Opportunities and barriers faced by early-career civil engineers enacting global responsibility

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ABSTRACT
The term ‘global responsibility’ projects a holistic sense of ethics, sustainability, and obligation. To achieve the long-term viability of human life on Earth, civil engineering must be conducted in increasingly responsible ways, and civil engineers must value and enact global responsibility in their work. Interviews conducted with nine civil engineers in London provide insight regarding engineers’ familiarity with the term, how they learned about it, what opportunities and barriers they face, and what might be done by professional and educational institutions to help them practice more responsibly. Results indicate: the term itself is novel but underlying concepts are not; continuing professional development has played a crucial role in their understanding; material selection and Health & Safety represent primary avenues for contributing responsibly at work. This paper provides advice to professional institutions regarding transparencies, procedures, and metrics to enhance the UK workplace and ideas for educational institutions preparing engineering students for practice.

Introduction

Civil engineers’ decisions impact society. They influence the world, and life on it, via ‘the use of material, energy and water resources, the development of infrastructure, the design of new products and so on’ (Dodds and Venables Citation2005, 8). The construction and operation of engineered buildings, networks, and systems directly affect energy use, carbon emissions, and climate at local and global levels. Although civil engineering improves quality of life via clean water, effective sanitation, public transport, et cetera, it carries many negative consequences as well. Engineers – designers, managers, leaders, and decision-makers – with a sense of global responsibility are needed to achieve holistic solutions to the problems facing us all.

Aiming to promote a holistic vision, the United Nations (UN) has, since at least 2005, encouraged use of the term ‘global responsibility’ (GRLI Citation2020). Engineers Without Borders (EWB) also promotes the term. A European collective of Professional Engineering Institutions (PEIs)

followed suit in 2011. Embracing a sense of global responsibility – and seeking to promote it among all engineers – the European Federation of National Engineering Associations (FEANI) emphasised:

We can no longer limit ourselves to addressing technical issues as we did in the industrial age. Instead, we need to take a holistic view of the economic, ecological and social impacts of our actions — and always do so from a global perspective. Our objective here must be to ensure that every engineer adopts an international point of view so as to enable him or her to contribute to the improvement of the quality of life for everyone on the planet. (Fuchs and Bochar Citation2011, 45).

FEANI (Citation2019) aims 'to strengthen the position, role and responsibility of engineers in society' (¶1) and address 'social and global challenges' (Fuchs and Bochar Citation2011, 42). Although FEANI leaders published the term 'global responsibility' in 2011, adoption of the term 'global responsibility' via engineering speeches, publication, and documents is not evident.

What's in the term? 'Global responsibility' implies concern for environmental and social sustainability as well as financial aspects of construction, as conveyed in the three pillars – environment, society, economy (Purvis, Mao, and Robinson Citation2019) – that should be given balanced consideration in decision-making (McDonough and Braungart Citation2010). The term ties closely to 'sustainable development' – the type of construction that would meet 'the needs of the present without compromising the ability of future generations to meet their own needs' (UN Citation1987, 15). All professionals in all realms should balance these aspects when making choices.

Specific to civil engineering, issues that urgently require attention include

the poor condition of the infrastructure in many nations, the occurrence of corruption in the global engineering and construction industry, the minimal involvement of civil engineers in the political process, the need to more fully embrace sustainability, the globalization of engineering practice, and the desire to attract the best and brightest to the profession. (ASCE Citation2007, 1)

At large scale, humanity is not on track to reach agreed performance targets set by the UN (Citation2019). The work of civil engineers directly impacts ability to the UN's (Citation2015) Sustainable Development Goals. Indeed, civil engineering has been linked to mismanagement of resources and large-scale corruption. Even today, bribery, human slavery, and blacklisting of vocal critics are all evident in the production of the built environment (Craven Citation2020). Ethically irresponsible decisions can pile up with detrimental effects, as evidenced in the United Kingdom (UK) by the tragic fire at Grenfell Tower (Bowsher Citation2020; Craven Citation2020; Sanchez-Graells Citation2020). To help overcome challenges like these, professional organisations develop codes of ethics and agree upon standards of conduct. In civil engineering, protecting health and safety and avoiding corruption and bribery emerged as primary concerns in recent decades; these have been poignant foci in the UK, where significant progress has been made (Health and Safety Executive Citation2019). To promote desirable values and responsible behaviours among engineering students worldwide, the Washington Accord sought to integrate sustainability and ethics into engineering curricula (International Engineering Alliance Citation2014). The 20 signatories of the Washington Accord include the UK and nations on every inhabited continent (International Engineering Alliance Citation2020).

