

# Inspiring the Next Generation of Project Managers: Embedding Sustainability in Engineering Projects through Project Management Teaching and Learning

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## Abstract

Sustainability is focussed on avoiding the long-term depletion of natural resources. Under the terms of a government plan to tackle climate change, a driver for improved sustainability is reducing greenhouse gas emissions in the UK to almost zero by 2050. With this type of change, new themes are continuously being developed that drive engineering projects, such as developing new cars and new power generation methods, which encompass challenging lead times and demanding requirements. The implementation of strategies and key concepts, which may engender sustainability within engineering and engineering projects, presents an opportunity for further critical debate, review, and application through a project management lens. Sustainability incorporation in project management has been documented in academic literature (Økland, 2015), with this emerging field providing new challenges. For example, project management education can provide a holistic base for the inculcation of sustainability factors to a range of industries, including engineering project management. Likewise practitioner interest and approaches to sustainability in project management are being driven by the recently Chartered profession of Project Management. Whilst this body makes a significant contribution to the UK economy across many sectors, it also addresses ongoing sustainability challenges. Therefore, by drawing on research and practitioner developments, the authors argue that an improved focus on sustainability in engineering project management may be achieved by connecting with the next generation through solution-based approaches and embedding sustainability issues within project management tools and methods.

**Keywords:** Sustainability, Engineering, Projects, Teaching, Learning, Project Management.

## Citation

Tite, C. N. J., Pontin, D., & Dacre, N. (2021). Inspiring the Next Generation of Project Managers: Embedding Sustainability in Engineering Projects through Project Management Teaching and Learning. *Ingenium*.

## Introduction

There is widespread agreement that sustainability is an area of focus that needs to be considered and addressed in engineering projects. Many authors address this subject area and consider methods for embedding sustainability within the engineering project management curriculum. For example, the Association for Project Management (APM) recognise the need for embedding sustainability at the project management level, although there is a more comprehensive global organisational perspective that also merits a high degree of consideration.

In considering an approach towards this aim, it should be underpinned by a clear definition of what is meant by sustainability in engineering education, with an agreed framework that can be implemented as a reference point in formalising the context in providing a robust and rigorous syllabus. For example, Glasser and Hirsh (2016) argue for a set of sustainability core competencies to develop robust learning for Sustainability. Further research is required to identify these competencies towards developing a framework for implementation that can be embedded in higher education.

Thürer et al. (2018) note that there is general, but not complete agreement on three dimensions to sustainability and sustainable development: social, economic, and environmental. Segalàs et al. (2010) wrote of a fourth dimension, being the institutional dimension, which encompasses the role of education and external stakeholders. While Watson et al. (2013, p. 106) argue, there has been a “rapid increase in the number of engineering schools in higher education institutions that have incorporated sustainability into their teaching”. Lambrechts et al. (2013) note that sustainability appears to be integrated in a piecemeal fashion.

From their review of the literature Thürer et al. (2018, p. 616) found what appeared to be “a lack of studies on implementations in developing economies”, and they called for more studies of how to grow and engender sustainable development in Europe and the US in particular. Therefore, a set of core competencies in sustainability needs to be identified, analysed, and developed in order to guide degree course and curriculum development (Dacre et al., 2019; Reynolds & Dacre, 2019), which may also guide changes in approach to sustainability education within academic institutions. Engineering project management may be best placed as a basis for determination of relevant concepts forming the basis of this set of competencies. This research paper thus focuses on framing the concept of sustainability by drawing on project management and engineering literature, ensued by a practice-based vignette stemming from extensive academic insights across three UK universities.

## Framing Sustainability

Experts in engineering education for sustainable development consider that institutional and social aspects are generally more relevant to sustainability than environmental aspects (Segalàs et al., 2012). This is in clear contrast to students and potentially the wider public, which mostly perceive the environmental aspect to be at the centre of sustainability and sustainable development. For example, Kagawa (2007) survey among students at Plymouth University found that almost half of the respondents related sustainability and

sustainable development primarily with the environment while social, economic, political, and cultural dimensions of sustainability were less represented and remained marginal in the understanding of most students.

