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# Reality check of sustainable engineering education: Exploring the leverage power of early graduates in the workplaces

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## Abstract

The societal sustainability transformation requires rapid actions from all organisations. Given that engineering students are increasingly being educated to consider sustainability in their future positions, early-career engineering graduates have the potential to accelerate sustainability transformation in their organisations. However, working life as an environment differs from university environment in terms of social relations and working culture. Despite extant research has identified that graduates face challenges when transitioning to the world of work, the early career perspective has remained relatively underemphasized in engineering education for sustainability research: how the sustainability expertise of recent graduates is being recognised and utilised, and how the employers view the role of graduates regarding the sustainability efforts of their organisations. Having deeper understanding of the reality that graduates face in their early careers could provide valuable insights for educating changemakers.

We interviewed ten employers and four graduates representing the water and environmental engineering field in Finland on their perceptions of graduates' sustainability expertise and role in the organisations. In addition, we explored factors that may restrict or enhance the leverage power of the graduates regarding the organizations' sustainability efforts. We transcribed and pseudonymised the interview data and then coded and categorised it using abductive theme analysis, which allows for utilising both deductive and inductive approach in creating the themes and subthemes.

Our key findings indicate that graduates are generally considered as beginners who need to grow as experts rather than welcoming them as sources of new approaches and insights. In addition, despite sustainability is increasingly being promoted in the education, the employers seem to prioritize other competencies when recruiting new graduates. After the recruitment, they lack measures to explore what the new employee knows and how to best utilise their competencies. As a result, the employers remain unaware of graduates' competencies, which forms a central hindering factor for the role of graduates as changemakers. Graduates' sustainability actions are also restricted by the lack of power due to their hierarchical position, and resources. However, measures seem to exist in the organisations to support graduate actions, such as implementing a sustainability strategy, and promoting an open culture.

We discuss the implications of these findings on the current pedagogical approaches to integrate sustainability in engineering education. We particularly emphasise how the education could improve the apparently low leverage power of engineering graduates in their early-career organisations through pedagogical approaches, and intensified academia-industry collaboration.

## **1 Introduction**

Work life collaboration has always been a central focus of engineering education, aiming at answering work life demands. Currently, engineering educators are putting substantial efforts to include also sustainability into courses and curricula, without forgetting the real-world context (e.g., Rosén *et al.*, 2019; Högfeldt *et al.*, 2019). However, it has remained unclear how the competencies and insights that graduates have acquired from this education are being utilised in workplaces. Therefore, there is a need to explore graduates' sustainability competencies in the context of their early career.

University - work life transition is an emerging research area (Stevens *et al.*, 2014). Recent studies suggest that graduates may perceive this contextual change as challenging due to novel social and cultural environments (Lutz & Paretti, 2021). There are also indications of an expectation gap between employers and graduates concerning graduates' proactiveness (Korte *et al.*, 2015). The employers also hold high expectations towards young engineers' sustainability competencies and change agency (Yamane & Kaneko, 2021) but might neglect workplace support that could be needed to strengthen the agency (Karvinen, 2024). Same applies to educational settings that focus on bridging a gap between graduate competencies and work life needs without acknowledging challenges brought by the contextual change (Stevens *et al.*, 2014).

Several workplace related factors have been identified to affect graduates' sustainability initiatives (e.g., Fernández-Manzanal *et al.* 2015; Vehmaa *et al.* 2018, Chance *et al.* 2022). The most important obstacles include the lack of resources and power, social factors like conflicting norms or values, and client demands. The most impactful ways to mitigate these relate to workplace support, such as assistance from colleagues, organisation's sustainability strategy, and supporting employees' learning in the organisation. In addition, considering sustainability in recruiting could be beneficial for organisational sustainability: employees who are motivated and already possess some sustainability knowhow seem to be more likely to learn more about these topics, which results in higher competence levels in the organisation (Roscoe *et al.*, 2019).

The previous research on graduate roles and sustainability agency in the early career is mainly focused on graduate perspectives, while the employer views have remained unexplored. In this paper, we focus on the employer perspective through studying organisations in the Finnish field of water and environmental engineering. In this context, recent questionnaire survey results indicate that both graduates and employers would like to utilise the potential of the graduates more, particularly when it comes to their sustainability knowledge (Karvinen, 2024). Moreover, it seems that the employers may overemphasise graduates' attributes and underemphasise the role of the organisation in supporting the graduates (Karvinen, 2024). To further clarify the employers' perceptions, we conducted a qualitative exploration guided by the following questions: How do the employers perceive early graduates' role and expertise, and what factors do the employers see affecting graduates' possibilities to influence on sustainability. By answering these questions, we hope to bring new insights in engineering education that help develop the support for graduates in the early career increase their possibilities to accelerate sustainability transformation.

