



Core Competencies for Sustainable Solutions Engineering

Bachelor's thesis

Information and Communication Technology, Bioeconomy

Spring 2024

Destiny Kiho

Opinnäytetyön tavoitteena on selvittää, mitä ydinosaamista ammattilaiset tarvitsevat vuoden 2030 kestävä kehityksen tavoitteiden edistämiseksi. Tähän tutkimuskysymykseen vastaamisen tarkoituksena on sekä kertoa lukijalle, mitkä ovat ydinosaamiset, joita tarvitaan vuoden 2030 kestävä kehityksen tavoitteiden edistämiseksi kestävä päätöksenteon kautta, että edistää Sustainable Solutions Engineering -tutkinto-ohjelmaa LAB-ammattikorkeakoulussa. Tutkimus koostuu kirjallisuuskatsauksesta, jonka tarkoituksena oli antaa tutkijalle riittävät taustatiedot ydinkompetenssien ehdottamiseksi. Ehdotettuja ydinkompetensseja sekä kestävä kehityksen koulutuksen menneisyyttä, nykyisyyttä ja tulevaa kehitystä käsiteltiin LAB-ammattikorkeakoulun aihepiiriasiantuntijoiden haastatteluissa. Haastattelujen deduktiivinen temaattinen analyysi viittaa siihen, että ehdotetut ydinosaamiset tukevat ammattilaisia tekemään päätöksiä, jotka edistävät vuoden 2030 kestävä kehityksen tavoitteita. Laajempi tutkimushanke tästä aiheesta voi kuitenkin paljastaa, skaalautuvatko tulokset suuremmalle määrälle vastaajia, joilla on laajempi osaamisalue.

Avainsanat kestävä kehitys, koulutus, kestävä kehitys tavoitteet, kehitys
Sivut 14 sivua ja liitteitä 41 sivua

The thesis aims to determine what are the core competencies that will be needed by professionals to progress the 2030 Sustainable Development Goals. The purpose of answering this research question is to both inform the reader on what are the core competencies necessary to progress the 2030 Sustainable Development Goals through sustainable decision-making and promote the Sustainable Solutions Engineering degree program at LAB University of Applied Sciences. The research is comprised of a literature review, which was meant to provide the researcher with sufficient background information to propose the core competencies. The proposed core competencies as well as the past, current, and future development of education in sustainability were then discussed in interviews with subject-matter experts at LAB University of Applied Sciences. The deductive thematic analysis of the interviews suggests that the proposed core competencies do support professionals to make decisions that progress the 2030 Sustainable Development Goals. However, a larger scale research project on this topic may reveal if the results scale across a greater number of respondents of a wider range of competencies.

Keywords Sustainable development, education, 2030 Sustainable Development Goals, circular economy, development.

Pages 14 pages and appendices 41 pages

Content

1	Introduction	1
1.1	Background.....	1
1.2	Sustainability in Education at LAB, Sustainable Solutions Engineering (SSE).....	3
2	Knowledge Base	3
2.1	Legislative Drivers.....	4
2.1.1	The 2030 Agenda for Sustainable Development.....	4
2.1.2	The EU Green Deal	4
2.1.3	The Circular Economy Action Plan (CEAP)	5
2.2	Proposed Core Competencies	5
2.2.1	System Science.....	6
2.2.2	Environmental Science	6
2.2.3	Sustainable Development.....	6
2.2.4	Circular Economy	7
3	Methodology	7
3.1	Literature Review	8
3.2	Interviews	9
4	Results.....	10
5	Conclusion	13
	References	14

Figures, tables and equations

Figure 1. Research Process Methodology Flowchart.....	7
---	---

Table 1. Codes and Themes Identified from the Thematic Assessment.....	9
--	---

Appendices

Appendix 1. Interview Transcription Kirsi Taivalantti

Appendix 2. Interview Transcription Pia Haapea

Appendix 3. Interview Transcription Kusti Alasalmi

Appendix 4. Interview Transcription Susanna Vanhamäki

Appendix 5. Data Management Plan

Appendix 6. Privacy Notification

Appendix 7. Accompanying Letter to Research Participants

1 Introduction

What skills are needed to build a sustainable future? This research report aims to answer the question: "What are the essential sustainable development competencies that professionals will need to make decisions that progress the UN's 2030 sustainable development goals"? By considering what competencies are at the core of education in sustainability in universities of applied sciences, we can infer what kind of competencies also support sustainable decision-making that progress the 2030 Sustainable Development Goals. The goals of the report are to provide the reader with the core competencies necessary to promote and advance the 2030 sustainable development goals (SDGs) through informed decision-making and to promote education in sustainable solutions engineering. In an era of simultaneous technological development and increased risks posed by climate change and resource scarcity, government planning around the globe progressively focuses on two things: addressing these challenges and improving technological competitiveness. These efforts may take the form of research, development, and investment projects, new national and international policies, as well as economic and industrial strategies. One example, and the focus of this thesis, is the European Union, which in 2020 adopted its new economic strategy, the Green Deal. The economic strategy has set the stage for the development of EU policy until 2050. The vision for the future of Europe as outlined in the Green Deal and its subsequent policies will create demand for more skilled personnel, but also wiser citizens. As a result, education and reskilling are recognized as a central tool for managing both the short and long-term challenges associated with implementing the strategy. To determine what competencies are necessary to promote sustainable decision making that are in line with development needs, the research for this report was partially based on interviews with subject-matter experts at LAB University of Applied Sciences. It compares the viewpoints of experts in the field of sustainable development with the proposed core competencies that have been developed based on background research.

1.1 Background

The background section aims to provide the reader with sufficient context to understand the drivers and significance of the growing demand for core competencies for sustainable decision-making. Throughout recent history, there have been calls to action to collectively address the major shared threats to prosperous human societies. Complex and interrelated global problems such as inequality, hunger, access to water and sanitation, climate change, biodiversity loss, and resource scarcity are said to be the defining challenges for the people

of our era (United Nations, 2015). The issue has been addressed frequently throughout the years by governments and international institutions alike. As recently as 2023, the Intergovernmental Panel on Climate Change (IPCC) announced that measures must be drastically increased to avoid potentially catastrophic impacts caused by intensifying climate change and to mitigate and adapt to the impacts we already experience, especially by the most vulnerable societies (Intergovernmental Panel on Climate Change, 2023). To address the growing urgency to respond to existing and impending global issues, the UN developed a set of sustainable development goals (SDGs) and global progress indicators for sustainable development in 2017. The creation of these goals and indicators in 2017 were the result of years of political, technological, and scientific advancements and discussions. (Department of Economic and Social Affairs, n.d.)

The term “sustainable development” is meant to express holistic development approach that delivers benefits without compromising on financial, social, or environmental sustainability. “Sustainable” refers to the long-term capacity to renew or avoid depletion of resources. (United Nations, 1987) The concept of sustainable development is famously outlined in the 1987 publication “Our Common Future”, a report by the UN that highlighted the importance of balancing human needs with the capacity of the natural systems that sustain all human societies in the face of changing global circumstances. (United Nations, 1987) The publication stressed the need for action in the coming decades, especially for cooperation between different nations and departments to better manage the resources on which we are mutually dependent (United Nations, 1987). In the years following, more calls to action were made- including the famous Paris Agreement.

In the present day, the EU’s Green Deal economic strategy for 2050 uses the UN’s SDGs to guide its policy, which enables the EU to also use the global progress indicators to monitor the success of the policy and to measure the EU’s contribution to global progress. (Eurostat, 2021) EU nations create subsequent policies that impact the individual national, regional, and local governments and businesses. The changing regulatory and market environments caused by the adoption of these policies are driving businesses as well as public services to develop and innovate more sustainable solutions to adapt and manage change. (Sitra, 2022) Such public services include education and higher education institutions, which are tasked with the responsibility of educating the future workforce of the EU. It is therefore important that we can identify specific core competencies that provide a strong basis for sustainable decision-making, because neither businesses nor societies can develop sustainably without having the common knowledge of what makes a solution sustainable, or how to make sustainable choices. For this reason, LAB’s experts from the Sustainable Solutions

Engineering program and education in sustainability were considered an appropriate source of information to explore what core competencies are necessary to make sustainable decisions that promote the 2030 Sustainable Development Goals.

