



Engineering Skills to Respond to SDGs: A Survey of Employers, Academics and Students

Henry, R., Morgan, M., Beagon, U., Bowe, B., Jani, R., & McKennedy, J. (2024). Engineering Skills to Respond to SDGs: A Survey of Employers, Academics and Students. In *The 39th International Manufacturing Conference proceedings* (1 ed., Vol. 65, pp. 1-4). (Engineering Proceedings). Irish Manufacturing Council. Advance online publication. <https://doi.org/10.3390/engproc2024065015>

[Link to publication record in Ulster University Research Portal](#)

Published in:

The 39th International Manufacturing Conference proceedings

Publication Status:

Published online: 24/05/2024

DOI:

[10.3390/engproc2024065015](https://doi.org/10.3390/engproc2024065015)

Document Version

Publisher's PDF, also known as Version of record

Document Licence:

CC BY

General rights

The copyright and moral rights to the output are retained by the output author(s), unless otherwise stated by the document licence.

Unless otherwise stated, users are permitted to download a copy of the output for personal study or non-commercial research and are permitted to freely distribute the URL of the output. They are not permitted to alter, reproduce, distribute or make any commercial use of the output without obtaining the permission of the author(s).

If the document is licenced under Creative Commons, the rights of users of the documents can be found at <https://creativecommons.org/share-your-work/licenses/>.

Take down policy

The Research Portal is Ulster University's institutional repository that provides access to Ulster's research outputs. Every effort has been made to ensure that content in the Research Portal does not infringe any person's rights, or applicable UK laws. If you discover content in the Research Portal that you believe breaches copyright or violates any law, please contact pure-support@ulster.ac.uk

Proceeding Paper

Engineering Skills to Respond to SDGs: A Survey of Employers, Academics, and Students [†]

Rosalind Henry ^{1,*}, Margaret Morgan ¹, Una Beagon ², Brian Bowe ², Ruchita Jani ² and Janet McKennedy ²

¹ School of Engineering, Ulster University, Belfast BT15 1ED, UK; m.morgan@ulster.ac.uk

² School of Transport and Civil Engineering, Technological University Dublin, D01 K822 Dublin, Ireland; una.beagon@tudublin.ie (U.B.); brian.bowe@tudublin.ie (B.B.); janet.mckennedy@tudublin.ie (J.M.)

* Correspondence: r.henry@ulster.ac.uk

[†] Presented at the 39th International Manufacturing Conference, Derry/Londonderry, UK, 24–25 August 2023.

Abstract: Addressing challenges posed by the Sustainable Development Goals (SDGs) will require the next generation of engineers from all disciplines to be equipped with specific skills. Given this context, a professional skills survey was designed, drawing on previous European-level research. Its results provide valuable localised insights for educators into the most important skills for the next generation of engineers (on the island of Ireland) to achieve the SDGs. They also reveal some variance in the views of employers, academics, and students.

Keywords: education; competences; SDGs; sustainability

1. Introduction

The professional skills required by engineers have been the subject of much research, generally at national or international levels [1–4]. More specifically, influential work conducted by Wiek et al, de Haan and Rieckmann [5–7] considered the skills required for sustainable development.

A recent European study [8] narrowed the focus further to competence requirements for engineers to support the achievement of SDGs. It presented 53 competences in six main categories, though it reported a lack of agreement on which competences should be prioritised.

This paper contextualises the 53 competences on a smaller scale (national, regional). It explores and compares stakeholder perspectives on the specific professional skills required for engineers in the context of achieving the SDGs.

This seeks to inform future educational initiatives, bearing in mind the UNESCO (2017) report “Education for Sustainable Development Goals: Learning Objectives” [9], which provides a framework for educators to enhance their curriculum, offering students an opportunity to develop much-needed skills required for the future. However, educators could feel overwhelmed by a list of 53 competences. So, identifying contextually relevant priorities could prove useful in informing educational initiatives in individual universities.

2. Methods

2.1. Context for the Research

This research was conducted as part of a Higher Education Authority (HEA) funded project entitled PROFESS 12.

