Australasian Journal of Engineering Education

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/teen20

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To cite this article: Shannon Chance, Rob Lawlor, Inês Direito & John Mitchell (2021): Above and beyond: ethics and responsibility in civil engineering, Australasian Journal of Engineering Education, DOI: 10.1080/22054952.2021.1942767

To link to this article: https://doi.org/10.1080/22054952.2021.1942767

Published online: 22 Jun 2021.

AUSTRALASIAN JOURNAL OF ENGINEERING EDUCATION
https://doi.org/10.1080/22054952.2021.1942767

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Above and beyond: ethics and responsibility in civil engineering

Shannon Chance [a], Rob Lawlor [b], Inês Direito [c] and John Mitchell [c]

[a]CREATE, Ireland and the Centre for Engineering Education, Technological University Dublin and University College London, Ireland, UK; [b]Inter-Disciplinary Ethics Applied Centre, Leeds University, UK; [c]Centre for Engineering Education, University College London, London, UK

ABSTRACT

This exploratory study investigates how nine London-based civil engineers have enacted 'global responsibility' and how their efforts involve ethics and professionalism. The study assesses moral philosophies related to ethics, as well as professional engineering bodies' visions, accreditation standards, and requirements for continuing professional development. Regarding ethics, the study questions where the line falls between what an engineer 'must do' and what 'would be good to do'. Although the term ethics did not spring to mind when participants were asked about making decisions related to global responsibility, participants' concern for protecting the environment and making life better for people did, nonetheless, demonstrate clear ethical concern. Participants found means and mandates for protecting the health and safety of construction workers to be clearer than those for protecting society and the natural environment. Specific paths for reporting observed ethical infringements were not always clear. As such, angalyses suggest that today's shared sense of professional duty and obligation may be too limited to achieve goals set by engineering professional bodies and the United Nations. Moreover, although professional and educational accreditation standards have traditionally embedded ethics within sustainability, interviews indicate sustainability is a construct embedded within ethics.

ARTICLE HISTORY
Received 7 June 2021
Accepted 10 June 2021

KEYWORDS
Ethics; health and safety; corruption; professional responsibility; duties; civil engineering; sustainability; moral philosophy; accreditation

1. Introduction

The profession of civil engineering was founded on 'a moral imperative' (ASCE 2007, 10) to serve and benefit society. Since the early 2000s, engineering professional bodies have placed increasing focus on 'ethics', which ASCE has described as 'a branch of philosophy' defining 'right and wrong behavior' and investigating 'how people should act' (Committee on Education 2019, 17). This paper investigates how ethics have been framed, and engineers 'taught to act' vis-à-vis accreditation and continuing professional development (CPD). Accreditation and CPD constitute primary ways to infuse desired knowledge into a profession, the first by informing curricula and the second by requiring structured learning across an engineer's career. Looking beyond practical aspects and recognising that 'what counts' (Downey and Lucena 2005, 252) as effective engineering knowledge shifts by time and place, we also explored relationships between moral philosophy and engineering ethics.

To investigate ethics in engineering, we conducted an exploratory qualitative study on engineers' perceptions of 'global responsibility'. To start, we reviewed the literature on the visions of change set forth by

CONTACT John Mitchell j.mitchell@ucl.ac.uk University College London, UK

Shannon Chance, PhD, SFHEA, LEED-AP, is a Registered Architect holding bachelor's and master's degrees in Architecture from Virginia Tech and a doctorate in Higher Education from William and Mary. She is Lecturer and Programme Chair (Honours BSc in Digital Construction) at Technological University Dublin. She is also Visiting Professor at University College London, Chair of the global Research in Engineering Education Network (REEN), Associate Editor of *IEEE Transactions on Education*, and member of the Editorial Board of the *European Journal of Engineering Education*. In the past, Shannon served as Full Professor of Architecture in the USA, Fulbright Fellow to Ireland, and Marie Curie Research Fellow to both Ireland and the UK. **Rob Lawlor**, PhD, joined the Inter-Disciplinary Ethics Applied centre at the University of Leeds in 2005 after completing his PhD, entitled 'Gradability in Ethics' at the University of Reading in 2005 (supervised by Brad Hooker and Andrew Williams, and examined by Tim Mulgan and Philip Stratton-Lake). Before the PhD, he earned an MPhil at King's College London in 2003 (his thesis was on moral luck and punishment) and a Philosophy BA at the University of Reading in 2001. The majority of Rob's undergraduate teaching involves teaching ethics to students in the Engineering Faculty (including Product Design and Aviation students). In addition, he also teaches students in Chemistry, Environment, Media, Medicine, Dentistry and Business. At the postgraduate level, he is involved in the MA in Biomedical and Health Care Ethics (online and campus), the MA in Applied and Professional Ethics (online), PhD supervision, and some of the Faculty of Engineering's Doctoral Training Centres. **Inês Direito**, PhD, is Senior Research Fellow at the UCL Centre for Engineering Education. She is a Psychologist working in engineering education research since 2007. Her main research focus is on the development of transversal and professional skills; gender, diversity and inclusion; and, more broadly, how social and cognitive sciences can inform engineering education and practice. She is the Chair of SEFI's Special Interest Group on Gender & Diversity, a member of the UK and Ireland Engineering Education Research Network steering committee, and a Fellow of the Higher Education Academy. **John E. Mitchell**, PhD, is Professor of Communications Systems Engineering in the UCL Department of Electronic and Electrical Engineering, Vice-Dean Education in the UCL Faculty of Engineering Sciences and Co-director of the UCL Centre for Engineering Education. Between 2012 and 2016 he was on secondment to the UCL Engineering Sciences Faculty office, where he led the introduction of the Integrated Engineering Programme. The team that led this major revision of the curriculum across the engineering faculty was awarded the UK Higher Education Academy Collaborative Award for Teaching Excellence (CATE). In 2009, he was awarded the UCL Provost's award for teaching and has published on curriculum development with engineering education. Professor Mitchell is a Chartered Engineer, Fellow of the Institution of Engineering and Technology (IET) a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), Member of the Board of Directors of the European Society for Engineering Education and Principal Fellow of the Higher Education Academy. He is currently Editor-in-Chief of the IEEE Transactions on Education.

professional engineering bodies in the UK. Then, we collected interview data from nine engineers practising in London. We asked about their experiences enacting global responsibility and we probed their understandings of responsibility and ethics. We analysed their responses with regard to shifts desired by ASCE (2007, 2009) the UK Engineering Council (2004, 2013) and also the United Nations (2020) goals for ethical and sustainable practice.

Perceptions of identity and responsibility vary across contexts, often along national lines, and key issues in teaching students about ethics involve relationships 'between the identity of the engineer and the responsibilities of engineering work' (Downey, Lucena, and Mitcham 2007, 468). Therefore, studying these issues in their natural context as a means to understand the lived experience of engineers in a given location is important. This study provides a first step and holds credibility as an exploration to map the existing terrain and inform future work. The following research questions guided our study:

RQ1) To what degree did ethics feature in London-based civil engineers' descriptions of enacting 'global responsibility'?

RQ2) To what degree did participant experiences align with UK accreditation standards and CPD requirements related to ethics?

RQ3) To what degree did narratives reflect various philosophical stances on ethics and responsibility, and what might this suggest for future development of professional standards?

A framework for assessing results was generated by exploring literature on (1) professional engineering institutions' (PEIs') evolving statements on ethics, (2) accreditation standards regarding ethics, and (3) licensure and CPD requirements regarding ethics, in addition to (4) philosophical stances on ethics in engineering.

Overall, participant narratives on global responsibility reflected an emphasis on sustainability with ethics embedded but rarely explicit. Participants readily associated health and safety (H&S) with global responsibility, but typically described ethics, anti-corruption, and bribery only when prompted. With regard to H&S and avoiding bribes, they expressed having very clear mandates, whereas other facets of corruption and how to avoid them were less obvious. Some important ethical decisions, it appeared, were being left to individuals rather than embedded in company policies and cultures. The discussion section of this paper unpacks this finding, and the recommendations section identifies implications for engineering education and practice.

2. Literature

Ethics and sustainability have been interconnected across time, often with one embedded within the other in professional statements and accreditation standards.

2.1. Professional statements and the overlap between ethics and sustainability

Civil engineering has tended to emphasise sustainability over ethics. The 2007 vision statement mentioned variants of 'sustainable' 32 times whereas variants of 'ethic' arose just 7 times (ASCE 2007). A survey conducted by ASCE as groundwork for this statement reflected a similar hierarchy. The survey asked world-leading engineers 'How important do you believe the following issues/developments/trends will be in impacting the civil engineering profession over the next 20 years?' (p.76). Scoring 8.30/10 (fifth out of 21 topics) was 'Engineering ethics and business practice ethics'. Concerns about the 'Number of civil engineers involved in the decision-making process for infrastructure policy' involved ethics implicitly and scored 8.40/10 (third place). The resulting vision statement described an ideal future reality where civil engineers would be 'universally recognized for their high ethical standards of practice' (ASCE 2007, 47). This would be achieved through 'greater education and training of engineers in ethics and a greater emphasis on ethics in global engineering practice' (p.25). Under this vision, civil engineers would 'serve competently, collaboratively, and ethically' (p.2) in a way that would specifically honour 'client confidentiality, codes of ethics within and outside of engineering societies, anticorruption and the differences between legal requirements and ethical expectations, and the profession's responsibility to hold paramount public health, safety, and welfare' (p.11).

By 2007, notions of 'sustainability', 'sustainable development', and 'green building' had been gaining prominence across civil engineering and allied professions, all informed by an underlying sense of ethics and responsibility. Unlike ethics, very clear operating procedures were being introduced for sustainable development as early as 1990, when the Building Research Establishment (BRE) was launched to help guide decision making. This UK-based organisation released the BREEAM green-building rating system that became widely adopted in the UK and beyond (Building Research Establishment Ltd 2020). The United Nations followed suit with a focus on development, issuing the Millennium Development Goals in 2000, and the Sustainable Development Goals (SDGs)

in 2015. When organisations and award programmes were developed to encourage environmental sustainability and guide ethical decision-making, the word ethics often appeared tangentially.

Similarly emphasising 'sustainability' but leaving 'ethics' implicit were formal statements by presidents of the UK's Institution of Civil Engineers (ICE). Sustainability was a major theme of the 2006 ICE Presidential Address (Leiper 2006). Specific topics of the address were climate change, H&S, resource use, the organisation's people and how to make 'something happen' (p.1) by considering various perspectives. The word ethics appeared in a graphic presented during the speech, but not in the written transcript of the speech. Likewise, the 2009 ICE Presidential Address used variations of the word 'sustainable' 14 times, and 'professional ethic' once (Jowitt 2010). This mention was provided as advice to 'young engineers' to be 'well-mannered and considerate with high standards of proper behaviour' (p. 8).

Nevertheless, ethics were becoming more explicit in the UK. Working together in 2005, the Royal Academy of Engineering (RAEng) and the UK's Engineering Council issued a joint 'Statement of Ethical Principles'. The statement was updated in 2017. It specified the 'standard to which members of the profession should aspire in their working habits and relationships [and applicable] in every situation in which engineers and technicians exercise their judgment' (Engineering Council 2020a, 7). The two groups established, in 2019, a joint Engineering Ethics Reference Group (Engineering Council 2020a), in a move that suggests increasing concern for ethics and how to describe, convey and regulate ethics across engineering in the UK.

Operationalising specific principles in 2013, the UK Standard for Professional Engineering Competence, UK-SPEC (Engineering Council 2013) introduced a requirement for engineers 'to exercise responsibilities in an ethical manner' (p.7). The Spec's Statement of Ethical Principles promotes (1) accuracy and rigour, (2) honesty and integrity, (3) respect for life, law and the public good, and (4) responsible leadership, which explicitly involves listening and informing (p.33). These expectations apply to all fields of engineering in the UK. The aim was to regulate the profession of engineering by 'setting the standard for the practice of engineering and maintaining the registers of professional engineers and technicians' (p.2).

Ethics as a concept, practice, or set of ideal behaviours has been rising to the forefront. In the UK today this is most evident with regard to discussions and investigations of the tragic 2017 fire at Grenfell Tower. Reflecting a shift from the tradition of putting sustainably first, leaving ethics under the surface, in 2019 the ACSE asserted that 'Sustainability is part of the ASCE Code of Ethics and permeates all professional work of civil engineers' (Committee on Education 2019, 40). In this instance, sustainability was described as a subset of ethics. Situations like Grenfell underscored the necessity for this type of shift. As a result of that disaster, caused by the faulty cladding that had been installed based on inaccurate and intentionally falsified fire-safety test results, even greater emphasis is now being placed on how 'to make whistleblowing work for individuals, organisations and society', as indicated on the landing page of Protect (2021), an organisation started in the UK in 1993 (then called 'Public Concern at Work'). Today the Engineering Council (2020b) provides explicit 'Guidance on Whistleblowing', defining what it is, what obligations engineers have when a concern arises, what the legislations says, how to raise a concern, and where to get advice.

