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THE SUSTAINABLE TRANSITION COMP. A COMPETENCE FRAMEWORK TO DRIVE SUSTAINABILITY THROUGH THE LENSES OF DESIGN AND ORGANISATIONAL CULTURE

The Sustainable Transition Comp. Um quadro de competências para impulsionar a sustentabilidade através das lentes do design e da cultura organizacional

ABSTRACT

This article presents and discusses a research study aiming to define a competence framework for sustainability training and capacity building in the specific context of manufacturing companies. It introduces the Sustainable Transition Comp (ST Comp), a competence framework developed under the ECODeCK project. The ST Comp is designed specifically for sustainability training and capacity building in the manufacturing sector. It adapts the Green Comp framework, originally developed by the European Joint Research Center, to meet the unique needs of Italian manufacturing companies. The framework was developed through a three-step process—analysis, synthesis, and refinement—guided by two key lenses: organisational culture and design. These lenses ensured the framework's relevance and applicability across various organisations. By incorporating design principles, ST Comp transcends traditional disciplinary boundaries, offering a holistic approach to addressing complex sustainability challenges. The framework identifies 11 competencies organised into four areas: Values Pillars for Sustainability, Thinking Style for Sustainability, Design Processes for Sustainability, and Agency for Sustainability. Each competency integrates knowledge, skills, and attitudes essential for promoting sustainable practices and driving innovation. ST Comp serves as a guide for creating design-based training initiatives, empowering employees to embed sustainability into their daily operations, and supporting the transition to

RESUMO

Este artigo apresenta e discute um estudo de investigação com o objetivo de definir um quadro de competências para a formação e capacitação em sustentabilidade no contexto específico das empresas industriais. Introduz o Sustainable Transition Comp (ST Comp), um quadro de competências desenvolvido no âmbito do projeto ECODeCK. O ST Comp foi concebido especificamente para a formação em sustentabilidade e o desenvolvimento de capacidades no sector da indústria transformadora. Adapta o quadro Green Comp, originalmente desenvolvido pelo Centro Comum Europeu de Investigação, para satisfazer as necessidades específicas das empresas italianas do sector transformador. A estrutura foi desenvolvida através de um processo de três etapas - análise, síntese e refinamento - orientado por duas lentes-chave: cultura organizacional e design. Estas lentes garantiram a relevância e a aplicabilidade da estrutura em várias organizações. Ao incorporar princípios de design, o ST Comp transcende as fronteiras disciplinares tradicionais, oferecendo uma abordagem holística para enfrentar desafios complexos de sustentabilidade. O quadro identifica 11 competências organizadas em quatro áreas: Pilares de Valores para a Sustentabilidade, Estilo de Pensamento para a Sustentabilidade, Processos de Conceção para a Sustentabilidade e Agência para a Sustentabilidade. Cada competência integra conhecimentos, aptidões e atitudes essenciais para promover práticas sustentáveis e impulsionar a inovação. O ST Comp serve de guia para a criação de iniciativas de formação baseadas na conceção, capacitando os trabalhadores para integrarem a sustentabilidade

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more sustainable and circular business models in the manufacturing industry.

nas suas operações diárias e apoiando a transição para modelos de negócio mais sustentáveis e circulares na indústria transformadora.

KEYWORDS

Competence Framework; Design-based Training; Organisations; Sustainability; Sustainable Transition.

PALAVRAS-CHAVE

Quadro de Competências; Formação baseada na conceção; Organizações; Sustentabilidade; Transição Sustentável.

1. INTRODUCTION

Manufacturing plays a vital role in national and international economies. However, it often depends on natural resources and energy, generating waste and emissions that affect society, the environment, and life forms. Thus, a sustainable transition in manufacturing is increasingly necessary, shifting from harmful practices to environmentally, socially, and economically sustainable ones (Rodríguez-Espíndola et al., 2022). This transition is long-term and multidimensional, involving changes in internal processes, infrastructure, policies, and behaviours (Dey et al., 2022). Achieving sustainability requires a major behavioural and mindset shift, along with new knowledge, skills, and attitudes (Rieckmann, 2012). In manufacturing, these competencies must impact all operational levels (Baldassarre et al., 2017), including revising traditional practices, adopting innovations, and considering the full product lifecycle—from design to end-of-life, including servitization and broader societal impacts (Rathi et al., 2022). Key to this is Organisational Culture and its role in promoting behavioural change for transformation. A sustainability-focused culture helps build a workforce aware of environmental and social implications, enabling daily sustainable practices (Rosen & Kishawy, 2012). This demands training that equips employees with the competencies and resources for sustainable behaviour. The ECO-Design Circular Knowledge (ECODeCK) project addresses this need.