1.2 Sustainability in Education at LAB, Sustainable Solutions Engineering (SSE)

LAB University of Applied Science is a Finnish higher education institution in the Päijät-Häme region with campuses located in Lahti and Lappeenranta. It is important to provide context about the regions where the university is based, because in Finland, universities of applied science cooperate closely with development in their regions (Finnish National Agency for Education, n.d.). They provide development and education resources for businesses, governments, and of course the future workforce- and as such their curriculum reflects the present and future needed skills of the local region. Lahti is a medium-sized city in Finland that was given the title of European Green Capital of 2021 by the European Commission (Green Lahti, n.d.). The city has set the ambitious goal to be climate-neutral by 2025, ten years before the Finnish national goal of 2035 (Green Lahti, n.d.). In the earlier history of Lahti, it could be said that the city was an example of water mismanagement. However, decades of development to improve waste management, water management, and reduce emissions has turned the city into a model for sustainability. (Green Lahti, n.d.) As a university of applied science, LAB's education in sustainability reflects the practical skills needed on a regional level as well as the global-level SDGs that EU and Finnish policies are based on (Appendix 1 and Appendix 2). LAB's Sustainable Solutions Engineering degree program aims to provide learners with the competencies to address systemic and complex issues related to the simultaneous development of environmental, social, economic, and cultural issues in the context of the development needs of the local region and the digital transformation of the economy (Appendix 1 and Appendix 2).

2 Knowledge Base

In short, the knowledge base provides the reader with the context of why competencies at the core of sustainable solutions engineering are important to develop and gives an overview of each of the proposed core competencies that were developed in the research process. It is comprised of the policy tools that have been identified as instrumental in driving the demand for sustainable solutions, and therefore the skills to develop them as well. Primary sources, for example, the UN's (2015) 2030 Agenda for Sustainable Development, the EU

Green Deal (2020), and its subsequent policies provide the context as to why sustainable thinking is an important part of educating the present and future workforce. Other key sources include interviews with experts in sustainable development in the field of education and the policy tools those experts have cited as drivers of increasing demand for competencies that advance the 2030 Sustainable Development Goals.

2.1 Legislative Drivers

2.1.1 The 2030 Agenda for Sustainable Development

The UN's 2030 Agenda for Sustainable Development is a plan consisting of 17 goals and 169 targets to measure the progress towards those goals. The agenda seeks to end global sustainability challenges such as poverty, hunger, war, inequality, and climate change. (United Nations, 2015, pp. 1-4) The agenda emphasizes the interconnected nature of the complex issues that can inhibit sustainable development. Such is the reason that the UN maintains that cooperative and integrated efforts are necessary to reach meet the Sustainable Development Goals. (United Nations, 2015, pp. 1-4)

2.1.2 The EU Green Deal

The EU Green Deal is the EU's strategy to do its part to promote and advance the Sustainable Development Goals defined in the 2030 Agenda for Sustainable Development (United Nations, 2015). At the same time, it is an economic strategy that aims to build a financial system that rewards sustainability and drives innovative solutions. By doing so, the EU hopes to cultivate an economy that is carbon neutral in 2050. (European Commission, 2020) The Green Deal calls for the reform of policies that may inhibit progress towards its targets and encourages research and innovation in circular and digital solutions that will support and enable the transition to a digital, green, circular economy. (European Commission, 2020) The merits of this strategy are that the EU will develop local markets for strategically important materials where they currently do not exist, such as those which are necessary for electrified transportation, green energy production and storage, and critical raw materials (European Commission, 2020).

2.1.3 The Circular Economy Action Plan (CEAP)

The Circular Economy Action Plan (CEAP) is the EU Green Deal's strategy to achieve climate neutrality and promote a competitive, fair, and resource efficient economy (European Commission, 2020). The CEAP is a set of actions, plans, indicators, and industry-specific strategies that are meant to transform the EU economy to be more circular, which is considered a prerequisite to decarbonizing the economy to meet the EU's 2050 carbon neutrality goals outlined in the Green Deal. It focuses on transforming EU industry and society by improving waste management standards, increasing education, awareness, and development of the circular economy in both businesses and society. (European Commission, 2020) For example, the CEAP has influenced the development of EU Waste Framework Directive (European Commission, n.d.).

2.2 Proposed Core Competencies

During the background research, topics were proposed to be considered as core competencies that are necessary to provide a basis for sustainable decision-making that would be in line with the SDGs, contributing to their progression. These competencies would be verified or rejected for their relevancy to answering the research question by the interviewees. The proposed core competencies were chosen for their prevalence in the legislative drivers and because they build upon each other as interrelated concepts. The proposed competencies are system science, environmental science, sustainable development, and circular economy. The core theme that unites these concepts is system science and the understanding of systems, as environmental science, sustainable development, and circular economy cannot be explained without acknowledging or explaining the different parts of systems and their relationships. For example, circular economy focuses on the systems within the economy that deliver value in an efficient way without compromising on sustainability. However, to be able to apply the knowledge of what is and is not sustainable when developing circular solutions, one must have an understanding of sustainable development principles, which are again rooted in the essentials of systemic thinking and problem solving. The SSE program and by extension sustainable education at LAB could similarly be boiled down to understanding systems, and more importantly by extension, one's own role in promoting sustainable development (Appendix 2, Appendix 3, and Appendix 4).

2.2.1 System Science

The key sources used in this report consistently refer to both the challenges and solutions required to achieve the SDGs as interconnected or systemic. System science serves as the basis for understanding our world (Hieronymi A., 2013). By studying the interactions between different parts, or elements, of the system and the outcomes of the interactions between those parts, we can increase our capacity to influence upon that system (Hieronymi A., 2013). Our climate and environment, economic systems, and societies, each with their own features function as unique yet interdependent systems. By gaining competencies in system science, one is better positioned to understand the nature of the complex problems at hand. It provides a set of base principles that drive understanding and problem solving in the other central themes.

2.2.2 Environmental Science

Our environment and the climate that sustains it are complex natural systems that are indivisible from our own complex human systems (Bianchi, G. et al., 2022.; Joan J. et al., 2023) We rely on the environment for everything we need, including, but not limited to food (nutrients), air, water, energy, and materials. By understanding the environmental processes that influence and support human development, one can systemically aim to avoid disrupting the capacity of our planet to support our societies- for example through smarter resource use, protecting biodiversity, and building natural capital (European Commission, 2020).

2.2.3 Sustainable Development

Sustainable development is a broad and interdisciplinary field, which aims to promote benefits in ways that are socially, environmentally, and economically sustainable. Sustainable development skills are needed in all decision-making processes at the citizen, business, local government, national, and international levels. (Bianchi, G. et al., 2022) A central aspect of sustainable development is that it cannot be facilitated without an understanding of systems science. Without the capacity or understanding to address systemic issues, solutions often end up only managing the symptoms instead of fixing the often complex and interconnected sustainable development challenges. (Bianchi, G. et al., 2022) Efforts to treat systemic issues that only focus on one element of the system in question often end up in creating new problems or moving the problems to other places, which counterintuitively creates the need to resolve the issues of a systemic problem once

again. Sustainable development builds upon the concepts of systems science, environmental and social sciences to approach these wicked problems. (N. Voulvoulis et al., 2022)

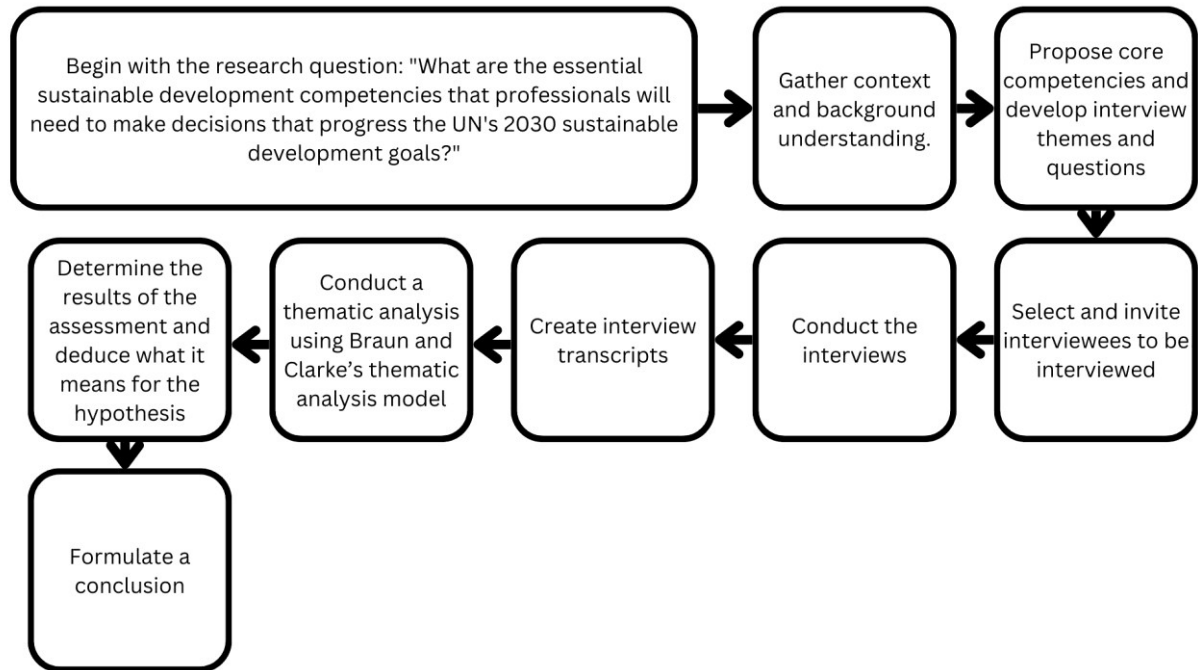
2.2.4 Circular Economy

The circular economy is an economic concept that is aligned with the principles of sustainable development. In a circular economy, resources are used, reused, refurbished or renewed, and so on, as much as possible to increase the productivity of a material over its lifetime. It prioritizes the prevention of waste in the forms of energy, materials, biological or natural capital, space, and other resources. (Ellen Macarthur Foundation, n.d.) By preventing waste through developing functioning markets and services that increase the duration of use and the capacity to reuse materials, the EU aims to decrease its carbon emissions as well as develop local markets for critical raw materials (European Commission, 2020). The skills to develop a circular economy, like those in sustainable development, are diverse due to the sheer breadth of the human systems that are covered by the field. The skills that are needed to implement circular solutions require that the individual understands sustainable development and circular economy principles, which require that one has an understanding of both system science and environmental sciences.