2.2. Accreditation standards regarding ethics

Universities were tasked to help achieve the envisioned transformation towards the more ethical and sustainable practice of engineering. To influence UK education, specific components were added via UK-SPEC. The nation started implementing changes around 2003 and it soon adopted the UK-SPEC, which sets standards for education (Engineering Council 2004). At that time, the UK's Joint Board of Moderators (JBM) issued specific Sustainability Guidelines for bachelor's and master's courses (Dodds and Venables 2005). JBM debates and makes accreditation-related recommendations for the Institution of Civil Engineers as well as the Institution of Structural Engineers, the Chartered Institution of Highways and Transportation and the Institute of Highway Engineers.

UK-SPEC, in its past and current forms, applies to all three-year B.Eng. degrees that are part of a path towards Chartered Engineer in the UK. It also guides all M.Eng. degrees leading to Chartered Engineer, and all Bachelor's degree programs leading to the qualification of Incorporated Engineer (i.e. engineering technologists 'who maintain, manage and apply current and developing technology'). The specification document 'provides detailed guidance concerning the "threads" of design; sustainability; health and safety risk management; and professionalism and ethics – all of which are required by the JBM to be fully integrated within engineering teaching and learning' (Engineering Council 2013, 2).

To support shifts in education practice and help educators do more to promote sustainable and ethical understanding and ability among students, the RAEng has, since at least 2008, been developing and distributing educational tools and techniques (Bourn and Neal 2008).

Global trends are similar in that, since 2013, the Graduate Attribute Profile of the Washington Accord (WA) has required students to 'apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice' (International Engineering Alliance 2014, 15). The WA informs curricula worldwide and it states that students must 'understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts' (p.15). These expectations have informed various accreditation systems, including ABET in the USA and the Engineering Council in the UK. Thus, since the adoption of the WA, increasingly clear standards have been implemented in civil engineering degree programs across the world, including the UK (Joint Board of Moderators 2018).

In the UK today, the Engineering Council (2020c) provides a set of standards, 'a framework for the assessment of the competence and commitment requirements for professional registration' and 'criteria that degree programmes must meet to be awarded accredited status'. This organisation sets the accreditation requirements for higher education engineering courses in a way that aligns with UK-SPEC (Engineering Council 2020d). The current standards specify six key areas for student learning. One is titled 'economic, legal, social, ethical and environmental context' and requires awareness of 'the various legal and ethical constraints under which [engineers] are expected to operate' and, more specifically 'understanding of the need for a high level of professional and ethical conduct in engineering and a knowledge of professional codes of conduct' (Engineering Council 2014, 13).

A new edition of UK-SPEC has been published for implementation during 2021 (Engineering Council 2020e). The number of learning outcomes has been reduced to increase focus on target areas, namely equitable and inclusive design, sustainability and ethics, security and mitigation of risks. Graduates at the Bachelors level must be able to 'Identify and analyse ethical concerns and make reasoned ethical choices informed by professional codes of conduct' (p.30).

There is increased recognition, originating in the US, that abilities related to ethics cannot be developed to the level needed during undergraduate years alone (Committee on Education 2019). Professional engagement and ongoing professional development are essential to developing and demonstrating such skills. According to new standards – specifically, the third edition of ASCE's *Civil Engineering Body of Knowledge*, better known as CEBOK3 – graduating engineers should be able to: acknowledge the importance of ethical behaviour, identify and explain the ethical responsibilities of a civil engineer, and comply with applicable ethical codes (Committee on Education 2019). Higher-level abilities are intended to be developed following graduation, through 'early career, mentored experience, which progresses in both complexity and level of responsibility' (Committee on Education 2019, 152). Thus, it is not until after graduation that civil engineers will be required to apply appropriate reasoning to an ethical dilemma, analyse ethical dilemmas to determine possible courses of action, or develop courses of action occurring in complex ethical situations. Other very high-level abilities are specified, but not necessarily expected to be achieved even during the period of structured mentorship. These are the ability to advocate for ethical behaviour in the practice of civil engineering, and the ability to assess courses of resolution to ethical dilemmas in complex situations.

2.3. Licensure and CPD requirements regarding ethics

Based on past efforts, one might expect recent engineering graduates to be entering practice with a heightened awareness of ethics and global responsibilities – fully understanding the role engineers play in achieving environmental, social, and economic sustainability – and equipped to act. Yet, developing the ability to discern and navigate through various ethical dilemmas may extend across a lifetime (Committee on Education 2019). Today, requirements related to ethics can often be found in licensure systems, and these increasingly involve maintaining an ongoing record of CPD in the years after graduation and professional credentialing.

In the UK, professional regulation is handled by the country's 35 licenced Professional Engineering Institutions (Engineering Council 2013). Only around 5% of engineers in the UK hold Chartership and although 'Chartered engineers represent only 5% of the engineering community, it is of the greatest significance that membership of the PEIs (including non-registered members) represent only about 15% of that community' (Uff 2016, 21).

Holding a degree is considered adequate for practice in the UK, and sufficient for signing off on most Certificates of Conformity, Certificates of Safety, Certificates of Design, and the like (Brinklow 2002). 'Engineer' is not a protected title and being Chartered is not required:

> *In general, there is no restriction on the right to practice as an engineer in the UK. However, there are a small number of areas of work, generally safety related, which are reserved by statute, regulations, or industry standards to licensed or otherwise approved persons.* (Engineering Council 2020f, 7)

Around 100,000 professional engineers are members of one of the civil, structural, or transportation

institutions overseen by the JBM (2017). Although not all members are fully Chartered, advice is available to members at all levels (e.g. student, graduate, technician, and associate, in addition to full/Chartered and Fellow). For those who want to become Chartered, earning a master's degree in engineering is essential. Chartership in civil and structural engineering has very clear requirements.

The current UK-SPEC identifies requirements and post-graduation CPD activities that must be met to gain certification (Engineering Council 2013). It encourages all PEIs to enact policies requiring CPD and to create systems for monitoring its members. CPD requirements thus affect all credentialed Engineering Technicians, Incorporated Engineers, and Chartered Engineers across the UK. Specific evidence is now required that certified professionals comply with the Code of Conduct of their respective institution, manage and apply safe systems for work, contribute to sustainable development, complete and record CPD to extend competence in their specific realm, and carry out their responsibilities in an ethical manner (Engineering Council 2013). UK-SPEC suggests ways that these requirements might be demonstrated. For instance, ability in sustainable development might involve operating and acting 'responsibly, taking account of the need to progress environmental, social and economic outcomes simultaneously' (p.12).

National policies have exerted pressure on PEIs to change. Whereas ICE had already been requesting roughly '30 hours of CPD per year up to the Professional Review stage [that confers Chartership] and then enough to develop and maintain the professional knowledge, skills and competence' (Continuing Professional Development 2014, 3), new national policies have increased the expectations and required new systems to enforce them. The Engineering Council (2020g) requires all PEIs to make random samples of members' CPD records and to provide them feedback. The Institution of Civil Engineers (2020a) explains how it is meeting this mandate. In January 2020, ICE requirements came into effect, requiring all professionally qualified members to update their Development Action Plans (DAPs) and Personal Development Records (PDRs) throughout the year. ICE now monitors these by way of an annual CPD Audit. ICE had been conducting random checks of members' CPD records since 2011, but expectations escalated. Today, 'if a member fails to submit their CPD records when requested as part of the annual audit, they will be removed from the membership roll and Engineering Council register' (Engineering Council 2020b, 10).

Thus, a significant and growing emphasis on CPD is evident across the UK engineering policy environment, and ethics and sustainability are explicitly included in the requirements. However, the majority of established engineers are not Chartered, and they are therefore not be affected by these new CPD requirements. In fact, there are no levers available to force them to update or expand their knowledge.

2.4. Philosophical underpinnings of ethics

Relevant to this exploratory study within the realm of philosophy is literature on duties, responsibilities, the public interest, occupational H&S, corruption, and bribery. We have pulled these into separate sections below, because participants readily associated H&S with global responsibility but the words ethics, corruption, and bribery typically emerged only when raised by the interviewer. We investigated the philosophical underpinnings of each of these topics individually within the literature review below and then used the same format when reporting results and findings.

2.4.1. Public interest duties and responsibilities

To understand basic concepts of ethics in engineering, it is necessary to consider professional obligations and duties, as well as economic and political constraints. In engineering contexts, Ladd (1982) explained, ethics have to do with a forward-looking sense of responsibility (asking *what engineers ought to do*, and more specifically, *what are their duties?*), rather than backwards-looking questions (like, *who is to blame?*). Philosophical literature related to ethics and responsibility tends to focus on duty, obligation, and requirements. Indeed, these terms are clearer than 'responsibility' and more explicit in what they mean. They make clear that something is *required*. It is not *optional*; it is something the engineer *must* do. There is a distinction between the responsibilities of individual engineers and the collective responsibilities of the engineering profession. For example, while only some individual engineers have the assigned responsibility to ensure the safety of drinking water in a particular community, engineers *as a whole* have a collective responsibility to provide supplies of safe water for the planet.

Kant made a distinction between duties of justice and duties of beneficence – whereas duties of justice are perfect and clear, duties of beneficence are imperfect 'such that it is not always clear who owes what to whom in what circumstances' (Gilabert 2012, 12). Supererogation is the philosopher's technical term for 'the class of actions that go "beyond the call of duty"' (Heyd 2002/2019, 1). The term highlights the crucial distinction between there being a moral reason to do X, and the claim that one *must* do X. For instance, according to most people's common-sense morality, one has a moral duty *not* to kill people, but – although there is a good moral reason for charity – giving a portion of one's income to address famine is

usually considered supererogatory, rather than one's duty. Some philosophers have challenged this conclusion, like Singer (1972) who argued that ignoring famine is morally wrong:

> *We would not be sacrificing anything significant if we were to continue to wear our old clothes, and give the money* [to prevent] *another person from starving. . . . To do so is not charitable, or generous. Nor is it the kind of . . . act which it would be good to do, but not wrong not to do. On the contrary, we ought to give the money away, and it is wrong not to do so.* (p.235)

A similar debate, between doing and allowing harm, is often discussed in terms of killing (doing) and letting die (allowing). A common view is that *all* engineers have a duty not to do harm and should not, for instance, dump toxic waste into a river that supplies a village's drinking water, regardless of the costs to the company of not polluting the water. In contrast, engineers do not have a comparable duty to *save* people from potential harms (assuming the harms were not caused by the engineers). Many believe the duty to avoid doing harm applies even in cases where the chain of causation is less straightforward. In engineering, the most obvious complication is risk. All civil engineers must assess the *probability* of doing harm, as nearly all projects hold some risk of harm. Although it introduces complications and shades of grey, one could argue that all engineers have a duty to avoid imposing significant risks of harm on the public. The Grenfell Tower fire provides one prominent example where engineers imposed an unjustifiable risk of harm on the public. The SDGs illustrate that perpetuating standard construction practices puts the health of humans and other living beings, as well as the overall planet, at risk (United Nations 2020). Protecting the public interest inherently ties to protecting the environment and working to achieve holistic, long-term sustainability. It is a moral imperative.

Going beyond the duty to avoid *doing* harm, however, leaves considerable scope to debate an engineer's duty to prevent harm (by not *allowing* it to happen). For example, following Singer's (1972) argument, one could argue that knowing about poverty and other problems (such as those raised by the SDGs), any person *ought* to act. If an engineer is aware of water shortages, lack of drinking water and basic sanitation, and resulting diseases and deaths, that engineer might have a duty to respond. Singer argued if a person can save lives 'without sacrificing anything of comparable moral importance' (1972, p.6) then the person is morally required to do so. Yet the implications of this view, and the demand it would impose on every engineer, indicate this view is radical. Despite the influence of Singer's work, it is accurate to say most moral philosophers do not agree with Singer. Chappell (2009) and Lawlor (2009) have provided views and arguments that contrast with Singer's. Regardless of what an individual might think about Singer's views, and where the line falls between duty and the supererogatory, various commitments have been made (e.g. the SDGs, the Paris Accord) that should be upheld, and engineers are a crucial part of the puzzle in achieving these commitments.

2.4.2. Responsibilities for Occupational H&S

According to the UK's Health and Safety Executive (Health and Safety Executive 2019) the construction sector comprises about 7% of the workforce. Due to evolving H&S practices and regulations, construction-related accidents and fatalities in the UK decreased, between 1987/88 and 2018/19, from 9.3 to 1.31 per 100,000 workers. The level of risk tolerated today is much lower than even a decade ago, and improvements have been dramatic. Yet, construction accidents still resulted in 37 fatalities (30 workers, 7 members of the public) in 2018/19. The rate of fatal injuries in the construction workplace was far higher than in either transportation/storage or manufacturing. To enforce safety, the HSE issues fines and brings to court companies that breach safety mandates. During the year before the 2018/19 report, 158 construction cases were prosecuted by the HSE, reflecting a drop from 202 the year before, yet 'Construction sector fines made up almost 30% of the total issued, second only to the manufacturing sector' (Rowland 2019, ¶7). There is clear room for improvement, but also an evident association between monitoring/enforcement and decreased number of accidents. Past success provides hope. Today, job-site safety is seen as everyone's responsibility, individually and collectively.

