Sustainability and the Civil Engineering Surveyor

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Key Words: Sustainability, Civil Engineering Surveyor, Sustainable Development Goals

SUMMARY

This paper critically reviews the application of sustainability in construction, with a focus on the civil engineering surveying profession. We explored the current landscape of sustainability and its interpretation in the context of civil engineering projects, assessed how organizations in the sector address it and identified key themes and necessary future steps. We administered a survey to establish the sustainability maturity level within civil engineering surveying organisations and conducted several workshops with commercial and geospatial surveyors to explore key themes. The findings emphasized the critical need for early engagement of civil engineering surveyors during procurement and initial project stages while staying updated with developments in the sustainability landscape. Sustainability competence and early involvement allow civil engineering surveyors to influence decisions that impact economic, environmental, and social sustainability. The findings also stressed the role of the government and the importance of sustainability regulations in driving the sustainability agenda forward.

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1. INTRODUCTION

Sustainability has been a well-researched topic for several decades, particularly since the Brundtland report. The need for sustainable development in the context of construction cannot be overstated, given the impact of the industry on natural resources, biodiversity, waste, and emissions (Tiza 2022; UNEP, 2022). The definition of sustainable development was coined in *Our Common Future* report as the 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland and Khalid 1987). This definition has expanded to encompass economic and social dimensions alongside environmental concerns (Hajian and Kashani 2021) with the emergence of the triple bottom line (Elkington, 2018). Despite its widespread use, there is no universally agreed definition of sustainability for different contexts (Delai and Takahashi 2016; Chang 2016).

Research on how sustainability is applied in construction and civil engineering projects is prevalent in the literature. Lima et al. (2021) did bibliometric research to investigate sustainability applications in civil construction and reported that the key areas addressed in the literature covering 433 articles published in 18 years are certifications and methodologies for environmental assessment, materials, on-site management and energy. The authors also noted that most studies failed to cover all three dimensions with more focus given to the environmental pillar (only 35.3% covered all three). A similar trend was reported in another study that reviewed environmental and social sustainability applications in the UK with more emphasis placed on the environmental pillar (Misopoulos et al. 2023).

Whilst most studies tend to focus on the environmental dimension of sustainability, Cruz, Gaspar and de Brito (2019) argue that it is important to consider the other two dimensions of the triple bottom line – social and economic to be truly sustainable - and developed a roadmap of practical actions to achieve the same at the operational, tactical and strategic level for the Portuguese construction sector. Likewise, Zuo, Jin and Flynn (2012) proposed 26 criteria to measure social sustainability in the construction context through semi-structured interviews with stakeholders (Zuo, Jin and Flynn 2012) Another study (Zhong and Wu 2015) demonstrated how economic sustainability can be brought into the picture through the comparison of cost, carbon and constructability of different structural options at an early design stage to inform decision making. All these studies provide insights into sustainability adoption in construction, predominantly on environmental sustainability while some cover the social and economic dimensions of the triple bottom line. However, studies covering how

each profession can contribute towards sustainability goals are not widely discussed in the literature.

An analysis of survey responses (Dixon et al. 2008) from a major international online survey of 4,600 RICS members on their engagement with the sustainability agenda showed that larger multidisciplinary firms and the public sectors are considered as 'Sector Leaders' while surveying private practice, civil engineers, investment managers in the private sector and oil and gas were identified to be "followers" (see Figure 1). Dixon et al. (2008) find this surprising given the organisational push to obtain green credentials. However, it is interesting to note that the 'Sector Leaders' pool does not relate to a single profession (except Architecture) while the 'Followers' pool singled out professions such as surveyors, civil engineers and investment management. This highlights why research on how each profession can contribute towards these goals and what skills and competencies are required to achieve the sustainability goals are crucial to becoming leaders in driving the sustainability agenda.

