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The Success of the Construction Industry's Adoption of the Carbon Assessment Strategy PAS2050

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Abstract. PAS2050 was introduced in order to help combat the extremely high levels of emissions that the construction industry emits, as well as the large volume of natural resources they use, through the life cycle of a project. It was developed to create a consistent method of assessing the life cycle of Greenhouse gases as well as a method to increase understanding of where they arise from within a supply chain. This is essential in today's world as without change, the climate will continue to rise in temperature and contribute negatively to the already dramatic effects of climate change that have already been seen. By implementing PAS2050 the industry aims to allow stakeholders to realise the impacts and encourage movement towards a more sustainable future. This research aims to determine how well the construction industry has adopted the carbon assessment strategy covered by PAS2050 through informed opinions, data and case studies. Using journals and research, alongside a questionnaire which will be distributed to individuals within the industry, an informed decision will be made to determine how well the construction industry has adopted PAS2050. The results found that the industry is having difficulty in adapting to the change at all levels and scopes. The findings of this research show that the industry has only touched the surface and although the larger organisations are leading the charge, enough is not being done by smaller organisations and the supply chain.

Keywords: Carbon; PAS2050; AHP; Climate change.



1. Background

Climate Change influences all aspects of our lives [1, 2], it could be considered the greatest threat to the natural world due to several reasons, including the increase in the atmospheric temperature [3, 4], high consumption of potable water [5, 6], and high intensity precipitations in some area that could cause floods [4, 7], and at the same time it causes drought in many areas [8]. The main reported reason for the climate change is the CO₂ emission from man activities, such the manufacturing of cement [9-11] and other construction related activities [12-14]. PAS2050 was introduced and was expected “to boost international efforts to carbon footprint products” [15]. Benefits were expected to be ‘invaluable’ as it’s a positive move towards ‘greater appreciation of our environmental impact’ which would be essential for long-term growth” [15]. There is an essential need to reduce our carbon footprint, especially in the construction industry that contributes to around ‘47% of the UK’s total carbon dioxide emissions’ [16]. Carbon footprints can have an effect on the environment, wildlife, human health and the economy; affects to any would be detrimental for a construction organisation and the stakeholders involved. The demand for change is more important than ever as the EU have set reduction targets for 2050 that require carbon trading levels to be 80-95% below the 1990 levels by 2050 [17]. The international construction industry has a duty to everyone, specifically its stakeholders, to do what they can to change. Arup stated that without immediate action there would not only be ‘long term rises in materials, energy and waste disposal’ but also a ‘risk to reputation, potential loss of market share’, [18], which would be difficult to reverse. As knowledge grows on the subject new ways to develop are coming into play; with carbon management, low carbon construction and life cycle analysis being just a few efforts made. The implementations of life cycle analysis and carbon analysis through PAS2050 allows for evaluating the environmental impact of all the processes and products. This means all elements that are used in construction, from extracting materials to disposal of the built structure, are analysed so that it can be indicated where and what can be changed or altered. Through life cycle analysis and following PAS2050 principles there will be a concise translation from inventory flows into a profile with ‘a number of environmental impact scores’, [19], which allows for better management and control and transparency; PAS2050’s guideline to share details with appropriate third parties. PAS2050 works alongside PAS2080, which looks at the whole life cycle of the carbon used within projects [20]. Within this paper information will be gathered in order to determine how well these ‘invaluable’ policies have been implemented through the industry. It will be explored to critically evaluate how well the construction industry has adopted PAS2050 and its criteria and understand the industries opinion on the adoption process. Ultimately understanding what stage of adoption the industry is at; the progress made so far and how the industry has taken it on board. All of this being essential as if we do nothing and to not reduce emissions soon, ‘the Earth's temperature will rise, the ozone layer will disappear, the Antarctic ice sheet will melt - causing sea levels to rise and flood most of the world’ [21].