2.4.3. Responsibilities against corruption and bribery

Moral philosophers and professional bodies have highlighted widescale, societal implications of construction-related bribery and corruption. Vogl (2012) argued 'corruption kills' (p.39), illustrating that in Haiti, contractors had sidestepped building codes by bribing officials. This led to calamity in January 2010 when a quarter-million people were killed by the earthquake-induced collapse of homes, offices, and apartment buildings.

Today's engineers sense a clear moral obligation to avoid doing harm via bribery and corrupt activity, but this was not the case even two decades ago. How was change achieved? At the end of the 20th century, it became increasingly clear that engineers had been complicit in corruption. In 2004, Institution of Civil Engineers (2004/2012) acknowledged this view, stating that bribery and corruption produced 'wholly malign' effects, 'particularly upon the poorest nations' (p.7). ICE highlighted engineers' involvement:

> *In some parts of the developing world bribery and corruption in construction and civil engineering is so widespread that it has significantly reduced the number of infrastructure projects. This could not have occurred without the participation in bribery and corruption of contractors and consultants based in the developed world.* (p.7)

Efforts to establish a clear and shared conception of corruption in the UK were documented in a paper by Stansbury and Stansbury (2005) regarding 'unethical behaviour and criminal acts' related to construction. A group was set up by the Society of Construction Law in London in 2003 to stimulate debate, boost awareness, identify core principles of ethical conduct, articulate standards of compliance, and influence professionals of construction law. The group identified acts that should be considered ethical breaches – whether or not legally designated as criminal – and made clear that 'tender collusion, claims fraud, and deliberate supply of sub-standard products or incorrect quantities' (p.iii) were to be considered fraudulent criminal offences, rather than just 'part of the game'. As a result, refusing to accept gifts and kickbacks shifted from 'going above and beyond', or being supererogatory in the UK, to being expected.

Singer (1972) would ask us to do more, and he is not alone. Consider contemporary discussions about 'fair trade' over 'free trade', where Wenar (2008) has argued for creating 'trade where now there is theft' (p.2). Seeing unfair trade as theft shifts the sense of responsibility. By this definition, unfair trade steals and those who benefit from it carry guilt.

3. Design and Methodology

This paper reports a *post hoc* analysis of existing interview transcripts conducted for an existing study on global responsibility. The analysis encompassed all extracts from the existing transcripts that involved the words health, safety, ethics, corruption, and/or bribery. The project began as an exploratory study, and one primary request set the tone for each interview: 'Please tell us about a time in your recent work when you'd say you made decisions related to global responsibility'. Interviewers did not define the term 'global responsibility' for participants but rather asked them to define it themselves.

3.1. Sample

Research Ethics at University College London (UCL) approved the project. Engineers without Borders UK (EWB) solicited participants via email, newsletters, and Tweets, and a webpage was available announcing the project (Appendix A). The online registration form requested basic demographic data and scheduling availability. To be included in the study, the participant was expected to have studied engineering, be employed in London, and be working in the realm of the built environment. All who volunteered and were available to interview within central London were included in the study. Participation was voluntary and participants were not offered any incentive or reward. As such, this study reports results of a convenience sample. The sampling method presented several limitations, discussed below. Nevertheless, the sample did include a spectrum of experience levels and did achieve data saturation regarding participants' definition of 'global responsibility' (the aim of our larger study).

Ultimately, the research team conducted in-person, hour-long, semi-structured interviews with nine participants during the first quarter of 2019. Table 1 provides basic demographic data pertinent to this study; it is organised in ascending order of time in the profession. All participants were white Europeans (all but one were British nationals). The sample included three women and six men, and all but two graduated in engineering since 2010. Each had four years of engineering-related studies leading up to the diploma date listed. All had earned their engineering-related degrees in England, with one having done an

Table 1. Participant Demographics.

Pseudonym	Sex	Degrees Held	Prof. Years	Employment Sector (Type of Work)	Charter Status
Ava	F	M.A. & M.Sc. (Sustainable Development)	3–5	Sustainable Development (Consulting & Research)	N/A (Ph.D. Underway)
Emma	F	M.Eng. (Civil & Environmental Engineering)	3–5	Structural Engineering (Infrastructure & Building Design)	Underway
Arthur	M	M.Eng. (Civil & Architectural Engineering)	3–5	Structural Engineering (Building Design)	Chartered
Mia	F	M.Eng. (Civil Engineering)	3–5	Structural Engineering (Building Design)	Underway (now Chartered)
James	M	M.Eng. (Civil & Structural Engineering)	5–10	Rail (Design Management)	Chartered
Thom	M	M.Eng. (Civil & Structural Engineering)	5–10	Structural Engineering (Infrastructure Design)	Chartered
Charlie	M	M.Eng. (Civil & Environmental Engineering)	5–10	Rail (Infrastructure Construction Planning)	Underway
Jack	M	B.Sc. (Geoscience)	10–15	Ground Engineering (Construction Costing)	Chartered
George	M	M.A. & M.Sc. (Civil Engineering)	30–40	Rail (Design Management)	Chartered

additional master's course elsewhere in Britain. All but two held degrees that include the word 'Engineering'. All except for the research-focused participant (n = 1) were engaged in licensure; theyalready held Chartership (n = 5) in one of the 35 licenced PEIs in the UK or were aiming for it (n = 3, and one of these three gained Chartership since the interview). This reflects a significantly higher level of engagement with Chartership than is typical across engineering in the UK (Uff 2016). The sample also reflected a higher level of engagement with EWB than typical: four mentioned involvement with EWB (George, Charlie, Emma, Arthur) and one more (Thom) said he envisioned getting involved in EWB.

3.2. Interview protocols and questions

Interviews started with the explaination, 'We've been asked to talk with you about the idea of "global responsibility" and how it connects with the work you do as a civil engineer. Learning more about your experiences can help the engineering profession support engineers better and also serve society better. Getting to talk about these issues should also be enjoyable since all three of us here today will get learn new things.' The interview team then provided a hard copy of the information and consent form (previously been emailed to the participant by EWB). The complete interview protocol is included in Appendix B.

3.3. Data analyses

Our research team analysed data through interdisciplinary lenses: our team was diverse with regard to primary discipline and nationality, and we all had some degree of prior experience in engineering education research. Specifically, the primary author (Chance) had expertise in architecture and sustainability, the second author (Lawlor) in ethics, the third (Direito) in psychology, and the fourth (Mitchell) in pedagogical and technical aspects of engineering. This diversity was by design, to ensure the credibility of our analyses and interpretations. Chance and Direito co-conducted the interviews, verified the accuracy of professionally transcribed interview text files by comparing with the audio version, managed data using NVivo 12.0, identified categories and themes using grounded theory, interpreted findings and drafted results for multiple publications, including one focused on early career researchers (Chance, Direito, and Mitchell under review), as well as this one on ethics. During analysis, Chance and Direito used the constant comparative method (specifically involving open, axial, and selective coding) to identify themes and group them into categories (Charmaz 2014; Strauss and Corbin 1994). They analysed data inductively within each theme to make interpretations and to collaboratively identify findings. For this particular report, Chance also conducted searches to locate specific words and terms, and carefully compared what she found with the grounded theory analysis she and Direito had previously conducted. Based on scope and space limitations for this journal, only results and findings most directly related to 'ethics' in engineering have been included. Interpretations were discussed and verified with the team's ethicist (Lawlor) and Chartered Engineer (Mitchell). Pertinent data are presented first. The data are then interpreted via the literature, using stated aspirations of engineering bodies and philosophical concepts as frames of reference.

3.4. Limitations

Aspects of the dataset limit what we can see and find. One limitation is the convenience sample provided by EWB, which, although appropriate and manageable for an exploratory study, still restricts the transferability of findings for two primary reasons: (1) the sample group's higher level of engagement in Chartership and EWB than typical across the population, and (2) the lack of (racial and national) diversity in the sample group and (racial diversity) in the research team. Moreover, the activity attracted people working in central London who were willing to discuss the topic 'global responsibility' (which was not defined). All of the participants were either Chartered Engineers or were seeking chartership – which requires being able to 'demonstrate a personal commitment to professional standards, recognising obligations to society, the profession and the environment' (Engineering Council n.d., 7). Half of the participants also described having involvement with EWB, and the sample was skewed towards those who received email, LinkedIn, or Twitter posts directly, or through their professional networks, that originated with EWB. Furthermore, it is not possible to know how many people were invited, as participants explained the email was shared widely across offices and among people likely to have an interest.

Due to their higher level of engagement with chartership and EWB, participants were more likely than the average engineer to have engaged with ethics (e.g. to demonstrate awareness of obligations to society as part of chartership), global responsibility, and addressing poverty (foci of EWB). Nevertheless, even these engineers found that costs often trump ethics in day-to-day decisions making. So rather than participants' high level of Chartership and EWB engagement presenting a limitation to the study, because of the sample not being representative of the whole population of UK-based engineers, the results are even more striking

since these results happened *even* for these participants.

We have provided detail about the sample (Table 1) as well as the research methodology and design to help readers assess the degree of transferability to other settings and groups.

3.5. Trustworthiness

We took a number of steps to help ensure the trustworthiness of this research, primarily: (1) gathering advice from an advisory committee, (2) combining emic and etic perspectives, (3) providing a diversity of disciplines and nationalities on the research team, (4) frequent peer debriefing, (5) writing the report with detailed input from all authors, (6) reporting underlying assumptions, and (7) conducting member checks.

An expert advisory committee, comprised of academic researchers and engineering professionals, reviewed the work throughout the process and provided input. The advisors included one expert in philosophy and ethics (Lawlor). The core research team held frequent peer debriefing sessions to discuss and revise the themes and the coding structure. The overall study of global responsibility was conceived by EWB, and that organisation gained financial support from RAEng. EWB then searched for a third-party researcher or team to conduct the work. This helped detach the findings from an underlying political or philosophical agenda. The university-based research team worked with the advisory committee but was able to provide etic (outsider) perspectives and generate meaning from the emic (insider) perspectives of the advisors and participants involved.

Through frequent peer debriefings and collaborative analysis, writing, and editing, the research team was able to address many inherent assumptions. For this paper, we probed the advisory committee's assumption that ethics and anti-corruption literature were relevant to the study and would surface in participant responses – because, as it turned out, the responses were not so explicitly linked to these topics. At the outset, the expert advisors pointed us to specific literature (engineering reports, transcripts of speeches, and synopsis of philosophical standpoints) that informed our study. Member checks conducted during peer review helped increase the trustworthiness of findings reported in this paper, with four participants providing specific feedback.

4. Discussion of results

The results reported in this section address RQ1) *To what degree did ethics feature in London-based civil engineers' descriptions of enacting 'global responsibility'?* We start with an overview of words participants associated with ethics, before drilling down into the data to explore participant understandings of H&S, the narratives of two participants who introduced the word ethics on their own, and how and when participants learned about 'ethics'. Our discussion starts with H&S because participants most clearly associated this term with 'ethics'.

4.1. Words associated with ethics

For this report, we collated all the statements participants made having to do with ethics, corruption or bribery, and H&S. We included ethics, corruption, and bribery because our advisory panel noted a relationship among these, whereas we included H&S because participants consistently indicated that protecting H&S was central to their practice of ethics. To illustrate, when we asked Mia, 'Would you have had ethics [in university]?' she explained '*we would have considered things like health and safety*'.

During analyses, we searched all interview transcripts for the words 'ethics OR corruption OR bribery' and their variants, because at least one of these terms was introduced in all nine interviews, if not by the participants then by the interviewer. Then, recognising the importance participants placed on H&S, we conducted searches to pull all mentions of 'health and safety', 'H&S', 'health', or 'safety'.

Table 2 indicates the number of participants who raised each topic unprompted versus prompted, and how many times they used each of the words. H&S is listed first, because it appeared most frequently and was, in fact, the only one of these words consistently raised by participants. Ethics, corruption and bribery were typically only discussed with prompting.

Analysis of the data, discussed in detail below, indicated that H&S was clearly understood, consistently described across participants, of agreed importance, and supported by participants' company cultures. H&S arose naturally when participants were asked how they had enacted 'global responsibility'. In contrast, other aspects of ethics were rarely mentioned without prompting. Moreover, mentions of ethics beyond H&S were described in less detail than those related to H&S. Nevertheless, when the term ethics emerged directly from a participant, the backstory held important clues regarding ethical dilemmas individual engineers may face.

This paragraph provides context about how each term emerged, to help readers assess credibility and transferability. Only Ava and Emma mentioned ethics without prompting. The interviewer introduced the term 'ethics' in discussion with Mia, Thom, and Jack. Like Mia (above), Thom was asked 'Would they have discussed ethics?' Charlie was asked, 'Did you touch on any of those aspects in your education so far?' In other cases, the 'corrupt' or 'corruption' was

Table 2. Frequency of words associated with ethics.