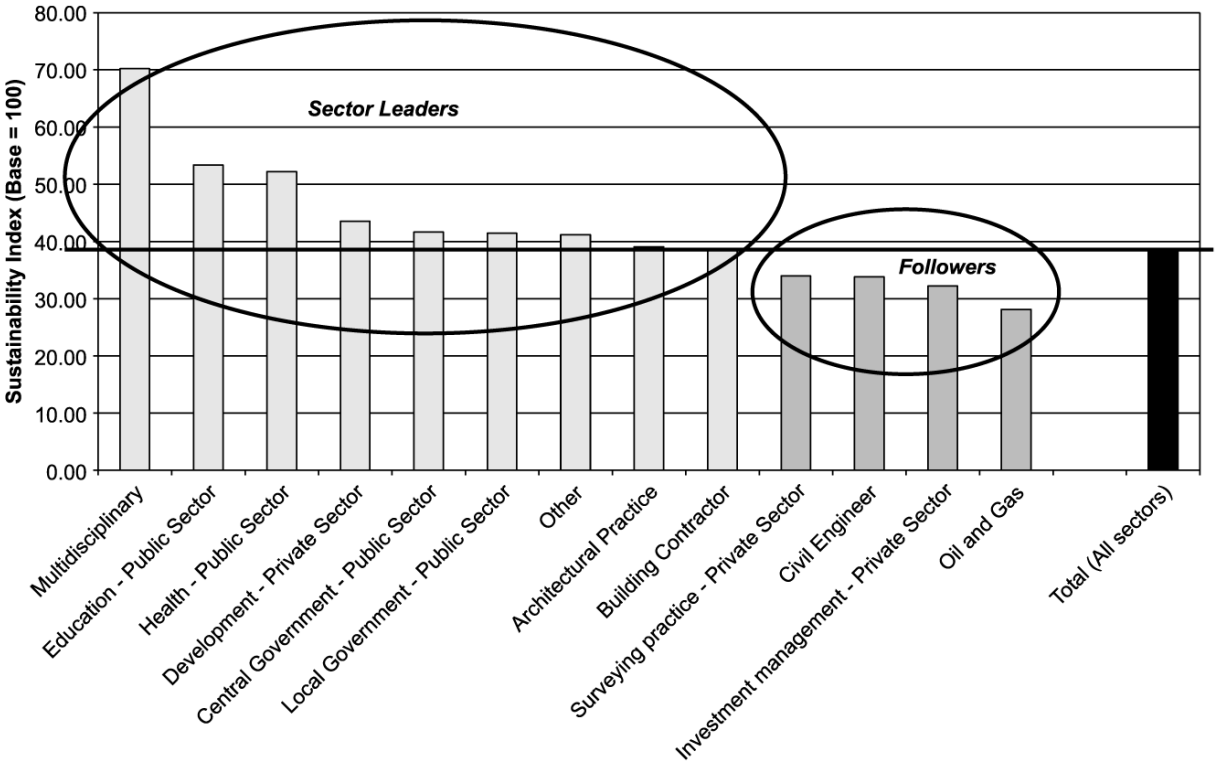

Figure 1: Sector Leaders and Followers: 'Sustainability Index' (source: Dixon et al., 2008)

A latest global survey by RICS (Zehra, 2024) with over 4,000 built environment professionals from 32 different countries highlighted some positive advancement in sustainability with increasing demand for green assets as they appear to attract a rent and price premium over comparable non-sustainable assets. On the other hand, high initial cost, skills shortage and inadequate training of professionals were found to be key impediment to sustainability.

Survey findings further highlights that collaboration between professionals is essential to overcome these challenges and to identify scalable solutions to decarbonise the built environment (Zehra, 2024) as inferred from Dixon et al. (2008). However, the survey does not provide any insights into specific professions or sectors similar to Dixon et al. (2008).
As the study focuses on the role of Civil Engineering Surveyors (CESs), we reviewed the role of the commercial surveyor (quantity surveyor) and geospatial surveyor reported in the literature.

CICES (2025) defines CESs as:

> *"Specialist professionals working in the disciplines of geospatial engineering and commercial management in infrastructure. Within these two fields, a CES may specialise in areas such as land and engineering surveying, hydrographic surveying, photogrammetry and remote sensing, GIS, utilities and subsurface mapping, quantity surveying, estimating, planning, cost engineering, procurement engineering, project management and construction law".*

The role of commercial managers and the competencies relevant to sustainability have been studied by a few researchers under the title of quantity surveyors. Chamikara, Perera and Rodrigo (2020) found that construction technology, environmental services, computer literacy, ethics and professional practice, leadership and management, and measurement and costing are the key aspects of sustainability relevant to Quantity Surveyors (QS). More specifically, Omotayo, Tan and Ekundayo (2023) argue that QSs should have an awareness of sustainable construction, play an adversarial role in green costing, carry out carbon cost planning, value sustainable properties and possess a common knowledge of sustainable construction. However, Ortiz, Castells and Sonnemann (2009) believe that the application of Life Cycle Assessment (LCA) is fundamental to sustainability which again places more emphasis on environmental sustainability. However, Perera and Victoria (2017) argue that QSs are best placed to do LCAs alongside cost estimates promoting dual currency appraisal to address both economic and environmental sustainability as demonstrated by Zhong and Wu (2015). Yet, social sustainability is missing in the picture.

On the other hand, the role of geospatial surveyors in achieving sustainability is indirectly reported in the literature. Researchers have noted geospatial technologies like Remote Sensing (RS), Geographic Information Systems (GIS), and Global Positioning Systems (GPS) have a high potential in measuring and monitoring Sustainable Development Goal (SDG) indicators (Acharya and Lee 2019; Reddy 2018). A survey conducted at the Norwegian Geotechnical Institute with a group of geotechnical engineers to find how the concept of sustainability relates to geotechnical engineering found that the development of sustainability assessment tools is the most relevant way of working towards sustainable goals in the geotechnical context followed by multidisciplinary collaboration and research (von der Tann et al. 2023). Although inferences can be made based on the above findings on the role of the geospatial surveyor, it was difficult to find research that makes direct reference to geospatial surveyors and that addresses all three sustainability dimensions.

Despite numerous studies addressing one or more dimensions of the triple bottom line, how CESs, both commercial and geospatial, can practice sustainability in their current roles is not well established. Furthermore, the latest global survey on sustainability by RICS highlighted that there is less progress across the construction industry particularly in measuring carbon emissions and assessing the impact of projects on biodiversity which are two key areas directly influenced by the CES (Zehra, 2024). This calls for research addressing this gap in the context of the CES. Therefore, this study aimed to answer the following research questions:

RQ1: What does sustainability mean in the context of CES?
RQ2: What does the sustainability maturity look like at the organisational level?
RQ3: How can the CES practice sustainability in their job role?

