How Do Graduate Civil Engineers Working in London Learn Global Responsibility and Support UN Sustainable Development Goals?

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Abstract

In this paper, we report what topics the participating engineers associated with global responsibility and how they learned about the topic over time. We then compare the findings with the UN's SDGs and with recommendations by PwC regarding where engineers can make the most difference related to the SDGs.

1 Introduction

What values and practices related to global responsibility have civil engineers in London taken from university to apply in their work as civil engineers today? How do these activities overlap the United Nations' Sustainable Development Goals (SDGs)? To begin investigating these topics, we interviewed nine engineers and asked how they define global responsibility, how they learned about it, and what activities they do in their work they would consider relevant to it.

2 Literature Review

"Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report, 1987, p. 15). Achieving sustainable development requires citizens and engineers "to consider much more widely than before the impact of our own lives and of the infrastructure and products we produce, both geographically and temporally" (Broers, 2005, p. 3).

Conducting research for the United Nations, Dugarova and Gülasan (2017) identified six "megatrends" affecting sustainable development: (1) poverty and inequalities, (2) demography, (3) environmental degradation and climate change, (4) shocks and crises, (5) financing for development, and (6) technological innovations. To understand the British perspective on sustainable development and what needs to be done, the UK government solicited an independent review by Dodds and Venables (2005), which projected global trends through 2036. It projected that achieving environmental, social, and economic sustainability would be framed by three primary factors: climate change, globalization, and inequality. Bourn and Neal (2008, p. 11) identified global dimensions in all the following concepts: sustainability, development education, global ethics, human rights, international relations, political analysis, justice and equality, cross-cultural capability, business responsibility, and citizenship, diversity, inclusivity, gender/race/ethnicity/nationality/ disability. Whether clients like it or not, "companies from all sectors are having to confront and adapt to a

range of disruptive forces including globalisation, increased urbanisation, intense competition for raw materials and natural resources and a revolution in technology that is challenging the business models of many sectors while forcing all companies to be more accountable to, and transparent with, all their stakeholders" (Preston & Scott, 2015, p. 6). Companies are having to face uncertainties in "energy costs, looming regulation on carbon emissions, concerns about access to raw materials and the availability of natural resources like water" (Preston & Scott, p. 6).

Broers (2005) insists that "engineers need to integrate consideration of whole-life environmental and social impacts – positive as well as negative – with the mainstream and commercial aspects of their work. Wise use of natural resources, minimum adverse impact and maximum positive impact on people and the environment are the targets" (p. 3). With regards to civil engineering and sustainable development, a focus has been applying engineering, science, and technology to meet humanity's basic needs, ranging from water and sanitation, to food security and shelter, to energy and transport (Bourn & Neal, 2008). Topics falling under this umbrella include, for example: resource consumption, material choices, ecosystem impacts, inclusivity, and social equity.

Creating a new, more effective model for engineering practice will require major re-thinking, with consideration of "what a sustainable, people-centred global economy and society would look like," say Bourn and Neal (2008, p. 8), and "critical analysis which allows learners to challenge their assumptions and the assumptions of others, to analyse a problem from a range of perspectives and to hear voices they would otherwise not be exposed to, is essential to understanding and exploring these complex issues."

> Engineers must therefore be key players in sustainable development, and have an obligation as citizens not just to act as isolated technical experts. Achieving sustainability through sustainable development will require some significant shifts in behaviour and consumption patterns. Often it will be – and should be – engineers who lead processes of making decisions about the use of material, energy and water resources, the development of infrastructure, the design of new products and so on. (Dodds & Venables, 2005, p. 8)

Are they up for this task? Are university-level engineering programs equipping them to meet this challenge? Topics of relevance for sustainable engineering include the UN's Sustainable Development Goals (SDGs), various green-building initiatives, and Life-cycle Cost Analysis which considers all costs over time involving the design, construction, operation, maintenance, reuse and/or demolition of engineered components and systems. In 2015, the United Nations adopted SDGs to be reached by 2030, and this has increased the level of demand across the business sector for assessment and accountability (Preston & Scott, 2015). Preston and Scott believe businesses should align with national strategy, and this strategy should increasingly reflect the SDGs to provide "a catalyst for innovation and new market opportunities" (p. 3) but this will require updated tools, strategies, and skills – as well as changes in behavior. Benefits of aligning with SDGs must be promoted to businesses (including engineering companies and the businesses that hire them) "in a way that resonates and can be easily interpreted and incorporated into normal business operations" (p. 3). In summer 2015, PwC conducted an *SDG Engagement Survey* with responses collected from 986 businesses and 2015 citizens – when businesses from Engineering and Construction were asked to "rank the five SDGs where you believe your business (and your value chain) has the greatest impact" (Preston & Scott, 2015, p. 11), the group ranked: (SDG 9) industry, innovation and infrastructure first; (SDG 8) decent work and economic growth second; (SDG 13) climate action third; (SDG 11) sustainable