Redressing this balance in favour of social and institutional aspects is consequently seen by many researchers as a key task of education for sustainable development (Boks & Diehl, 2006; Kagawa, 2007; Segalàs et al., 2010; Segalàs et al., 2012). Thüerer et al. (2018, p. 609) asked “what is the current state-of-the-art on integrating sustainability and sustainable development into engineering curricula?” The degree of change in the curricula ranges from new material on sustainability in an existing module, to a new module on sustainability in an existing program, to an entirely new program of study on sustainability. Based upon this systematic review, twelve crucial future research questions emerged. This includes exploring the knowledge and value frameworks of students and teachers, the exploration of stakeholder influences, including accreditation institutions, industry partners, parents and society, and the use of competencies for the evaluation of implementations.

There is no doubt that there is a strong political will and commitment towards sustainability and sustainable development (Thüerer et al., 2018). University leaders and educators have begun to recognise the importance of sustainability and sustainable development. There is a growing body of literature on the integration of sustainability and sustainable development into engineering curricula at universities around the globe. However, to the question – What should engineers learn on sustainable development? – Svanström et al. (2012) answer was: (i) what are the problems; and (ii) how should they be solved. During this review, it was felt that most of the cases focused on creating environmental awareness and system thinking when identifying problems and solving them.

There is a plethora of approaches to embedding sustainability within the higher education context. Haney et al. (2020) reported that developing sustainability leaders requires new knowledge and skills and new ways of thinking and ultimately an underlying motivation to act. Making sustainability personal for individual leaders is a crucial aspect for embedding sustainability and this can be achieved through learning outcomes. A framework creates a foundation for individual leaders to gain personal understanding, a feeling of being committed to the necessary change and empowerment to embed sustainability in their organisations.

Personal dimensions and a softer, more individual dimension of sustainability competencies have been previously illustrated as being particularly salient. Thus, framing sustainability and sustainable development is key to understanding the core concepts required in the engineering project management curriculum. Figure 1 outlines a conceptual summary to frame sustainability across social, economic, environmental, and organisational dimensions. The latter including practice and educational elements. As such, in this research the authors also include sustainability core competencies specific to this area.

