Teaching social sustainability to engineering students with the help of social impact audit tool

Teaching Social Sustainability to Engineering Students with the help of Social Impact Audit Tool

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Abstract

In this paper we will explore the less practiced aspect of social sustainability in engineering education, focusing on the Ansys Academic Social Impact Audit Tool (SIAT Excel-based) and SIAT Application (SIAT App) and experiences of educators, who have used either of the SIAT versions in their teaching. While the integration of specific methodologies, such as Social Life Cycle Assessment (S-LCA) are still being explored and unevenly applied in engineering curricula, the topics, such as engineering ethics and recognition of soft skills as critical (or transversal skills) are simultaneously being discussed and widely accepted (contributions from the European Society for Engineering Education (SEFI) conferences 2023 and 2024).

The SIAT App is based on originally developed Excel-based SIAT (Ashby et al, 2019). The SIAT helps to teach concepts of S-LCA. The SIAT is now an interactive application. It helps to visually analyse potential social impact at a national scale, enabling comparison between products' life cycles. The SIAT largely follows the UN S-LCA guidelines 2009, 2020 as well as the ISO 14075, aligning with the S-LCA Performance assessment methodology. The data is consistent with the Ansys Granta EduPack Sustainability Database (EduPack). The SIAT App itself is available to download from Ansys Education Resources Website for the licensed users of the EduPack.

Broadly, the SIAT and its digital successor help students to: recognise the fundamental concept of S-LCA, aiding to a fully holistic assessment of a product life cycle, if coupled with Environmental LCA and Life Cycle Costing analysis; and examine scenarios with potential socio-economic impact of product-related decisions, using a variety of data visualisations.

In this paper we will first focus briefly on historic developments behind S-LCA, continue with a description of the SIAT and its further development into a digital version, concluding with the most recent experiences from academics, who have used the SIAT and SIAT App in their teaching. We will finish with the discussion points.

1 Introduction

1.1 Broader context

UN Sustainable Development Goals (SDGs) (2015) and its targets are reflected in an Environmental, Social and Governance framework (ESG) with companies now obliged to report on their operations from a

sustainability-perspective. An example of a regulated approach is the Corporate Sustainability Reporting Directive (CSRD) in force since Dec 2022. Companies are increasingly looking for data, methods and tools to assess sustainability impact. Life Cycle Sustainability assessment is becoming a new paradigm with methods and tools being increasingly developed and tested (Valdivia S. & Sonnemann G. *eds*., 2024).

There are established methods for analysing Environmental Impact (e.g. Environmental Life Cycle Assessment with its ISO 14050 standard from 2006), with Guidelines for LCA now existing for more than 20 years. Life Cycle Costing approach is used for economic assessment. While Social Sustainability and guidelines on SLCA were first introduced in 2009 and subsequently updated in 2020, and the SLCA-specific ISO guidelines (14075) are published in 2024.

In terms of its maturity and data availability SLCA is the weakest compared to the other two (Valdivia S, 2024). SLCA largely shares the ISO framework, yet has distinctive features leading to its own guidelines and ISO framework, for instance, definition of stakeholders and consideration of their concerns is essential, quantitative and qualitative data are used and are related to third parties, inventories not only per functional unit but also for the whole organization, there are positive and negative impacts to consider, an iterative assessment process is promoted to validate results (*Ibid*.).

1.2 A case of a higher education

The UN SDGs reinforced the importance of sustainability education and provided a common language around actionable goals, deployable in an engineering education context. UNESCO has the whole program to enhance countries' capacity to provide quality education in sustainable development area. For more than a quarter of a century, universities have been offering courses focusing specifically on sustainability in an engineering curriculum (e.g. MPhil in Engineering for Sustainable Development at the University of Cambridge). Engineering curricula now includes sustainability knowledge and skills as a standard – often driven by accreditation bodies and implemented top-down (e.g. ABET accreditation) or initiated by individual academics, responsible for teaching. The depth and spread of a taught sustainability remain varied and demand its own research.

When introducing the social side of sustainability, traditional health and safety and environmental consideration prevail (Vakhitova et al, 2015; discussions at SEFI conferences 2024, 2025). Integration of social science methods and tools into traditional engineering curriculum e.g. such as methodologies of social impact assessment, Social Life Cycle Assessment (S-LCA), and stakeholder analysis are still being unevenly applied in different universities (SEFI conference 2023, 2024.). At the same time, topics of ethics are becoming more prominent in discussions and there is a strong acceptance of soft as critical or transversal skills (e.g. EESD conference 2020 & Ibid.).

