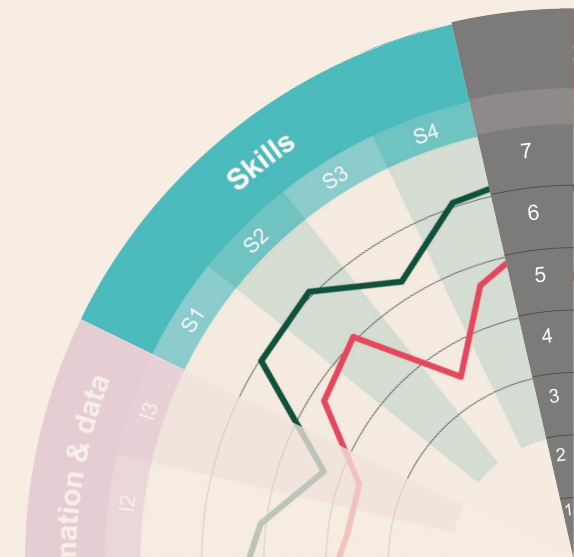
- Despite the limited existence of organisational baselines, respondents thought they were capable of setting appropriate carbon baselines and targets, as well as developing and delivering low carbon designs.

This aligns with earlier construction research that found that low-carbon skills are not necessarily an impediment to change. Rather, the motivation to develop them stalls progress

- Carbon management skills are not often embedded across organisations, being held by specialists.

Skills in your organisation...

S1	You have access to relevant carbon calculation tools
S2	You know how to set appropriate carbon reduction targets
S3	Carbon management skills are embedded in across the organisation
S4	You have the ability to develop and implement low carbon designs

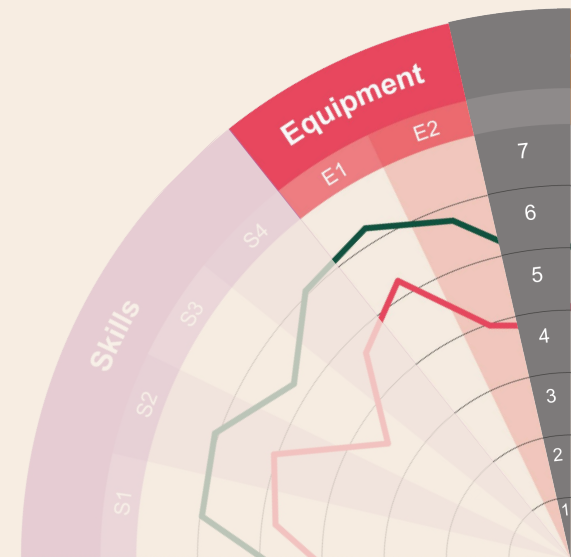


Equipment

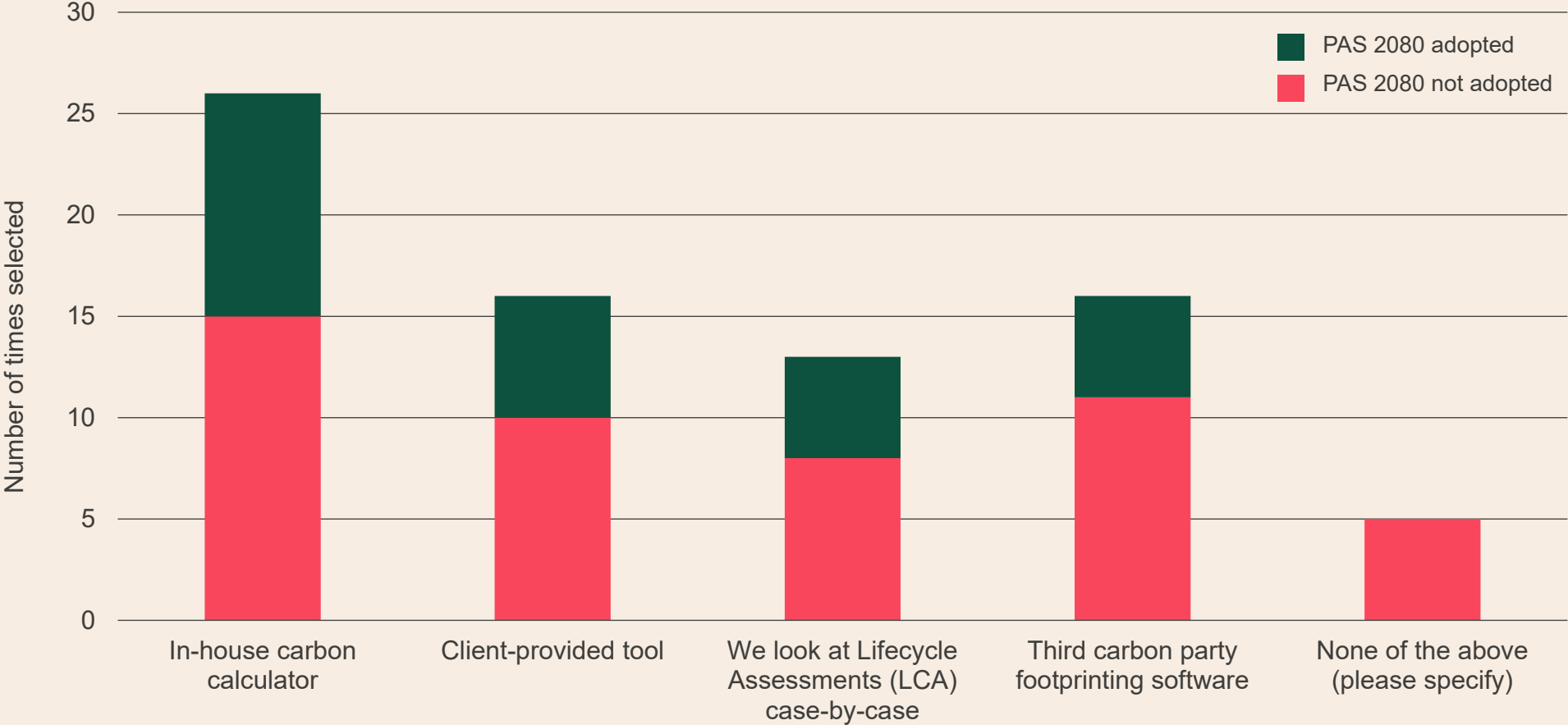
- Carbon calculation tools are largely available to respondents.
- 19 unique supplier companies report using an carbon calculator **maintained in-house**.
- Interviews reported the inconsistency in these tools, and the importance of comparability to address baseline “gaming”.