3 Methodology

To determine what competencies are necessary to progress the 2030 Sustainable Development Goals the research methodology consisted of a literature review and interviews with subject-matter experts in LAB's Technology Unit, which specializes in in circular economy and industrial technology (Appendix 1). This research process was chosen because it first provides a basis to propose what the necessary core competencies are and follows it up with an attempt to determine the validity of the proposal. In other words, the results of the interviews and their assessment are intended to help deduce if the proposed core competencies are truly relevant to promote the progression of the 2030 Sustainable Development Goals. Figure 1 shows the process of attempting to answer the research question as a flow chart.

Figure 1. Research Process Methodology Flowchart



3.1 Literature Review

The literature review mostly served to create background knowledge and a wholistic understanding of the context of the global and EU-level development challenges and how the efforts to resolve such challenges may manifest a change in the types of competencies that are necessary in the workforce. For this reason, sources such as the UN, EU Commission, and other international institutions were central in developing a perspective of the large-scale changes that are intended and how it may impact the development of education or the role of sustainability in education, for example. During the literature review, it became evident that the widely accepted basis for solving the systemic problems that are outlined as the 2030 SDGs lie in integrated solutions (United Nations Department for Economic and Social Affairs Department of Sustainable Development, 2015, p. 5; United Nations, 1987, p.7; Intergovernmental Panel on Climate Change, 2023, pp. 28-30). Furthermore, it is apparent that education and education in sustainability are central for cultivating a workforce that can meet the challenges posed by the Green and Digital EU transition strategy (Bianchi, G. et al., 2022). Ultimately the conclusion of the literature review is that because the EU's strategy for 2050 is aligned with the 2030 Sustainable Development Agenda, the core competencies in sustainability needed by students at universities of applied sciences, for example, will reflect the core competencies needed to promote the advancement of SDGs through sustainable decision-making. Another result of the literature review were the proposed core

competencies, which also contributed to the basis for formulating the interview themes and questions as well as select interview participants.

3.2 Interviews

The purpose of the interviews was to fill in potential information gaps and to seek the opinion of experts on the proposed core competencies. To conduct the interviews, a research permit was obtained from LAB University of Applied Sciences to be able to collect and utilize the data from the interviews with LAB staff. In total, four interviews were conducted with professors, lecturers, and the head of the Technology Unit at LAB. The interviews were thematic, semi-structured interviews. This form of interview was chosen because the type of desired response is open-ended in nature but still provides the researcher the opportunity to identify a recurring pattern across different interview responses. The primary themes of the interview questions included sustainable development in education at LAB, the proposed core competencies (especially systems thinking), and key development drivers. Each interview had a unique purpose or was meant to answer a specific set of questions. The interviews were tailored to the expertise of the individual being interviewed. Each interview had around 5 planned questions for the participants to answer, but also included spontaneous questions that arose as the themed discussion progressed- such is the nature of semi-structured interviews. Participants were selected for their expertise in the area of questioning (stratified sampling). The reason for selecting each of the interviewees is elaborated on in the interview transcriptions (Appendix 1, Appendix 2, Appendix 3, Appendix 4). The interview themes and questions as well as the proposed core competencies were first determined and then appropriate interviewees were picked from the LAB staff in the Technology Unit. Although the search for interviewees did also encompass the other units, the best results seemed to lie in the Technology Unit, which makes sense in the context of LAB's history of expertise in technology and environmental engineering, as the interviewee in Appendix 1 mentioned. When the interviews were completed a transcript was made to assist in the assessment of the interviews. The interviews were then assessed for repeating or common ideas or topics by using a deductive approach to a thematic analysis, because the purpose of the interviews and their analysis was to validate the hypothesis that the core competencies for promoting the 2030 Sustainable Development Goals are the proposed core competencies of systems thinking, environmental science, sustainable development, and circular economy. The approach chosen is based on a summary of Braun and Clarke's thematic assessment model (Caufield J., 2023).

4 Results

To assess if there was any strong pattern in the responses to the interview questions a thematic assessment is made, where the first step was to code particular types of responses, or ideas that were similar to each other within the interview transcripts. The next step was to group the similar types of coded responses with each other to establish a general theme in the responses of the interviewees. The expected result was that the interviewees would respond to the themed interview questions with similarly themed responses, since the objective of the interviews was to gain confirmation that the proposed core competencies are suitable for enabling sustainable decision-making that promote progress towards the 2030 SDGs. If the proposed core competencies were not considered core competencies, then it was expected that the interviewee would clarify what they believe those things are; making the topics different from what was expected. The results section provides the assessed themes and their definitions, as well as a comparison of the themes to what was expected and if there were any specific outliers or unexpected results from the interviews. It concludes by determining if the results of the assessment are similar enough to the results that were expected to consider the proposed core competencies as relevant for promoting the advancement of the 2030 Sustainable Development Goals. The table below shows the codes and themes identifies both in the questions asked and responses given. Colors were used to differentiate the different codes from each other, and the color coding of the chart allows the reader to review the transcripts with the color coding.

Table 1. Codes and Themes Identified from the Thematic Assessment

Color Code in the Interview Transcription (Appendices 1-4)	Coded Question or Response Type/Idea	Themes	Theme Definition
Bright yellow	Themed questions on sustainable development in education at LAB.	Sustainable development at LAB	The question focuses on developing education in the field of sustainability at LAB.
Orange	Themed questions that ask for the	Proposed Core	The question focuses on

	viewpoint of the interviewee on one or multiple of the proposed core competencies.	Competencies	validating the appropriateness of one or more proposed core competencies.
Bright green	Themed questions and their responses that ask what the interviewee thinks are key drivers of development.	Key Development Drivers	The question and answer are focused on political tools that are used to influence the demand for core competencies related to promoting the 2030 SDGs.
Bright blue	Multidisciplinary approach	Sustainable Development	The coded response is related to sustainable development as a discipline or sustainable development concepts such as methodologies or principles.
Light blue	Sustainability nexus		
Purple	Systems thinking		
Light green	Environmental science		
Light red	Circular economy		
Dark green	Skill gap	Green and Digital Transformation	The coded response is related to the EU's Twin Transition and/or the development response to meet the needs of the
Gray	Development		

Blue-green	Digitalization		transition.
Brown	Disagreement with proposed core competencies or different suggestions for core competencies	Outliers and Disagreements	Statements that do not support the proposed core competencies that were presented in the question.

The results of the interviews generally confirmed what had been proposed as a result of the literature review. Themed questions on the proposed core competencies often got responses that affirmed the relevance of systems thinking, environmental science, sustainable development, and circular economy as central concepts for education in sustainability. Themed questions on sustainable development at LAB were met with responses that unsurprisingly tended to focus on concepts directly related to cultivating skills and knowledge for sustainable development such as future development intentions for the education in sustainability and how curriculum can help address the regional and larger-scale demand for competencies in sustainable development. Lastly, there were some points where the proposed core competencies were contested, for example in one interview, the interviewee suggested that project workers can execute their tasks just fine with only a basic understanding of the impact of their work. Additionally, interviewees stressed the importance of digitalization and digital skills as a part of developing a circular economy. Generally, the responses and themes of the responses given were complementary or similar to the proposed core competencies and the themes of the interview questions. All of the interviewees felt that political tools that were produced under the EU Green Deal are influencing the change in demand for skills that has prompted the research question: "What are the essential sustainable development competencies that professionals will need to make decisions that progress the UN's 2030 sustainable development goals?". It can be concluded that the basic core competencies that have been proposed can provide an understanding that can be used to promote and progress the UN's 2030 SDGs- with the exception that digitalization especially should also be taken into account.