cities and communities fourth; and (SDG 12) responsible consumption and production fifth. Unfortunately, most sectors selected very similar sets, implying many SDGs are being ignored by business. One of the commonly overlooked SDGs is sustainable cities and communities and thus the engineering sector can have great impact here, where other businesses aren't contributing. Citizens prioritize the SDGs differently than business, for citizens the order of importance was: (1) zero hunger, (2) climate action, (3) quality education, (4) no poverty, (5) clean water and sanitation, and (6) good health and wellbeing. Engineering and Construction can clearly impact these, even though engineering respondents didn't prioritize them.

3 Research Design

This exploratory study was intended to identify shared conceptions of global responsibility and challenges and opportunities surrounding the topic in civil engineering. The research team conducted hour-long semi-structured interviews with nine engineers (eight early-career and one senior engineer), a small and manageable sample size appropriate to identify issues for a more detailed follow-up study. The project was reviewed and approved by UCL's Ethics office. Participants were solicited using email and Twitter posts from EWBUK staff, who also scheduled the interviews. After having the interviews professionally transcribed, the research team compared the written text to the audio recording to verify accuracy. Two experienced engineering education researchers worked together, using NVivo 12.0 for Mac to manage and code data. They worked together to achieve thematic coding, regularly discussing and revising the themes and coding structure, and then analyzing data inductively within each theme to make interpretations and collaboratively identify findings. The research design, process, results, and findings were checked for quality by an advisory team composed of four engineers, an ethicist, and an additional education researcher.

4 Results

The interview data revealed what topics the engineers associate with global responsibility and how they have gained knowledge about it. Below, we identify what participants mentioned regarding (1) environmental sustainability, (2) social sustainability, and (3) ethics. Then we describe how they came to learn about these topics in their university degrees (sources of learning), and finally, we look at how what they told us about their work experiences relates to the UN's SDGs.

4.1 Environmental

In the realm of environmental sustainability, they described work related to: materials (selection, efficiency, reuse, chemical processing, weight); carbon (footprint, embodiment, climate change, transport reduction, local sourcing); water (amount and usage, drainage and pollution); site (land use, less groundwork, construction impacts, ecosystems, urbanism); performance (energy and building performance, structures, envelope/fabric, layout efficiency, earthquake resistance, thermal effects); building or system retrofit, and flexibility to change over time; pollution and contamination (including soil remediation); logistics, methods, procurement (integrated vs bolt-on approach, optimizing process or decisions over time); resourcing (including depletion and extraction), and electric power (access to electricity, renewable energy).

4.2 Social

The topics participants choose to discuss in the realm of social justice were: corporate social responsibility (CRS), empowerment of people, linking global to local (impact on local business), outreach to schools and kids, research locally applied, standard of living, supporting charity organizations, urban regeneration (including participatory design and place-based decision making), and working with stakeholders.

In the realm of accessibility, or rather access to essential services, they discussed: transportation and movement; education (including, e.g., need for instruction on how to use the HVAC for building occupants); housing; public spaces; water; electricity; moving goods; communication; and information.

Regarding longevity and future generations they discussed minimizing harm, not mortgaging the future, their own personal goals for the future, and risk assessment and mitigation (including LCA, uncertainty, risk management and trade-offs).

They discussed various aspects of work in, or goals for, developing nations. They also identify the importance of gender and diversity, mentioning: cultural differences; diversity and inclusion; rights and balance regarding gender and diversity. They also talked about engineering and construction projects creating jobs.

Participants, particularly those working for construction companies, mentioned that efficiency often has social benefits. Topics raised about public welfare included: air quality (inside and out); public health and safety; and suicide prevention in the design of public spaces.

4.3 Ethical

Mentions of ethics were scarce. Only two participants mentioned ethics without the topic being raised for them by the interviewer. As a result, we gave a prompt and all nine discussed ethics in some shape of form, with a total of 14 mentions of the word ethics by participants.

> *P4: 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. […] You have a duty to act ethically and uphold the Code of Conduct […] For Chartership, you do* [have to read about these things]. *You have to fulfill all these objectives. Most of them are work-based technical things or management type things, but they have aspects of understanding legal context and understanding aspects of sustainability. So and the, you're tested on that, in an interview.*
>
> *P6: the ICE* [Institution of Civil Engineers] *themselves have a Code of Conduct […] the development of others, in inspiring others that want to pursue a career in engineering, that's also part of it.*

Only one raised the topic of corruption without prompting. When the word was mentioned by the interviewer, three other participants had something to say on this topic. Two described observing corrupt behavior, but most said they hadn't experienced such. Six participants discussed occupational health and life safety as an ethical issue, providing 19 passages on job-site health & safety.