2. METHOD

A mixed-method approach was adopted for this study due to the nature of the research questions. Johnson and Onwuegbuzie (2004) argue that mixed-method approaches can frequently result in superior research compared to single-method approaches due to their methodological pluralism. We adopted concurrent mixed method where quantitative and qualitative methods of data collection is used within a single phase. This allows for both datasets to be interpreted concurrently to provide a comprehensive response to the research questions compared to a mono method (Saunders et al, 2024). A quantitative approach was used to establish the adoption level of sustainability in civil engineering surveying organisations and a qualitative approach enabled the exploration of key themes and areas of focus while both quantitative and qualitative methods used to triangulate what sustainability means in the context of the CES (see, Figure 2).

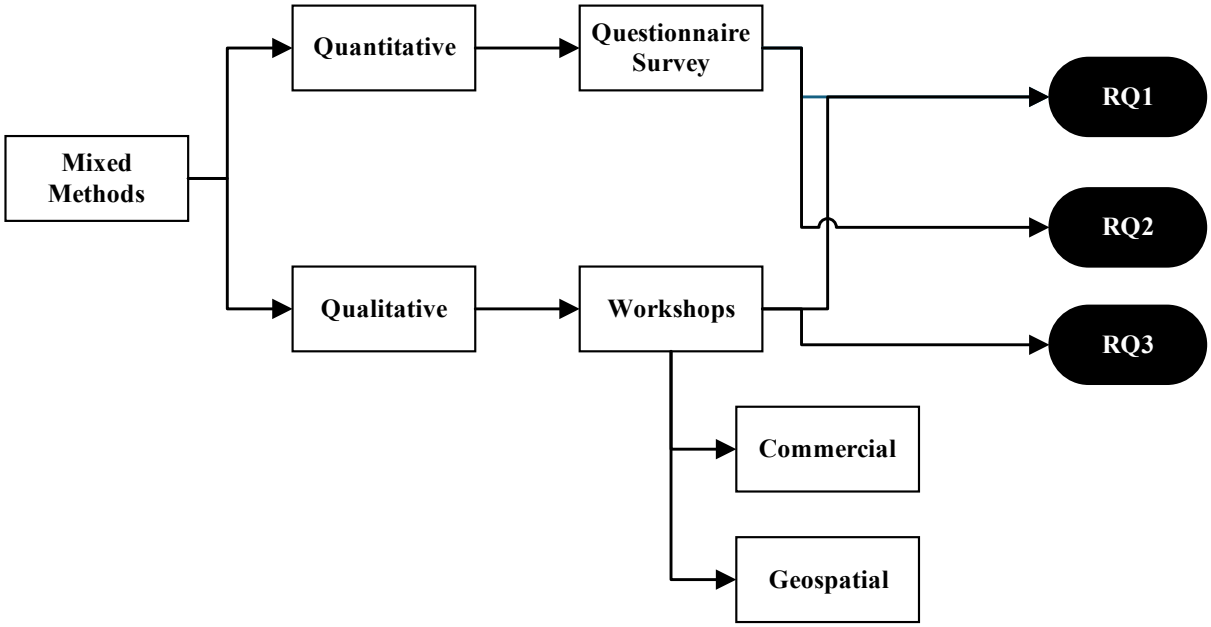

Figure 2; Research Design

We chose voluntary sampling technique for our questionnaire survey to achieve a higher response rate (see, Murairw, 2015). An online questionnaire survey was administered to the whole population of the Chartered Institution of Civil Engineering Surveyors (CICES) members to define sustainability in the context of CES and to understand the level of sustainability adoption at the organizational level. We administered the survey through emails and social media channels and sent two reminders to follow up the initial request. The population represented approximately 4,500 members at the time of the survey. The survey returned 120 responses, which is 2.67% of the membership. It can be noted that even with voluntary sampling the response rate has been very low, so it can be argued that the other sampling techniques would have returned fewer responses. Figure 3 presents the respondent's profile. The respondent pool represents a mix of clients, manufacturers, commercial, geospatial, third-sector organisations and retired civil engineering surveyors. Most of the respondents share a commercial background, while more than a quarter did not disclose their organisations.