Discussion of ethics and sustainability is now common among civil engineers and PEIs in the UK. In 2004, UK civil engineers adopted a 'Code of Professional Conduct' (ICE Citation2017). They built on this with detailed 'Advice on Ethical Conduct' (ICE Citation2012). ICE has periodically updated these, indicating that they are living documents. ICE presidents have promoted sustainable development through inaugural addresses (Jowitt Citation2009; Leiper Citation2006) and other highly visible messages to members. PEIs have created guides on sustainability for engineers (Dodds and Venables Citation2005) and university instructors (Bourn and Neal Citation2008). To encourage life-long learning on these topics among engineering in the UK, PEIs recently introduced Continuing Professional Development (CPD) requirements that included structured recordkeeping, reporting, and auditing (Engineering Council Citation2020).

To facilitate shifts in higher education, UK PEIs adopted new accreditation requirements in ethics and sustainability (Engineering Council Citation2004, Citation2013). Yet, even though Higher Education

Institutions (HEIs) have been working to integrate sustainability and ethics into engineering curricula for decades, the results of such activity are largely unknown. Recognising this gap, Bourn and Neal (Citation2008) called for 'further research on the impact and value of the "global engineer" concept in the contribution of engineering to positive world change and meeting the skills needs of the UK workforce' (3). This study constitutes a first step, seeking to uncover the degree to which target values and abilities are reflected in civil engineering in the UK today. We aimed to determine how early career engineers (who would have entered practice after new accreditation standards for sustainability were adopted) currently understand and enact global responsibility. We wanted to know what they, their employers, and their PEIs have been doing in this realm.

In this exploratory study, requested by Engineers without Borders UK (EWB-UK) and supported financially by the Royal Academy of Engineering (RAEng) and the European Union, our university-based research team has taken a grassroots approach to generating new understanding of engineering practice in the UK. We interviewed nine London-based civil engineers (eight early career and one senior manager) about 'global responsibility' and analysed their interview transcripts inductively to understand what these early career engineers feel they can and can't change and what systematic improvements might be made to support them. We offer what we found as advice to PEIs (regarding procedures, quantification, and transparencies that our data suggest might enhance the workplace) and HEIs (as they work to prepare students for engineering practice).

Literature on global responsibility

'Being globally responsible means appreciating that there is a world beyond us; a world we are a part of and one that we can – and should – play an active role in improving' (Saint Michaels University School Citationn.d., ¶1). Across engineering however, this term is not well known. Literature reviews and interviews suggest concepts underlying the term are well known in engineering, but synonyms and close concepts are used in lieu of the term 'global responsibility' itself.

Emergence of the term 'global responsibility'

The book Global responsibility: In search of a new world ethic (Kung Citation1991) used the term, associated it with both ethics and

'Planetary Responsibility', and asserted 'an ethic of responsibility' (viii) should be adopted in lieu of the prevailing and individualistic success-driven mentality so prevalent in Western societies. The term gained some traction, and a dozen years later, Biefnot's (Citation2003) review of literature identified several clusters of understanding: eliminating poverty, reducing social inequality, respecting human rights, and protecting the natural environment.

The private sector has taken a leading role, initially differentiating itself from other sectors, 'by implying that doing good should also be good for business' (Biefnot Citation2003, 17). The business sector worked with schools and the UN to launch an initiative in 2005 'to catalyse the development of globally responsible leadership and practice in organisations and societies worldwide' (GRLI Citation2020, footer). The sector also launched, in 2010, a peer-reviewed Journal of Global Responsibility focused on management and governance (Emerald Publishing Limited Citation2020, ¶ 3). To facilitate assessment and accountability, the business sector adopted the terms 'corporate citizenship' and Corporate Social Responsibility (CSR). The later provides a self-regulating model wherein companies hold themselves accountable for impacting society in positive ways regarding the three pillars, with specific connotations of CSR varying from one industry to the next (Chen and Scott Citation2020).