2. Methodology

2.1 Strategy and Methods

A questionnaire was introduced to understand the significance of the changes and how they have so far impacted the industry by exploring stakeholder and industry opinions. The questionnaire was developed in order to collect data as it provides a direct response from stakeholders and professionals within the industry. It allows for collection of qualitative and quantitative data from both open and closed questions. Each question had a specific purpose. The ideal questionnaire sample size was set at 50-100 participants. As the research requires an industry overview in order to determine an answer, the whole construction industry population was targeted through LinkedIn with simple random sampling. There was no specific requirement, no knowledge required, just being within the industry.

A case study was also created for in-depth understanding of one organization’s adoption process. It will allow for identification of how one organization has changed and implemented processes or methods in order to meet requirements of PAS2050. This understanding will be found by determining the new rules and guidelines that were introduced and the program made. In order to understand the adoption of PAS2050 further, an in-depth a short

case study was produced on the actions taken by a given organization within the construction industry through questionnaire answers and discussions with a carbon manager within the organization itself. The case study aimed to answer specific questions surrounding how the organization has implemented plans to tackle climate change and implement PAS2050 but also to discover how they see and compare with the industries adaptations.

2.2 Data Analysis

The case study is being created in order to determine how a singular entity within the industry has taken steps to adapt. The analysis within this will be used to determine how well adjusted they are and if their steps will help make a change to their carbon footprint, at all levels, as well as their impact on the environment. This will be done through the primary researcher gathering information and processing it in a similar way to that of the questionnaire in order to produce a minimally subjective opinion on how well the industry has adopted PAS2050.

Analytical Hierarchy Process (AHP) will be used for analysis of the questionnaire answers gathered in this study. AHP is a structured multi-criteria decision-making tool for assessing and analyzing complex decisions [22]. It uses analysis of elements in a hierarchy for creating the best decision as seen in Figure 1.