Ethics topic	Participants
H&S (occupational)	5 unprompted, 6 in total[1]
Safety (public)	1 unprompted, 2 in total[2]
Health (public)	1 unprompted, 2 in total[3]
Ethics	2 unprompted, 9 in total[4]
Corruption	1 unprompted, 4 in total[5]
Bribery	0 unprompted, 3 in total[6]

[1]There were 19 mentions of "H&S" related to the jobsite, plus 1 "life safety" and 7 "safe" or "safety".
[2]There were 9 mentions of "safety" explicitly beyond the jobsite.
[3]Involved 3 mentions of "health" explicitly beyond jobsite.
[4]There were 14 mentions of the word "ethics" by participants.
[5]There were 8 mentions of the word "corruption" by participants.
[6]There were 2 explicit mentions and 1 implicit mention of "bribery" by participants.

introduced. George (the senior engineer) was the only person to mention corruption without prompting. The interviewer raised the topic when speaking with Mia, Jack, James, and Charlie, asking some variant of the question, 'Have you faced anything particularly stressful or corrupt?' As a result of probing, we had enough data on relationships between ethics and 'enacting global responsibility' to generate credible results and findings regarding ethics.

Looking at the bigger picture, we determined that, although the term ethics rarely surfaced without prompting from the interviewer, nearly all descriptions of making decisions relating to global responsibility reflected an underlying sense of ethics. For instance, there was consistency in their definitions of 'global responsibility', with longevity, concern for future generations, and the three pillars of sustainability (Purvis, Mao, and Robinson 2019) frequently mentioned. Participants were keenly aware that the decision they made daily affected the climate (via embodied carbon/carbon footprint) and the natural environment (via the use of natural resources, water and land). They also identified social aspects that they influence, but the effects and the chains of causality were not always as clear as with environmental impacts. Included under 'global responsibility' were community-building, accessibility, service to developing nations, etc. Some had done outreach work locally or abroad in an effort to be socially responsible.

Discussion surrounding ethics, corruption and bribery were not as straightforward as those related to H&S, where word searches proved sufficient during this report's analyses. Analysis of 'ethics' required more than a word search because, as noted previously, although the term 'ethics' did not spring forth, participants' concern for protecting the environment and making life better for people was permeated by a sense of ethics. Thus, we also referenced thematic coding we had previously conducted on our entire data set; we used the constant comparative method to identify passages linked to these concepts that did not use these specific words. With Arthur, ethics was a very clear theme across the entire interview, although the specific terms 'ethics', 'corruption', and 'bribery' were never raised. Similarly, Ava explicitly mentioned 'ethics' but she also described situations where corrupt practices disturbed her. Because she did not specifically mention the word 'corruption' the situations she mentioned are not tabulated above, but her experiences of corruption are analysed below.

4.2. H&S as a primary concern

During analyses, we discovered a distinction in participants' use of the term 'health and safety', because most passages implicitly described occupational H&S but not public H&S. They also sometimes used the word 'health' or 'safety' not in combined form 'H&S', as shown in Tabl 2. Comparing frequency counts reveals that for participants in this sample, occupational/job-related H&S has been a primary concern. In total, 5 participants (Jack, Charlie, Emma, Arthur, James) self-identified occupational H&S as a component of global responsibility, but no one mentioned 'bribery' of their own accord.

OCCUPATIONAL H&S

All but one statement about H&S was followed with a specific reference to the construction site. Whereas Mia did not explicitly reference job-site H&S when she described (above) learning about H&S in university, Jack said he learned about such topics by '*dealing with larger projects that have more of a focus on environment, safety and responsibility around construction*'. Overall, participants' sense of responsibility for ensuring occupational H&S was highly apparent.

> James: *I think there's a responsibility there . . . certainly projects in the UK are very strict with respect to health and safety, which they should be. It is everyone's mantra that people working in construction will return home at the end of shift. You could argue there's a global responsibility there because by showing such commitment to health and safety you're leading the way and letting others know how we should all be working.*

Likewise, Arthur's opening statement was, '*I'd say that pretty much all decisions we make in some ways impact on global responsibility and through more local aspects of that, say life safety and safety in impact in that, but also straight through to economics and the environment*'. Following up on this later in the discussion, the interviewer (somewhat inaccurately) summarised his opening as 'At the beginning of the interview you mentioned health and safety – ' and he immediately agreed, '*Yes, that's always on the core ones in structural engineering*'.

A focus on H&S was highly evident among those at the construction end of the engineering process. Those working as construction planners and cost estimators – Jack and Charlie – started discussing H&S either at the outset of their interview or as a core value. An important aspect of protecting workers' H&S involved

training provided to workers before they joined a site. Jack said organisers of one '*huge infrastructure project*' in the UK, '*said that 'safety is our number one priority and we are going to put people through this very intensive onboarding process*' that takes two days to complete. '*So, any contractor that comes on there, they charge for* [having] *two days of sitting down in a room and going through the process*' and this is done '*at the start of the job*' to ensure '*maximum safety*.'

PUBLIC H&S

Only George explicitly identified broader issues of (public) H&S on his own, although Arthur moved into this realm when invited to follow up on his earlier comments about '*life safety*'. Arthur's detailed response spanned occupational and public H&S in ways not covered in other interviews, e.g. '*Ultimately we need a safe building and then below that you need to be safe to construct*'. He explained '*you don't want your building to fall down!* [Also] *we try to make sure it's constructible, we're not injuring people, we're not using harmful materials . . . from asbestos, right down to just chemicals and paints and things*'. Likewise, Emma was looking forward to learning about '*the health and safety views, on site*' for an international development project she planned to support, indicating a similar breadth of concern and highlighting a relationship between public culture and H&S at job sites. On this topic, Jack stated, '*Health and safety is extremely good in this country, and can be very poor in other countries*'.

The senior engineer, George, had a comprehensive view of H&S, having worked in diverse international settings and in both water and transport infrastructure. He discussed a myriad of relevant issues ranging from safety clearances for rail lines, to installing water tanks in under-developed areas, to designing water systems to protect public health as well as marine environments. Protecting public wellbeing had always been a driving force in George's life. His ideas of wellbeing were continually expanding, and his recent work and CPD activities gave him a broader perspective – expanding beyond safety clearance in rail design to, today, helping ensure safety in public spaces (with increased consideration for diverse people with various sizes, needs, and abilities) and new strategies to protect vulnerable populations (e.g. those considering suicide). Whereas George used the word 'safety' throughout his interview, concerns for individual safety and public wellbeing were left implicit in other participants' comments. For instance, Emma wanted to provide equitable transport for women in the Middle East, Ava was designing spaces for the public good, and several participants discussed community cohesion.

PUBLIC SAFETY

Only one participant (the senior engineer) raised the issue of public 'health' without prompting. George said 'health' three times (in conjunction with water '*chlorination levels*', '*primary health care*', and '*building [a] health centre*'), but he also raised related topics (e.g. *air quality*) without mentioning 'health'.

Arthur used 'safe' in this broader sense once (safe building for people to use), and he voiced concerns for safety of those working in manufacturing plants abroad, thus indicating concern beyond the immediate construction site. Arthur saw opportunities to make the world safer everywhere he looked. As noted earlier, a sense of ethics permeated his narrative. Although he did not mention the word 'ethics', he discussed '*low-income housing in the UK* [intended] *to help solve the housing crisis*'. He talked about sourcing materials from China with consideration of impacts on the environment and individuals. He described the '*threat of climate change*' and his '*awareness of how globalisation might impact workers in the Dakar – or cause, you know, oil extraction, or mineral extraction – in Africa* [and] *might cause war*'. Further linking local and global, Arthur continually organised outreach for school kids '*teaching them about sustainability and the impacts in the environment, and how engineers are meant to try and mitigate those negatives*'.

MANDATES TO PROTECT H&S

Being responsible often carries a cost during construction. Participants described feeling mandated to protect H&S and compelled to protect workers, even when doing so would increase the project's cost. Participants said that large-scale publicly funded projects currently provide more opportunity to consider global responsibility and integrate such concerns into the design than private profit-driven projects. This, however, was not the case for H&S which they felt a clear and pressing mandate to protect. Concerning other aspects of responsibility (i.e. environmental sustainability, social sustainability) cost presented a barrier. There can be an upside to economic efficiency, however, because whereas cost hinders getting their ideas accepted by private clients, it also constitutes an incentive to cut waste and streamline designs.

James asserted, '*that one thing cost doesn't drive, is health and safety. It does cost a bit more, but it does ensure someone does remain safe and that will also include safety and construction and also in operation and maintenance, decommissioning. And I think that is a contribution towards global responsibility*'. Although James's statement prioritised occupational aspects, it also hints at implications for building users.

Jack said the commitment to H&S from his company involved contract procurement and ensuring that, from the start of a project, they allocated enough funds to ensure safety. *'Constructing safely is often extremely slow, and extremely expensive'* he explained, and high safety standards require time and money that must be considered in pricing each project. In Jack's experience, '*there is often a split between price, quality,*

environment' on large-scale projects, '*and health and safety as well*', whereas with smaller projects, '*tenders are assessed by price and duration*'.

Arthur noted, '*Health and Safety is probably the* [responsibility] *that we keep the longest. You might not pick up on environmental sustainability, or you might not . . . spend as much time considering it*'.

REMOVING ONUS BY MANDATING ACTION

Jack's company had taken pride in protecting workers' wellbeing, even where it carried expense and meant losing work to lower bidders. For instance, they did not allow the use of vibrating hand tools that could cause '*vibration white finger*'. The company prohibited '*forward tipping dumpers*' which are prone to overturn. Since his employer '*has made the decision to ban*' their use, he understood clearly that for his role in construction planning and bidding, he has '*got to find an alternative method*' even though '*we miss out on projects, because the next company won't ban it*'. By clearly stating its priorities, his company provided reassurance and removed the onus from him, individually.

> Jack: *I'm working within a framework where we have banned this . . . . That's clear to me. If the only alternative is to use something else that costs more, we lose that job. It's not a decision. That is our procedure, and we cannot go outside of that. . . . We try and sell that to clients. We sell that, "We're safer." We sell that "We're progressing the industry."* [But beyond the clear prohibitions, funding also] *depends on the contract and the client to how much weight is put onto that.*

Charlie agreed, there is '*100%*' support from his company for pointing out problems, rather than hiding them. The acronym SPQR (safety, profitability, quality, and respect) conveys his company's values and priorities. '*You can always go to any of* [the managers] *with safety*' concerns, he said, because '*we like to point out things that could cause accidents before they happen*'. This implies a strong emphasis on occupational safety across his company's culture.

4.3. Areas of H&S lacking clarity

Overall, the imperative to protect individuals was very clear regarding *construction sites*, but a corresponding mandate to protect the health, safety and wellbeing of the *public at large* was not as clear.

George wanted to see perceptions of H&S widened to include more. There '*are soft aspects for civil engineering which I think need to come in more responsibly*', he explained. Examples include '*the safety of public spaces, the ability to walk safely, the ability to access public transport safely with information available*'. He described how attending a recent lecture had opened his eyes to facets of H&S he had not noticed before; among users of the built environment, '*at least 50% of the people are going to be women* [but] *the needs have never been assessed from the perspective of the women*'. Recent efforts to act more responsibly have included the introduction of '*diversity and inclusion as a scoring category*' for bidding on rail projects, he said. It is worth noting here that learning had been a core focus for George. He regularly participated in CPD events like the one that exposed him to these new ideas, and he also provided mentorship to engineers at various levels.

4.4. Ethics of preventing corruption

Participants' high level of clarity and definitiveness regarding H&S stood in contrast to other aspects of ethics. As a result, it appeared, grappling with tough challenges was often left to individual engineer. Participant narratives suggested that there is a lack of clear paths for reporting potential or perceived problems, even though the code of ethics and participants' company standards for reporting gifts are very clear.

Both Thom and Charlie learned about ethics on the job and said it was not explicitly covered at university. When asked if they would have discussed 'ethics' in their courses, Charlie said, '*Not really*', although he noted his course was infused with issues of environmental sustainability, and Thom said '*Not that I recall . . . in terms of at the university, I don't think we touched on ethics really. No*.'

> Thom: *Ethics, though, obviously it's a big thing. When you start working, it's a big thing.* [Interviewer: How so?] *Because of the commitment that British companies have to make to acting ethically and not accepting bribes and the like. And we have to do mandatory training around that kind of thing. And, um, companies being—sort of understanding that acting ethically is of a benefit to an organization as well.*

During company induction, Thom heard, '*You have a duty to act ethically and uphold the Code of Conduct*'. Charlie found that '*very early on in my career, there were discussions regarding bribery policies and things. That ties into corruption perhaps. Yes, that's as far as it really went*'. He described avoiding murmurs of possible corruption.