## **2 Methodology**

### *2.1 Data collection*

We conducted fourteen semi-structured interviews in Aug-Oct 2024. Our target group consisted of the employers (n=10) and graduates (n=4) of Aalto University's Master's Programme in Water and Environmental Engineering (WAT), which has been intensively studied during the past decade (Karvinen,

2024). The interviewees represented seven organisations (Table 1), covering a large part of WAT graduates' first workplaces (Vehmaa, 2018). From the large organisations, we interviewed 2-4 persons each, while the three SMEs and the one small water utility were represented by one interviewee each. The interviewees were found through WAT staff members and an open call posted to the WAT alumni e-mailing list.

The interviewed graduates had worked for their current employers for 2–3 years in expert positions with titles such as a planner or consultant. They had no managerial responsibilities. The titles of the interviewed employers were for example project manager, head of unit, and managing director. They had worked for their current organisations from two to sixteen years, with an average of 7,5 years. All the employers had experience in guiding recent graduates, and most of them had managerial responsibilities.

Table 1: Summary of interviewees' backgrounds (SME = small and medium-sized enterprises).

Interviewee ID	Interviewee profile	Type of organisation	Gender
I1	Employer	SME 1	Male
I2	Employer	Big consultancy company	Female
I3	Graduate	Big consultancy company	Male
I4	Employer	Large water utility	Male
I5	Employer	Large water utility	Female
I6	Graduate	Big consultancy company	Female
I7	Employer	Big consultancy company	Male
I8	Graduate	SME 2	Female
I9	Employer	Big consultancy company	Female
I10	Employer	Big consultancy company	Female
I11	Graduate	Large water utility	Female
I12	Employer	Small water utility	Female
I13	Employer	SME 3	Female
I14	Employer	Large water utility	Female

The interview structures for the two groups differed slightly: the employers' interviews emphasised their views as representatives of their organisations and experiences of guiding graduates, while graduates' interviews focused more on their experiences of the workplaces. The interviews were held online in MS Teams, they lasted in average 50 minutes and were conducted in Finnish. They were recorded with the consent of the participants, transcribed using MS Teams, and pseudonymised for data analysis. The ethical guidelines of the Finnish council for research integrity were followed throughout the research process: the interviewees were asked for a consent to participate in the study and informed on their right to withdraw anytime without negative consequences. They were informed on the handling of their personal data.

## 2.2 Data analysis

The transcriptions were analysed using abductive theme analysis, which allows for combining deductive and inductive analysis of the data (Timmermans & Tavory, 2012; Thompson, 2022). The approach provided a fruitful way for looking into a new research area: we were able to lean on previous research and highlight possible novel findings emerging from our data.

We mainly applied a process presented by Thompson (2022), which includes eight phases: 1. Transcription and getting familiar with the data, 2. Coding, 3. Codebook, 4. Creating themes, 5. Theorising, 6. Comparing

data groups, 7. Presentation of the data, and 8. Writing. However, we excluded the phase 3. Codebook., which according to Thompson, provides structure for the coding if done by a research group, and is beneficial when the analysis takes a long time. In our case, only one of the authors coded the data during a short period of time, as this study is based on the data the author collected for her master’s thesis (Pajukari, 2024). The comparative phase (phase 6.) was also excluded, as this was not the focus of our study.

The coding was done in three rounds in Atlas.ti, following the recommendation of Thompson (2022). The codes included words, phrases, and short dialogues between the interviewer and the interviewee, for example “resources”, or “demands from clients”. The coding phase resulted in 125 codes, which were divided into initial categories and finally, to themes and subthemes that were visualised into theme maps.

### **3 Results**

#### *3.1 Employer views on graduate role and expertise*

The main result emerging from the employer interviews was that they had challenges to identify how the potential of the graduates could be better utilised, particularly in sustainability questions. This was explained by the employers’ insufficient understanding of and low interest towards finding out what the graduates know and can do: the graduates were mostly perceived as beginners and learners that have a potential to adapt to the workplace culture and practices (Fig. 1). This revealed to be also one of the key factors hindering graduates’ possibilities to influence on sustainability in the workplaces (see 3.2).

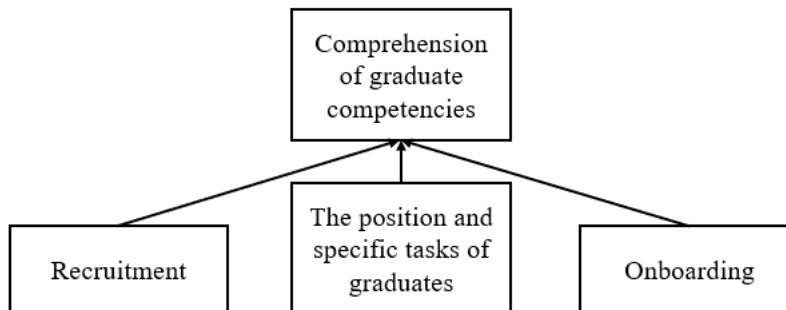


Figure 1: Theme map illustrating the factors that affect employers’ views on graduates’ influencing possibilities.