To facilitate assessment and accountability across all sectors, the UN (Citation2015) adopted a set of 17 SDGs to be reached by 2030 that built upon Millennium Development Goals (MDGs) introduced by the World Health Organization (Citation2020) in 2000. Like MDGs, SDGs measure contributions toward environmental, social, and economic sustainability. Businesses, including engineering firms, can contribute to achieving the SDGs by using them to guide activity, e.g. identifying goals and benchmarks, monitoring impact, and tracking progress (Preston and Scott Citation2015; PwC, GMIS, & UNIDO Citation2017).

Within engineering, a group of engineers and scientists assembled a new organisation in 1991 and included the term in their title (INES Citation2020). They later defined 'global responsibility':

First, global responsibility means working for the betterment of humanity. Practically this means using one's talents and skills for

constructive rather than destructive purposes. Second, it means speaking out, individually or collectively, against dangerous and destructive uses of science and technology. Third, it means putting the welfare of humanity as a whole ahead of the considerations of any one nation. (Krieger Citation2007, ¶ 8)

Although principles of 'global responsibility' appeared in seminal documents of the American Society of Civil Engineers (ASCE), the term was mentioned neither in the organisation's vision for civil engineering (ASCE Citation2007) nor its strategic roadmap for achieving the vision (ASCE Citation2009). The words 'global' and 'responsibility' were used individually, but not together.

Overall, in engineering, the term 'sustainable development' has been used more readily. In civil engineering, greater sustainability is sought to enhance the profession's proud legacy of providing water supply and sanitation systems, transportation systems, and towers and bridges that are iconic, functional, and safe (ASCE Citation2007; Jowitt Citation2009; Leiper Citation2006). With increasing recognition that humans have been using more energy and materials than the earth can replace, civil engineering leaders have called for transformed approaches to improve the world's infrastructure and equitable access to it (ASCE Citation2007; Jowitt Citation2009). Major transformation is needed in the realms of construction, transport, energy, and political engagement (Bourn and Neal Citation2008).

Use of the term 'global responsibility' in research on engineering practice

In engineering, CSR encouraged 'ideas of sustainability, including human rights and environmental issues, as well as a chain of responsibility and duty of care' (Bielefeldt Citation2018, 42), yet the stated ideals have not been easy to achieve in practice. CRS for sustainable development is typically used as a marketing strategy; it rarely reflects 'a more sustainable long-term commitment to changes in organizational culture and also society' (Richards and Zen Citation2016, 275).

Regarding sustainability and engineering, two different ideologies emerged in the 1990s, alternately emphasising (1) technological and (2) socio-cultural change (Sakellariou Citation2018). Looking at socio-technical networks within structural engineering, Chilvers and Bell (Citation2014) asserted that despite pressure to address ethical and

normative issues (e.g. sustainable development, climate change, technological advances), there are professional arrangements that limit engineers' reach and the level of impact their work can have.

Chilvers and Bell (Citation2014) conducted an ethnographic study of a case conducted at Arup that used Actor-Network Theory. They found that 'the professional arrangements of the construction sector make the desire to deliver a more efficient and sustainable structure untenable' (338) because the architect serves as the 'central mediator within the actor-network of the design team' (338) and the structural engineer has little voice in driving design decisions. Structural engineers have become disassociated from the design process over time. Other barriers to change are 'practical habits of the construction sector' (Chilvers and Bell Citation2014, 338) and contract arrangements (that, for instance, allow the client to drive decision-making). The study by Chilvers and Bell is of particular interest because it included similar research questions and focused on sustainability without a specific focus on 'global responsibility'.

The term has been central in some empirical research related to engineering practice, however. These include studies titled 'global responsibility: sustainable development in information and communication technology' (Griese et al. Citation2001), 'strategies for high risk reduction and management as global responsibility' (Miccoli and Destefano Citation2010), and 'exploring site roles in global corporations: balancing local identity to global responsibility' (Wiktorsson et al. Citation2016).

Use of the term 'global responsibility' in research on engineering education

Several engineering education researchers have focused on global responsibility. A journal article by Wilson (Citation2010) focused on 'promoting active citizenship and global responsibility amongst populations in the global north' and a conference paper by Wigal (Citation2007) investigated 'the use of engineering design projects for student understanding of engineering's societal impact and global responsibility'. Tossavainen (Citation2009) identified global responsibility as a primary goal for internationalising the engineering curriculum, and Lappalainen (Citation2011) used the term in the text of a paper on 'cooperation as methodology for teaching social

responsibility to engineers' (513). Today, it is quite common for the term to appear in papers on curriculum or course design, for example: the 'GO GREEN' engineering course (Fox et al. Citation2008); study abroad (de Carvalho and Moore Citation2011; Songer and Breitkreuz Citation2014); and an engineering master's degree integrating sustainability (Gustafson, Vieth, and Eagan Citation2013). Scholars have investigated ways to incorporate global responsibility into first year engineering coursework (Kelly Citation2002; Reid et al. Citation2013). The term has also appeared in national overviews of engineering education, including Finland (Takala and Korhonen-Yrjänheikki Citation2013) and Australia (Dowd Citation2010).