2. THE ECODECK PROJECT

ECODeCK is part of Made in Italy Circolare e Sostenibile (MICS), an Extended Partnership funded by the Italian Ministry of University and Research through the NextGenerationEU programme. It supports sustainable transformation in Italian manufacturing—particularly fashion and furniture—through people upskilling and reskilling. Led by a design research team from the Department of Design of Politecnico di Milano, ECODeCK develops a design-based educational model grounded in the Transformative Learning approach (Mezirow, 2003; Balsiger et al., 2017), aiming to challenge and reshape existing sustainability paradigms. Identifying the competencies professionals need is key to determining the knowledge, skills, and attitudes required for sustainable practices. This article presents a study defining a competence framework for sustainable upskilling tailored to manufacturing. It examines how the research team adapted a general framework (Green Comp by the European Joint Research Center) into a domain-specific model for Italian manufacturing employees. The article contributes by detailing both the adaptation process and the resulting Sustainable Transition competence framework. The study was conducted by ECODeCK researchers with diverse experience in design education and training across academia, private/public sectors, and social communities.

3. STATE OF THE ART: EXISTING COMPETENCE FRAMEWORKS FOR SUSTAINABILITY

The concept of competence in education has evolved since the late '90s, emphasizing practical abilities and mindsets for effective action (OECD, 2005). Competence is a dynamic "combination of knowledge, skills and attitude" (Kiilakoski & Basarab, 2022) enabling complex problem-solving. Knowledge includes facts, concepts, and theories; skills are the ability to apply knowledge to achieve results; and attitudes refer to dispositions toward ideas, people, and situations (Council of European Union, 2018). Competencies are developed through learning and experience, combining these elements to act in complex contexts. Hence, competence frameworks are clusters of competencies in a given set that allow for a shift of the educational focus from what is thought to what is learnt and enable the design of learning experiences that foster the development of knowledge, skills, and attitudes. Their structure depends on their goals, perspective, and learners (Bacigalupo, 2022). The rise of sustainability education brought many definitions of the knowledge, skills, attitudes, and values needed. Yet, Bianchi (2022) noted confusion around terms—competence, skills, abilities, and capabilities are often used interchangeably (Cebrian & Junyent, 2015; Baartman et al., 2007). Still, research has helped define sustainability competencies in formal education (Brundiers et al., 2021; Redman & Wiek, 2021). In professional contexts, "skills" and "green skills" (Bianchi, 2020) refer to what's needed to support sustainable outcomes in business, industry, and society. However, consensus is lacking on how to frame these competencies for workplace training. According to Bianchi (2020), two main views exist: one from education and sustainability scholars advocating broad competencies for sustainability-related jobs (Heiskanen et al., 2016); the other from economics experts identifying green skills mainly for environmentally-focused roles (Pruneau et al., 2013). Given the urgent need for sustainable transition across industries, embedding sustainability competencies in all jobs is crucial. The literature shows a clear need to develop a framework identifying and updating these competencies for all types of work, whether directly tied to sustainability or not.

3.1. The European Green Comp: Aim, Design and Limitations

In the specific European context, the European Commission (EC) is on the front line to develop competence frameworks and promote them through various initiatives to create a common language to bridge the world of education and the job field. To support the sustainable transition, the EC has launched several strategies; above all, the EU Green Deal explicitly calls for activating education and training through skills development, behaviour change and investment in sustainable education (Scalabrino, 2022). The policy underlined the urgent need for a "European competence framework to help develop and assess knowledge, skills and attitudes on climate change and sustainable development" (ibid., p.19). Within this scenario, the Green Comp, the European competence framework on sustainability, was published in 2022 (Bianchi et. al, 2022) to clarify and define the necessary sustainability competencies to build a more resilient and sustainable Europe and guarantee a smooth digital and green transition. The Green Comp framework aims to foster a sustainability mindset and includes the competencies to responsibly think, plan and act with care for our planet and all life forms. It frames 12 competencies organised in four areas (Appendix 1) and outlines the knowledge, skills, and attitudes that people need to develop to solve complex problems and exploit opportunities in favour of sustainability. Within the GreenComp, sustainability competence is defined by the following statement:

> "A sustainability competence empowers learners to embody sustainability values, and embrace complex systems, in order to take or request action that restores and maintains ecosystem health and enhances justice, generating visions for sustainable futures." (Bianchi et al., 2022, p. 12)

This definition focuses on developing knowledge, skills, attitudes, and values that enable effective, embodied action concerning real-world sustainability problems, challenges, and opportunities, according to the context (Redman & Wiek, 2021). Also, the definition includes the crucial role of values related to sustainability as they are the motivational drivers needed to enact effective behaviour change for sustainability (Molderez & Fonseca, 2018). Furthermore, it has been selected as a reference framework for the present research for two main reasons. First, the framework's relevance within the socio-political and values context in which the Italian manufacturing sector is embedded (i.e., EU policies). Second, the reliability and credibility of the EU Joint Research Centre which developed the framework based on years of refining a solid methodology for creating competence frameworks. However, in its form, GreenComp is of limited support in informing the development of capacity-building in the context of manufacturing companies. Indeed, the framework is designed to support training programmes for lifelong learning addressing people with no differences of age, educational level, and learning setting – formal, non-formal and informal. There is a need to turn it into action, adapting it to the operational context in which it will apply. As stated by Bacigalupo (2022), "competence frameworks remain generic, and they will always need to be adapted when applied, especially at the level of learning interventions" (p. 30). Adaptations can refer to full or partial translations of the competencies, including terminology to suit the context, creating new sets of competencies that respond to specific requirements, and contextualization to provide relevant guidance to specific groups of users.

4. METHODS: ADAPTING GREEN COMP TO THE ORGANISATIONAL CONTEXT

The team defined a method to adapt the Green Comp to the organisational context. Before starting the adaptation process, it was crucial to identify the two conceptual lenses to guide it, explained in the sub-section below.

4.1 Identifying Two Lenses to Inform the Adaptation Process

The two lenses (see Fig. 1) that emerged as the most relevant to consider throughout the process were i) the organisational culture lens fundamental to reframe the competencies according to the specific organisational context where the training model is applied and ii) the design lens fundamental to reframe the overall organisation of the competence framework to suit the design-driven nature of the training model and its envisioned design-based approach.

The organisational culture lens (i) was crucial to adapting the competence described in the framework to the organisational context in which those competencies have to be acquired by people and used to inform their actions. To study and explore how knowledge, skills, and attitudes evolve within the context of manufacturing organisations, the research team refers to Organisational Theories specifically related to Organisational Behaviour (OB) and Organisational Learning. In the past two decades, the field of OB has been outlined into three distinct subfields: micro-organisational behaviour that directs its attention to the actions and behaviours of individual members within an organisation; meso-organisational behaviour that examines the dynamics of individuals working collectively in teams or groups; macro-organisational behaviour that aims to understand and analyse behavioural

patterns and interactions across the entire organisational structure (Wagner & Hollenbeck, 2020). Recognising the interplay and interdependencies between micro, meso and macro organisational behaviours is crucial for fostering organisational improvement and facilitating change initiatives, such as sustainability-related ones. The organisational lens allowed to read and reframe a generic competence framework by considering how organisations, as complex and multi-level systems, embrace change and diverse employees, as part of those complex systems, can play a fundamental part within that transformative path according to their organisational role (Edwards & Greenberg, 2003). Moreover, this lens was relevant in adapting the language and wording of the whole framework while keeping it generic enough to describe the sustainability competencies to be acquired by all employees in different organisational roles and positions (e.g., cross-department, various job levels). The design lens (ii) was necessary for several reasons. Competencies are characterized by being not directly linked to a specific disciplinary field, but to many (Voogt & Roblin, 2012), being general guiding learning objectives. Since design has been widely applied in many fields, to accelerate idea generation, interdisciplinary collaboration, innovation and discovery, hence the design lens applied to the competence framework adaptation allowed for transcending disciplinary boundaries, offering a holistic perspective that integrates diverse fields to address complex problems (such as sustainability). Moreover, this lens allowed the adaptation of the Green Comp, also considering its later application in design-based learning training, which is particularly effective for holistic competence development in a constructivist learning paradigm.