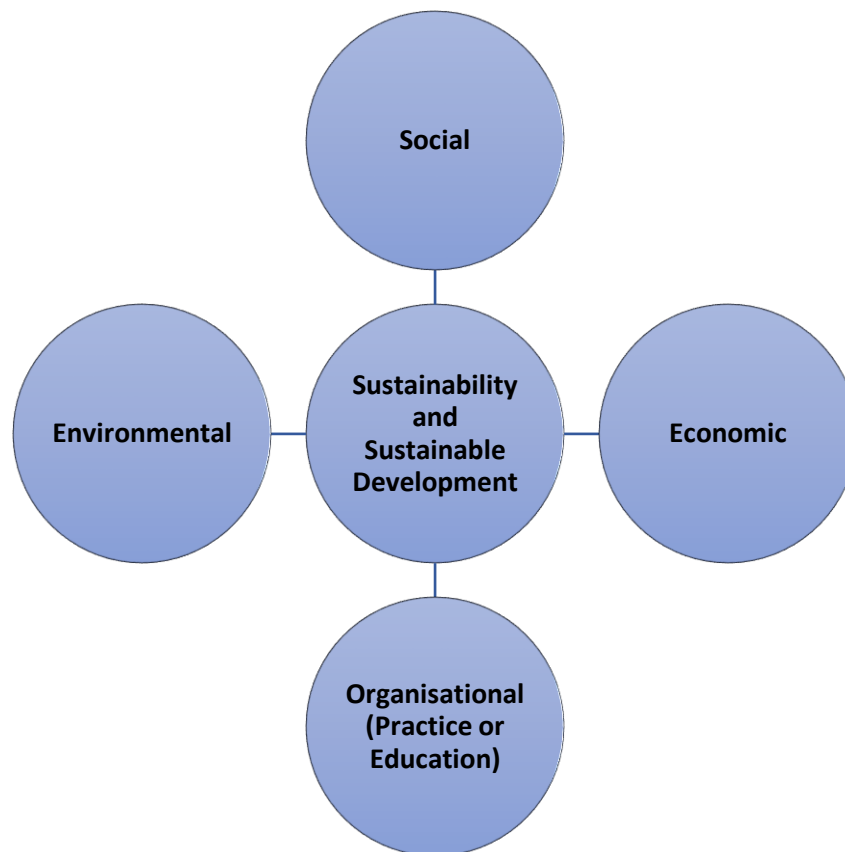


Figure 1. Framing Sustainability

Bringing these ideas and influences together within the engineering project management area is essential, and leadership aspects are key in understanding personally. It is also important in relation to the area of Engineering Project Management because of the area of leadership which brings a range of disciplines together in order to achieve successful project outcomes.

### **Simulating Practice**

The authors' experience of teaching students across different UK universities suggests that many students are well informed and highly motivated towards projects with a vital sustainability element. When students are presented with choice over projects to research, many select projects with sustainability elements or associated ethical elements, such as green buildings, renewable energy, electric vehicles and associated infrastructure, CSR projects, healthcare in developing countries, and charity sector projects. This suggests that rather than just raising awareness of sustainability within projects, effort should also be made to define the particular skills required for effective sustainable project delivery and develop business simulation exercises where these can be reviewed, developed, and crafted.

Business or project simulation exercises have become a popular teaching approach in project management courses and create a conducive learning environment where students can apply theory and current practice (Dacre et al., 2019; Pontin & Adigun, 2019; Yao & Tite, 2019). They provide an opportunity to combine hard or technical project management skills such as scope definition and work de-construction using Work Breakdown Structure

(WBS), planning, scheduling and cost estimating with soft or interpersonal skills such as effective communication, leadership, motivation, influencing and problem-solving within a multi-disciplinary team setting (Dacre et al., 2019). A carefully developed exercise can simulate the planning phase and the execution phase and introduce students to the dynamic and often disordered nature of real-life projects (Pontin & Adigun, 2019; Yao & Tite, 2019). The ability to effectively communicate, motivate and influence others, have difficult conversations, work across different cultures, reflect and be self-aware are some of the qualities business leaders claim they need in graduates but do not always get to the level they desire (CMI, 2018). Project simulations exercises provide an environment where these skills can be tested and developed (Pontin & Adigun, 2019; Yao & Tite, 2019) but without the commercial consequences if errors are made in the learning journey.

Researchers support the role of “play-based approach” as part of an innovative learning environment in Higher Education (Dacre et al., 2019; Smith, 2019). However, there are gaps. Many of the simulation exercises cover the planning phase but less so the execution phase and often risk management is not included (Zwikael & Gonen, 2007). Where the execution phase and the possibility of risk events occurring are introduced, the simulation becomes closer to real life and a richer educational experience. Such exercises enjoy excellent student engagement, positive student feedback, and help develop those skills the employers say they need for the workplace (Pontin & Adigun, 2019). However further research is required to assess the transference of these skills and further whether there is evidence that the skills do transfer to the workplace (Romero et al., 2015).

TEDI-London is a new engineering school that is taking the concept of project-based learning to a greater level with up to 55% of the learning based on project or scenario based learning. Founded by three universities with strong research credentials the pedagogy is described as “disruptive” and aims to transform engineering education providing new qualifications at graduate and post graduate level in Global Design Engineering (Raper, 2019). The authors are also developing new research informed teaching materials with a heavier emphasis on project management application.

A new module aims to provide students with a systematic understanding of how to apply project management tools and methods within various industry sectors. Students will gain a critical awareness of the challenges of the application of a range of PM tools and methods in the areas including business change project management, engineering project management, IT project management and construction project management. They will be able to consider and establish new insights in the application of project management methods, being mindful of advances in this area of both academic study and related professional practice related to established PM Methodologies. Sustainability issues can be added to this list.