Three key factors seemed to affect this insufficient understanding of graduate competencies (Fig. 1). The interviewees explained that graduates usually start in low hierarchical positions with specific tasks. Therefore, the recruiting process focuses on finding out how the graduates could perform these tasks instead of exploring graduate competencies or sustainability related knowhow more holistically. The same applied to the onboarding phase, which, according to the interviewees, is lacking practices that could inform the employers more widely on graduate competencies and insights.

#### *3.2 Factors affecting graduates’ influencing possibilities*

As mentioned above, employers’ limited understanding of graduate competencies is one of the key factors hindering graduates’ influencing possibilities. Other limiting factors that emerged included the low positions of graduates, limited resources, and hindering social environment (Fig. 2). Both graduates and employers described situations graduates had no leeway to suggest sustainable solutions, as the key

decisions had already been made by project managers or clients. The graduates explained that they simply perform tasks that are given from above, and that the managers are the ones who have power to affect on sustainability in projects. The employers reminded that people in managing positions are responsible for the projects and therefore, the younger experts may be given only restricted degrees of freedom.

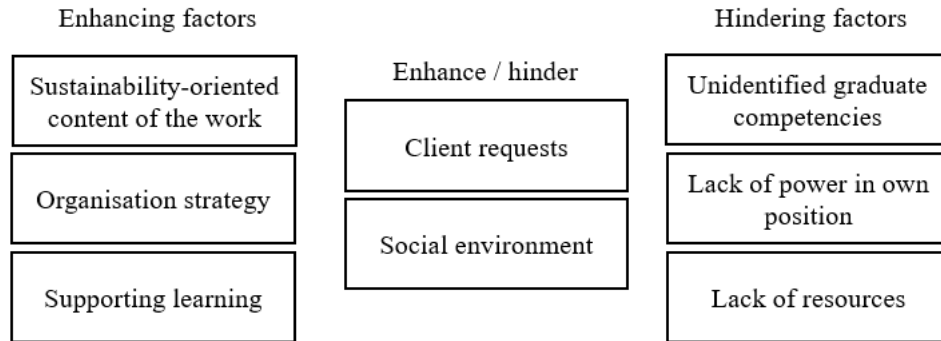


Figure 2: Factors affecting graduates' influencing possibilities according to the interviewees.

It was also revealed that graduates, and other employees, prefer to suggest solutions that they are already familiar with instead of exploring and developing more sustainable options. The interviewees told that this was mainly due to limited time and financial resources particularly in consultancy companies, where projects are funded by clients. However, almost all the graduates mentioned that utilising familiar solutions was partly driven by conservative mindsets and resistance to (sustainability-oriented) change by some of their senior colleagues, and some clients. Graduates perceived this kind of hindering social environment at the workplace more negatively than conservative requests or attitudes of clients.

Three main factors that seemed to promote graduates' influencing possibilities were the sustainability-oriented content the work, sustainability strategy and how it is implemented, and supporting the learning of employees (Fig. 2). The interviewees described that the field of water and environmental engineering is tightly connected to sustainability, and that this becomes evident already during university studies: they perceived that students of this field have a personal motivation and interest towards sustainability. The participants also identified a connection between the field and sustainability in their daily work. This connection, in their view, automatically results in graduates having possibilities to promote sustainability.

In many interviews, the sustainability strategy of the organisation was mentioned as one of the key means to promote sustainability in daily work. The employers emphasised this much more compared to the graduates. The interviewees particularly underlined that the strategy enabled, and partly also forced, sustainability aspects to be systematically implemented throughout projects and processes. The strategy also created a frame that helped all employees understand why sustainability needs to be considered. For graduates, practical tools through which the strategy was implemented revealed very helpful, specifically project and document templates where sustainability had already been embedded, and sustainable material policies made by the organisation. Although these tools were perceived as a surface approach to sustainability, almost all the interviewees found them beneficial. The main reasons behind this were that the tools made sustainability visible and reminded of taking it into account, and the different templates also nudged the less interested employees to go through their projects' sustainability aspects.