> Charlie: *I've not really seen any of that. There's always rumour and whispering of—but that not really—it can't lead to a positive outcome, in my view, to discuss things like that. You shouldn't be oblivious to anything that might happen in terms of corruption, at the same time, there's nothing there to be talked about.*

He had explicitly encountered 'ethics' when preparing for Chartership:

> Charlie: *the ICE themselves have a Code of Conduct which will be linked to various things we discussed, so sustainability and sustainable development, has its own objective, as well as two separate* [ones], *but abiding by the Codes of Conduct which probably do cover corruption. There's almost a criminal aspect to*

> *that as well, but the development of others, in inspiring others that want to pursue a career in engineering, that's also part of it.*

Thom touched on the role of Chartership in promoting ethics as well:

> Thom: *For Chartership, . . . they have aspects of understanding legal context and understanding aspects of sustainability . . . you're tested on that, in an interview.*

Jack and Charlie both identified clear rules within their companies regarding corruption and bribery. When asked about ethics, Jack emphasised rules and procedures to enhance transparency. He asserted that in *'larger organisations, like the one I work for, there is quite strict rules*' for declaring gifts above £5. Failing to report such would be '*a clear breach of our operating procedures*'.

> Jack: *Honestly, I've never seen it, anything untoward. I'm not saying it doesn't go on, but I don't think it's just common place as it used to be. I think the world is a far more transparent place now, than perhaps 20, 30 years ago. I don't think, in the industries that I work in, that it is a particular problem. But you know, there is clear guidelines in place, for us receiving gifts or et cetera, from people that could compromise our decision-making. That is in stone. That is very, very clear.*

The senior engineer (George) was the only participant who mentioned the word 'corruption' without prompting. He brought this up when identifying two specific barriers that he said work against global responsibility in civil engineering: '*not being accepted by clients and all the corruption*' that has gone on. George said it was easier to talk about these topics today and that people were now more open to discussing ideas than they were in past decades.

It is important to note that, although the words ethics and corruption did not emerge from Jack, he was highly cognisant of the ethics of H&S having referenced 'safety' three times and H&S eight times, before this question was asked about corruption.

In all, four participants (Jack, Charlie, Emma, Arthur) asserted corruption was something they had not seen. James explained, '*I've certainly not come across any corrupt decisions*' but indicated that most decision '*lie in the hands of one or two people*' and perhaps outside his zone of perception.

4.5. Company cultures of ethics

The importance of company culture in upholding ethics and ensuring integrity was raised by Charlie, who explained his company promotes '*the idea to be open and honest. I mean, it's a bit of a human reaction sometimes, especially if you've made a mistake, is to hide it. Whereas that never actually works*'. He proceeded to explain, '*It's something that's always been encouraged in my company, so that's a cultural thing*'. Entering the company, he heard a lot about SPQR, where '*safety is at the forefront of everything we do. That's quite common within the industry. Then the P was for profitability, Q is for quality, installing something that works, and the R was for respect* [for] *colleagues* [and] *people you work with.*'

Emma and Arthur both worked in companies where there was specific and measurable support for both environmental and social sustainability. Both their companies encouraged dialogue and in Emma's company, individuals could opt out of working on projects they found ethically challenging. '*I'd like to think I don't bury my head in the sand*', Emma said, but she also tended to surround herself '*with people and environments that naturally mean I don't get exposed*' to things '*as negative as corruption or collusion*'.

Nevertheless, engineers also carry the responsibility as individuals to act ethically. Emma and Ava discussed their responsibility as individuals, as well as the power of a group when getting things done, and Arthur argued that, '*As an engineer, as any person, you're responsible for the outcome of your own actions. And as a technically qualified person, you should be more aware of than a layperson, especially within your field of responsibility*'.

Emma, one of the two who mentioned ethics on her own, opened the interview by discussing an ethical dilemma and describing how she achieved resolution. Discussions with co-workers were central to achieving satisfactory resolution of a dilemma involving '*women's rights*'. She faced '*an internal ethical questioning*' where she asked herself, '*Do I want to be working on a project whereby I'm supporting the government, that actually has views about women and equality, and even the environment, that didn't really sit well with me?*' She discussed her concerns with colleagues and ultimately could '*justify to myself – that actually*, [this project] *is enabling women, to transport themselves around, without the need for a man to accompany them everywhere*'. She acknowledged that perceptions of right and wrong vary from place to place. Later in the interview, Emma described having consciously cultivated her sense of ethics and considered varying cultural contexts, via volunteer work in developing countries. On-site engineering work had been '*challenging and very hard, but I learned a huge amount.*' She found that her '*experiences of being in different countries and cultures*' helped to '*form my personal opinions, and my* ***judgements*** *and ethics.*' She recently signed up to do pro-bono work, partly supported by her firm. Her decision to do that '*comes back to my ethics and my experience*, [because] *I have this drive inside me, I guess, that makes me want to experience that again*'.

4.6. Where to turn when things go wrong?

Emma, Ava, and Mia described experiences where ethical dilemmas were not so effectively resolved. In

these cases, it was not clear where these engineers, as individuals, could have turned to achieve more favourable outcomes.

Emma had faced a dilemma where a project she was involved with had been touted and widely advertised as sustainable because it used timber. When researching for a presentation, however, she discovered the wood was being shipped from the other side of the globe and its processing involved particularly onerous chemicals. She realised '*the message we were sending out, which was all the grand carbon offsetting benefits, were actually completely invalid*' and '*that was another moment where I sort of, I think to myself, "Is this the right message? Do I have a responsibility to raise this to anyone?*"' She asked her project manager who said he was aware of both omissions, adding ''*there's no method of reincorporating that', because we have a set system and it doesn't fit the standard*.' In the end, she said, '*there was nothing *done* to curb the snowball effect to this project*' and nothing was reported or said about how the information '*was slightly manipulated*'.

Over time, Ava had begun to realise that the engineering company employing her was steering work towards preferred recipients. It was also giving its own applicants for green building certification an unfair advantage by not reporting where the clients had failed to instal promised features. Ava described developing awareness that some sort of scheme was in operation and starting to scratch the surface and ask questions about what she was seeing. '*I started to feel like this is not something I can fully embrace, ethically and otherwise*', she explained, so she left the job and returned to academia.

> Ava: *all of my colleagues had at least two degrees, so they were intelligent professionals, and I was thinking, 'If this is rather obvious to me, how is it not obvious to them, and how come that I'm the, seemingly, only one who's questioning this?' So, I was closer to some of my colleagues and we had discussions about this, and it turns out that they were aware as well but they somehow, some way, justified themselves that it's okay, or they don't have other option to work for a company who are more ethical, or more genuine, or that every company is the same. So, there is a set of excuses that you can come up with, but I couldn't agree with any of this, basically. And when I concluded that, 'Yes, it is what it seems to be,' I just made a decision that I do not wish to work for an employer like that, and I don't want to believe that every company is like this because someone has to start making changes if we want the world to be a better place.*

Ava's narrative provides an indication of both corruption and greenwashing, even if she didn't use these specific terms. Ava also had perceived some degree of gender bias against her. She had experienced many moments of confrontation with her boss at that company. She explained, '*he essentially did not have meetings with me, because I questioned him. I asked questions*' as she began probing the systematic misrepresentation on '*professional and scientific*' levels that she observed in her company's process for seeking green building ratings for clients and throwing work to favoured parties.

Similar instances of biased selection were described by Mia, who had observed projects where there was '*a quite rigorous tendering process*' for contractor selection, '*and yet, they end*[ed] *up going to someone who's not necessarily the cheapest, or not necessarily the most competent, because of a relationship that's been set up*'. In one instance, she said, '*this led to a really awful construction process*' riddled with '*bad practice*'. She observed '*shortcuts taken on the site in relation to health and safety, poor quality construction*' since the owner's priority was bottom-line finances and not the long-term usefulness of the structure being produced. It is worth noting that Mia raised these topics only when probed, as her conception of global responsibility dealt mainly with '*the sustainability side*'. When asked if she had encountered ethics in the university curriculum, she explained, '*We did project management modules and they would have covered ethics. Yeah, so we would have considered things like health and safety and things like that. I'm not sure how strong the link to sustainability was in them either though*'.

George identified recent changes in tendering designed to affect '*how companies are addressing D&I* [diversity and inclusion] *in the way they are forming up the teams to work*' as one new way to help overcome systematic bias and gender discrimination.

5. Recommendations

Through analysis of interview data, we saw a high level of clarity regarding rules and regulations to protect construction-related H&S – and we saw clear systems for sounding alarms when such problems were noticed by anyone at nearly any point in decision-making. There have been dramatic and measurable improvements related to occupational H&S, in recent decades as described in interviews and documented by the UK's Health and Safety Executive (2019), such that today, H&S consistently trumps cost. Participants described some clear expectations around preventing corruption and bribery, as well, but ways to flag problems during design and tendering were not described.

With regard to promoting ethics and fair business practices, our literature review highlighted advancements. The American Society of Civil Engineers (ASCE 2009) had developed strategies to promote 'competency, honor, integrity, dignity, impartiality, fairness to others, and [to improve] ethical practice by example, education, and leadership' (p.47). We saw evidence (in the interviews and literature) that aspirations stated by ASCE (2009, 47–48) were being

realised in the UK. These included: publishing and promoting the discussion of case studies on ethics; encouraging the development of codes of ethics where they did not exist; creating minimum universal guidelines aimed at eliminating bribery, fraud, and corruption; encouraging monitoring and enforcement; and engaging multi-national corporations to assist with the reduction of bribery, fraud, and corruption by, for instance, identifying negative impacts such practices can have on the corporations' global competitiveness. Efforts to define 'unethical behaviour and criminal acts' in the UK (Stansbury and Stansbury 2005) were evidenced, yet none of our participants discussed the existence of the Engineering Council (2020b) 'Guidance on Whistleblowing' or the organisation known as Protect (2021). Evidentially, sounding the alarm was not something participants had prepared for in university or at work, and these findings have implications for the practice of engineering.

The sub-sections below provide recommendations, or clear takeaway lessons, drawn from our analyses.

5.1. Congruence with professional statements

Whereas the specific aspirations of ACSE listed above appear to have traction, interview data suggest more could be done regarding the following recommendations from (ASCE 2009, 48):

- Promote ethics education as a required part of civil engineering curricula (since participants could not recall having such lessons);
- Promote zero tolerance of bribery, fraud, and corruption by example and leadership (since occupational H&S was closer to zero-tolerance in that it promoted reporting problems);
- Establish outreach programs to educate the engineering and construction industry on both the negative impacts of bribery, fraud, and corruption and how to improve practices (since ways to improve practice by flagging issues was not fully evident).

'Zero tolerance' of corruption was not evident, and no examples of people having flagged concerns were identified in interviews. Bribery was operationalised (e.g. the £5 gift limit), but other forms of corruption, and when or how they should lead to whistleblowing were not clear. Taking bribes was recognised as being wrong; mandates and reporting standards to avoid corruption oneself seemed clear. Yet, more nuanced aspects of corruption remained problematic; how to address ethical misconduct observed in other people, systems or measurement instruments, was entirely unclear. Universities and PEIs can thus do more to convey their desires and expectations on whistleblowing. They need to show, convincingly, how to flag problems while avoiding fallout (Engineering Council 2020b; Protect 2021). Evidence emerging about the 2017 Grenfell tragedy and the intentional falsification of fire testing data have been providing impetus for such discussions in the UK, but these topics did not surface in the interviews on global responsibility conducted in the spring of 2019.

Because engineers in our study did feel empowered to act on occupational H&S, we now wonder: Can we use the levers that facilitated sweeping changes (both in both occupational H&S and bribery avoidance) to facilitate quick change in other areas of ethics (specifically environmental and social aspects of sustainability and justice)? Individuals may feel more compelled to act to address problems when the profession creates a culture that encourages alerting others to concerns and pursuing answers through to resolution. Today, the balance of individual versus collective responsibility is not always clear, and this can leave some problems seen but not addressed. It can also subtly encourage people to ignore issues that they feel they cannot change.

Ideally, to achieve stated goals, graduate engineers would feel encouraged (within their office cultures, by their professional organisations, and by society as a whole) to consider ethics and enact global responsibility in decision-making, and they would have clear and reliable routes for addressing concerns, shortfalls, and/or problems they discern. They would feel compelled to identify as well as address ethical dilemmas and would be part of a system where their concerns would be heard and considered without fear of retribution. It appears that many engineers do not have a good way to report problems, as evident in interviews with both Emma (who worked in a place where such topics were open for discussion, but errors and omissions might slip past, un-challenged) and Ava (who worked in a place where tough questions were not open for discussion at all).

Today, office policy (e.g. funding for volunteer work and CPD, maintaining of sustainability portfolios, H&S standards for bidding) and office culture (email chains, office chat, peer pressure) play a part in who gets exposed to new knowledge about ethics, sustainability, and 'global responsibility'. Some offices appear more receptive to difficult conversations than others, thus permitting a wider range of challenge and debate. Moreover, the fact that many of the participants worked in firms where they could openly discuss ethical incongruencies, and some could even opt out of work they found ethically challenging, led us to wonder: Is allowing an opt-out the best way, or might it simply get the most conscientious among us to focus elsewhere when the profession and society really need their critical eye? Would it be more advantageous for society and the profession to encourage conscientious objectors to take a more challenging, less passive, stance?