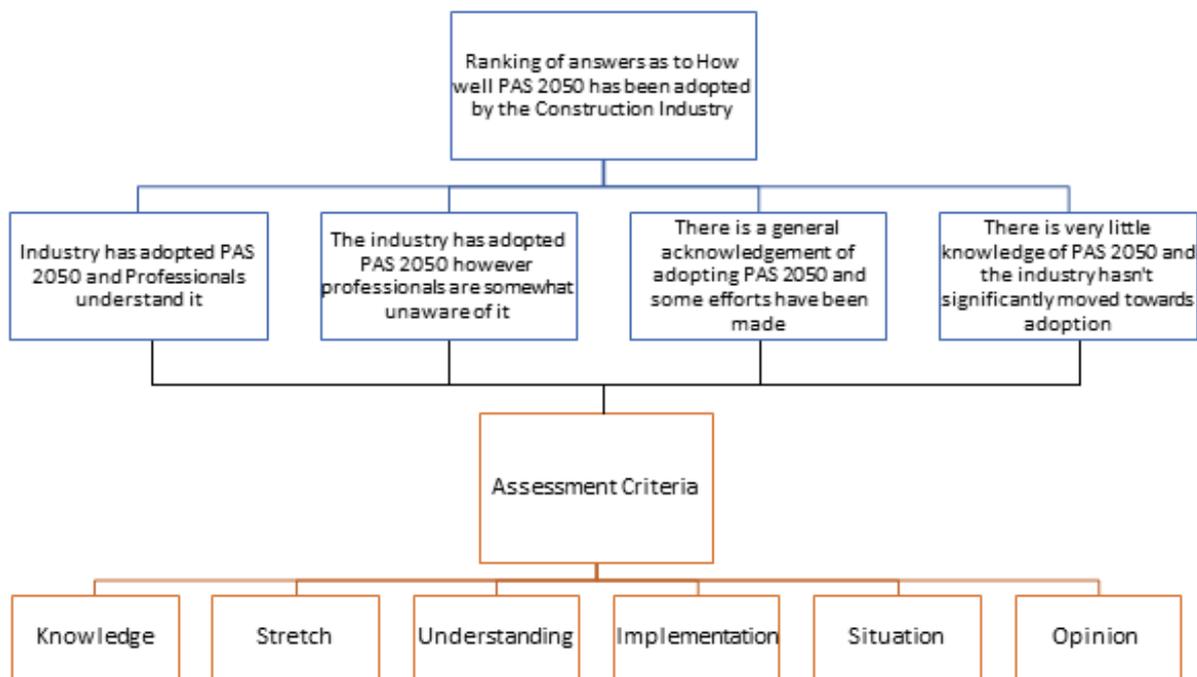


Figure 1: Hierarchical Structure of Ranking and Selection of answers

This study answers the key research questions “Has the industry adopted PAS2050? To what extent? What was the industries opinion?” The two main steps of this study are to determine (a) weights of criteria for the assessment of how well the industry has adopted PAS2050, and (b) the scores of how everyone has been impacted by it. We do this based on certain criteria as seen in Table one. The process begins by ranking different conclusion alternatives according to multiple criteria and determines the appropriate answer for ‘how has the industry adopted PAS2050’. The criteria used and displayed in Table 1 applies to the data supplied through an administered questionnaire.

Table 1: Assessment Criteria Description

Criteria	Description
Knowledge	Is there knowledge of it at all levels within the industry; not just within decision-makers, includes lower job levels too.
Stretch	Does the knowledge stretch across various employers, enough to indicate for the whole industry?
Understanding	Significance of understanding of PAS2050 within the industry.
Implementation	Number of implemented regulations or schemes (on average).
Situation	Stage or situation at which the schemes are at.
Opinion	Positive or Negative Opinions

Through AHP there is the allowance for data to be compared in a rational and consistent format for processing an informed decision about the progress of implementation. We can also determine the successfulness so far. Using the 6 criteria for the assessment, the next step is to determine weights for each criterion using the AHP. The questionnaire combines both quantitative and qualitative data. The opinions from stakeholders within the industry will be determined to be negative or positive in order to rank the ratio and understanding of PAS2050 will be ranked on the primary researcher's authority. The performance scores displayed in Table 2 are collected, normalized, and analyzed in this study to give an overall decision.

Table 2: Performance Scores of Criteria

Criteria	Scores	
	0	10
Knowledge	No knowledge of PAS2050	Knowledge of PAS2050 at all levels
Stretch	1 organization surveyed	10+ companies surveyed
Understanding	No understanding of PAS2050	Complete and intense understanding of PAS2050
Implementation	Zero schemes known to be introduced (on average)	10+ schemes known to be introduced (on average)
Situation	No schemes completed or in operation	All schemes fully operational
Opinion	All negative responses	All positive Responses

The AHP obtains experts' input through comparisons of the criteria and examines the consistency of answers. Inputs from multiple experts are compiled and used to calculate the weights of criteria. Numerical priorities are derived to determine which best suits the decision goal. These criteria are then used to assess PAS2050s implementation in the industry. The analysis of the questionnaire will determine one of the following answers: Industry as adopted PAS2050 and professionals understand it/ The industry has adopted PAS2050 however professionals are somewhat unaware of it/ There is general acknowledgement of adoption and some efforts made/ There is very little Knowledge and movement towards adoption. This will be determined through assessments of decisions in Table 3 which categories the requirements for each decision.

Table 3: Assessment of Decision

Decision	Criteria					
	Knowledge	Stretch	Understanding	Implementation	Situation	Opinion
Industry as adopted PAS2050 and professionals understand it	8-10	0-10	8-10	5-10	5-10	5-10
The industry has adopted PAS2050 however professionals are somewhat unaware of it	4-9	0-10	4-9	3-7	3-7	3-7
There is general acknowledgement of adoption and some efforts made	2-5	0-10	2-5	2-5	2-5	2-5
There is very little knowledge and movement towards adoption.	0-5	0-10	0-2	0-2	0-2	0-2

3. Results and discussion

3.1 Questionnaire Findings and Analysis

The questionnaire responses were fully analysed by the primary investigator. In total 5 organizations were surveyed; the organizations are labelled A-D for easy analysis. Job level ratings were determined by the primary researcher based on the levels, ranging 1-6. In total, sixteen participants responded to the questionnaire, their results can be seen below.