2 Social Impact Audit Tool

In 2019 we introduced a Social Impact Audit Tool (SIAT) (Ashby et al, 2019) to increase awareness of the socio-economic consequences of product-related decisions, based on methodology of S-LCA of products. The methodology is in turn based on the widely accepted UNEP/SETAC "Guidelines for Social Life Cycle Assessment of Products" (2009 and 2020), allowing students to explore scenarios that illustrate the S-LCA, using recommended Protocol. The main audience are students of Materials Science, Engineering and Design. Simply, the tool adds value in product design decision making, when assessing the flow of materials,

energy, and money in each phase of product life, and their environmental, economic impacts and social consequences. The SIAT fits well with EduPack software, in particular, its EcoAudit Tool for a streamlined Life Cycle Inventory with its costing function and socio-economic data from its Sustainability Database.

The SIAT has now been developed into a Python based application. App development took place in close collaboration with representatives from three Universities, namely University of Patras, Chalmers University and the Norwegian University of Science and Technology during Q4 of 2024 and Q1 2025. Their feedback helped to improve App's usability, contextual outputs and to develop user- and technical guides.

With the digital version of SIAT (App), users can visualise patterns in global socio-economic data, explore social hotspots in different stakeholder groups, analyse the number and depth of social hotspots across product lifecycles. This includes more varied and multi-level data visualisations and additional functionality to explore potential social impact for key stakeholder groups. The data, however, remains similar, compared to SIAT in Excel, and comes from EduPack Sustainability Database "Nations of the World." The SIAT App has been reported as more interactive, visual, and engaging, compared to its prototype in Excel (internal user survey).

The next part will provide an overview of experiences from different academics, who were using SIAT (Excel-tool) and the beta version of SIAT App in different formats of teaching/research. Due to a delay with the release of the App due to its licensing aspects, the paper focuses on SIAT Excel tool use-case and a beta-version of the App.

3 Experiences from Educators

A comprehensive use case from Chalmers University of Technology describes a session with the SIAT (excel version), delivered in a half-day workshop format for groups of bachelor level students from "Mechanical Engineering" program (160 students); Materials engineering and Production engineering Master-level programs (55 students) and Product Design Engineering bachelor's program (28 students). Students were asked to analyse the social impact of electrical consumer products to optimize production chains, exploring different scenarios (Fernandes P. et al, 2025).

Data from common platforms (Miro boards), surveys, and facilitator observations was used in evaluation of the SIAT's efficacy. It concludes with a statement that the SIAT helps to enhance critical thinking about the social impact of products, supporting future designers in the creation of socially sustainable products (*Ibid*.). SIAT promotes "systematic analysis of social impacts in product design while fostering critical understanding of social sustainability metrics" (*Ibid*. abstract).

The challenges students had were a difficulty to set-up a threshold to explore scenarios, sustainability trade-offs, social impact prioritization, and data interpretation. The workshop's results highlight more awareness among participants of data sources importance (as a follow-up activity after the results of SIAT), alignment of priorities and interpretation of social sustainability among group members. As a result, many students have reported reconsideration of materials choices and production locations, based on social impact. Overall, the use of the SIAT had high engagement from students during the workshop sessions. The SIAT helped in provision of a shared vocabulary and data to analyse social impact. Finally, it is still important to provide theoretical basis and contextual case studies to avoid oversimplification of social sustainability (*Ibid*.).

The second use case is from the University of Cape Town. The 120 Mechanical engineering bachelor-level students were exposed to the SIAT App during its development period (2024 Q4 and 2025 Q1). The students were introduced to circularity topics prior to using the SIAT and were working in groups. The SIAT App has provided them with a starting point to focus on more research of countries, which came out in overall analysis using the App. While the students were expecting to have more details in the SIAT App itself and in data from Nations of the World Database, they were encouraged to do extra research and have SIAT App outputs as a starting point for their investigations.

The third use case comes from University of Patras and focuses on testing of SIAT App's beta-version (2024 Q4). Two academics and a PhD-researcher have provided several iterations of their feedback, while the technical work on the App took place on Q4 2024. Their overall assessment was "It is a great app for raising awareness on how Social Impact Assessment is directly linked to lifecycle of products" (unpublished internal presentation and survey responses). Colleagues from University of Patras have reviewed the SIAT App and its data in detail, helping us to navigate the clearest way to present data visualisations to be helpful in answering questions of social sustainability. This exchange has led to making more clarification, for instance, in the Help menu of the SIAT App and extended information in accompanying user guide.

4 Conclusion

Overall, the SIAT and the SIAT App have been successfully used in the teaching of social sustainability in engineering and product design courses. It is paramount to contextualize the results received with its help and provide an initial theoretical introduction to social sustainability to students before delving into using the Tool.

At this stage, the SIAT App is available for teaching purposes with an accompanying survey for feedback collection. Throughout the application development process (second half of 2024 and first part of 2025) university partners evaluated and provided feedback on its functionality and learning outcomes achieved when using the SIAT App.

The SIAT App was used in a workshop format and as a tool to support a lecture series. We will continue to collect feedback from academics and students via a survey, using Microsoft Forms.

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