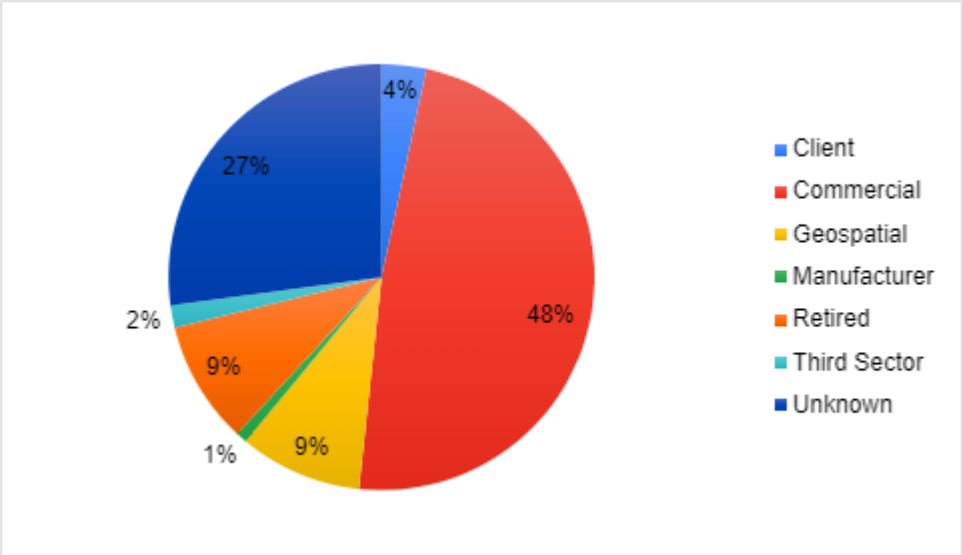

Figure 3: Survey respondent profile

Simultaneously, we employed participants for the workshop through a purposive sampling technique where researchers use their judgement of the topic and the field of data to choose the sample (Fellows and Liu, 2021). This technique is useful to ensure the workshop participants have expertise in the topic researched. We ran several workshops with 26 commercial and geospatial surveyors (from various stages of their careers) to get insights into how sustainability is applied in their roles. The workshop participant profile is presented in Table 1 which represents a diverse participant pool to emulate the population.

Table 1: Workshop participants' profile

Commercial Workshop Participants		**Geospatial Workshop**	
Managing Director	2	Managing Director	3
Head of Design Management	1	Head of Survey	1
Senior Quantity Surveyor/ Cost Manager	3	Assistant Director of Lands, Ministry of Lands, Housing and Country Planning	1
Senior Commercial Manager	4	Senior HDS Surveyor	1
Senior Consultant	1	Senior Utility Surveyor	1
Retired professionals with experience in sustainability	3	Civil, Geo and Land Surveyor	1
		Land surveyor	1
		Package Manager	1
		Senior Project Manager	1
		Retired	1

3. ANALYSIS & DISCUSSION

3.1. Survey Findings

3.1.1. Definitions

We gathered definitions for economic, environmental, and social sustainability and asked survey respondents to indicate their level of agreement with these definitions. This feedback was used to develop a definition suitable for civil engineering projects. Additionally, respondents were invited to provide qualitative comments on what they believe the definitions should include.

The proposed definitions were:

- **Economic Sustainability**: Striking a balance between the costs and the environmental & social benefits of civil engineering projects.
- **Environmental Sustainability**: Reducing the environmental impact caused by civil engineering projects
- **Social Sustainability**: Improving the quality of life of people and communities through civil engineering projects and associated activities

Most respondents agreed with the proposed definitions with the caveat that the following points should be addressed in the definitions:

- The definition should be holistic without overlooking any of the three sustainability dimensions (although based on the survey findings, more weight was placed on the environment and social sustainability, see Figure 4)
- Respondent stressed that a heightened emphasis on enhancing rather than merely minimising the impacts on various stated areas is important while also retaining a viable commercial focus.
- Suggestions not to limit the definition to civil engineering only.

A tree map was generated for the qualitative comments received by the respondents to identify common themes and dominant words/phrases used. The tree map as illustrated in Figure 4 highlights the emphasis on environment followed by balance, benefits and social.

Figure 4: Word cloud of the proposed changes to the definitions

Accordingly, the new definition reached by consensus runs as follows:

"To minimise the negative effects of construction on the environment and society, while also improving the quality of life for people in the communities where we operate, all while maintaining a profitable business."

3.1.2. Sustainability Maturity at Organisational Levels

Economic sustainability is mainly practised by 'appraising alternative options', 'engaging the project team earlier on in the project' and 'hybrid working' as per the survey findings. Half of the respondents said that their organisations opt for standardised materials to achieve economic sustainability. This suggests that the industry believes that the use of standardised materials reduces both emissions and costs. However, it is important to note that this only considers capital cost and an industry-wide application of life cycle costing and carbon assessments in evaluating alternatives is lacking (see, Zhong and Wu, 2015). Furthermore, 48% of respondents said feasibility studies are conducted in the initial stages of projects to assess the economic sustainability of projects, which is surprising as it is expected that all civil engineering projects bypass this stage to justify public spending. With regards to Design for Manufacture, Assembly and Disassembly (DfMAD), only a quarter of the respondents have witnessed their organisations supporting DfMAD. This suggests that the sector believes that the use of standardised materials reduces both cost and carbon emissions as the benefits of DfMAD may not be well understood (see, Figure 5).