Equipment in your organisation...

E1	You have access to relevant carbon calculation tools
E2	You have good access to a complete lifecycle analysis database



What carbon calculation tools do you use to establish carbon impacts on projects: select all that apply



Materials and products

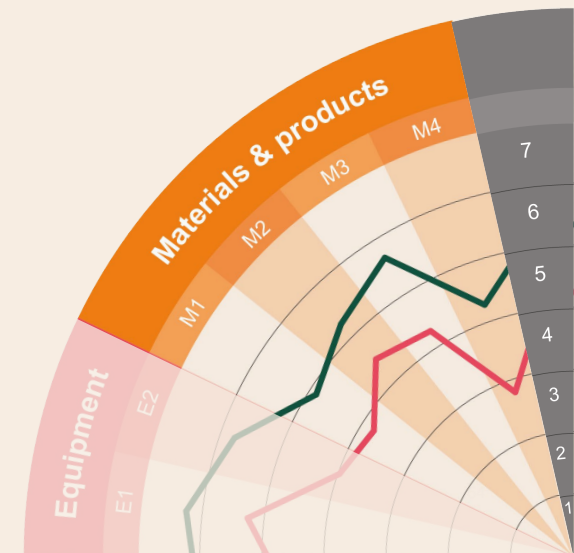
- There was a strong consensus that more can be done to improve the carbon effectiveness of design, and to ensure the adoption of these designs.

This could be a function of the relatively low prevalence of established processes for challenging material designs and specifications for their carbon content.

- Interviews reported that even with PAS 2080, constructors were often unable to effect change as the specifications or cost envelopes set prior to their engagement precluded it.

Materials and products in your organisation...

M1	There are well established processes for challenging materials, designs and specifications for their carbon content
M2	Opportunities for reducing material use are implemented
M3	Processes are in place to ensure that carbon reductions are implemented on projects
M4	Enough is done to improve the carbon effectiveness of designs and to ensure their adoption



Materials and products

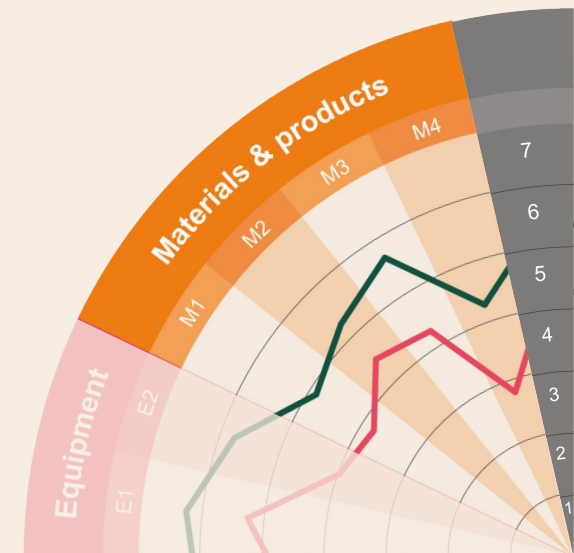
- There was a marginally positive response when asked about the implementation of material and carbon reduction on projects. However, one interviewee described how designers thought that they ‘were already doing [carbon reduction]’.