Table 4: Questionnaire response analysis

Response ID	Criteria					
	Job Level	Organization	Understanding	Implementation	Situation	Opinion
72656642	6	D	7	2	3	4
72767286	5	C	9	10	10	7
72774404	5	C	8	5	9	9
72786629	5	C	3	0	3	6
72786486	3	C	8	10	10	9
72787863	5	C	2	2	3	5
72788426	5	C	6	10	10	9
72790265	5	C	3	2	6	8
72790926	4	C	5	2	6	8
72791879	3	C	1	0	0	4
72800875	5	A	8	8	6	8
72818786	4	C	7	10	3	10
72832110	2	B	0	0	0	0
72873977	4	B	7	2	10	9
72934509	4	C	1	2	3	5
73699789	5	E	3	0	0	6

In terms of the stretch of research, the questionnaire reached a total of 5 companies through its distribution. This would quantify stretch to value 5. In terms of knowledge, it is hard to determine the extent in the industry as there was few responses from the lower ranking job levels. However, using the difference in responses that clearly comes within organization ‘C’, knowledge is varied in all levels. As there was evidently contrasting levels of understanding at the same levels and inability to judge that of the lower ranking levels the knowledge will also be valued at 5. With all data collected from questionnaire presented in Table 4, it was averaged out using basic mean average calculations. The results for all calculations and criteria can be seen in Table 5.

Table 5: Results for final criteria values

Criteria					
Knowledge	Stretch	Understanding	Implementation	Situation	Opinion
5	5	4.875= 5	4.063= 4	5.125= 5	6.688= 7

Using this data and implementing it into Table 3: Assessment of Decision, determines the outcome of the information received from the questionnaire. By using the results from the questionnaire and then the finalised criteria value above they can be applied to the decision table. The values that can apply to a given criteria will be highlighted red. This display will then determine and ultimate decision: the decision that fully fits the criteria

Decision	Criteria					
	Knowledge	Stretch	Understanding	Implementation	Situation	Opinion
Industry as adopted PAS 2050 and professionals understand it	8-10	0-10	8-10	5-10	5-10	5-10
The industry has adopted PAS 2050 however professionals are somewhat unaware of it	4-9	0-10	4-9	3-7	3-7	3-7
There is general acknowledgement of adoption and some efforts made	2-5	0-10	2-5	2-5	2-5	2-5
There is very little Knowledge and movement towards adoption.	0-5	0-10	0-2	0-2	0-2	0-2

model will be the ultimate result.

Figure 2: Determination of the decision gathered from AHP

As can be seen by the red highlighted section in Figure 2 only one decision criteria is met 6 out of 6 suggesting that the finalised decision is ‘that the industry has adopted PAS2050 however professionals are somewhat unaware of it’. Although due to the answers and a 5 five out of the 6 criteria match, it could also be considered to meet or fall closer to the other decision which states ‘there being a general acknowledgement of adoption and some efforts made’ but PAS2050 is not fully adopted. The opinions provided by the questionnaire offer a further insight into the adoption of PAS2050 into the construction industry. Although varied, responses provide an insider’s perception. One question asked was ‘what do you think the industry’s reaction is to PAS2050 and new carbon assessment strategies?’. In response to this participant 72656642 stated that the industry’s reaction has been poor so far and the commercial impact has not been embraced to the fullest extent. This suggests that although there has been an uptake in some procedure, not all parts of the business have taken a move towards adopting PAS2050. Participant 73699789 described the reaction to be good in part and ‘those with specialist knowledge are well tuned in and trying to promote PAS2050 so that it makes a change, but it is not a widespread movement across the industry’. This participant stated that with the pressures of time/ knowledge/ cost will make it hard to implement.