5 Conclusion

In conclusion, based on the responses of the interviewees to the proposed core competencies which have been based on a literature review, there is an indication that the proposed competencies are relevant to developing the necessary decision-making skills that will progress the 2030 Sustainable Development Goals. Interviewees commonly agreed that systems thinking helps to form the foundation of other central ideas in education in sustainability. Although the core competencies that were proposed are not perfectly suited to every kind of job, as was pointed out by the interviewee in Appendix 3. Furthermore the proposed competencies should have a stronger focus on digitalization, such as how digitalization supports the development of circular economy. While the findings of this exploratory research are generally supportive of the initial proposal, the research methodology can be improved upon with further research using a different methodology. For example, while the open-ended questions allowed the interviewees to more freely and specifically express themselves, it also opens up the research to confirmation bias, despite efforts to avoid loaded questions and still keep the discussion on track. Although in this case as an initial exploratory research method gathering detailed responses provides more insight into the perspectives of the interviewees, and therefore some of the basis for judging and interpreting the responses of the interviewees. Another iteration of this project may benefit from a more generalized and structured interview or survey approach, where the interviewees are more numerous and represent a more diverse range of competencies. Such an approach would be able to better build upon the current results by determining if the results of this research scale well.

References

Bianchi, G., Pisiotis, U. and Cabrera Giraldez, M.. (2022). The European sustainability competence framework, Publications Office of the European Union, [doi:10.2760/13286](https://doi.org/10.2760/13286)

Caufield, J. (2023). *Thematic Analysis*. <https://www.scribbr.com/methodology/thematic-analysis/>

Department of Economic and Social Affairs. (n.d.). *Goals*. <https://sdgs.un.org/goals>

Ellen Macarthur Foundation. (n.d.). *Circular Economy Introduction*. <https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>

European Commission. (n.d.). *Waste Framework Directive*. https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en

European Commission. (2020). Circular Economy Action Plan: For a Cleaner and More Competitive Europe. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2020:98:FIN>

European Commission. (2020). Critical Raw Materials for Strategic Technologies and Sectors in the EU- a Foresight Study. <https://op.europa.eu/en/publication-detail/-/publication/8e167f11-077c-11eb-a511-01aa75ed71a1>

Eurostat. (2021, June 15). *How Has the EU Progressed Towards the Sustainable Development Goals?* <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/wdn-20210615-1>

Finnish National Agency for Education. (n.d.). *Universities*. <https://www.studyinfinland.fi/universities>

Green Lahti. (n.d.). *Story*. <https://greenlahti.fi/en/story>

- Hieronymi A.. (2013). Understanding Systems Science: A Visual and Integrative Approach. <https://doi.org/10.1002/sres.2215>
- Joan J. H. Kim, Nicole Betz, Brian Helmuth, John D. Coley. (2023). Conceptualizing Human–Nature Relationships: Implications of Human Exceptionalist Thinking for Sustainability and Conservation. <https://doi.org/10.1111/tops.12653>
- Sitra. (2022). Sustainable Growth with Circular Economy Business Models Playbook for Businesses. https://media.sitra.fi/app/uploads/2022/12/sitra_sustainable_growth_with_circular_economy_business_models.pdf
- United Nations. (1987). Report of the World Commission on Environment and Development: Our Common Future. <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>
- United Nations Department for Economic and Social Affairs Department of Sustainable Development. (2015). Report of the Capacity Building Workshop and Expert Group Meeting on Integrated Approaches to Sustainable Development Planning and Implementation. <https://sustainabledevelopment.un.org/content/documents/8506IASD%20Workshop%20Report%2020150703.pdf>
- United Nations. (2015). Transforming Our World: the 2030 Agenda for Sustainable Development. <https://undocs.org/en/A/RES/70/1>
- N. Voulvoulis, T. Giakoumis, C. Hunt, V. Kioupi, N. Petrou, I. Souliotis, C. Vaghela, WIH. binti Wan Rosely. (2022). Systems thinking as a paradigm shift for sustainability transformation. Centre for Environmental Policy, Imperial College London, United Kingdom. <https://doi.org/10.1016/j.gloenvcha.2022.102544>
- Intergovernmental Panel on Climate Change. (2023). AR6 Synthesis Report- Climate Change 2023. https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_SPM.pdf

LAB University of Applied Sciences. (n.d.). Bachelor of Engineering, Sustainable Solutions Engineering, online studies, 240ECTS.

<https://lab.fi/en/study/bachelor-engineering-sustainable-solutions-engineering-online-studies-240-ects>

Appendix 1. Interview Transcription Kirsi Taivalantti

Interview Information

Date of Interview

December 7th, 2023

Interviewer

Destiny Kiho

Interviewee

Kirsi Taivalantti, Technology Unit Leader at LAB University of Applied Sciences

Reason for Interview

As the Technology Unit Leader at LAB University of Applied Sciences, Kirsi has the big-picture perspective on why programs like LAB's Sustainable Solutions Engineering Program are important for regional and larger-scale economic development.

Note

The transcription is not an exact account of what was spoken. Filler words such as “umm” and content of the discussion that was not related to the interview have been removed. What has been recorded in the transcription is strictly the interview questions and the response by the interviewee, because this is what they have agreed to be published in the thesis and removes irrelevant information from the data.

Transcription

Destiny: “Yeah basically, the reason I wanted to interview you is because you’re the person who has the big-picture understanding of the role of the Technology Unit in not only regional development, but also developing competencies in sustainability issues in general for our future workforce. It’s one of the key roles of the UAS.”

[Kirsi agrees]

“I was wondering if you could tell me first off tell me a little bit more about the Technology Unit in particular, and why it has these different growth platforms like Technical Cycles, Biological Cycles, Carbon-Neutral Built Environment, and so on. Why the Technology Unit and not the other units at LAB?”

Kirsi: “I think first of all there’s the history behind it. Before LAB, there was already quite strong RND in the field of circular economy at LAMK, and also in Saimaa University of Applied Sciences actually quite strong knowhow, strong competencies in digitalization and digital twins- especially in construction. This was the history. Then when we went to LAB, we have these focus areas. So circular economy was taken as one of the focus areas and already then there was this quite big technological investments in going on in the laboratories. And at the same time we were investing in laboratories and technology and investing in new professionals, we have been able to grow these material cycle competencies especially in the faculty of technology. And that’s why even though of course sustainability and circular economy are quite multidisciplinary, that’s maybe why we have the strong technological competencies in LAB. What we’re doing at the moment then after the last couple of years- according to our strategy, we want to also build our degree programs towards RDI strengths. We want to more and more build our education based on our RDI strengths, and this is what we’re doing at the moment. That is basically shortly the history of what happened at LAB so far in the field of sustainability and circular economy. Actually, what you will hear next Monday, the rector will have the information on how our key competencies are as part of the strategy process as of this year- what are the changes. So you will hear that it is no longer circular economy and sustainable solutions, but it will be sustainability and multipurpose materials- I believe is the wording. So it is even more based on biomaterials and material cycles and multipurpose of materials. But you will hear more about this next Monday, but anyway that’s the next step. I don’t know if I answered your question but I tried.”

Destiny: “Oh you answered it great, thank you. And I will definitely be hearing about that on Monday. So the original reason why we have such a strong focus on what is essentially technology in sustainable development is coming a lot from LAB’s history, but it’s also coming from the general development direction of the region as well?”

[Kirsi agrees]

“But you also mentioned the SSE program, the Sustainable Solutions Engineering program. That was one reason why I wanted to talk to you today, because as far as I have heard, this

program was your idea- and I was wondering what specifically inspired you to produce this program that has this strong focus on systemic knowledge of for example, society, economy, and environment and of course building upon that, what we can use in RDI for example.”

Kirsi: “Well I don’t know if it was my idea exactly, I think it was a group effort. But what we wanted to do- first of all, internationalization is very important and we really wanted and needed new English programs, new international programs. There are very practical reasons for that. There are economical reasons for that, for example. There are regional reasons for that. For the next years we don’t have enough young people in Finland to meet the requirements of industry. That’s one reason why we need more international programs. Another one is funding, it’s another way to grow outside funding. And the third is of course internationalization itself. We thought that our RDI really is strong enough that we really could build education what is more close- which is more based on our RDI. The environmental engineering, what we now call Sustainable Solutions Engineering was quite an obvious way to go when it comes to the international programs, because it is growing- growing as we know, the need for this kind of knowhow. Then of course, what we debated a lot is that the program being online and not an on-campus program. And I think it still will be debated, whether we will start that program sometime on campus. Being online, at the moment we don’t get that many people from abroad. The students come mainly from Finland. But I think there will also be the time that the online programs will also have a demand globally. The main reason is that this was based on our strategy in LAB. There really is no other clear reason or explanation for that. Also of course, we saw that basically there was no competition. There was none of this kind of sustainable solutions online English programs, going on- at least not that many, and in Finland not at all. When it comes to the competencies of the program. In the future I would like to see it go more also in a technological way. So this is something that we should discuss this with our experts also: what kind of competencies this program will give to those that will attend and have their degree. I think that yes, of course sustainability has all the aspects: economical, ecological, social, cultural, but where we are strong is the actual solutions in circular economy and the industrial applications, industrial size technical and economical solutions that you can base actually industrial solutions on, and I would like to see that program go that way. Now, going further.”