4.4 Sources of Learning

We asked participants how they first learned about topics they associated with global responsibility. They identified important introductions from secondary school:

> *P7: I did Geography at A level, so that was a really good foundation to bringing up both physical and social issues that exist on the globe.*
>
> *P9: I probably learned more about that in geography in A-level than in the last—. At least consciously.*

What they said about their undergraduate studies is of high importance to understand how sustainability has been embedded in the curriculum of engineering degrees. Most participants mentioned learning experiences focused on global responsibility issues.

> *P3: At university […] in final year, you could choose your modules and I chose alternative building materials.*
>
> *P6: at college, here actually, sustainable development is a big part of what we were taught, the importance of it. […] I'm always referring back to my book knowledge, if you like, from college […and] good scenario-based work*
>
> *P8: I did civil and architectural engineering. And a lot of that was about building physics, embodied carbon, understanding how the facade shape things, impacting the space inside. […] we didn't do anything directly international global, but we did put a lot of emphasis on making sure that our buildings were designed to mitigate those impacts. […] I knew a lot more about embodied carbon, about thermal effects. […] most people didn't do nearly as much building physics and environmental design, and architectural design as we did*

However, these learning experiences were not always specific to global responsibility.

> *P4: at university, I guess a lot of the sales part of studying civil engineering is about how it's a global career. It's socially useful. […] We didn't do any specific modules, or anything, about this kind of thing. It was just general interests.*
>
> *P7: Actually, the course I did was […] Civil and Environmental Engineering. I thought that would be engineering from a sustainability perspective but it wasn't. It was more from a sewage-treatment perspective!*

Two participants had proceeded into postgraduate studies to learn more holistic approaches to civil engineering.

Participants mentioned learning that happens as a result of today's cultural context. They learn, for instance, from books and magazines. The news and popular media also provide opportunities for learning.

> *P8: To a certain extent it's increasingly in the news. You know, my generation has always grown up with threat of climate change and not just my generation, it's always been there. Also, increasing awareness of how globalization might impact workers in the Dakar or cause—you know, oil extraction, or mineral extraction, in Africa might cause war, you know. blood diamonds and all those things that came into public consciousness. A lot of it was—as a kid growing up, I became*

> *aware of that. […] I follow a lot of the news and make sure I keep them up to date with roughly what's going on.*

4.5 Relation to SDGs

Early-career engineers face many limitations, and the successes they have often feel small and incremental. Moreover, there is a huge divide between the utopian visions articulated by professional organizations and the actual ability of these young engineers to influence decisions or alter the status quo.

They say they need tools and metrics, and this is in line with what PwC argued in 2015. "Assessing impact is fundamental to valuing the positive and negative contributions a business makes towards the SDGs. Without the tools identified and in use, business will struggle to engage effectively" (Preston & Scott, 2015, p. 26). They also need clearer guidelines and more support from their companies for making globally responsible choices in their work.

In the PwC SDG Engagement Survey reported by Preston and Scott (2015), engineers indicated they could most effect SDGs related to (SDG 9) industry, innovation and infrastructure; (SDG 8) decent work and economic growth; (SDG 13) climate action; (SDG 11) sustainable cities and communities; and (SDG 12) responsible consumption and production.

From the statements provided by these nine civil/structural engineers employed in London, it appears that engineers can also have great influence upon: (SDG 6) ensure availability and sustainable management of water and sanitation for all; and (SDG 7) ensure access to affordable, reliable, sustainable and modern energy for all.

> *P1: What I'm trying to target in my current research is how you achieve responsibility for the planet and the natural environment, and cross reference it with responsibility for […] achieving the Sustainable Development Goals, and responsibility towards people. Because the SDG say, "Leave no one behind." How do you close this divide of people who have no access to clean drinking water, or really just basic things to live in a decent way, let's say? How can the environmental responsibility positively feed in and help the social responsibility?*

Engineers' work also can have positive influence upon: (SDG 4) ensure inclusive and equitable quality education and promote lifelong learning opportunities for all; (SDG 5) achieve gender equality and empower all women and girls; (SDG 10) reduce inequality within and among countries; (SDG 15) protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss; and (SDG 16) promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels. Their collective organizations can also enhance global partnerships: (SDG 17) strengthen the means of implementation and revitalise the global partnership for sustainable development.