A transferable example of transforming work culture occurred at Korean Airline, which went from worst to best-ranked for safety in a remarkably short period. Advisors helped teach airline staff to question poor decisions of their superiors, a practice at odds with prevailing cultural values in Korea (Gladwell 2017). The airline achieved change by encouraging individuals to challenge authority and voice their concerns, without fear of being reprimanded or shunned.

Engineers need similar assurances. Medicine provides a helpful example of a profession that re-made itself substantially. Major shifts happened in the 1800s, resulting in the 1858 Medical Act and other legislation. During this 'age of reform', medicks formed a self-image, as public servants, and they fought for *recognition* of this image. They pro-actively challenged (and sought prosecution of) quacks who were a danger to the public, while writers like Thomas Wakley (founder of *The Lancet*) challenged complacency, nepotism, and incompetence in the London colleges (Brown 2007, 2011, 2014; Burney 2007).

The engineering profession might benefit from similar reforms – working to address current challenges wherein less than 15% of UK engineers are registered and only 5% are Chartered, there are few restrictions on what work can be done by non-registered engineers, and PEIs often are 'seen to be self-interested' (Uff 2016, 67) and 'very inward-looking, focusing on survival above all else' (p.37). Even 40 years after the Finniston Report (UK Parliament 1980), the profession has not effectively responded to claims that the existing 'voluntary system of registration' is insufficient to 'achieve the critical objectives of a national registration system for engineers' (UK Parliament 1980, 128), as emphasised by Lawlor (2018) and Inter-Disciplinary Ethics Applied (2018).

On a more positive note, the research team for this study was notified that change may be underway. During the peer-review process of this manuscript, we conducted member checking. In January 2021, Charlie read two of our pending manuscripts and wrote to us about a '*very obvious change*' he encountered when setting up his annual performance review:

The first two questions my manager now needs to answer [about me] *are . . .*

1. I am confident safety is the number one priority for this employee?

2. Does the employee have an ethical approach to situations/results under all circumstances?

While the first question hasn't changed in the last 10 years, the second one has.

The major implications from this section tie to ACSE's recent CEBOK3 report that provides advice on 'preparing the future civil engineer' (Committee on Education 2019, 1). Comparing recommendations with the experiences we heard, we see the need for: increased ethics education across the engineer's career; lower tolerance for corruption to be expressed via policies; and clearer procedures to voice, challenge, and address errors, omissions, and poor decisions. We heard that, in instances where early-career engineers observe unethical or corrupt behaviour, they may lack sufficient guidance on how to address it. The type of structured mentoring described in CEBOK3 is intended to address this type of problem. It could help individuals navigate through tricky situations – and seems needed. No engineer in our sample mentioned receiving such mentorship (although two described providing mentorship or supervision for teens and undergraduates). Assessment measures like the one described by Charlie (in the feedback he provided above) can help open this type of dialogue and bring ethical expectations to the fore.

5.2. Accreditation and CPD: Are these meeting stated goals?

This section addresses RQ2) *To what degree did participant experiences align with UK accreditation standards and CPD requirements related to ethics?*

Because UK-SPEC has been in place since 2003 and the WA since 1989, with increasing requirements for degree programs to incorporate ethics and sustainability, one might expect that all individuals graduating in engineering since 2010 (thus, all in the sample except Jack and George) would have encountered aspects of ethics having to do with sustainability and professional conduct as part of their accredited-degree programs. More specifically, seven of our participants should have been affected by the Sustainability Guidelines for bachelor's and master's courses enacted by the JBM 2003–2004 (Dodds and Venables 2005). Thus, in the process of data collection and analysis, we were surprised to discover few recollections of ethics and sustainability training received during university years. Charlie and Thom, for instance, did not recall having discussions about ethics in university. On the other hand, Arthur's architectural engineering programme was permeated with environmental and social justice discussions, even though he never used the word 'ethics', and Charlie's scenarios-based civil engineering course did aim to foster understanding and values about the environment. Several participants (the researcher Ava, senior engineer George, and study-abroad alumna Emma) emphasised that they had encountered these topics outside the traditional, undergraduate engineering curricula.

Thus, although some (e.g. Mia) indicated ethics was probably covered in their professional practice classes, it was not covered in a way that was 'sticky' enough for them to recall (Mia, Charlie, and Thom). It is likely that in curricula where ethics permeates across modules, rather than being allocated to a specific module

or two, it is less recognisable to students. Likewise, when preparing for accreditation, educators themselves often express difficulty knowing if, when, or how they cover ethics (Martin 2020; Reed et al. 2004).

Comparing results with CEBOK3 (Committee on Education 2019), published just after our interview data were collected, proved valuable. The prominence of ethics has increased beyond the earlier CEBOK versions guiding engineering accreditation in the US, and this is likely to inform subsequent global policy (e.g. through the WA). Descriptions have become clearer of how individual engineers are expected to learn about ethics and sustainability. Now, only two points must be demonstrated at the undergraduate level: identify and explain a civil engineer's ethical responsibilities (cognitive domain) and acknowledge importance and comply with ethical codes (affective domain).

Based on data we collected, it appears our participants would have reached those Level 1 and 2 thresholds upon and/or near the point of graduation (e.g. Thom and Charlie expressed being consciously aware of ethical and anti-corruption codes upon entering their companies). Indeed, during their interviews, all participants 'demonstrated abilities' consistent with CEBOK3 requirements for the affective domain, which are to value ethical behaviour in the practice of civil engineering (Level 3, expected after graduation); display ethical behaviour in the practice of civil engineering (Level 4); and advocate for ethical behaviour in the practice of civil engineering (Level 5) (Committee on Education 2019, 151). These three points are meant to be achieved through mentored practice. For our participants, the three items were achieved through CPD and company culture. For Ava, who found values too lacking, aligning with these points required moving to a new work setting. Participants indicated that they learned about 'global responsibility' topics through workshops, company-sponsored events, lectures from their professional bodies, and via personal research and reading on their own time (e.g. CPD). This sample group continued learning – prompted by voluntary involvement in their professional bodies' structured CPD systems.

During analysis, we came to realise that although in the call for participants, Engineers without Borders had noted the main incentive was 'the opportunity to shape and define our profession in the years to come', several participants described an incentive to earn CPD credit for their Chartership applications. Thus, an incentive invisible to the recruitment and research teams yielded a group of volunteers more highly concerned with Chartership than most (because 95% of people practising as engineers in the UK do not get Chartered). Through member checking, Arthur indicated this percentage is likely to be higher in the '*construction industry. Especially the civil and structural side of it*', where he believes a higher portion gets Chartered.

Findings suggest that using CPD requirements as a lever can indeed bring greater attention to target issues, like ethics and sustainability, but that most of the UK engineering population will not have the same direct pressure to upskill via required CPD. We recognise some firms do allocate staff hours to CPD, hopefully affecting people who are not seeking Chartership as well as those who are, but it was not clear from interviews if companies mandate any minimum level of engagement in CPD by staff, beyond understanding company policy and their professional body's Code of Conduct.

CEBOK3 (Committee on Education 2019) points to 'mentored experience' for developing higher-level abilities in ethics, but across this sample, no mentoring system was described to help engineers, post-graduation. Such a mentoring system could pair graduate engineers with seasoned practitioners outside their immediate firms. Narratives suggest that some participants could have used supports outlined by the Committee on Education (2019, 150) for applying appropriate reasoning to an ethical dilemma (Level 3), analysing ethical dilemmas to determine possible courses of action (Level 4), developing courses of action to ethical dilemmas in complex situations (Level 5), and assessing courses of resolution to ethical dilemmas in complex situations (Level 6, the one to be achieved through 'self-development').

Although Ava, Mia, and Emma had all encountered or observed ethical dilemmas, and all participants had applied ethical reasoning in various ways (e.g. occupational H&S), we did not find evidence of an adequate or effective system for supporting early-career engineers and mentoring them in ethics. Mia and Emma described office cultures where they could discuss and opt out of work, whereas Ava could discuss dilemmas but could not opt out. Ava was not part of an office culture where ethical breaches were considered problematic until she returned to academia. Some scenarios reflected sound reasoning (e.g. leaving a firm where corruption was rampant) and effective resolution (e.g. justifying the creation of public transit systems in counties that typically suppress women's rights). Other scenarios reflect a willingness to overlook problems in order to move on, both in cases where the individual might reasonably have facilitated change (to improve the reliability of a faulty carbon assessment tool) and ones where addressing the problem might not be reasonable (addressing false advertising that resulted from inaccurate calculations or addressing where a client's representative allowed faulty work to pass due to favouritism in bidding). In all these cases, having an external point of view could have helped.

As a result, we recommend that the UK sector studies the CEBOK3 proposal for 'structured mentoring' and provide a system of external mentoring to help engineers. In this way, proper development can be 'accomplished through early career, mentored experience, which progresses in both complexity and level of responsibility' (Committee on Education 2019, 152).

Regarding the relationship between ethics and sustainability, the results of this exploratory study also lend support to moving ethics up the hierarchy, as has been done in CEBOK3 (Committee on Education 2019), such that ethics is no longer tucked under sustainability but now resides alongside it – with both as top-level priorities. Although professional and educational accreditation standards have traditionally embedded ethics within sustainability, our analyses, as well as CEBOK3 and Martin, Conlon, and Bowe (2020), suggest sustainability is a construct embedded within ethics.

Key implications from analyses related to accreditation and CPD are: (1) achieving sustainability is one aspect of ethics; (2) not all engineers practising today will have encountered formal education on ethics, or even sustainability; (3) Chartership provides an incentive to engage with and learn about ethics and sustainability; and (4) new approaches, like more highly mentored practice, are needed to help support individuals facing ethical dilemmas. Specifically, individuals need more ways to confront and address corruption, environmental damage, and social injustices they see occurring in the construction sector – if humanity is to achieve goals stated in the SDGs and agreements such as the Paris Accord. Individuals also need more support to recognise ethical dilemmas that they may not feel prepared to acknowledge or address. Support for whistleblowing needs to be more widely understood by practising engineers.

5.3. Philosophical congruence

This section addresses RQ3) *To what degree did narratives reflect various philosophical stances on ethics and responsibility, and what might this suggest for future development of professional standards?*

In interpreting the degree to which participant narratives reflect various philosophical positions related to ethics, and what this suggests for future development, we have focused on obligation, duty, and collectivisation. Kant's distinction between duties of justice and duties of beneficence holds relevance: duties of justice are perfect and clear, while duties of beneficence are imperfect. Thus, 'it is not always clear who owes what to whom in what circumstances' (Gilabert 2012, 12). It appears society and the profession could benefit from increased clarity. This could help engineers understand more clearly where they are obliged to act when they see problems related to ethics, environment, social justice, or corruption. Today much of this is left up to the individual to grapple with or ignore.

Converting some topics traditionally considered simply 'good and right' to being considered 'required' of engineers, both individually and collectively could help individual engineers in their day-to-day work. The collective needs to better evaluate what is required and convey these messages strongly and clearly, as it did with H&S. By doing so, the collective (PEIs) could move some of the onus from the individual to the collective. This would allow individuals who point out opportunities and flaws to understand their effort as positive and desirable, *as well as mandatory*. Making this shift would build on Samuel Florman's (1987) observation that 'the law has taken over many substantive areas that used to be the province of professional ethics' (p.87). Regulations and building codes, Florman argued, have reduced the need for ethical judgements by individual engineers. Protecting H&S is a legal obligation, and protecting human and planetary wellbeing should be, too, with more included under this banner.

Philosophers often distinguish between a duty of beneficence (a duty to do good) and a duty of non-maleficence (meaning, a duty to refrain from harming others). Although non-philosophers may not use these specific terms, the distinction is also a part of common-sense morality. Most would agree with Ross (2007) that 'non-maleficence is apprehended as a duty distinct from that of beneficence, and as a duty of a more stringent character' (p.10). Yet the line between causing harm and feeling required to stop it remains blurry today. Based on this distinction, one could plausibly argue there is a limit to what can be required of engineers to respond to global poverty (SDG #1), but that engineers should not ignore opportunities for responsible consumption and production (SDG #12), climate action (SDG #13), ensuring availability and sustainable management of water and sanitation for all (SDG #6), or creating sustainable cities and communities (SDG #11). Based on current expectations within engineering, however, entry-level engineers face both subtle and overt pressure to ignore opportunities in these areas. It appears difficult for a civil engineer to completely avoid 'doing harm' to the natural environment when seeking to 'do good' for society – and pressures of time and budget make it hard to pursue opportunities to 'do better'.

So where should we draw the line in engineering, between what is required and what is supererogatory (good but not required)? Singer (1972) provided a fairly radical view regarding obligations to improve the wellbeing of others. It is a stance that most moral philosophers reject as being too extreme, but we think it is worth considering a full spectrum of possibilities,

especially because scientists believe humanity is at a precipice regarding climate. That means a dramatic and immediate shift would be beneficial about performance expectations for engineering and construction. We believe engineers' sense of obligation and duty must shift to reflect a wider range of concerns, as envisioned by ASCE (2007) but not yet achieved. If engineers are to realise such visions, they need to work together to empower themselves, individually and collectively, to force change, before it is too late.