Destiny: “Ok, one moment please, I need to collect everything what’s been said. If I could try to summarize what you’ve said- the SSE program has been made of course because of LAB’s strategy, but LAB’s strategy is being driven by actual demand for these competencies both in development and as you said before, skills around the globe. So we know that these

are skills that people will be needing in very broad fields of work in the future as well. One of my last questions, when it comes RDI- and LAB has been working with a lot of public as well as private entities- maybe you're not the best person to ask this question, but I feel I should ask anyways. Do you think there is any overlying themes of what needs to be developed? Is it a systemic understanding, is it an environmental understanding, is it just simple social-ways that people expected or do expect things to function what is kind of driving the development in the region or in Finland in general? Is there anything that is lacking, or anything that there is a lot of that is really pushing us to be able to develop good solutions?"

Kirsi: "I think the systemic approach is something that is not yet there. It is so easy to try to solve one problem at a time and not to see the effects on other things. So I think that the systemic approach is something that is not understood widely or broadly. Also I think understanding that systemic and systemic change in our society, I think that the importance of how people and societies, groups of people influence that systemic change is also something that needs to be understood more clearly. Especially because of how peoples values and behaviors are changing. For example, I think that especially older generations still think that our economic or people's employment and people's choice of careers or choice of job or choice of employment are based on salary, or that kind of values; but more and more individuals choices are based on values based on responsibility- values like sustainability and responsibility. And I think that this influence that this has on the economy as itself, or the actual technological economical cycles and systems is not yet fully understood, I think- as an example of what I meant by that systemic change and understanding that. Then on the other hand, I think that when it comes to RDI, we are going through a technological break. So also I think that new technologies are not yet there. They are not yet an everyday thing. There is still development of new technologies going on. So I think both those approaches as a part of that systemic understanding are still not there. There is still a lot to be done."

Destiny: "Right, but LAB is doing a lot of work actually in both of those fields in education."

Kirsi: "Yeah, that is what we are trying to do."

Appendix 2. Interview Transcript Pia Haapea

Interview Information

Date of Interview

December 4th, 2023

Interviewer

Destiny Kiho

Interviewee

Pia Haapea, Principal Lecturer at LAB University of Applied Sciences

Reason for the Interview

Pia is one of the professors that participated in the development of the SSE program at LAB UAS. She also recently published a thesis that analyses the alignment of LAB's implementation and contents of sustainable education with its strategy.

Note

The transcription is not an exact account of what was spoken. Filler words such as "umm" and content of the discussion that was not related to the interview have been removed. What has been recorded in the transcription is strictly the interview questions and the response by the interviewee, because this is what they have agreed to be published in the thesis and removes irrelevant information from the data.

Transcription

[The interview starts by Destiny giving more context to the purpose of the interview and information about the thesis as well as learning more about Pia and her expertise in this subject.]

Destiny: "About the thesis in general, I thought that your thesis was super interesting- how close it was to mine already. And I read through your abstract- it's kind of a long thesis I didn't go through the whole thing-."

Pia: "It is. I always write very long documents, so it is typical for me. So sorry for that"

Destiny: "So, is it like, your thesis is basically covering- correct me if I'm wrong, how the strategy at LAB is reflecting- basically- the needs of education in sustainability".

Pia: "Yes, yes. But maybe in the other way; that how our curriculums, these sustainable educations- how they are connected with LAB's strategy. I mean the content and the implementation and these kinds of issues. That was the main target of my thesis."

Destiny: "So you are exactly the person to come to for my questions, really."

Pia: "OK. Excellent. I hope so."

Destiny: "So my questions are- the idea of the thesis essentially, which is kind of in my letter to participate, is that we want to answer the question: what are these basic competencies that people in the workforce need if we want to progress the 2030 sustainable development goals. What I mean when I say that is- for example when I went to school: we had science class, and in science class we learned about the environment, and things like the water cycle, and that kind of thing. I think that besides going into different sciences like biology, many people don't at this present time learn too much else about our world and our impact on it."

[Pia agrees]

"It's pretty standardized that way, but we kind of know that we have to kind of change our economic system and our social system at the same time; and that means that we have to have a new basic set of competencies for people."

[Pia agrees]

"From developing the Sustainable Solutions Engineering course, I have of course gone through very much EU and Finnish policies on these matters. Some things that I have identified throughout making the course is that there are some very consistent themes. It

seems to me, for example, that one must start with the understanding that the world is made of systems.”

Pia: “Yes, exactly.”

Destiny: “Because when we’re thinking about what kinds of problems that people have to solve, or problems that even normal workers need to be thinking about, or at least be aware of in the back of their minds- is that we’re not just fixing the one thing. There is probably a systemic issue, just the awareness that there are systemic issues is probably a good place to start.”

[Pia agrees]

Destiny: “Then, learning about where do the issues necessarily come from, and how do you identify them, how do you plan to tackle them, and these kinds of things.”

Pia: “Yes, and how they are interacting with each other. That is also the one.”

Destiny: “Exactly. Of course once you understand that the world is made of systems- traditionally people have been thinking like, that we can have economy and social, and we don’t have to stress too much about the environment because we have an abundance of resources- but we know that’s not necessarily the case anymore. So it would make sense to take this idea of systems, and then explain it as in: we are a group of humans, and this our system, our society, and our society is a part of the greater system, which is the climate system, and we can’t separate ourselves from our environment. That kind of thing. I think you’ve been through the SSE courses quite a lot?”

Pia: “Yeah, I have and actually, the whole curriculum for that program has been done by me. Of course, I have interviewed many, many, many of my colleagues and experts and scientists and so on for preparing it- but yes, I am quite familiar with that.”

Destiny: “So you guys did the actual planning when it comes to what kind of courses should we have, what sort of fields of knowledge should the students be aware of- so now is where I kind of get into my specific questions now that we have gone over- we’re on the same page.”

“How do you feel about the SSE courses, by the way? In terms of content, do think that they- because you had an idea. You know what the course should have in it. So, I’m wondering

how do you feel about how they actually came out? Do they focus on the right things? I kind of hope so since we haven't had any requests to change anything."

Pia: "Yes, do you mean these SSE- these goLAB courses, or the study program as a whole, the Sustainable Solutions Engineering degree program?"

Destiny: "At this particular moment, I'm talking about the goLAB courses."

Pia: "So you are asking how those 60ETCS are answering for these big questions?"

Destiny: "Yeah, kind of. In the context of my questions, I'm mostly talking about these online courses because they are a little bit more open to everybody, shall we say."

Pia: "Yeah, they are basically really good. The content and the materials are excellent. You have and goLAB team have done a really good job. You are covering, in my opinion, all the necessary aspects what are related to those subjects. But the main problem is, as I have mentioned a few times is: how do we really know that students are understanding those issues? ... Of course, all the information we can share through the internet is kind of on a basic level. These are the basic courses, of course. The basic level, very good contents, very well presented, and the materials- I think they are really good."

Destiny: "I am so happy that you feel that way, especially now since I'm doing my thesis on this."

Pia: "Yes, but they are very good. Of course, I haven't gone through all those courses very detailed, but they are very good."

Destiny: "Context out of the way, how do you feel about the role of universities of applied sciences in Finland specifically, when it comes to cultivating the future skills of the workforce?"

Pia: "You mean universities of applied sciences as in general?"

Destiny: "Yeah, it is my understanding that it is the responsibility of universities of applied sciences to provide skills that are needed especially in their particular region. So, the idea is that people in the UAS are having skills that are specifically related to development in their

regions- or that will give them workplace competencies, especially those basic things like project planning.”

Pia: “Yes, that is the main issue and is also mentioned in the law- the law for universities of applied sciences that the regional development is the core; but of course especially within this kind of subject, these sustainable solutions and sustainable development goals, we must look at the bigger picture. Someone wiser has told “think globally, act regionally”. So we have to give them skills that they can survive in regional companies and in the public sector, but of course they have to have the skills and knowledge of course, that they can survive outside of the region. Of course, in these international study programs, like we have this Sustainable Solutions Engineering study program- our students, they are mostly in Finland in Helsinki. So we can’t just think “Päijät-Häme region”. So we have to offer them the knowledge that serves wider.”