> "Design-based learning is […] the educational approach where learners construct knowledge, skills and abilities as they self-direct the process of creating futurable solutions to real, open-ended and ill-defined design problems in a situated context that aims at recreating a dynamic of real-world interactions." (Mattioli, 2022)

The ECODeCK project aims to develop a design-driven training model, which means that the overall approach will be design-based, and the activities will be experiential and hinged on collaboratively framing open-ended problems and their solutions by envisioning preferable future organisational actions. Similarly to designers, participants in the training will be asked to identify problems, generate innovative solutions, and critically evaluate their efficacy. Therefore, the design lens allowed for adapting the competence framework by considering its application: guiding instructional projects with a hands-on and constructive nature. Lastly, the design lens is multi-focal: the design discipline is the common thread among all researchers involved, but each author deals with different research areas (i.e., social design, design futures, cross-cultural collaborative design, strategic design, creativity, design for sustainability) and practice areas within the discipline (i.e., product design, interior design, fashion design, service design). Therefore, the design lens ensures a certain degree of uniformity (i.e., the overall design approach) and a certain degree of plurality (i.e., each authors' specific expertise), contributing to adapting the contents and vocabulary of different competencies and areas.

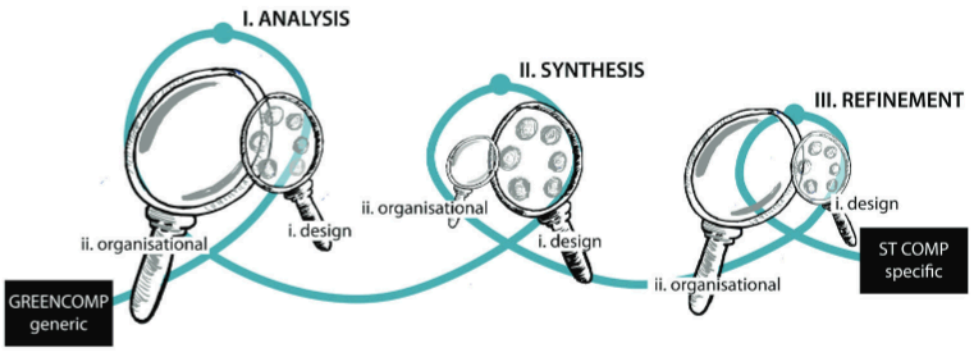


Fig. 1
Visualisation of the three-step adaptation process from Green Comp to ST Comp.

4.2 Three steps to develop the adaptation process

The ST Comp has been built through a three-step iterative process guided by the authors. The steps followed in the scoping process and presented in this section are: a) analysis, b) synthesis, and c) refinement.

a) Analysis: The first step helped building a shared understanding of the GreenComp content among the research team. A first broad iteration was undertaken to understand the relevance of the different competencies in an organisational context. In practice, each person in the research team read the framework autonomously, and then, through a series of meetings, the team started a group reading, discussion and commentary around each competence described in the framework. During this phase, notes of discussions and points of agreement (or disagreement) were taken into a shared spreadsheet to keep track of the conversations. The organisational culture lens was particularly relevant in this phase as it was used as the primary lens of analysis and allowed the group to start planting and growing a shared vocabulary and understanding of the competencies in context. The design lens, especially our specific domain expertise within design, was crucial for connecting concepts and building interconnections across competencies and with concepts related to our individual expertise. The step allowed us to identify overlaps and commonalities across the competencies and to point out their relevance with the organisational context, understanding the implications on the internal and external level of the company ecosystem.

b) Synthesis: the second phase aimed at synthesising the analytical phase, by adapting and reorganising the competencies to be included in the ST Comp. The first step was to identify and extract recurrent key themes and areas of focus from each competence analysed, grouping them within the components of knowledge, skills, and attitudes (Fig.2).