Implications of 'global responsibility' for engineering education

Today, HEIs are mandated to produce 'graduates and qualified engineers who understand sustainable development and can deliver significantly more-sustainable solutions for society', according to Dodds and Venables (Citation2005, 45), who add that effective change will require intense involvement from practicing engineering, training managers, university leaders, and course coordinators.

The Engineering Council UK (2004) – which is the UK regulatory body for the engineering profession – took action to embed new requirements and enforce uptake via accreditation. Enacting the UK Standard for Professional Engineering Competence (UK-SPEC), the Council began requiring all engineering students to engage in activities related to sustainable development. In civil and structural engineering, the UK's Joint Board of Moderators issued Sustainability Guidelines that apply to bachelor's and master's courses, stipulating graduates should understand drawbacks of the extractive model of development, identify and implement methods to counteract negative impacts, and make design decisions in the context of sustainable development (Dodds and Venables Citation2005).

To assist HEIs, the RAEng supported development of guidebooks, example curricula, and teaching tools (Dodds and Venables Citation2005) specifically including model projects, assignment briefs, and the like (Bourn and Neal Citation2008). The RAEng appointed fellows to develop, pilot test, and refine innovative techniques in the hope engineering graduates would bring awareness, interest, and ability to enact change when entering practice, along with solid understanding of the role

engineers can play in facilitating change. Because this initiative launched over 15 years ago, target values and abilities should be evident among graduate engineers in the UK today.

Yet, preparing graduates with a full suite of skills and abilities is a tall order. Making fully ethical and sustainable decisions in complex contexts cannot be entirely mastered in 3–4 years of undergraduate study. Today, there is increased recognition that developing abilities in these areas must start in university and extend into the working years. In the United States, new accreditation criteria have been released via CEBOK3 (Bielefeldt et al. Citation2019). The new criteria delineate which knowledge- and values-based skills should be developed in sustainability and ethics. The criteria also indicate when and how such skills may be demonstrated effectively. Although specific cognitive and affective abilities are identified for development during university, CEBOK3 recommends the more complex, higher-order skills be developed through guided mentorship in the years following graduation (Committee on Education Citation2019).

Design and methodology

A primary objective of this study was to assess the degree to which civil engineers practicing in London value and enact ‘global responsibility’ in their work. Additional objectives were to assess the level of familiarity they had with the term ‘global responsibility’ as promoted by the UN since 2005 (GRLI Citation2020) and to gauge the level of saturation the term has achieved within engineering. The research team aimed to discover how participants defined global responsibility and how they experienced the phenomenon of ‘making decisions related to global responsibility’.

We investigated definitions of the term, sources of learning related to it, and the spectrum of experiences participants described from positive to negative, using the following research questions:

How do early-career civil engineers working in London conceptualise and define ‘global responsibility’?

How have they learned about global responsibility?

What aspects of global responsibility do they feel able to influence in their day-to-day work? What opportunities and barriers have they encountered?

Analyses surrounding those three questions helped us answer a final, overarching, question:

(4)
How might PEIs, HEIs, and engineering educators better support early-career civil engineers in their efforts to enact global responsibility?

Participants
EWB-UK identified the topic of global responsibility as well as the size and composition of the sample. The organisation recruited participants – three females and six males – via email and social media. Sampling was pragmatic and purposeful, intended to distill insight into engineers' experiences working in London. Eight participants had been in the profession less than nine years (see Table 1). Only two participants had practiced for more than a decade – one for 12 years and the other for 37. The one with 12 years overall, Jack, had entered engineering by way of a geoscience degree and considered himself an early career, saying 'I'm relatively young and there's still a lot to learn'. Participants' statements suggest they were motivated to provide interviews because they enjoy learning, have desire to share knowledge, and realised they could log CPD hours toward Chartership under sustainability.