Shared perceptions of what is required by humans in many fields must be expanded if humanity is to persevere and thrive. In engineering, there are signs of hope and precedents for achieving better results. Clear improvements have been made in the UK regarding occupational H&S. Some companies are exceeding current standards because they have been able to identify problems and they have chosen (internally, as a collective unit) to work to alleviate them. Yet – realising that accident and fatality rates are still higher in the construction sector than in either transportation/storage or manufacturing – there is still room for improvement.

There is also room to expand UK engineers' understandings of H&S from the job site outward. Only two participants explicitly identified public health and public safety under the banner of 'global responsibility', whereas occupational H&S was described frequently and in detail. Because participants were very highly attuned to occupational safety in a way engineers would not have been a couple of decades ago, we believe the mechanisms (policies, procedures, etc.) enabling that shift should be replicated to achieve change more broadly. We also note that, in the US, the standard term across architecture, engineering, and construction is 'safety, health, and welfare', not just 'health and safety'. These words are typically uttered together in the States, reminding everyone there of collective wellbeing.

The narratives analysed in this study suggest UK engineers may need clearer guidelines and more support from their companies for making globally responsible choices in their work. Without clear mandates, metrics or parameters, engineers are likely to see activities related to ethics and responsibility as supererogatory, rather than as duties. We ask: which issues (e.g. CPD, eliminating poverty, ensuring clean water) and which Sustainable Development Goals (United Nations, n.d.) should the profession designate as duties that require definitive action by engineers? Where national commitments have been made to the SDGs and to reducing carbon emissions, for example, the profession could do more to align with stated goals. Because the UK has made commitments at the national level, there should be an apparent shift across the business sector to align with national strategy (Preston and Scott 2015, 3). Innovation to achieve national priorities should involve updated tools, strategies, and skills – as well as changes in behaviour.

Levers to facilitate change include policies, laws, accreditation and CPD requirements. In the US, many (though not all) of the states require professional development hours in ethics for the renewal of engineers' professional licences. This affects a larger segment of the engineering workforce there since a larger portion is professionally licenced than in the UK. Despite developments since the 1980s, including the formation of the Engineering Council which operates at a national level to help determine policy, there is still no statutory requirement for engineers to be licenced or registered with the UK (Engineering Council 2020f), and there are few restrictions on what can be done by non-registered engineers (Engineering Council 2020f; Uff 2016). It seems easy to ignore emerging priorities and continue practising the status quo as an engineer in the UK. With licensure and CPD being optional in Britain, the profession's ability to upskill its workforce and transform its practice are fairly limited. Benefits of CPD were apparent in this sample group's interest in building knowledge around 'global responsibility' yet, without wider requirements, the society served by UK engineers will keep missing out on the potential benefits of CPD.

Participants in this study appear to be highly engaged individuals specifically because they are among the few who gain Chartership. As such, this particular group likely does more learning related to these topics than others – especially those not seeking this optional credential. They described learning both during office hours and on their own time. The primary benefit of participation in this study was increased awareness and understanding of social, environmental, and ethical issues related to the practice of engineering – yet only those involved in Chartership or PhD studies volunteered. CEBOK3 acknowledges that ability in the realms of ethics and sustainability requires engagement beyond undergraduate studies (Committee on Education 2019). Study participants were had been engaging in conversations on these topics beyond graduation, but they may not reflect the norm. Others who work aside them in the companies that do provide support for volunteerism and CPD hours are likely to do such learning.

Regarding collective responsibility, some philosophers have started to talk in terms of duties to collectivise (Collins 2013; Collins and Lawford-Smith 2016; Smiley 2017). Given the current state of the engineering profession in the UK, there is a strong case for arguing that, if anyone has a duty to collectivise, it is engineers because there is a need to strengthen the profession. This need was evident in interviews with those who had encountered ethical dilemmas and was also evident within the literature (e.g. Lawlor and Morley 2017). The need to collectivise may be

particularly poignant in the UK where the profession has traditionally regulated itself rather than being overseen by the state (Uff 2016; UK Parliament 1980). Two of our participants, both of whom discussed experiencing ethical dilemmas, also described the ability to achieve change as requiring collective as well as individual action:

> Emma: *For me*, [global responsibility] *is a very personal, individual thing. I don't feel like it comes from a collective. And I feel like dealing with global issues that come under the 'global responsibility' umbrella are *dealt with* by the power of the team, the power of the group, united vision, united thoughts and united strategy on these things. I think that's how things change. But when it comes to global responsibility, I feel like it comes from a place within. And where your ethics lie, and where your interests lie. And how aware you are, through your own personal experiences and upbringing, of some of the many problems that face society.*

> Ava: *it really depends on how you define 'global responsibility'. Global as a collective responsibility of engineers towards what the planet, the people, the provisioning of basic services? There's a lot of different angles.*

Based on detailed grounded theory analyses conducted across the course of this project, we found that at least three of nine participants had witnessed foul play or corrupt behaviour in recent years, yet their primary means to address it as entry-level engineers had been to switch jobs or opt out. Having these individuals avoid rather than confront or draw attention to the problems does not yield the best long-term result, however, for the profession or society at large. We believe that addressing corruption must be viewed as an obligation for all engineers. The UK's Institution of Civil Engineers agrees and emphasises that senior managing engineers are particularly obliged (Institution of Civil Engineers 2004/2012, 8):

> *They* [senior managing engineers] *should set in place anti-corruption protocols and procedures so that junior employees are not drawn into corrupt practices through intimidation or persuasion by senior colleagues, and whereby they are able to report such practices without fear of reprisals of any kind, in particular, damage to their careers or prospects of advancement.*

Several participants (Charlie, Jack, James) discussed the efficacy of having ethical dilemmas handled by people above them, removing the onus from them. George noted the mantra has shifted over the decades to better facilitate H&S – and now increasingly public H&S, accessibility, diversity and inclusion. Yet participants other than George did not convey a sense of being able to step in and make changes themselves. For instance:

> Ava: *So ultimately, he* [the boss] *is going to make these decisions and it can't come from someone like me. I realized that I have no influence or power, I don't know what is the correct word, but, in my everyday work and my profession, I do believe in a more collective approach where we work as a team and we all would like to achieve something good. And, it's not my achievement or your achievement, it is something we should all be collectively proud of. But that was not the case there. That was a major restriction.*

This particular engineer (Ava) felt the lack of collectivisation and cited it as detrimental to her and to society at large. Our data indicate that young engineers envision having greater influence over such decisions in the future and doing work with far-reaching, positive impact as they gain status and experience. Several participants said they want to hold higher-level management roles in the future. Indeed, the senior engineer (George) described having high-level influence and comprehensive decision-making authority. The participants in this study are climbing the management ladder now and are determined to hold Chartership in the UK, where doing so is not mandatory or even standard practice.

Key implications, distilled interpreted through philosophical lenses, indicate a need: (1) for a clearer delineation of when and how an individual engineer is ethically compelled to act to address problems or opportunities; (2) to harness the power to change, as previously exhibited in the realm of occupational H&S, and to apply those methods more broadly; (3) to strengthen the engineering profession in the UK by collectivising so that more people are empowered, and indeed compelled, to act.

6. Final Conclusions

Overall results were not consistent with initial expectations regarding 'ethics', because when commencing this study on enacting 'global responsibility' our advisory committee implied that ethics and anti-corruption were key to the definition. Implications, based on the literature our advisors recommended (ASCE 2007, 2009; Leiper 2006; Jowitt, 2009; Stansbury and Stansbury 2005), were that participants would bring up ethics and corruption on their own. Such assumptions did not hold. Only two participants introduced the word ethics. Corruption was mentioned by only one without prompting.

Results indicate that although the term ethics did not spring to mind when these engineers were asked about making decisions related to global responsibility, their concern for protecting the environment and making life better for people nevertheless reflected a sense of ethics. Participants' narratives suggested they saw occupational H&S and engineering Codes of Conduct as important parts of ethics. They recognised bribery as unethical, and not protecting people's H&S also as unethical – and yet mandates and paths to protect the H&S of construction workers were more specific and

definable to them than mandates to protect the natural environment or society at large.

In the analysis above, we have identified key takeaways intended to help strengthen the profession and its response to social and environmental needs. To follow up and build upon this exploratory work, we propose conducting a large-scale survey of civil engineers across the UK, taking specific steps to ensure a diverse sample (regarding gender, ethnicity, national context/background) to capture more conceptions of ethics. We propose to design the survey's items based on the findings of this exploratory study, and with the items to be ranked in order of importance, similar to the surveys conducted by the American Society of Civil Engineers (ASCE 2007). Open response boxes could be provided for most questions as a way to allow survey participants to include, and possibly also rank, responses that did not previously emerge. The study design could potentially allow researchers to assess change over time, or similarities and differences across various sub-fields of engineering in the UK.

Acknowledgments

The lead researcher for this study was supported by a Marie Sklodowska-Curie Actions (MSCA) fellowship from the European Union (H2020-MSCA-IF-2016, Project 747069, DesignEng). Additional support was provided to Engineers without Borders UK by the Royal Academy of Engineers. Special thanks to our interview participants, the Engineers without Borders lead (Katie Cresswell-Maynard), our advisory committee (Jon Pritchard, Professor Nick Tyler, and Dr Rob Lawlor), the Engineering Council's Katy Turff for providing resources on whistleblowing, and the scholars who reviewed our drafts and provided valuable, constructive feedback.

Disclosure

No potential conflict of interest was reported by the author(s).

Funding

Data collection was supported by the H2020 Marie Skłodowska-Curie Actions [747069]. The Royal Academy of Engineering also provided support to Engineers without Boarders UK for work they did to support this project.

Notes on contributors

Shannon Chance, PhD, SFHEA, LEED-AP, is a Registered Architect holding bachelor's and master's degrees in Architecture from Virginia Tech and a doctorate in Higher Education from William and Mary. She is Lecturer and Programme Chair (Honours BSc in Digital Construction) at Technological University Dublin. She is also Visiting Professor at University College London, Chair of the global Research in Engineering Education Network (REEN), Associate Editor of *IEEE Transactions on Education*, and member of the Editorial Board of the *European Journal of Engineering Education*. In the past, Shannon served as Full Professor of Architecture in the USA, Fulbright Fellow to Ireland, and Marie Curie Research Fellow to both Ireland and the UK.

Rob Lawlor, PhD, joined the Inter-Disciplinary Ethics Applied centre at the University of Leeds in 2005 after completing his PhD, entitled „Gradability in Ethics" at the University of Reading in 2005 (supervised by Brad Hooker and Andrew Williams, and examined by Tim Mulgan and Philip Stratton-Lake). Before the PhD, he earned an MPhil at King's College London in 2003 (his thesis was on moral luck and punishment) and a Philosophy BA at the University of Reading in 2001. The majority of Rob's undergraduate teaching involves teaching ethics to students in the Engineering Faculty (including Product Design and Aviation students). In addition, he also teaches students in Chemistry, Environment, Media, Medicine, Dentistry and Business. At the postgraduate level, he is involved in the MA in Biomedical and Health Care Ethics (online and campus), the MA in Applied and Professional Ethics (online), PhD supervision, and some of the Faculty of Engineering's Doctoral Training Centres.

Inês Direito, PhD, is Senior Research Fellow at the UCL Centre for Engineering Education. She is a Psychologist working in engineering education research since 2007. Her main research focus is on the development of transversal and professional skills; gender, diversity and inclusion; and, more broadly, how social and cognitive sciences can inform engineering education and practice. She is the Chair of SEFI's Special Interest Group on Gender & Diversity, a member of the UK and Ireland Engineering Education Research Network steering committee, and a Fellow of the Higher Education Academy.

John E. Mitchell, PhD, is Professor of Communications Systems Engineering in the UCL Department of Electronic and Electrical Engineering, Vice-Dean Education in the UCL Faculty of Engineering Sciences and Co-director of the UCL Centre for Engineering Education. Between 2012 and 2016 he was on secondment to the UCL Engineering Sciences Faculty office, where he led the introduction of the Integrated Engineering Programme. The team that led this major revision of the curriculum across the engineering faculty was awarded the UK Higher Education Academy Collaborative Award for Teaching Excellence (CATE). In 2009, he was awarded the UCL Provost's award for teaching and has published on curriculum development with engineering education. Professor Mitchell is a Chartered Engineer, Fellow of the Institution of Engineering and Technology (IET) a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), Member of the Board of Directors of the European Society for Engineering Education and Principal Fellow of the Higher Education Academy. He is currently Editor-in-Chief of the IEEE Transactions on Education.

ORCID

Shannon Chance http://orcid.org/0000-0001-5598-7488
Rob Lawlor http://orcid.org/0000-0002-9621-2977
Inês Direito http://orcid.org/0000-0002-8471-9105
John Mitchell http://orcid.org/0000-0002-0710-5580

References

ASCE. 2007. "The Vision for Civil Engineering in 2025." In *Proceedings, Summit on the Future of Civil Engineering*. Reston VA: ASCE. https://doi.org/10.1061/9780784478868

ASCE. 2009. *Achieving the Vision for Civil Engineering in 2025: A Roadmap for the Profession*. Reston: ASCE.