Construction typically uses an incremental approach to change, in which existing designs, materials and techniques are refined.

- One report suggests that net zero carbon agenda has the potential ‘to change everything’, and so this incremental approach to change may no longer be appropriate.

Materials and products in your organisation...

M1	There are well established processes for challenging materials, designs and specifications for their carbon content
M2	Opportunities for reducing material use are implemented
M3	Processes are in place to ensure that carbon reductions are implemented on projects
M4	Enough is done to improve the carbon effectiveness of designs and to ensure their adoption



Appendix B

Action Plan: Activities, Alignment and Stakeholders – Output from Roundtable 2

Activities

1. Galvanise infrastructure clients to adopt PAS 2080

Ref	Activities	Alignment with other industry workstreams, e.g.	Key stakeholders and roles
1.1	Infrastructure clients to commit to adopting PAS 2080 on their projects and programmes and prepare a roadmap for getting accredited.	<ul style="list-style-type: none"> Commitment wording addressed by the Cambridge Centre for Smart Infrastructure and Construction (CSIC) Carbon Reduction Code. Race to Zero campaign 	Influence policy via: <ul style="list-style-type: none"> TRIB ICE's The Carbon Project ICG (via Greenbook) CLC (via Construction Playbook)
1.2	Identify and support advocates of PAS 2080 within ICG, TRIB, GCB, and professional institutions. Provide collateral for them to influence their peers.	<ul style="list-style-type: none"> Builds on the work of ICE's The Carbon Project and their upcoming PAS 2080 revision 	
1.3	Encourage the industry C-suite and funding organisations to make significant vocal & formal commitments to carbon reduction pathways.	<ul style="list-style-type: none"> CSIC Carbon reduction code of practice could be used as a basis for these declarations; Construction Leadership Council's CO2nstruct Zero campaign developing a range of metrics to demonstrate progress 	<ul style="list-style-type: none"> TRIB ICE's The Carbon Project CLC ICG / Mark Thurston IPA (metrics project) Martin Perks (Highways England) John Pettigrew National Grid CEO
1.4	COP to coordinate with ongoing sector PAS 2080-related activities to ensure there is a clear, single message to organisational leadership across the sector.	<ul style="list-style-type: none"> ICE are reviewing the institution's documentation for consistency and compatibility with PAS 2080 	<ul style="list-style-type: none"> ICE / Kat Ibbotson BSI

Activities

2. Build whole life carbon management & PAS 2080 awareness across the sector

Ref	Activities	Alignment with other industry workstreams, e.g.	Key stakeholders and roles
2.1	Work with the Carbon Literacy Project to embed whole lifecycle carbon management principles and a PAS 2080 overview into their standard training programme for the construction sector. Develop standard curriculum for infrastructure.	<ul style="list-style-type: none"> • Carbon Literacy Project • ICE's The Carbon Project • Supply Chain Sustainability School • CEEQUAL • Carbon Trust activities • IStructE 	<ul style="list-style-type: none"> • ICE • Bodies that are developing training material
2.2	Infrastructure clients and funders to proactively communicate their project and organisational carbon roadmaps with their whole value chain.	<ul style="list-style-type: none"> • CSIC Carbon reduction code 	Stimulate through <ul style="list-style-type: none"> • ICG • ICE
2.3	Infrastructure clients and funders to establish their supply chain's current carbon management maturity through PQQ processes.	<ul style="list-style-type: none"> • Individual organisations have made steps forward. • Link with BEIS sustainable procurement work. • ICE's The Carbon Project which is putting together recommendations for procurement and contracts that can support PAS 2080 alignment 	<ul style="list-style-type: none"> • A future workstream rather than a simple action
2.4	Institutions to invest in a coordinated communications campaign when the PAS 2080 refresh is launched, to raise awareness of the importance of carbon management and the direction of travel.	<ul style="list-style-type: none"> • ICE's The Carbon Project • IStructE, embodied carbon • RIBA 2030 challenge. • BSI PAS 2080 relaunch 	<ul style="list-style-type: none"> • SCSS • ICE's The Carbon Project