Assessment for this new module will focus on the quality of the proposed project management application solution. Students will need to demonstrate that the particular constraints and peculiarity or the requirements of the industry or sector chosen have been understood. Originality, creativity, innovation or problem solution (new solution or transference of a solution from another industry or sector) will be valued and assessed along with the reasoning and justification behind the proposed solution.

Effective communication of the proposed solution to a simulated executive audience will also test and allow the development of this important skill for engineers and managers alike as is expected in the workplace. All these skills are equally important for effective sustainable project delivery. This type of module design where new sectors, application or project management development can be added easily and progressively within the module and curriculum design lends itself to sustainability themes to be included.

Stakeholder management or more recently stakeholder engagement is a recognised knowledge area within the project management professional association's body of knowledge and the interest and evolution of thought over the last ten years has developed in line with thinking on front ending (project selection techniques) and back ending (benefits realisation). Closely linked with the soft or interpersonal skill set, effective stakeholder engagement draws on deep listening and communication skills, strong leadership, and hard or technical stakeholder analysis skills. In a world where attitudes are in transition such a skill set is particularly relevant for successful project delivery where an enhanced sustainability element exists. Adding a stakeholder engagement element to the project management simulation exercise could enrich the learning experience further and test, assess, and allow learning related to this important emerging knowledge area.

Within such developments in engineering and project management teaching and learning community elements of sustainability could be incorporated. A balanced curriculum including case study examples covering both successful and failed projects with strong sustainability elements, teaching around the particular skill set required and an opportunity to apply, practice and develop through project simulation exercises could be a way forward to embed sustainability into our teaching and learning. In essence, it is not that the authors claim to have achieved all this but rather explain how the thinking is developing. Therefore, this paper invites other ideas and potential collaboration as the engineering and project management teaching and learning community seek to embed sustainability into the programmes and see the benefit for our students and society as a whole.

## **Discussion**

For students, the definition of sustainability and their understanding of aspects of sustainability are important. Rampasso et al. (2019) found that according to the students' perception, the reason for the eliminations of Concern With Employees (CWE); Support for Local Communities (SLC); is related to the students' perceptions. In this case, the students from our sample did not consider these issues when they are analysing sustainability. That is, for them, the parameters related to employees and local communities are not included in their sustainability analysis. This is because the students have a low correlation with the overall sustainability grade, i.e. when students evaluate sustainability, they are not considering those parameters. So, what is sustainability for these students in the context of their learning?

Many research examples point out the excessive focus on environmental sustainability as a problem in engineering education (Björnberg et al., 2015; Guerra et al., 2017; Yuan & Zuo, 2013). In this research, the students do not consider this as a primary. This means that students consider its parameters as the least important. Another argument for the Engineering Project Manager to bring a personal understanding and thereby impetus to the

embedding of sustainability in engineering projects. There is evidence of a divergence in the approach to embedding sustainability in different countries, cultures and courses. (Dagiliūtė et al., 2018) conducted research in two universities from Lithuania and the results pointed out that the students consider that social sustainability is the most important aspect of a sustainable university. In their research, engineering respondents were a small part of their sample. It is clear that students from the sample are better prepared in relation to social aspects of sustainability, especially the concerns regarding employees and local communities. This is particularly important when it is considered the role of engineers in the development and improvement of production systems (Rampasso et al., 2019).

The link between sustainability concerns and the development of new products and services is important but it is insufficient. Engineers must present reasonable levels of concern regarding environmental issues, such as a proper use of water and energy, emission of polluting gases, legislations, as well as they must be aware that they are responsible for what they produce and that the disposal they produce is their responsibility and of their companies. Although it is an exploratory research, the findings here can be useful for researchers as a starting point for other studies and for professors and program coordinators from higher education institutions who can use these findings to analyse their own engineering programs and evaluate what they need to prioritize the improvements they perform. As a future research, it is recommended to replicate this methodological procedure in undergraduate engineering programs from other higher education institutions to broaden the debate about students' perception regarding sustainability issues.

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