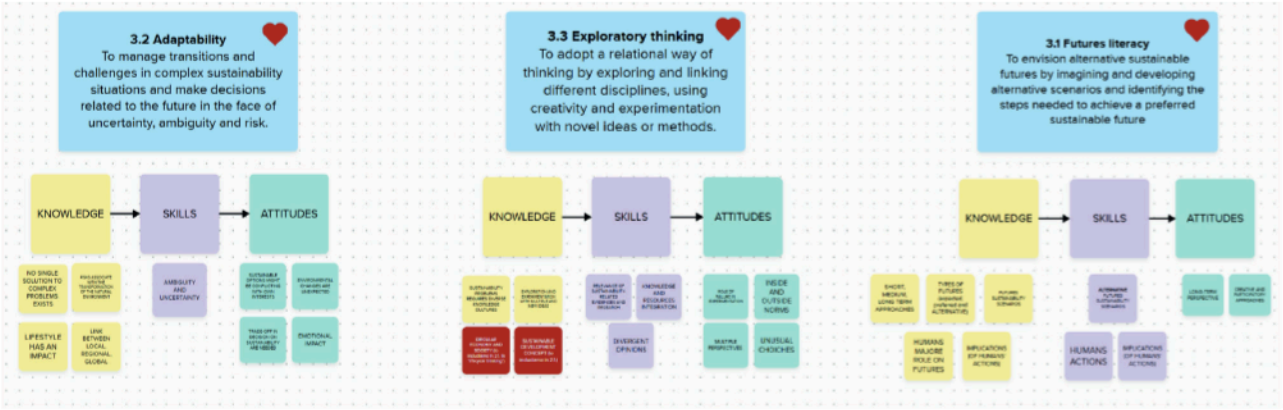
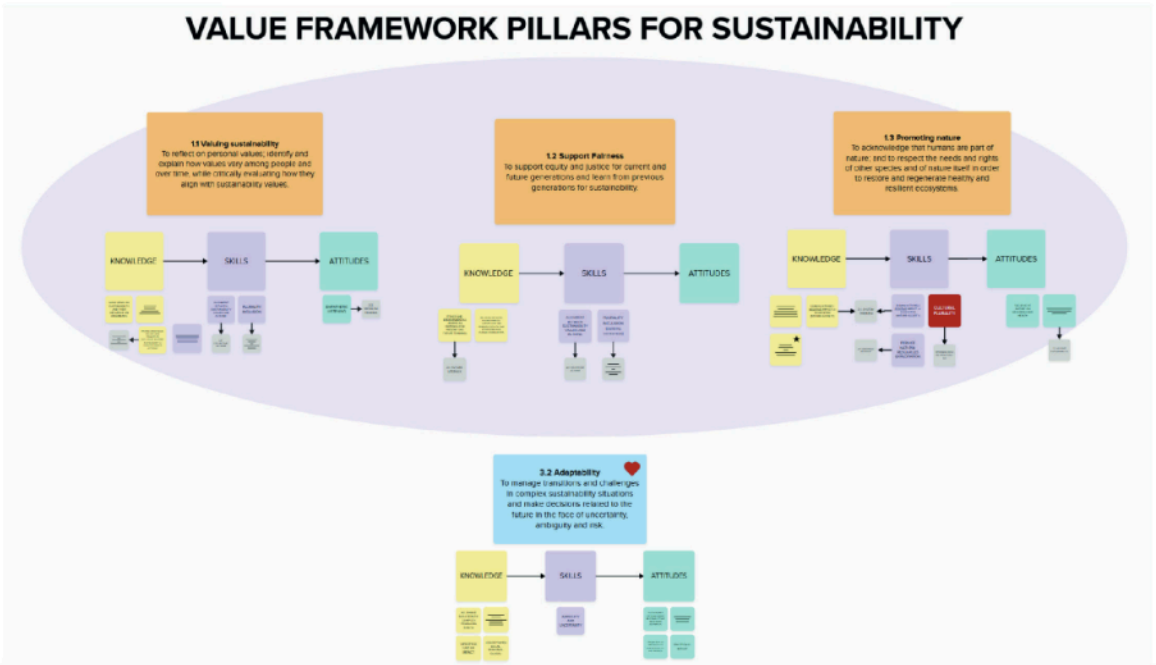
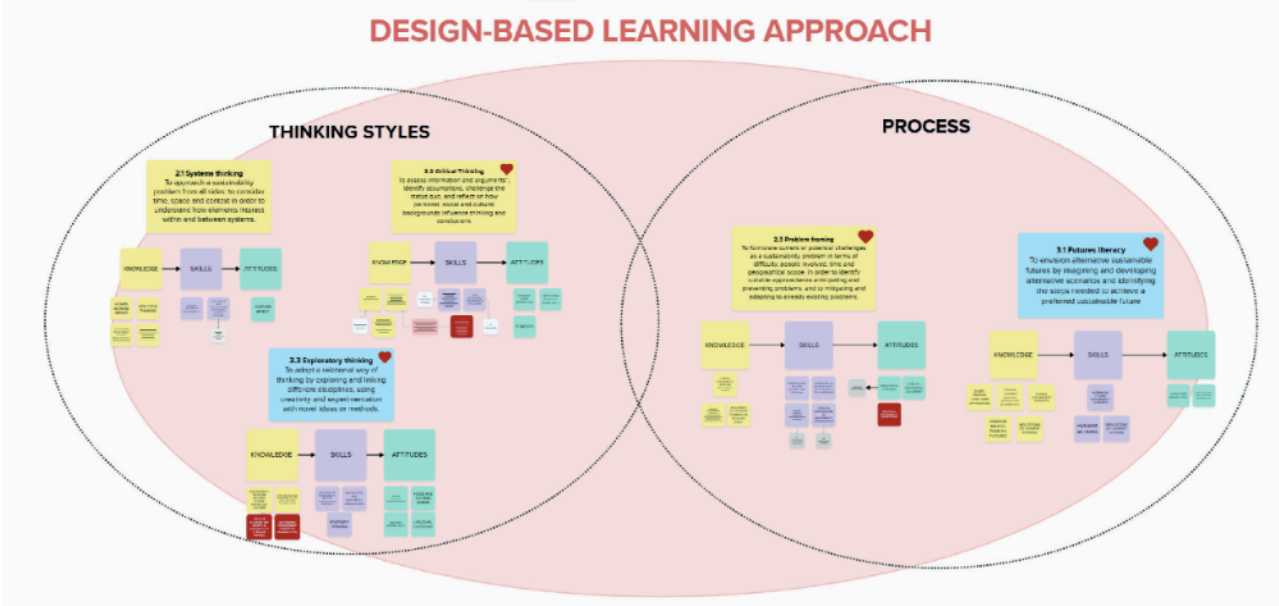