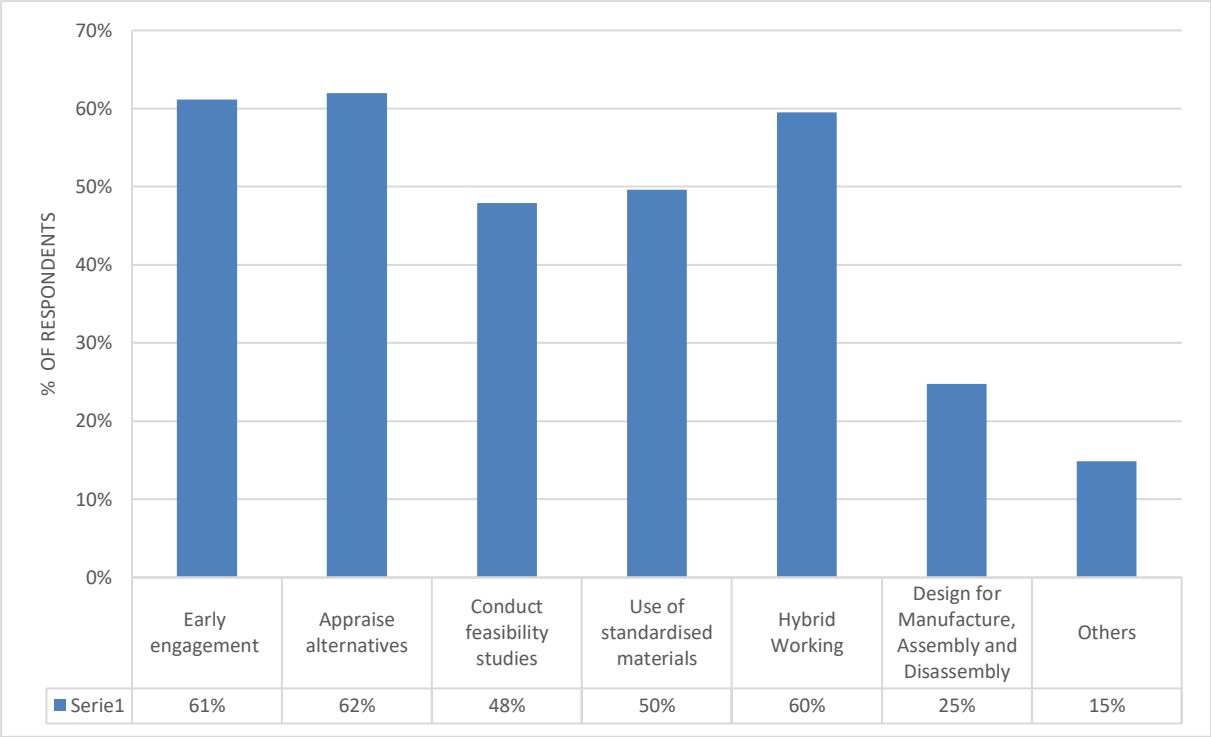

Figure 5: How economic sustainability is practised at the organisational level

Most of the survey respondents (93%) said that their organisations address environmental sustainability through the 'use of standard delivery streams', with the next most selected options being 'reduced business travel/opting for virtual meetings' and 'electrification of fleet'. While the first two options are easy wins, it is encouraging to see that 70% of respondents have witnessed fleet electrification in their organisations, which is one of the key priorities of the UK government's agenda on Net Zero. However, based on the responses, most organisations tend to stick with the standard delivery streams as discussed in economic sustainability instead of exploring low-carbon alternatives. This is further affirmed by the responses where only 31% of respondents confirmed that their organisations use low/zero carbon concrete and/or steel. This may be due to a lack of awareness, cost considerations and/or supply chain constraints. On the other hand, it is encouraging to see that 61% of the respondents are working to an environmental management standard like ISO14001 and 52% are procuring locally sourced materials where appropriate. Interestingly, 36% of the respondents said that flexible working is supported by their organisations - a popular trend post-COVID, which helps reduce Scope 1 and 2 organisation-level emissions.
'Use of renewable energy sources' scored low, with only 21% of respondents seeing it adopted in their organisation, reflecting the industry-wide slower uptake. However, with the greening of the grid, this is not a priority for many organisations (see, Figure 6).

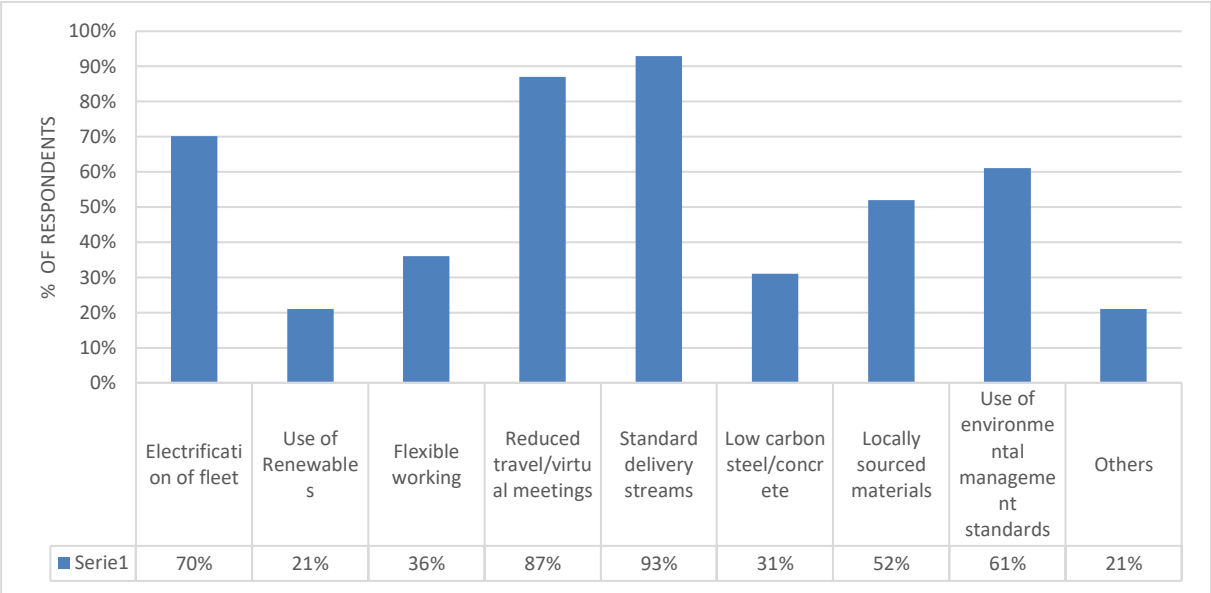

Figure 6: How environmental sustainability is practised at the organisational level