All the studied organisations supported the learning of their employees. Most of the learning was informal and happened through daily routines, including searching for new information, and learning from

colleagues and clients. Semi-formal arrangements were also mentioned, where the more senior members were officially appointed to share from their experiences and guide the junior members. In addition to these, most of the organisations provided at least some formal internal training including e-learning materials associated with the onboarding process, occasional coffee events with training agendas, or longer training events. Some organisations had distributed the development responsibility to specific persons, who then attended trainings and shared the information within their units. Practices that the interviewees shared relating to external trainings varied from having no trainings at all to encouraging employees to attend conferences, events and trainings to learn and build networks. Specifically large companies seemed to support trainings relating to their sustainability strategies.

Organisation size and societal sector seemed to affect all the limiting and enhancing factors described above. In small water utilities, graduates seemed to have more freedom and responsibility in their positions compared to large water utilities, where graduates were mainly recruited into lower-level technical tasks. In the large consultancy companies, graduate tasks focused mostly on client projects, and graduates' influencing possibilities were limited to choosing, which projects they would prefer. Similarly, in these large companies, the trainings were mostly provided for senior employees, as they were seen more capable of distributing this information to the whole organisation compared to junior employees. On the other hand, some interviewees said that the juniors are cheaper and therefore can be allowed to use more time to explore new solutions. In these cases, graduates were also seen as energetic and innovative creators.

#### **4 Discussion and conclusions**

Our findings suggests that employers' perceptions of graduates varies but their unawareness of graduates' competencies create a major hindering factor for graduates' influencing possibilities. Further, the results indicate that means to improve the situation are currently underdeveloped, but senior employees might be in key position to improve graduates' leverage power concerning sustainability. We next discuss what engineering education could do help promote graduates' leverage power over sustainability.

In line with previous research (Stevens *et al.*, 2014), our results indicate that employers fail to consider the contextual change that graduates face in work life transition. To help graduates tackle the situation, engineering education is encouraged to further develop their work life readiness. Apart from disciplinary expertise, work life readiness is related to personal competencies, such as adaptability, courage, and self-knowledge (Korte *et al.*, 2015; Karvinen, 2024), whereas competencies that underpin sustainability agency include acknowledging own values, mental models, and emotions, and an ability for self-control and initiative. These personal competencies could be best promoted through transformative pedagogical approaches that promote deep self-understanding and initiative and allow for considering affective dimensions of sustainability-related learning. Such approaches include critical reflection and active learning (Holdsworth & Sandri, 2021), and contemplative practices like reflection and mindfulness (Wamsler, 2019).

Despite graduates have their own responsibility to be prepared for the work life, our findings suggest that a key obstacle to utilising their potential is the employers' mindset. In line with the results of Korte *et al.* (2015), our employers see graduates mainly as learners that adapt to the workplace instead of fully utilising the information and insights graduates could transfer from their education. This was particularly evident in the recruiting and onboarding practices of our interviewees and seemed to specifically concern sustainability competencies. Further, the key factors that our participants mentioned to affect graduates' influencing possibilities are all somehow related to the guidance of graduates, whether it was passive

through strategy, or active through peer learning and trainings. In active guidance, graduates' leverage power is very dependent on the senior colleagues and managers: do they consciously ask for junior experts' insights, and are trainings provided to the young experts.

In our view, engineering education could bridge the gap between employers and graduates through informal and formal educational settings. Informal settings include various communication channels, such as these supervision processes, and general awareness-raising whenever engaging with stakeholder organisations. A good example showcasing the meaning of awareness-raising emerged when distributing the initial results of this paper to the interviewees: some of them had never thought of graduates' potential in the way it has been discussed in this study. When widening their perspective of graduates' role and potential to accelerate sustainability transformation, some of them were about to implement immediate changes into their recruiting and onboarding practices that concern summer jobs opening for this year.

In formal settings, established practices already exist that engage students with work life (Högfeldt *et al.*, 2019). Based on our findings, educators are encouraged to further develop these practices to include more intensive interaction between the parties. A recent example from the WAT Programme of Aalto University works as an example: a project course where students solve practical cases and are mentored by work life actors has been complemented with a training course provided to the mentors. The training engages them to learn about team facilitation and brings them to workshops with students that focus on sustainability, and systems and futures thinking. This provides the mentors deeper understanding of the current ways of teaching, and of competencies that graduates develop during studies. In the end of the training, the mentors are assigned to distribute their learnings and insights of the experience in their organisations.

To conclude, our study concerning the Finnish water and environmental engineering field shows that engineering education and work life need to intensify collaboration around sustainability to improve graduates leverage power. The key development areas identified in this paper are: 1) transformative approaches to embed more reflection and other agency-promoting pedagogies to engineering courses, and 2) informal and formal educational means that raise employers' awareness of graduate competencies and potential. We see that it is of utmost importance to acknowledge the competencies and insights of junior engineers to accelerate sustainability transformation in organisations and society.

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