Fig. 2
Shared board where the research team analysed the themes addressed by each competence of the Green Comp.

A visual map of all the recurrent themes for each competence has been created to aid in the identification of similarities and links between the different themes. The competence with the key themes identified has been scanned using the design lens to assign them a priority and reorganise them in four novel areas (Fig.3) that better address the needs and requirements of a design-based approach to training. The organisational lens was employed, even though to a lesser extent, to select and adapt the themes for adult education in organisational contexts. This phase resulted in a higher-level shared understanding of GreenComp and its organisation and a re-organisation of the competencies included and their themes. If the first phase of analysis was a very in-depth discussion of the details of the general competence framework, the GreenComp, that allowed a shared understanding of its content, this second phase allowed a comprehensive understanding of its organisation and a mapping of its content across its composing parts.





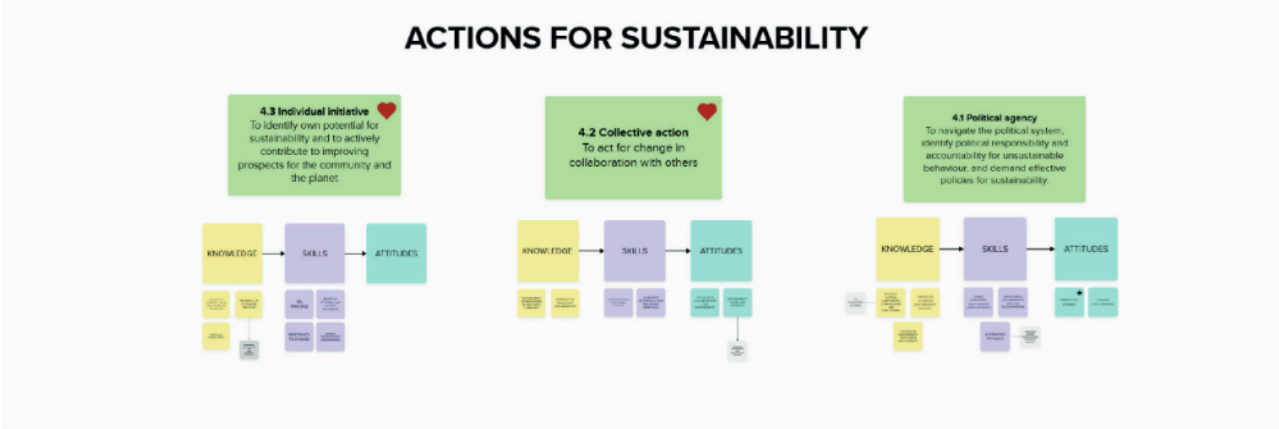


Fig. 3
Visual map of the reorganised competencies in light of the design process.