'Prioritising employee safety' was voted as the primary way of ensuring social sustainability in civil engineering organisations, followed by 'engaging with educational establishments to share best practices' and 'ensuring fair pay'. Nearly 50% of the respondents said that their organisations 'invest in community projects' to support communities within which they operate and support employees through 'company social groups' and other 'initiatives in the workplace' to improve employee wellbeing. However, only 30% of respondents noted that their organisations comply with the Public Services (Social Value) Act 20128, which requires people who commission public services to think about how they can also secure wider social, economic and environmental benefits. This low value may be due to a lack of awareness or communication from the top management to the lower levels of employees on how their projects comply with the act (see, Figure 7).

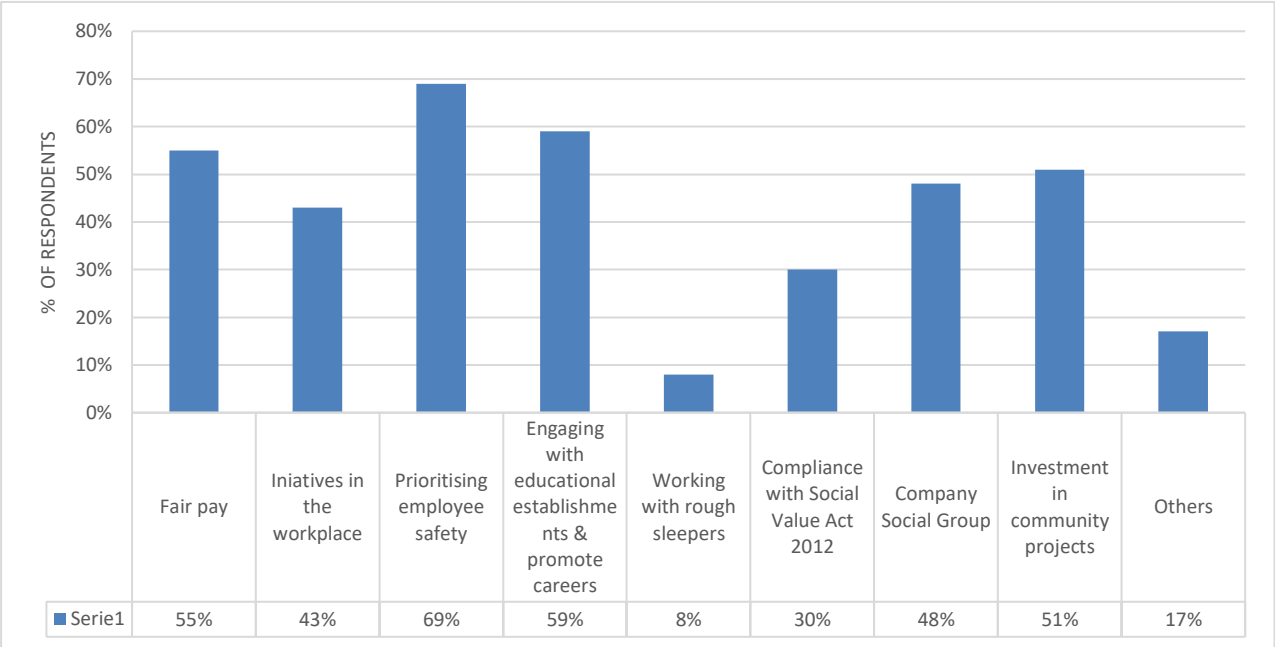

Figure 7: How social sustainability is practised at the organisational level

3.2. Workshop Findings

After establishing the sustainability maturity levels, five workshops were conducted to investigate what CES can do to drive sustainability in their day-to-day roles.

The key themes identified from the workshops are presented in Figure 8.