2.2. Approach

A professional skills survey, developed using MS Forms, was based on previous research [8], which identified (at the European level) the skills that engineers needed to meet the SDGs. Ethical approval for this survey was granted by the Research Ethics and Integrity Committee in TU Dublin (REIC-21-74). The survey (piloted prior to launch



Citation: Henry, R.; Morgan, M.; Beagon, U.; Bowe, B.; Jani, R.; McKennedy, J. Engineering Skills to Respond to SDGs: A Survey of Employers, Academics, and Students. *Eng. Proc.* **2024**, *65*, 15. <https://doi.org/10.3390/engproc2024065015>

Academic Editor: Paddy McGowan

Published: 24 May 2024



Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

(November 2022)) requested information on respondent profile capturing characteristics such as category (academic/employer (including sector, size)/student (including year)) and demography (gender, age, region). The first question seeking stakeholder perceptions explored awareness of the SDGs. Further questions sought ratings on the importance and preparedness of engineering students and graduates and then priorities for teaching with reference to the 53 competences identified in six competency sets [8]. Finally, an open-text response was provided for additional feedback (if any). Invitations to participate in the survey were issued (primarily via email) to students in TU Dublin and Ulster University; academics in the research team's personal networks (wider than TU Dublin and UU); and engineering employers in the research team's personal networks and through professional institutions (such as Engineers Ireland and Institution of Structural Engineers).

This paper describes findings on awareness of SDGs and the importance of the competences only. Analysis of survey responses by category of respondents (academic, employer, student) has been undertaken to examine which competences are rated most important by category. It does not further differentiate by region nor by gender, though views are likely to differ within some if not all, sub-groups. This could form the basis of further research and analysis. Some other aspects of analysis are considered elsewhere: another paper [10] based on the same primary research (survey) considers findings disaggregated by region rather than by category of respondent.

3. Results

Key findings are presented below, with initial consideration given to the profile of respondents.

3.1. Profile of Respondents

Of 235 survey respondents, slightly over one-third were from Northern Ireland ($n = 88$), with most being from Ireland ($n = 147$). A small number of responses ($n = 7$) from elsewhere were excluded from this analysis. Students provided the most responses (over half, 54.9%) and academics almost one quarter (23.0%). Employers (mostly multinationals and SMEs (8.9%) and nationals (4.3%)) provided the remainder of the responses.

3.2. Awareness of Sustainable Development Goals (SDGs)

Overall awareness of the SDGs measured on a five-point Likert scale (from 5—extremely aware to 1—not at all aware) was 3.2 (somewhat to moderately aware). However, awareness was not consistent within categories: unsurprisingly, the highest (4.1) was amongst academics. Awareness amongst all employer categories was markedly lower: 3.3 for multinationals and nationals. The lowest levels of awareness were amongst SMEs and students (2.8 each).

3.3. Importance of Competences

Respondents rated importance on a five-point Likert scale (from 5—very important to 1—not important) for 53 competences in six competency sets. All are rated as being of at least some importance, with an average rating of 3 or more. The five most important competences (Table 1) overall had ratings greater than 4.5.

Disaggregating results by category (Table 1) shows that whilst the competences ranked as the most important are broadly similar, there were also notable differences in rank order and in the inclusion/exclusion of certain competences in each category. Ten different competences are featured across all categories. In most categories, there are more than five competences in the top five rankings, as some competences share average importance scores.

Table 1. Importance of Competences by Category—Ranked 1–5.

Category	Top 5 Most Important
Academic	1 = Problem Solving; 2 = Teamwork / 2 = Critical Thinking; 4 = Respect for Others; 5 = Collaboration / 5 = Communication
Employer–Multinational	1 = Problem Solving / 1 = Communication; 3 = Respect for Others; 4 = Collaboration; 5 = Critical Thinking / 5 = Teamwork / 5 = Technical Skills
Employer–National	1 = Communication; 2 = Teamwork; 3 = Critical Thinking / 3 = Sustainability Awareness / 3 = Time Management
Employer–SME	1 = Problem Solving / 1 = Communication / 1 = Teamwork; 4 = Adaptability; 5 = Collaboration / 5 = Time Management
Student	1 Problem Solving; 2 Communication; 3 Respect for Others; 4 Teamwork; 5 Time Management
All	1 Problem Solving; 2 Communication; 3 Teamwork; 4 Respect for Others; 5 Critical Thinking

In Table 1, coloured font is used to illustrate similarities/differences between categories. Each competence is allocated a colour; its rank for each category is shown in the same colour. Three competences are shown in black font; each of these only appears once in the table.