c) Refinement: the last step of the process was dedicated to refining the competencies to create an adapted hands-on competence framework to be used by instructional designers to develop training activities for adult education in organisational contexts. The refinement phase has the main objective of normalizing the overall structure, carefully organising the themes into the competencies, aligning the new areas emerging from phase (b) with the contained competencies, the writing of each competence and the wording within the whole document, by considering and including the considerations, notes and comments developed in the previous two phases. In practical terms, the team defined an overall structure to re-write the competencies; then, each of the four researchers focused individually on re-writing the competencies included in one area of the competence framework. Then, during several team meetings, we collectively read and discussed each competence to ensure maximum coherency among terms and the minimum number of diverse, complex terms to foster accessibility. Given the scope of this phase, the primary lens employed was the organisational lens, which was of key importance in finetuning the language used.

Also, the refinement was significant in reconsidering many of the discussions and notes made during the analysis phase and consequently, using the two lenses was very similar to that phase. Indeed, the design lens was considered mainly in terms of including the most accurate yet understandable wording related to specific domain expertise included in the adapted competencies. Following this iterative process of rewriting each competence, the framework underwent finetuning, with particular attention paid to defining terms. A glossary annex was developed to provide clarity and consistency in terminology usage. The final framework has been presented and discussed with experts in design for sustainability and education for sustainability to bolster the credibility and robustness of the adapted version, ensuring its applicability and efficacy within the organisational landscape.

5. RESULT: THE SUSTAINABLE TRANSITION COMP

The ST Comp aims to support training and skills development in the context of manufacturing companies. This framework is designed to engage professionals working at different levels of the organisation, from managers to employees, offering them guidance for integrating core principles of sustainability into their daily practices, developing the ability to understand the ethical pillars of sustainability and translate them into tangible actions, as well as being capable of analysing and addressing sustainable challenges with innovative and forward-looking perspectives. It is designed to support capacity-building model training to promote transformation and circular sustainable innovation within companies through design-based

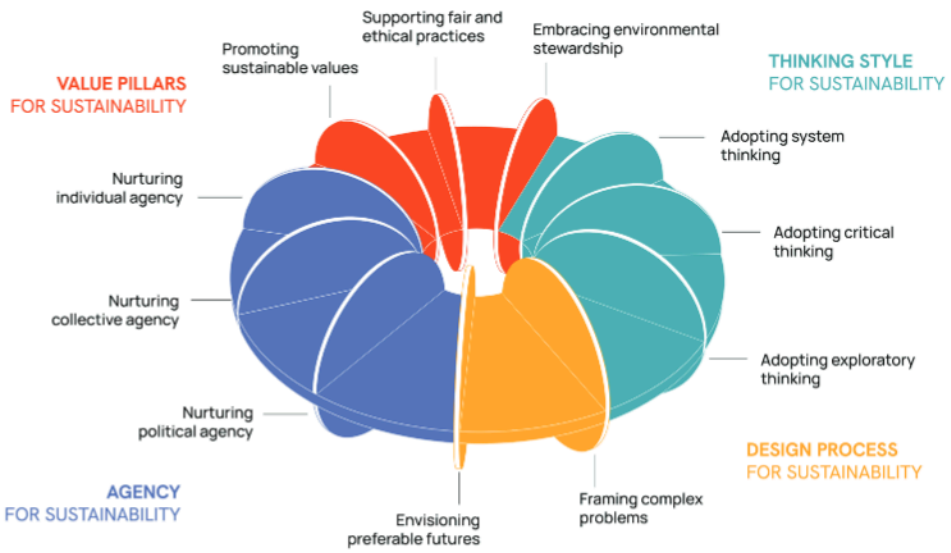


Fig. 4
Visualisation of the 4 main areas identified in ST Comp, and the competencies.