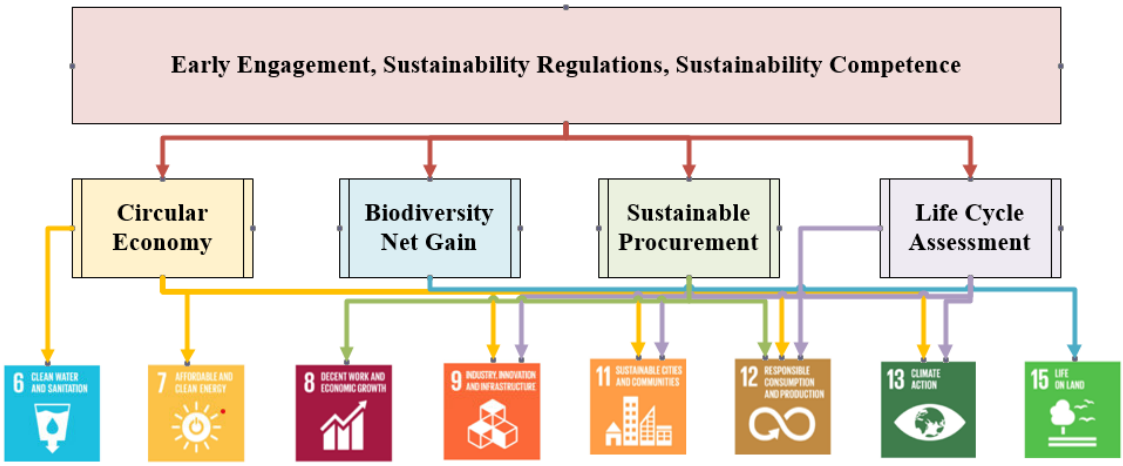

Figure 8: Key themes and contributions to SDGs

3.2.1. The Umbrella Themes

Early engagement, sustainability regulations and competency appeared to be the overarching themes for all sub-themes identified during the workshops including circular economy, biodiversity net gain, sustainable procurement and life cycle assessments. Each theme is colour coded so that their contribution to SDGs can be distinguished easily through the colour coded arrows.

Early Engagement

Findings reveal that early engagement of a CES helps to embed objectives from the start and results in better advice on benefits and capital costs. Survey findings also support this as 61% respondents have noted that they achieve economic sustainability through early engagement. Often, the capital costs associated with achieving sustainability goals can be offset by or at least measured against the benefits through a cost-benefit analysis and appraising alternatives as per the survey findings. Early engagement is essential if those relevant parties want to make better decisions based on the specialist knowledge of our professions. Participants argued that if interventions are made early in a project lifecycle, the more accurate the stated objectives and outputs will be. Further, if these 'baseline' sustainable goals are prioritised in the project requirements and incentivised properly, they are more likely to be met successfully.

Sustainability Regulations

Findings argue that the power of Government in implementing sustainability cannot be overstated. If legislation and guidance compliance is required contractually, it will always be more likely to be taken seriously than if it is voluntary. However, survey findings show that 61% of respondents confirming the use of environmental standard to achieve sustainability in their organisations despite these standards being voluntary. Given that areas of standardization are constantly evolving with new data, emerging technologies, and best practice innovations, the CES must stay updated on these developments. This will ensure they deliver value with clarity, confidence, and competence.

Sustainability competency

Continuing Professional Development (CPD) should not be underestimated in the broader conversation about sustainability. CESs should strive to keep up to date with the advancement of discussions around sustainability in the industry and educate themselves through formal and informal CPD to stay current and sustainability competent. Surveyors who are highly aware of their carbon emissions are likely to take steps to reduce them. People of that calibre will be in demand by organisations that are sustainability-conscious and looking to lower their overall carbon footprints.

3.2.2. Sub-themes

Circular Economy

Circular economy directly contributes towards several SDGs as illustrated in Figure 8. For example, circular economy helps minimise water usage and promote water recycling (SDG 6), supports renewable energy and energy efficiencies (SDG 7), encourages innovations and sustainable use of resources (SDG 9), advocate for sustainable urban development and waste management (SDG 11), help reduce waste and promote responsible consumption (SDG 12) and through all of the above reduce emissions and mitigate climate change (SDG 13).

However, participants found that circular economy is often pigeonholed as a strategy for waste management or recycling which are familiar to the CES operating in the infrastructure sector. However, the CES has significant opportunities to explore. During the workshops, it became evident that more effort is needed to communicate the benefits of improving existing buildings and infrastructure, rather than removing and replacing them. The lower financial outlay required for improvements may drive this perspective. On the other hand, survey findings show that there is appetite for electrification of fleet, locally sourced materials and reduced business travel post-covid within the CES organisations all of which support circular economy. However, DfMA is not widely adopted currently with only 25% reporting of this practice within their projects.

Therefore, a Commercial CES is expected to be aware of circular economy principles and their application to advocate upgrading and maintenance of existing structures where possible, rather than demolishing and rebuilding. Similarly, it is also important to understand how circular principles can be applied on new construction. This way **promote circular thinking right at the outset of the project.** A geospatial surveyor on the other hand is instrumental in **eliminating or minimising waste through high-precision site measurement techniques**.

Biodiversity Net Gain (BNG)

The Environment Act 2021 protects the environment through the concept of BNG. The law requires developers to deliver a BNG of 10% more than there was before the development, improving the quality of the natural habitat. Achieving BNG helps achieve SDG 15, through mitigating negative impacts on biodiversity as well as compensating, leading to net positive outcomes for nature. If a 10% gain is not achievable on that site, it is required by the law to be offset somewhere else. However, RICS highlighted that there is less progress across the construction industry in assessing the impact of projects on biodiversity (Zehra, 2024) which needs to be paid attention to.

As this legislation becomes more understood by stakeholders, biodiversity offset providers will need **accurate baseline data from the surveyors** (such as vegetation and arboreal surveys). This will then equip ecologists to devise management plans to deliver the required

BNG. The 'skill' of surveying is in **the appraisal and understanding of a site** and not in merely recording measurements alone. Workshop participants also believe that the surveying professionals should have input on the design management plans to enhance efficiencies.