4. Conclusions

Amongst survey respondents, there are interesting differences in awareness of SDGs. There is broad agreement on the most important competences required by engineers, but there are also notable differences. Although this is perhaps to be expected given the different environments in which academics, employers, and students operate, it is notable that some competences (Communication, Teamwork) feature in all employer categories’ top five, whilst there are also distinctive competences for each employer type. Overall, this provides useful insights for academics to consider in engineering curriculum design and in managing students’ expectations to reflect employer priorities.

Author Contributions: Conceptualization, U.B., B.B. and M.M.; methodology, U.B. and M.M.; formal analysis, R.H.; investigation, U.B, R.J. and M.M.; writing—original draft preparation, R.H.; writing—review and editing, M.M., U.B., R.J. and J.M.; supervision, B.B.; project administration, U.B. and M.M.; funding acquisition, B.B., U.B. and M.M. All authors have read and agreed to the published version of this manuscript.

Funding: This research was completed as part of the PROFESS 12 project, funded by the North–South Research Programme (a collaborative scheme funded through the Irish Government’s Shared Island Fund). This programme is administered by the Higher Education Authority (HEA) on behalf of the Department of Further and Higher Education, Research, Innovation, and Science (DFHERIS). The APC was covered by the conference organisers.

Institutional Review Board Statement: This study was approved by the Research Ethics and Integrity Committee of TU Dublin (reference: REIC-21-74, date of approval: 3 November 2022).

Informed Consent Statement: Informed consent was obtained from all respondents to this survey through the online questionnaire.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors upon request.

Acknowledgments: The authors would like to thank the academics, employers, and students who contributed to this survey.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of this study, in the collection, analyses, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

References

1. Passow, H.J.; Passow, C.H. What competencies should undergraduate engineering programs emphasize? A systematic review. *J. Eng. Educ.* **2017**, *106*, 475–526. [[CrossRef](#)]

2. Male, S.A.; Bush, M.B.; Chapman, E.S. An Australian study of generic competencies required by engineers. *Eur. J. Eng. Educ.* **2011**, *36*, 151–163. [[CrossRef](#)]
3. Kovesi, K.; Csizmadia, P. Industry perception of new engineering graduates: The gap between requirements and reality. In Proceedings of the 44th Annual SEFI Conference, Engineering Education on Top of the World, Industry-University Cooperation, Tampere, Finland, 12–15 September 2016.
4. Colman, B.; Willmott, P. How soft are ‘soft skills’ in the engineering profession? In Proceedings of the 44th Annual SEFI Conference: Engineering Education on Top of the World: Industry-University Cooperation, Tampere, Finland, 12–15 September 2016.
5. Wiek, A.; Withycombe, L.; Redman, C.L. Key competencies in sustainability: A reference framework for academic program development. *Sustain. Sci.* **2011**, *6*, 203–218. [[CrossRef](#)]
6. de Haan, G. The Development of ESD-Related Competencies in Supportive Institutional Frameworks. *Int. Rev. Educ.* **2010**, *56*, 315–328. [[CrossRef](#)]
7. Rieckmann, M. Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? *Futures* **2012**, *44*, 127–135. [[CrossRef](#)]
8. Beagon, U.; Kövesi, K.; Tabas, B.; Nørgaard, B.; Lehtinen, R.; Bowe, B.; Gillet, C.; Spliid, C.M. Preparing engineering students for the challenges of the SDGs: What competences are required? *Eur. J. Eng. Educ.* **2022**, *48*, 1–23. [[CrossRef](#)]
9. UNESCO. *Education for Sustainable Development Goals: Learning Objectives*; UNESCO: Paris, France, 2017.
10. Henry, R.M.; Morgan, M.; Beagon, U.; Bowe, B.; Jani, R.; McKennedy, J. Addressing Challenges Of The SDGs: Stakeholder Perspectives On Skills Required By Engineering Students On The Island Of Ireland. In Proceedings of the 51st Annual SEFI Conference: Engineering Education for Sustainability: Reflecting on the Role of Engineering and Technology Education for a Sustainable World, Dublin, Ireland, 11–14 September 2023.

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.