Destiny: “Right, so sustainability is becoming more and more a part of preparing the students for working life. They have to have these kinds of competencies, and that comes not only from the legislation that says that it’s something that UAS has to do- they have to give you work skills. But it’s also something that is coming from the economic development policy of the EU, and that’s why sustainability is being included there. So from your perspective, there’s a couple questions I have about this. How is LAB implementing this? There is the Sustainable Solutions Engineering degree program, but I guess my question would be how does the SSE program specifically, how does it prepare the students? What competencies are there that you think are the absolute core for the students. Like I was saying before about systems thinking- so on the very basic level, how do you think those courses in sustainability are actually preparing the students for working life? How is it relevant to them, I guess?”

Pia: “Yes, and now we are talking about the goLAB courses or the SSE study program?”

Destiny: “SSE in general.”

Pia: “Let’s see. Yes, every time that we start to plan the study program, we have to really carefully think about especially those skills that are needed. These general skills, and also these competence skills based on the subject- like here it is this sustainable solutions. Of course, we cannot cover all the competencies that is needed in that area. And for this SSE study program, these main competencies are environmental management, material efficiency, and resource efficiency as a whole. Those are kind of the core competencies of the study program. And then of course there are those basic competencies like science,

language- like English and writing and speaking and presentations, and project management skills. Then, students, they can select some other fields as well. So if they would like to get more into, for example, energy issues, like renewable energy and so on. Then we are offering those, but they are not complementary.”

Destiny: “Ok. One thing that kind of stood out to me was that first thing that you say about resource efficiency and environmental management, and these kinds of things- would you say that those topics- like when we think about a broad genre or field, those could kind of fall into environmental science and circular economy kind of competencies on the big picture?”

[Pia agrees]

“How would you say, specifically, do all the students need to have- so this is what you’re saying: so all the students would need to have that understanding of the circular economy, and of the environmental science, and of course the system science that’s underneath all of that. How do you think they will be applying that in their future job? Is it something at the back of their mind, or do you think that most of the students will actively work with it every day or-?”

Pia: “That’s a difficult question. It’s very much depending on the students, of course- personal issues and of course where they are going to work. But I really hope that we can give them some kind of holistic understanding of the whole system, as we discussed earlier- that they understand those interaction with the biological system, and this interaction with technological circles and so on. And then they can apply that kind of knowledge in every kind of business. Even if it’s in metal industry or electrical industry, or even if they are working in the public sector- so that they will really understand the holistic connection between different systems.”

Destiny: “You have done so much research on this, so my question was: from your perspective, what is one of the most driving pieces of policy that is causing the shift in the needs of the workforce, for example, this demand for more skills in sustainability?”

Pia: “So what are the main driving force for-?”

Destiny: “Right, so is it the Green Deal in general, the Circular Economy Action Plan, or the Industrial Act, or these kinds of things, which ones-?”

Pia: "Like, these political tools?"

Destiny: "Yes."

Pia "I think- at least in my point of view, I really like this Circular Economy Action Plan. It is giving concrete, giving really- not so really, but giving quite good, realistic, concrete actions for offer. There is a long list of different actions which are related to that Circular Economy Action Plan. Maybe I can say this because it's the most familiar of those policies for me. But I have found it to be really, really good to use and to implement."

Destiny: "Alright, so we can say that that's one of the ones that's kind of creating the most changes. Well, like you said, and in my experience as well- one of the most concrete pieces of documentation or policy that they have made- as to "hey, what should we do about this whole green transition thing"."

Pia: "I have thought that this Circular Economy Action Plan is a part of this Green Deal action plan. So it is kind of one of the tools to implement the green transition in the EU. One thing I must add that I forgot when we forgot when we were discussing the core competencies of this program, I forgot to mention digitalization in circular economy. ... You can also get familiar with the curriculum in the study program-."

Destiny: "... When you say digitalization, the digitalization is certainly- it definitely falls under the circular economy, because we have to have the infrastructure, you know?"

[Pia agrees]

[End of transcription]

Appendix 3. Interview Transcription Kusti Alasalmi

Interview Information

Date of Interview

December 7th, 2023

Interviewer

Destiny Kiho

Interviewee

Kusti Alasalmi, Teacher in Electrical Engineering and Product Development

Reason for the Interview

Kusti was chosen as an interviewee for his expertise in development, electronic systems, and carbon-neutral built environment.

Note

The transcription is not an exact account of what was spoken. Filler words such as “umm” and content of the discussion that was not related to the interview have been removed. What has been recorded in the transcription is strictly the interview questions and the response by the interviewee, because this is what they have agreed to be published in the thesis and removes irrelevant information from the data.

Transcription

Destiny: “I wanted to talk to you because you have expertise in development, electronic systems, and carbon-neutral built environment- and one thing that Pia Haapea mentioned to me when I was interviewing her is that digital infrastructure is one the keys for being able to facilitate the circular economy, and we can assume therefore, the green transition in general. So, skills related to this is very interesting for me. One of the skills I have understood is growing a lot is building information modeling, for example. I was wondering from you, what

are the skills that we need to be able to produce things like digital twins? So like, in general, what are the things that the students or the workers of today could be learning that would be furthering those kinds of skills that would be needed?"

Kusti: "Yeah so first of all, when I came to LAB University of Applied Sciences two years ago. I started as a project manager in build environment technology in [] project. You might remember that [] project. We developed a couple of digital twins for buildings. Another one was a new building, and the second one was an existing building, and old one. But today when I started as a lecturer teacher one year ago, I'm teaching in mechanical engineering. So my perspective is a little bit different at the moment, and of course also this product development together with Pia Haapea- but in mechanical engineering the situation is a little bit different compared to this built environment project what I had to do two years ago. So concerning these digital twins, I'm not at the moment teaching any issues related to digital twins when I'm teaching in mechanical engineering, those machine technology courses."

Destiny: "Right, but you have experience with implementing these kinds of digital infrastructure that we need to produce a digital twin."

Kusti: "Yeah actually, I was managing that project and I kind of had the overall view- what kind of specs we needed from the customer. Actually, in the first phase we arranged a meeting with the customer where we collect their needs. What kinds of needs they expect and what kinds of demands they set for the digital twins. After these, we started developing these digital twin for building. Of course, those were quite concrete. Actually, you could calculate afterwards what was the effect for carbon dioxide emissions, but they were interested for heating systems and how to balance the heating systems, etc. How to have for users, and how it flows in the building."

Destiny: "Right, and the reason why they wanted to know those kinds of things was so that they could optimize for example, the resource consumption of the building."

Kusti: "Yeah, the outcome of that was that, yeah."

Destiny: "So, from your perspective, on your team that you had working on this kind of project- what were like, because they need to know of course- they need to have the digital skills to know how to actually build these kinds of systems, you know, what goes where and what do we use, and what kind of platforms do we use and that kind of thing... but I'm asking about even more kind of basic concepts. What did those kinds of guys need to know about,

for example, sustainability and circular economy, and carbon neutrality, these kinds of things- what did those guys need to know when they want to actually to conceive or innovate this kind of solution for the problem customer or problem owner?"

Kusti: "It's an interesting question. I haven't thought about it before. Because when customers had these kinds of needs- ok to put this short I don't think they need any direct information about this circular economy and those; because they were actually doing these areas- ok for the heating for the ventilation and the IT was really focused on how to collect the information from different actuators and different sensors, and how to get this data flowing through the network, and finally get it into the 3D model, into the digital twin. So the needs for those, they would be more on the project management a little. But of course, it was over one ago when I was in that project. So I little bit have to collect this information again from my head. One year has passed, I haven't been in an active role. So it's like you see, I have to a little bit think and remember afterwards."

Destiny: "Yeah, no worries. Like I said I am just curious about what kinds of things people need to know to make good choices about these kinds of things, you know. If we want to decarbonize our economy, we have to decarbonize our urban centers. And for me that saying that ok the people who are designing these systems or you know, one building at a time we're coming up with how do we optimize the building and these kinds of things. So I have been thinking about in general what kind of basic principles everybody needs to know who wants to kind of work with those kinds of solutions. For me, when I have been thinking about it before- I have been thinking like "ok, well, we need to understand the importance of green energy and these kinds of things", really generally just designing something more sustainable- but we can take it a step further and ask what is going on on the actual teams that implement these as well."

Kusti: "Yeah, but in those projects of course, it's a good thing to motivate the project personnel- to educate them to know the basic facts about energy and how to produce energy, what it demands to produce energy, and what are the different ways to produce electrical energy. Is it wind power? Is it nuclear power? How the can utilize it? What is needed when we have this huge nuclear power plant Olkiluoto 3 and it's not- there's certain kinds of needs and it's problematic for them because it's so huge and there has to be some safety systems when this huge system comes down. Ok- when we are choosing the wind power, we have to have some kind of background for the situation when it's not windy. So the system collects different ways of producing electricity and energy, and also of course these central heating with kaukolämpö. So, we have moved from coal to using wood as a

source, but the carbon dioxide doesn't know does it come from coal or wood. So the carbon dioxide is the key, and okay what is the alternative way to produce energy and not to raise the carbon dioxide levels. I think for the project personnel it would be very useful and motivating to know these basic facts from the energy but also of consuming energy and what is actually- okay, if we take a look at a concrete building, what kind of activities in separate buildings are causing most of the electrical or energy consumption? Of course, the heating of the building- of course I don't remember the percents, but of course in Finland it's quite a big share; but also the heating of the water that we use for our dishes and our showers, its maybe as high as the total heating for the building."