Sustainable Procurement

Sustainable procurement in construction helps achieve SDG 9 and SDG 12 via responsible consumption and innovative supply chains. Participants agreed that organisations that are working to promote sustainability should not focus solely on the 'headline' aspect of net zero carbon and should consider other sustainability aspects such as what is covered in the Public Services (Social Value) Act 2012. For example,

'How what is proposed to be procured might improve the economic, social and environmental well-being of the relevant area…'

Survey findings report that 52% are already procuring locally sourced materials and 70% confirmed the use of electric fleet which are positive. However, as discussed previously low carbon steel and concrete are still not commonplace and the majority (93%) confirmed that they still rely on standard delivery streams which can be bottlenecks to achieving SDG 9 & 12.

While survey results show good uptake of environmental standards by the CES organisations, workshop findings highlight that any business that has ISO20400 Sustainable Procurement standard and the like should not consider it merely as an aspect of management and compliance but as a tool to enhance the overall economic, environmental and social sustainability of the organisation and the community in which it operates.

Therefore, the CES is expected to have a **broad understanding of standards and legislations governing sustainable procurement** and an **awareness of the carbon intensity of materials and supply chains** so that they can influence decisions at an early stage of projects.

Life Cycle Assessment

Life cycle assessments contribute to SDG 9, SDG 11, SDG 12 and SDG13 as shown in Figure 8 by ensuring emissions from the whole life cycle of an asset, product or material are considered during design, manufacture and procurement related decisions(SDG 9, SDG12) and sustainable urban development (SDG 11). This in effect help contributes towards climate action (SDG 13).

A major contribution CESs can make to promote sustainability is the routine measuring, interpreting and reporting on the data of all aspects of projects, regardless of individual discipline and specialism.

Before emissions can be minimised, they must first be measured. Conveniently, carbon assessments can be done in tandem with cost assessments known as a 'dual currency appraisal' (see, Perera and Victoria, 2017) due to the nature of the inputs and measurement techniques involved, allowing economic and environmental goals to be considered simultaneously. These dual currency appraisals should start during the early design stages of projects, so that recommendations can be made regarding alternative design/procurement solutions, to achieve an optimum balance between cost and carbon, as the reduction potential is extremely high during the initial stages of projects. This is confirmed through survey results as well with respondents confirming to appraising alternatives (62%) and conducting feasibility studies (48%) at early stages of a project However, it is important to remember that the reduction potential reduces drastically as the design develops, leaving minimal options to be considered or scope for radical changes, resulting in cost, time and resource inefficiencies.

Therefore, the role of a commercial CES highlighted in the workshop is to have an **awareness of carbon assessment methodologies and promote dual currency appraisal** in civil engineering projects, an area which has not progressed much as per a recent RICS survey (Zehra, 2024). In addition, it was highlighted during the workshops that a CES should always **review and monitor the actual emissions to track changes and develop benchmarks for future projects.** On the other hand, a geospatial CES should be able to **measure accurately and capture the reality of the site** in a way that adds value to all reporting focusing on relevant metrics such as ground changes and tracking machines.

4. CONCLUSIONS AND RECOMMENDATIONS

This paper argued for the need for research on how sustainability can be practised at the professional level by using the CES as an example. We reviewed existing literature and found that most papers tend to focus on the environmental dimension of sustainability rather than all three dimensions – economic, environmental and social (known as the 'triple bottom line'). The main reason for this can be attributable to the immediate need to address climate change caused by the increase in the average global temperature due to increased GHGs in the atmosphere. However, it is poised by many researchers that true sustainability can be achieved when all three dimensions have been considered holistically before any decisions are made. Also, private surveying practises and civil engineers were identified as 'followers' in terms of sustainability adoption. Recent RICS sustainability survey also concluded that measuring carbon emissions and assessing BNG are two areas that have not progressed much but they align perfectly with CES's expertise. Therefore, we have investigated how commercial and geospatial civil engineering surveyors can practice sustainability by covering all three dimensions, as part of their job role through a mixed-method approach.

Our research highlighted that sustainability is practised by CES through various means at varied levels. Some areas are promising (fleet electrification, virtual meetings, hybrid working, ISO standard adoption, employee health and safety) while others still need work done (use of sustainable materials, innovative delivery streams, DfMAand lack of

communication from senior management about compliance with regulations/standards). Both survey and workshop findings highlighted that early engagement of the CES is crucial in setting appropriate objectives from the outset of the projects so that thorough analysis is done before decisions are made to maximise the reduction potential (economic, environmental and social impacts). The knowledge of sustainability regulations and standards is also important to promote these and ensure compliance, monitoring and reporting throughout the project life. In addition, we also recommend that the CES keep up to date with ever-evolving sustainability topics so that they can make and/or influence decisions that impact the overall sustainability of the project/organisation and society overall. We have identified four key themes to which the CES can contribute including circular economy, BNG, sustainable procurement and most importantly LCA.

The findings from our research inform the CES, both commercial and geospatial, how sustainability can be practised and how those actions contribute towards various UN SDGs. We also emphasize the need for mandatory government regulations to drive sustainability if we are to see a real change in the trajectory.

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