Bourn, D., and I. Neal. 2008. *The Global Engineer: Incorporating Global Skills within UK Higher Education of Engineers*. London: Engineers Against Poverty and the Institute of Education.

Brinklow, P. (2002). "Licensing for Engineers". Discussion Board of the Institution of Engineering and Technology. Retrieved 22 July 2020 https://communities.theiet.org/discussions/viewtopic/795/3852

Brown, M. 2007. "Medicine, Quackery and the Free Market: The "War" against Morison's Pills and the Construction of the Medical Profession, C.1830–c.1850." In *Medicine and the Market in England and Its Colonies, C.1450-c.1850*, edited by M. S. R. Jenner and P. Wallis. p.238-261. New York: Palgrave Macmillan.

Brown, M. 2011. *Performing Medicine: Medical Culture and Identity in Provincial England, C.1760-1850*. Manchester: Manchester University Press.

Brown, M. 2014. ""Bats, Rats and Barristers": The Lancet, Libel and the Radical Stylistics of Early Nineteenth-century English Medicine." *Social History* 39 (2): 182–209. doi:10.1080/03071022.2014.905277.

Building Research Establishment Ltd. (2020). "What Is BREEAM?" https://www.breeam.com/

Burney, I. A. 2007. "Medicine in the Age of Reform." In *Rethinking the Age of Reform: Britain 1780-1850*, edited by A. Burns and J. Innes. 1st ed. p.163-181. Cambridge: Cambridge University Press.

Chance, S. M., I. Direito, and J. Mitchell. in press. "Challenges Faced by Early-career Civil Engineers Enacting Global Responsibility in the UK Workplace." *European Journal of Engineering Education*.

Chappell, T. 2009. *The Problem of Moral Demandingness: New Philosophical Essays*. Basingstoke: Palgrave Macmillan.

Charmaz, K. 2014. *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*. London: Sage Publications.

Collins, S. 2013. "Collectives' Duties and Collectivization Duties." *Australasian Journal of Philosophy* 91 (2): 231–248. doi:10.1080/00048402.2012.717533.

Collins, S., and H. Lawford-Smith. 2016. "Collectives' and Individuals' Obligations: A Parity Argument." *Canadian Journal of Philosophy* 46 (1): 38–58. doi:10.1080/00455091.2015.1116350.

Committee on Education. 2019. *Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future*. 3rd ed. Reston VA: American Society of Civil Engineers. doi: 10.1061/9780784415221.fm.

Continuing Professional Development. (2014). "CPD Requirements for Engineers in UK". https://continuingprofessionaldevelopment.org/cpd-requirements-for-engineers-in-uk/#:~:text=CPD%20Requirements%20for%20Chartered%20Engineers%20in%20UK&text=Institution%20of%20Civil%20Engineers%20(ICE,you%20need%20for%20your%20role

Dodds, R., and R. Venables, Eds.. 2005. *Engineering for Sustainable Development: Guiding Principles*. London: Royal Academy of Engineering.

Downey, G. L., and J. C. Lucena. 2005. "National Identities in Multinational Worlds: Engineers and 'Engineering Cultures'." *International Journal of Continuing Engineering Education and Lifelong Learning* 15 (3–6): 252–260. doi:10.1504/IJCEELL.2005.007714.

Downey, G. L., J. C. Lucena, and C. Mitcham. 2007. "Engineering Ethics and Identity: Emerging Initiatives in Comparative Perspective." *Science and Engineering Ethics* 13 (4): 463–487. doi:10.1007/s11948-007-9040-7.

Engineering Council. 2004. *UK-SPEC: UK Standard for Professional Engineering Competence*. 1st ed. London, UK: Engineering Council.

Engineering Council. 2013. *UK-SPEC: UK Standard for Professional Engineering Competence*. 3rd ed. http://www.engc.org.uk/engcdocuments/internet/Website/UK-SPEC%20third%20edition%20(1).pdf

Engineering Council. (2014). "The Accreditation of Higher Education Porgrammes". https://www.engc.org.uk/ahep

Engineering Council. (2020a). "Statement of Ethical Principles". www.engc.org.uk/professional-ethics

Engineering Council. (2020b). "Guidance on Whistleblowing". https://www.engc.org.uk/standards-guidance/guidance/guidance-on-whistleblowing/

Engineering Council. (2020c). "Standards". https://www.engc.org.uk/standards-guidance/standards/

Engineering Council. (2020d). "Accreditation of Higher Education Programmes (AHEP)". https://www.engc.org.uk/ahep

Engineering Council. 2020e. *Accreditation of Higher Education Programmes (AHEP)*. fourth ed. https://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/fourth-edition-to-be-implemented-by-31-december-2021/

Engineering Council. (2020f). "European Directive: Recognition of Professional Qualifications". https://www.engc.org.uk/glossary-faqs/frequently-asked-questions/international-activity/european-directive-on-recognition-of-professional-qualifications/

Engineering Council. (2020g). "Continuing Professional Development (CPD)". https://www.engc.org.uk/cpd

Engineering Council (n.d.). "The CEng eBook". Available from: https://www.engc.org.uk/engcdocuments/internet/Website/CEng%20eBook.pdf

Florman, S. 1987. *The Civilized Engineer*. New York: St. Martin's Press.

Gilabert, P. 2012. *From Global Poverty to Global Equality: A Philosophical Exploration*. Oxford University Press on Demand.

Gladwell, M. 2017. *Outliers: The Story of Success*. Little, Brown.

Health and Safety Executive. (30 October 2019). "Construction Statistics in Great Britain, 2019". Available from: www.hse.gov.uk/statistics/

Heyd, D. 2002/2019. "Supererogation." In *The Stanford Encyclopedia of Philosophy*, edited by N. Zalta, https://plato.stanford.edu/entries/supererogation/

Institution of Civil Engineers. (2004/2012). "Advice on Ethical Conduct". https://www.ice.org.uk/ICEDevelopmentWebPortal/media/Documents/About%20Us/advice-on-ethical-conduct.pdf

Institution of Civil Engineers. (2020a). "Continuing Professional Development (CPD)". https://www.ice.org.uk/my-ice/my-membership/continuing-professional-development
Institution of Civil Engineers. (2020b). "Professional Review". https://www.ice.org.uk/my-ice/my-membership/professional-review
Inter-Disciplinary Ethics Applied. (2018). "Engineering Ethics 2028 Vision". University of Leeds. https://ahc.leeds.ac.uk/engethics2028/doc/engineering-ethics-conference-2028-vision Accessed 10 March 2021
International Engineering Alliance. (2014). "25 Years Washington Accord: 1989-2014 Celebrating International Education Standards and Recognition". https://www.ieagreements.org/assets/Uploads/Documents/History/25YearsWashingtonAccord-A5booklet-FINAL.pdf
Joint Board of Moderators. (2018). "Joint Board of Moderators 2017: Guidelines for Developing Degree Programmes (Version 1, Revision 2)".
Jowitt, P. (2010). "*Presidential Address 2009: Now Is the Time*". Presented by Paul Jowitt, at his inauguration as 145th President of the Institution of Civil Engineers. In Proceedings of the Institution of Civil Engineers – Civil Engineering, 163.
Ladd, J. 1982. "Philosophical Remarks on Professional Responsibility in Organizations." *Applied Philosophy* 1 (2): 58–70. doi:10.5840/ijap1982129.
Lawlor, R. 2009. *Shades of Goodness*. Basingstoke: Palgrave Macmillan.
Lawlor, R. (2018). "Bringing the Principles to Life: Making the Standards Stick". https://mymedia.leeds.ac.uk/Mediasite/Play/d28cb66327a84fff850819512b95a5891d Accessed 24 March 2020
Lawlor, R., and H. Morley. 2017. "Climate Change and Professional Responsibility: A Declaration of Helsinki for Engineers." *Science and Engineering Ethics* 23 (5): 1431–1452. doi:10.1007/s11948-017-9884-4.
Leiper, Q. (2006). "*Presidential Address 2006: Making Tomorrow a Better Place*". Presented by Quentin Leiper, at his inauguration as 142nd President of the Institution of Civil Engineers.
Martin, D. A. (2020). "*Towards A Sociotechnical Reconfiguration of Engineering and an Education for Ethics: A Critical Realist Investigation into the Patterns of Education and Accreditation of Ethics in Engineering Programmes in Ireland*". Doctoral Thesis, Technological University Dublin. https://arrow.tudublin.ie/engdoc/126/
Martin, D. A., E. Conlon, and B. Bowe. 2020. "Exploring the Curricular Content of Engineering Ethics Education in Ireland." In *2020 IFEES World Engineering Education Forum-Global Engineering Deans Council (WEEF-GEDC)*, 1–5. IEEE.
Preston, M., and L. Scott. 2015. *Make It Your Business: Engaging with the Sustainable Development Goals*. London, UK: PwC.
Protect. (2021). https://protect-advice.org.uk/
Purvis, B., Y. Mao, and D. Robinson. 2019. "Three Pillars of Sustainability: In Search of Conceptual Origins." *Sustainability Science* 14 (3): 681–695. doi:10.1007/s11625-018-0627-5.
Reed, P. A., S. Presley, A. Hughes, D. I. Stephens, and R. B. Hill. 2004. "The Status of Ethics in Technology Education." In *Ethics for Citizenship in a Technological World*, edited by R. B. Hill, 163–186. Peoria, IL: Glencoe/McGraw-Hill.
Ross, D. 2007. *The Right and the Good*. . Oxford: Oxford University Press, UK.
Rowland, M. (2019). "Rate of Construction-worker Injuries Rises for First Time in Five Years". *Construction News*. https://www.constructionnews.co.uk/health-and-safety/rate-construction-worker-injuries-rises-first-time-five-years-31-10-2019/#:~:text=The%20rate%20of%20non%2Dfatal,to%20366%20in%202018%2F19
Singer, P. (1972). "Famine, Affluence, and Morality". *Philosophy & public affairs*, 229–243. https://www.utilitarian.net/singer/by/1972—-.htm
Smiley, M. 2017. "Collective Intentions and Collective Moral Responsibility." In *The Routledge Handbook of Collective Intentionality*, 316–326. London: Routledge.
Stansbury, N., and C. Stansbury (2005). "*Unethical Behaviour and Criminal Acts*". Paper presented to the Society of Construction Law in London.
Strauss, A., and J. Corbin. 1994. "Grounded Theory Methodology." In *Handbook of Qualitative Research*, edited by N. K. Denezin and Y. S. Lincoln, 273–285. Thousand Oaks: Sage Publications.
Uff, J. (2016). "UK Engineering 2016: An Independent Review Led by Prof John Uff CBE". *QC, FREng*. https://www.raeng.org.uk/publications/other/uk-engineering-2016
UK Parliament. (1980). "Engineering Profession (Finniston Report)". https://api.parliament.uk/historic-hansard/commons/1980/jun/13/engineering-profession-finniston-report
United Nations. (2020). "The Sustainable Development Goals Report". https://unstats.un.org/sdgs/report/2020/
Vogl, F. 2012. *Waging War on Corruption: Inside the Movement Fighting the Abuse of Power*. London, UK: Rowman & Littlefield Publishers.
Wenar, L. 2008. "Property Rights and the Resource Curse." *Philosophy & Public Affairs* 36 (1): 2–32. doi:10.1111/j.1088-4963.2008.00122.x.

Appendix A. Call for participation (EWB)

Human activity will decide the future of the planet – altering the composition of the atmosphere, reshaping landscapes, changing people's daily activities; much of our ability to effect change is due to our ability to engineer. But to what extent are engineers factoring social and environmental impact into their decision making? Are there opportunities to do this better?

We're looking for engineers working in the built environment field to interview as part of the study. If you're interested in taking part, and you have an hour available to be interviewed in London before 22 February 2019, please complete the [linked] form.

This piece of research has the opportunity to shape and define our profession in the years to come so, if you meet the criteria, please get in touch to find out more, arrange an interview and get involved.

Appendix B. Interview protocol

Our primary, opening interview question asked each participant to:

(1) *Tell us about an instance in your recent work as a civil engineer where you feel you had made decisions related to 'global responsibility.'* In response to their specific answers,

we followed up with who, what, when, where, why prompts, as a way to gather details and explore topics each of them raised in more depth.

(2) *How did you learn about global responsibility?*

(3) *What attracted you to civil engineering?*

With regard to global responsibility:

(4) *What barriers have you faced? Anything particularly stressful or corrupt? And what opportunities do you see?*

(5) *You mentioned earlier that you [faced a specific challenge], what prior experiences helped prepare you to meet this challenge?* (with follow up probes on more about how).

Nearing the end of the interview, we asked:

(6) *At this point, can you please summarise how you define 'global responsibility'?*

Our wrap up revisited the primary question in case something else had occurred to them in the meantime: (7) *Do you have any other examples of times you considered 'global responsibility' in your work? Or, do any other examples come to mind with regard to 'global responsibility'?* and (8) *Before we conclude, is there anything you would like to add that you haven't had a chance to talk about?*