Activities

3. Develop the evidence base to encourage PAS 2080 adoption in the supply chain

Ref	Activities	Alignment with other industry workstreams, e.g.	Key stakeholders and roles
3.1	Identify and implement PAS 2080 pilot studies to demonstrate what it takes to implement and to gather evidence on benefits.	<ul style="list-style-type: none"> • BSI have recently begun exploring this • GCB (ICR) promoting the creation of demonstrator projects • CSIC developing case studies from Carbon Reduction Code pilot. 	<ul style="list-style-type: none"> • TRIB
3.2	Develop case examples that demonstrate the financial pros and cons of adopting PAS 2080 and opportunities to maximise ROI at each step of the journey (the business case)		
3.3	Provide detailed case studies and guidance on PAS 2080 implementation and benefits for different organisation types.	<ul style="list-style-type: none"> • PAS 2080 Guidance documentation update. 	<ul style="list-style-type: none"> • ICE's The Carbon Project

Activities

4. Ensure the sector can access the necessary capabilities to improve their approach to carbon management

Ref	Activities	Alignment with other industry workstreams, e.g.	Key stakeholders and roles
4.1	Establish a comprehensive, co-ordinated and highly effective carbon skills development programme.	<ul style="list-style-type: none"> Carbon Literacy Project Supply Chain Sustainability School (SCSS) Institutional CPD requirements. ICE's The Carbon Project (James Norman) IstructE – lots of great carbon resources RSSB role in upskilling rail industry CECA – demystifying for the SME – working group CLC CO2nstruct Zero Programme 	<ul style="list-style-type: none"> ICE are developing this to progress this. Paper has been produced Supply Chain Sustainability School to link through with the supply chain. Requires long term funding. Link with IstructE who have recruited a carbon curator.
4.2	Develop a common methodology to help organisations baseline their current carbon maturity levels.	<ul style="list-style-type: none"> ICE's The Carbon Project which is intending to include a section on carbon maturity in the PAS 2080 guidance documents ICE's The Carbon Project, Capability building workstream (Steve Denton) 	<ul style="list-style-type: none"> Infrastructure steering group?
4.3	Identify / establish an appropriate sector framework for developing a carbon reduction roadmap, baselines, targets.	<ul style="list-style-type: none"> UKGBC activity around Science Based Targets. Net Zero Infrastructure Industry Coalition promoting the development of sector-wide carbon trajectories PAS 2080 revision IPA – embedding carbon into guidance BEIS – establishing sector budgets/roadmaps RICS – guidance on data/verification 	<ul style="list-style-type: none"> The ICR/7 recommends Infrastructure Integrator ICE's The Carbon Project: Developed a maturity matrix to include in the PAS 2080 guidance. IPA / BEIS
4.4	Develop a network of carbon mentors willing to work with the SME community to advance their carbon maturity.	<ul style="list-style-type: none"> SCSS and contractors are focusing on their major suppliers CECA will ask their members to help Strategic Supplier relationship group possible conduit to the supply chain 	<ul style="list-style-type: none"> Mark Fenton to raise with the ICG
4.5	Identify / develop a common sector specific carbon procurement PQQ to support clients in achieving their desired carbon outcomes.	<ul style="list-style-type: none"> ICE's The Carbon Project's task group on contracts and commercial integration BEIS activities on sustainable procurement. Build UK Common Assessment Methodology 	

Activities

5. Drive down the costs of implementing carbon-focused change

Ref	Activities	Alignment with other industry workstreams, e.g.	Key stakeholders and roles
5.1	Encourage the sector to collaborate to standardise carbon data sets, tools and assumptions to avoid duplication of effort.	<ul style="list-style-type: none"> • ICE's The Carbon Project are working on improvements on common carbon data and benchmarking • GCB support updating the existing Carbon Benchmarks database (circular ecology) • RICS updating WRAP database • CSIC declaration: work towards a infrastructure carbon dataset by 2025. • IStructE carbon tool • Rail industry carbon tool hosted by RSSB • Supply chain school carbon reporting tool - organisation reporting 	<ul style="list-style-type: none"> • Revisit this question in 6 months' time.
5.2	Develop carbon management implementation guidance for different organisation types, showing integration with existing (ISO/BS) systems & processes.	<ul style="list-style-type: none"> • PAS 2080 revision 	<ul style="list-style-type: none"> • Kat Ibbotson to update the COP on progress. Community to provide comments on draft documents.
5.3	Develop and publish standard clauses relating to carbon management for tenders and standard supplier questionnaires (e.g. Achilles) for the supply chain.	<ul style="list-style-type: none"> • ICE's The Carbon Project's task group on contracts and commercial integration • Build UK Common Assessment Methodology 	
5.4	These standard clauses should accommodate and reflect the variety of current levels of carbon maturity, and will provide a clear improvement trajectory for the value chain to work towards to mitigate the risks of loss of work.	<ul style="list-style-type: none"> • ICE's The Carbon Project's task group on contracts and commercial integration 	



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part of the Useful Simple Trust

Thank you.

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