Destiny:" That's very interesting. So would you say that it's more important for project managers, for example, to know so that they can kind of use that information to steer their team? "

[Kusti agrees]

"There's some lacking information as well. So far what you've kind of pointed out to me is that people don't necessarily realize is the embedded energy and the embedded activities that go into things. I think that one way that we can educate people or one general thing that maybe could be taught to most people project managers should also know for example, could be to have a systemic understanding of how the economy works, for example. Maybe once we have that- you can tell me. Maybe once we have that then we can consider what is actually more resource efficient in terms of actual economy as well, not just cost and unit efficient.

Kusti: "Yeah this was a good phrase what you used, this "systemic understanding". I think this is the key. This is something I have taught a lot when we have these two campuses. We have this campus in Lahti, and we have this campus in Lappeenranta, and we have this energy consumption of both and there is the heating of the building; but we also have to travel between those two campuses. There is two or three options: there is options to use public transportation- a bus, train, and bus in other end; or there is this another way to drive a car between the two campuses. When we look at this all, we should actually look at the distance and how do we travel between these campuses, and this is making the total carbon dioxide impact during one year. This is something I have taught a lot because we have this goal for- do I remember right- to be carbon dioxide neutral in year 2025 or something or 2030."

[Destiny agrees]

“Ok it comes from the building, it comes from the traveling between those campuses and it comes from which kind of food we eat in lunches. The total consumption comes from these and from that point, how much our students have to travel to our campuses, how much they consume energy when they come to campuses, and what is the balance between teaching in classes or having a Zoom lesson where students don't have to travel to get this education.

Destiny: “Ok, that's almost all of my questions. Maybe one more thing. So you also talk about these with your mechanical engineering students for example, these kind of systemic things that they may want to be thinking about when they're designing something?”

Kusti: “Yeah this is something which I was thinking beforehand, before your interview. When I'm teaching this product design and product development, in product development, it's quite built inside to have as optimum as possible this machine. And this means that ok, it has to use as less material than what is possible, at the same time have the strength and the functionalities in this product or machine. Optimize the material, optimize the cost of the material. Quite often the cost of the material is related to the point of how much the material effects on the carbon dioxide. Also optimize the weight of the product- more light product helps- ok if it's a transportation product, a bicycle or a motorcycle or car, when it's lighter, it helps to decrease the energy consumption because of fewer masses. So it's more or less built inside this product development. But of course this material recycling, if this recycled material would be cheaper than virgin material, like in plastics, I think then it would be used. But if it's the opposite way, if the recycled material is more expensive than virgin material, then it easily goes another way. This was in discussion with Pia in Ympätistötekniikka that we should quite control these issues with politics and taxing so that it would be more economical to use this recycled material today. I think that that would be the key issue and the key tool to use them more than what we are doing at the moment.”

Destiny: “Right. So this kind of also goes with the theme of what I'm covering in my thesis is- you mentioned that the legislation is playing a very important part and we have so many human systems where this systemic understanding is becoming very important like our food, water, and energy systems for example. And that's starting to include already a very very wide range of jobs where people need to have this understanding of people and environment are part of the same system and the economy is part of the same system as the environmental system and so on. So what do you think are some of the most important

pieces of policy or legislation right now that are kind of shaping this demand for these particular kind of competencies?"

Kusti: "I would think that ok, I don't remember the legislation number and the directive. I think there is coming some kind of European directive for products, that if you produce some kind of product, you will ensure for customers that you are offering the spare parts for, I assume, ten years. Because in today's world, it is possible to sell products that if it breaks after the warranty time, then it's possible that you can't find spare parts for this product. We know what this means. But if the directive comes that it will force sellers and companies to have a product that will have spare parts for spare parts for 10 years or something, then it will change this system quite much, and how product development will design those products. It's possible that the product is a little bit more expensive in the beginning but the total cost for customers will be lower, and the total energy and carbon dioxide consumption during the lifetime will be much lower than today's products which are one-time products quite often."

Destiny: "Do you think that by changing the way that we provide value, through the legislation as you just said- if we have to provide spare parts, then we also have to manage our product lifecycles in a little bit more controlled way. Do you think that is the reason why it's going to be driving this investment into systemic knowledge and things so that we can really build our product lifecycles and manage our products in a way that is sustainable?"

[Kusti agrees]

Appendix 4. Interview Transcription Susanna Vanhamäki

Interview Information

Date of Interview

December 11th, 2023

Interviewer

Destiny Kiho

Interviewee

Susanna Vanhamäki, Chief Specialist of Circular Economy, Sustainable Societies at LAB University of Applied Sciences

Reason for Interview

As an expert in circular economy and sustainable societies, Susanna can give an expert opinion on the proposed core competencies for sustainable solutions engineering.

Note

The transcription is not an exact account of what was spoken. Filler words such as “umm” and content of the discussion that was not related to the interview have been removed. What has been recorded in the transcription is strictly the interview questions and the response by the interviewee, because this is what they have agreed to be published in the thesis and removes irrelevant information from the data.

Transcription

Destiny: “The thing that I have heard from everybody that I have interviewed so far- the thing I have heard most often is that system thinking and understanding our world as systems is one of the main competencies that students will need if they want to develop sustainable solutions. Like, I heard from Kusti. It’s important for mechanical engineers for example, to

design sustainable products and processes as well it can be good for project managers to motivate their teams and to help them better execute their project. From Pia I have heard that it is important for changing our economy and our government at the same time, and these kinds of things. And so I was wondering what is your opinion on that systems thinking. As what I have heard so far it's the most core idea. Do you agree or do you have other suggestions, how do you feel about that?

Susanna: "Yeah well of course, our teachers have a better view from the student perspective. My job is not so closely connected to the students in everyday life. I mostly come across our students more individually, if we have them doing some part of a project, or interns- from that perspective. But from the research and development perspective I agree with what you have discussed with the others. And that also applies to- in the research and development projects the students have to understand how the task is connected to bigger picture, even if they are working with something specific related to whatever they are doing. They have to understand their piece of the puzzle and not only in that one project, but also in a bigger scale, and that's the system. So they learn to understand how things are interconnected and how they also have to develop skills to work with other experts, not just engineers. They have to develop skills to understand the business world, design, wellbeing, and health perspectives- everything is connected. And I think that the possibilities that we can offer where the students have to cooperate with the students coming from another discipline are really fruitful for the students and of course also from LAB's perspective and the whole society's perspective in preparing them for the future. It is a possibility for us to be open to invite students from other faculties to our technology classes, but there is a challenge to organize those kinds of courses where the students could come and work together across the disciplines."

Destiny: "That kind of brings me to my next question. From your perspective, this is just one of the many kinds of ways that LAB is also trying to integrate sustainability into learning. This cooperative learning is then also a part of LAB integrating sustainability into teaching. Could you think of any other examples?"

Susanna: "Examples of integrating the sustainability?"

[Destiny agrees]

“Well through cooperation with the industry and the stakeholders and the society we bring in the real-life context of the student’s work and tasks. Well, it’s not of course always so that the one from the outside world gives the tasks to the students emphasize sustainability. I think increasingly they probably are. But if they would not be, that’s also one perspective that the students should bring to all tasks they are doing during their studies; so that they are able to think about the sustainability from different perspectives- ecological, economical, social, and cultural when it’s needed. They should understand that these perspectives should be considered in whatever they do. For us to support that, that is also a challenge too- where to support our staff and our teachers in this- to increase this understanding and the ability to bring this perspective up along the way.”

Destiny: “Alright, so it’s very much still in development. Your focus, your expertise has been on the sustainable societies. Does that also once again- because we have to have this cultural change in the wellbeing, it’s an extremely important part of building our sustainable future. Does it all once again boil down to the systems thinking where ok- first we have to understand the culture and how it intersects with the government, and how that intersects with business, and how that intersects with my project and these kinds of things?”

Susanna: “Well yeah, I think that the sustainable societies part of our circular economy focus area is the one where we have a lot of cooperation across LAB and are working with all the different perspectives of sustainability, and integrating the societies and people to the circular economy in general so that we are increasing the understanding. It is not enough to have the technical solutions if they are not utilized by the society. So from that perspective, we are trying to also develop the research and development projects so that we also have the connection with the society.”

Destiny: “Ok, so from your perspective this 3-dimensional understanding is one of the most important sustainability skills that the students need?”