This shows that implementation is possible however the industry is not offering enough time or money to educate its employees. Participant 72786486 stated that so far it appears that “the larger companies are taking their responsibilities seriously and have employed the required qualified staff to assist in preparing PAS2050 assessments and reduction strategies”. This again shows key players in the industry are looking for change however, without full support of the smaller organisations and supply chain, the change cannot escalate to the required scale. A number of participants stated the process needs to be started properly, but we are only just starting to touch the surface and there is not much difference yet. It was also said that most companies in the industry have made tremendous efforts to make steps within scope 1 and scope 2 reduction, but scope 3 had been mostly ignored. These opinions support each other; without everyone changing, the change will not be enough.

Understanding impact and significance is also essential to understanding how well PAS2050 has been adopted. In asking for opinions on this matter there was again a varied response. Participant 72767286 stated it is “significant impact because clients require demonstration of reductions in the carbon impact of projects now”. This shows that clients are requesting it and could indicate to the smaller organisations and supply chains causing the issues. However, one participant, 73699789, said in response to significance, “I would say not significant, simply as it is not commonly talked about by clients, in bids, but on projects there is specific requirements/ target but it’s not specifically PAS2050”. This states that although there is requirements of the same trajectory, there is not any specific to PAS2050. One participant (72786486) responded to the questionnaire stating, “initiatives put in place by the larger companies are having a significant effect on their GHG emissions but the whole industry needs to come together, and all adopt similar initiatives”. They also provided a recommendation in saying ‘fully qualified GHG reduction specialists either need to be in place in all companies or available as consultants to help drive down the industries GHG emissions.

3.2 Case Study and Analysis

3.2.1 Case Study

The organisation set out to map out their total carbon outlay and determined which areas have the largest number of problems, using this they developed an action plan to determine how to get to net zero emissions through tweaking elements in the whole life cycle of their products. This has created a 15-year action plan which aims to get them to a position of net zero emissions by 2035. The plan, if implemented correctly, is expected to eliminate over 1,250,000 tonnes of carbon dioxide equivalent (tCO₂eq) from their carbon footprint and expected to help save £6million.

For maximum progress, the organisation states there is essential movements that need to be taken in order to engage not just staff but clients and partners. This means they have taken steps into educating those stakeholders thoroughly on the topic for increased awareness and delivering a concise structure on the strategy for improvement of their processes. This step aims to clean up not just scope one and two, but scope three as well making it a whole life cycle change. Educating is essential for these organisations plan as they believe for many people carbon management is seen as a significant financial burden when in reality it can save money, cut carbon and reduce things such as deliveries which can help reduce air pollution, noise and disruption to local communities.

Within the 15-year plan there is many key steps mostly surrounding PAS2080 but the plan ultimately involves reducing their footprint to net zero and offering low carbon solutions to clients. The way in which they are monitoring their life cycle means, indirectly, they are also adopting PAS2050. The reasoning for this implementation is to meet the UK governments target to be net zero by 2050 as well as to address and tackle the greenhouse gas emissions associated with the built environment. Hence the need for reduction of emissions at every life cycle stage: design; delivery; usage of assets and end of like of the assets. The organisation has already closed on year one of the plan and stated 6 key progressive movements. These involved training senior members of staff; reducing vehicle emissions and creating a plan to transition the fleet of vehicles to electric or hydrogen

powered alternatives by 2030; optimising designs aligned with PAS2080; accelerating clean growth strategies; integrating new systems to help improve life cycle management.