By 2020, PwC (Preston & Scott, 2015) expected to see businesses having: identified relevant SDGs; engaged with corporate social responsibility (CSR); specific projects engaging with the SDGs; embedded SDGs in their strategy and their way of doing business; aligned goals with SDGs; identified and be using indicators to track relevant SDGs; issuing annual sustainability reports with regard to the SDGs; and

identified and using tools to assess impact against relevant SDGs. The narratives of the nine civil/structural engineers in our study suggested that some of their employers were meeting predictions.

> *P9: the Millennium Development Goals, for example. I keep thinking about clean water, poverty, famine, education. That is, they are distinct goals I think maybe the UN set out. I feel like that's separate to how, I, as an engineer, am thinking on a day-to-day basis. […the set of goals], to me, is their action plan for global responsibility. […] I think big organizations, small organizations too and big organizations are acting with global responsibility in mind. That doesn't mean it has to be through the projects that they do but it could be through how they invest, say, in Corporate Social Responsibility or in charitable projects that they might sponsor, for example. At project delivery level, I feel like I've worked on projects which do have global responsibility and within it, I would say is at the heart of it.*

Members of the sample suggested their companies had: identified relevant SDGs; engaged with corporate social responsibility; and have specific projects engaging with the SDGs. On the other hand, there seems to be quite a way to go in many areas where one would expect to see change by 2020. Narratives suggest civil engineering may be falling behind expectations by not having greatly: embedded SDGs in their strategy and their way of doing business; aligned goals with SDGs; identified and be using indicators to track relevant SDGs; have been issuing annual sustainability reports with regard to the SDGs; and have identified and be using tools to assess impact against relevant SDGs.

Because the profession may be falling behind the expectations stated in the 2015 report, it may be wise to review the 7 steps Preston and Scott (2015, p.28) identified for successful engagement with the SDGs.

1. Agree which SDGs your business and its value chain have an impact on directly and indirectly, in the countries you operate in
2. Agree the methodology and measure your business impact across all these SDGs
3. Understand where your business has a positive or negative impact on each SDG
4. Understand the priorities of the governments your business operates under
5. Prioritise reducing negative impacts and increasing positive impacts according to what needs to be achieved by governments
6. Incorporate this learning into business planning and strategy
7. Evidence how you impact on the SDGs and your contribution
8. Making a smooth transition to this new model where

5 Discussion

Regarding the definition of global responsibility, participants associated social and environmental aspects of sustainability with this umbrella term being promoted by EWBUK who invited us to investigate this topic, but most did not mention ethics and anti-corruption efforts as being crucial elements. Of central importance to understand engineering education practices for sustainable development, most participants could not recall lessons or discussions related to the topic from their university years, suggesting that if these topics had indeed been included in the curriculum, they hadn’t been delivered in a way that was ‘sticky’ enough to be retained. Participants did cite learning that occurred later, on the job and as part of their Chartership process.

As a result of these analyses, we see a need for further research—to investigate the degree to which these patterns hold true more widely. We recommend conducting a survey of civil engineers across the United Kingdom to identify what topics they associate with global responsibility, what aspects of global responsibility they encounter day-to-day, what opportunities and challenges they see in their work, and what could be done by professional organizations to support them in becoming more globally responsible.

The civil engineers in our study expressed efforts and perspectives similar to those of Dugarova and Gülasan (2017), who stated policy makers must be involved if we are to achieve the UN's Sustainable Development Goals.

> *P3: I'd like to be optimistic about it and I think that we are having to set up and pay attention to it because of legislation, because of global impacts that we've signed. There's the UK government […] looking to reduce the construction industries' carbon output by 50% in the next eight years or something. I know that goals are being set and we are being driven by the government which I think is generally the only way really to make a change across the industry. I know private sector is much more positive and they are looking to do it all the time for private sector. I think you need that kick from governance that tells you have to do it. I think that is coming in and industry best practice is getting better all the time. The ICE as a driver that is always looking to promote that kind of activity and they see it as really important.*

Dugarova and Gülasan asserted that policymakers need to rely on evidence, and they must seek coherence at various levels of policy and places around the world. Moreover, they must work to maximize synergies and minimize risk, and finally, inclusive and broad-based participation is crucial to shaping effective policy and moving forward. Participants in this study told us they need reliable tools for identifying environmental impacts and predicting performance of future constructions. To convince developers and other private clients, they need clear metrics, requirements and imperatives. They need more muscle to push for better decisions, even when these cost more. Dodds and Venables (2005, p.8) believe "engineers must recognise and exercise their responsibility to society as a whole, which may sometimes conflict with their responsibility to the immediate client or customer". This challenge was at the forefront of discussion in the nine interviews we conducted.

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