Susanna: “Yeah I think it is very important that they have this understanding of the whole system, but of course we also have this great task in educating our students so that they understand the big picture, but they are also developing expertise specifically in some part- so that they can feel that they have some skills in this part, and then they also understand that “my piece is one piece here in the puzzle, but the other pieces are also needed”. So I think that it is important to develop the system understanding, but also to support the students that they get enough deeper understanding of at least one part of the picture.”

Destiny: “Ok, part of my interview questions for the thesis. We have been talking about now that the workforce needs to be developing specific skills basically, because we have this Twin Transition going on. **And I was wondering, from your point of view, what legislation is driving the need to educate ourselves in those fields the most?**”

Susanna: “Well, the **legislation related to for example, the material circles (material loops)-** the legislation is obliging the producers to take care of also the end of life of products. So of course, for instance, these kinds of skills are central in changing the system to develop the **sustainability understanding as a whole.** This is important for us also to educate our staff and that way the students in the changing legislation. **And also for example in city planning there are new digital tools coming, and that is one reason why we are going to update our curriculum.** Of course it is updated all the time, but at the moment we are then thinking about how to update that part of the curriculum to better be able to meet the new changing requirements of the society and legislation. And **that is where the use of planning and data and use of data is in a very significant role.**”

Destiny: “That is very interesting. That is something that Kusti also mentioned- that being having an understanding of digital systems for example is very important in being able to use the digital tools. And that policy you were referring to, would that maybe be the Extended Producer Responsibility?”

Susanna: “Yes, yes exactly. Tuottaja vastuu is being brought into new fields all the time. It is brought into new fields all the time like in the textile sector is this discussion, really. Also related to for instance, shoes- things that we don't yet have here, but in other countries are already under active discussion or plan to take into action.”

Appendix 5. Thesis Data Management Plan

THESIS DATA MANAGEMENT PLAN

The data management plan exists to explain how research materials (data) will be collected, processed, and stored during and after the execution of the thesis for which the material is gathered.

Management and storage of research data

The thesis research will include interviews of LAB employees and potentially other entities than those associated with LAB University of Applied Science. The interviews will be recorded in audio format and the audio recordings will be done on a recording device before being transferred to a dedicated USB drive for storage. After the recording is copied to the USB drive, the files will be deleted from the recording device and backups of the data will be copied to a second USB device. Only the research controller will have access to either of the USB drives, and these drives will be stored in a locked safe/box that only the controller has access to.

In accordance with the General Data Protection Regulation (GDPR) interview participants will be given a privacy notice and accompanying letter before their participation in any interview. The only personal data that will be collected will be the name and position of the participant, which will be collected and handled on the legal premise of consent. E.g.: "Jane Doe, Researcher at LAB University of Applied Science". It has been agreed with the commissioning party that sensitive or confidential information will not be collected at all.

Openly available datasets may also be used in the thesis research, such as those from reputable sources like The World Bank, European Environment Agency, Statistics Finland, EUROSTAT, etc... Such openly available datasets will be used in accordance with the individual dataset's terms of use and its source will be referenced using HAMK's reference guide (APA 7 format).

Processing of personal data and sensitive data

Interview material (transcriptions) and the related personal information (name and position) may be published as an appendix to the thesis when given the explicit consent of the interviewee. The interviewee will be asked to sign the privacy notice before the interview takes place. The personal information collected (name and position) will be handled/processed only by the research controller (Destiny Kiho).

Ownership of thesis data

The data and results of the thesis will be jointly owned by the author (Destiny Kiho) and the commissioning party (Susanna Vanhamäki, LAB UAS). Both will retain the right to use the thesis and its data after its publication.

Further use of thesis data after the work is completed

After the thesis has been completed, the research data will not be made available for further use. The author of the thesis/research controller will store the research data for one year after the thesis has been approved to facilitate the potential additional verification of the thesis if necessary. After this point in time, the data will be wiped from the USB storage devices mentioned in section 1.

Other materials related to research data will be stored as follows:

- Data management plan- stored as a part of the thesis.
- Privacy notice- stored as a part of the thesis.
- Accompanying letter to research participants- stored as a part of the thesis.
- Thesis plan- stored for 1 year after the approval of the thesis.
- Research permit(s)- stored for 1 year after the approval of the thesis.
- Consent to the processing of personal data- stored for 1 year after the approval of the thesis.

Appendix 6. Data Protection Notification

FINAL THESIS DATA PROTECTION NOTIFICATION model

EU's General Data Protection
Regulation (2016/679),
Articles 13 and 14

Date:
1/11/2023

Why is the personal data collected? / Purpose of personal data processing

The objective of the thesis is to determine what are some of the core competencies that are needed by decision-makers in businesses that will enable businesses to contribute to the 2030 sustainable development goals.

To determine what kinds of skills are needed by the workforce of the future, interviews will be held with staff at LAB UAS, a university that is known for its commitment to education in sustainability and helps to design solutions in cooperation with both the municipality and local businesses to strengthen the green transition and further sustainable development goals in the Lahti area.

What data are we collecting? / Content of data filing system

The following data will be collected: name, job title, responses to interview questions. A transcript of the interview will be made and stored with the interview file.

Why are we collecting data? Legal basis of personal data processing

The data is collected on the basis of consent.

From where do we collect the data? Data sources

Data is collected directly from the subject (interviewee).

Will we disclose the data to anyone? / Data transfer and disclosure beyond the research group

Interview material (transcriptions) and the related personal information (name and position) may be published as an appendix to the thesis. By consenting to the interview, the interviewee agrees that these collected data may be published as an appendix to the thesis.

The contents of the thesis may be shared by the thesis owners on other platforms. Collected data will not otherwise be shared or stored on external entities. After 1 year since the approval of the thesis, stored data will be erased, and the interview material will be anonymized.

Where will data be transferred? / Data transfer and disclosure beyond the EU or EEA

Data collected for the thesis will be stored in the EU. The data will not be transferred beyond the EU or EEA.

Security of the collected data / Safeguarding of the data file

The following security measures will be taken:

- Data will not be stored in cloud services.
- Data will be stored on a USB drive in the EU.
- There will be 1 backup copy of the data files on a second USB.
- Both USB drives will be stored in a locked place that only Destiny Kiho can access.

How long will the data be stored? / Processing of research material after the project ends

After the thesis has been completed, the research data will not be made available for further use. The research controller will store the research data for one year after the thesis has been approved to facilitate the potential additional verification of the thesis if necessary. After that time period, the collected data will be erased.

What type of decision-making takes place? / Automated decision-making

No automated decision-making takes place in the data processing.

Your rights / Rights of the data subject

Data subjects have the right to withdraw their consent if the data processing is based on consent. Data collected before the data subject withdraws his/her consent may be used as a part of the research data.

Data subjects have the right to lodge a complaint with the Data Protection Ombudsman if the subjects consider that the data processing regarding them is in breach of data processing legislation in force.

Data subjects have the following rights under the EU's General Data Protection Regulation:

- a. Right of access to data concerning the data subject
- b. Right to rectification of data
- c. Right to erasure of data. The right to erasure shall not apply if the processing is necessary for archiving purposes in the public interest, scientific or historical research purposes or statistical purposes if the right to erasure prevents or significantly hinders the data processing.
- d. Right to restriction of processing
- e. Right to data portability to another data controller.

Data filing system

Name of the data file in storage: Interviews with LAB Employees_2023

There will not be follow up research using the data collected for the thesis.

The research for the thesis will be done starting from the approval of the research permit until 1.12.2024.

Duration of data storage:

- Privacy notice- stored as a part of the thesis.
- Accompanying letter to research participants- stored as a part of the thesis.
- Research permit(s)- stored for 1 year after the approval of the thesis.
- Consent to the processing of personal data- stored for 1 year after the approval of the thesis.

Data controller and contact person

Destiny Dawn Kiho

Researchers

Destiny Dawn Kiho Susanna	Vanhamäki,	LAB	UAS	(commissioner)
------------------------------	------------	-----	-----	----------------

Appendix 7. Accompanying Letter to Research Participants

Letter to Research Participants, Core Competencies for Sustainable Solutions Engineering

Dear participant,

Thank you for your interest in being interviewed for the purpose of the thesis. You will be asked questions about a variety of topics, including sustainable development, education at LAB UAS, and key skills for the modern workforce.

The thesis “Core Competencies for Sustainable Solutions Engineering” aims to answer the question of what basic skills are needed in the modern workforce to promote sustainable development. The thesis examines publications and policies by key institutions and compares them to the observed themes within LAB’s Sustainable Solutions Engineering degree program and the responses of interviewed LAB employees on the subject. The idea is that identifying the overlapping principles between the three sources will give insight into what knowledge and skills are most central for decision-makers to choose sustainable solutions.

The interview will be transcribed and appended to the thesis. The collected data such as your name, position, and interview responses will be handled according to the privacy notice.

Best regards,
-Destiny Kiho