The organization's carbon manager stated that climate change needs to be tackled in steps. 'It is not possible for an overnight transformation of any industry', not only because it is a slow process but primarily because the population isn't educated thoroughly enough on how to do it efficiently. As can be seen from the organizations policies PAS2080 was closely aligned, this was stated to be because of its maturity and understanding however it was suggested that 'PAS2050 will follow a similar trajectory'. Maturity is to be built with PAS2050 and as it becomes legal, maturity in all areas will jump as there is a necessity to it rather than a choice. This jump should come with the 2022 carbon tax changes, which ultimately states that there will be a large increase in costs of material with high carbon costs. The industry will subsequently start working towards using lower impacting materials to lower taxes and increase potential profits. Furthermore, with the industry legally liable for making it publicly available what they are doing to eliminate their impact, which includes publishing the numbers to match, those organisations that had previously held back from making changes will make change for fear of carbon callouts and subsequent loss of business. This also means they will now be complying with mandatory GHG emissions in scope 1 & 2.

In the questionnaire it was said by one employee that many companies have plans in place for committing to PAS2050, however they are struggling to put those plans in action, unlike the organization discussed above that was described as 'one of the few that have' made steps into the role out process. It was also said by one participant that the organisation has supported the PAS2080 guidance to the industry and one project was cited as a great example of how early engagement and collaboration can reduce embodied carbon and drive sustainability.

3.3 Discussion

The finalised decision using AHP was 'that the industry has adopted PAS2050, however professionals are somewhat unaware of it' however as previously discussed it narrowly aligned with 'there being a general acknowledgement of adoption and some efforts made' within the industry meaning that PAS2050 is not fully adopted. By using this information and comparing it with the questionnaire's qualitative responses and case study data, it can be determined an exact decision for how well PAS2050 has been adopted. The opinions gathered through the questionnaire suggested most commonly that although there has been an uptake in some procedure, not all parts of the industry have taken a move towards adopting PAS2050. It was also determined that without full co-operation impact to climate change would be minimal. As discovered through the case study it is essential that all areas of the industry engage in the changes and in order to make this possible, education is the only key. Without it at all levels and sectors of the industry implementation is not fully viable. When comparing this with the case study it was clear education is not in the lower ranks and until effort is put into allowing time to educate and improve knowledge about the impact on everything including costs and the processes required, uptake will not increase. As many stated, the supply chains were slow to react, which will only hinder progress. It was made clear through all responses and information that its more than PAS2050 making a difference, a lot of the organisational improvements discussed in the case studies are centred around PAS2080 which is said to run alongside PAS2050 and other similar standards. This comes as maturity is key to implementation hence why PAS2080 is much more understood in the industry. As described, PAS2050 is set to follow a similar trajectory but this will only begin once there is necessity, a necessity that comes with the 2022 tax initiatives. It is clear that we are only just starting to touch the surface of the problem, and although organisations have made significant changes and have committed to net zero targets, many still do not have a viable plan in how to achieve it. This means there is not much in the way of adoption or change yet. When understanding the organisation within the case study its clear the process towards a carbon secure future is slow and involves lots of steps, this is likely why the industry is still processing it.

Despite how the one organization investigated has helped make huge step to lead the industry, one organization is not enough. When comparing these finding with those decisions gathered through AHP the alignment in all opinions is predominantly with there being a general acknowledgement of the adoption and PAS2050, however there is only a few efforts made and PAS2050 is not fully adopted. This decision was made as the information clearly points towards too many organisations being neglectful of the adoption therefore giving the decision that PAS2050 was adopted would not be representative of all sectors including supply chain.

4. Conclusions

The present project is about the adoption of PAS2050 into the construction industry. Results showed that generally there is movement being made into a sustainable future however not enough. It was found that although many big organisations are making strides and beginning the teaching process, many within the supply chain have not due to the lack of legal necessity. This is a damaging discovery for this moment in time as it was determined that without significant teaching, progress will not reach its full potential. The results of this project showed that the industry still has tremendous strides to take in teaching and implementing for PAS2050 to be implemented and make a difference, and although steps are being made with PAS2080, without all efforts, it will not be enough.

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