programs. The results obtained from the analysis, synthesis and refinement process led the research team to identify 11 sustainability competencies organised into four main areas of competence development (Fig.4).
The ST Comp indeed includes the crucial competencies that, taken together, promote sustainable development for people operating in the context of the manufacturing field. It aims to be the reference framework for training and empowering professionals working at different levels of the organisation, from managers to employees, offering them clear and precise guidance for acting responsibly in their daily working practices with a sustainable mindset. Fundamental is the ability to understand the ethical pillars of sustainability and translate them into tangible actions, as well as the ability to analyse and address sustainable challenges with innovative and forward-looking perspectives.
The framework presents the competencies by using the following items:
Area: it represents the broad category or domain that encompasses a cluster of related competencies. It defines the general theme or focus, offering a way to group similar competencies under a common purpose or functional scope.
Role of the person in the organisational ecosystem: It provides a general description of how an individual with the given competence contributes to the organisation. It provides a contextual understanding of why this competence is important and how it affects the organisation's ecosystem from the person's point of view.
What the person knows: It refers to the knowledge in terms of theoretical and factual information that a person must possess. This could include specific information, concepts, theories, and models relevant to the competence.
What the person can do: It refers to the skill in terms of practical application of knowledge. Skills are often demonstrable through action. These are the capabilities that allow a person to perform tasks.
What attitude the person has: It refers to an attitude in terms of mindset, outlook, or behavioural tendencies related to the competence that a person exhibits.

5.1 Description of the areas and the competencies

The 11 competencies identified are equally important and all of them should be developed and encouraged. To improve their understanding, they have been clustered according to their nature, identifying four main areas that are highly interrelated and described below (Fig.5).
Values Pillars for Sustainability: This area covers the core competencies that underlie the ethical considerations and values needed to promote sustainable and responsible practices and decision-making in both personal and organisational actions. This includes recognising the importance of managing the environment to respect the needs and rights of all species, applying fair and ethical practices for future generations, and identifying narratives for sustainability.
Thinking Style for Sustainability: this area involves adopting a holistic and systems-oriented approach to problem-solving and decision-making. This includes understanding the interconnectedness of social, environmental, and economic systems and the long-term consequences of actions. Competencies in this area entail developing critical thinking skills, systems thinking abilities, and the capacity to analyse complex issues creatively through a sustainability perspective.
Design Processes for Sustainability: this area refers to the ability of individuals within the organisation to face problems and envision solutions with a design approach that puts human and planetary needs at the centre of organisational actions and decisions. It includes competencies related to anticipating future problems, mitigating the existing ones, as well as the ability to envision preferable future scenarios analysing their impacts for sustainability.
Agency for Sustainability: this area refers to the capacity of individuals and organisations to initiate and drive positive change towards sustainability goals. This involves proactively

VALUES PILLARS FOR SUSTAINABILITY	1.1. Promoting sustainable values	The competent person reflects on organizational values at the different levels and can identify and explain how values vary among people and over time while critically evaluating how they align with organisational narratives, actions and values for sustainability.
	1.2. Supporting fair and ethical practices	The competent person supports equity and justice in the organisational actions to respect the interests of current and future generations and learn from past traditions and actions for sustainability.
	1.3. Embracing environmental stewardship	The competent person acknowledges that the organisational ecosystem are part of nature, being committed to respecting the needs and rights of other species pursuing the goal of restoring and regenerating healthy and resilient natural ecosystems.
THINKING STYLE FOR SUSTAINABILITY	2.1 Adopting System Thinking	The competent person approaches the organisational problems on sustainability as a system comprehending their interrelations with the organisational ecosystem, and simultaneously considering the elements interacting within it, such as the problems' context and different scales of time and space.
	2.2 Adopting Critical Thinking	The competent person practices an intense cognitive process to assess information and identify assumptions to question the organisational status quo. Can reflect on how the personal, social, and cultural backgrounds within the organisational ecosystem influence the understanding and actions in the sustainability realm.
	2.3 Adopting Exploratory Thinking	The competent person explores sustainable challenges by connecting the various expertise in the organisational ecosystem and combining different points of view with a hands-on and experimental pioneering approach.

Fig. 5
Condensed visualisation of ST Comp competencies and their descriptions.

addressing sustainability challenges, advocating for policy changes, and engaging stakeholders in collaborative efforts. Developing competence in this area entails fostering leadership abilities, effective communication and collaboration, stakeholder engagement, and mobilising resources to achieve sustainability objectives.
The areas, as well as the competencies, are strongly interrelated and interconnected and should be treated as parts of a whole. Therefore, sustainability encompasses all of them taken together (See appendix 2 for a detailed description of the competencies).

6. DISCUSSION AND CONCLUSION

Training and skills development in the context of manufacturing companies should involve the use of a comprehensive framework aimed at empowering professionals, from managers to employees, at all levels of the organisation. The ST Comp represents a unique and comprehensive guide for integrating the specific competencies for the sustainable transition in the daily practices within the organisational context. It is conceived for equipping employees with the ability to analyse and address sustainability challenges with innovative and forward-thinking approaches. A design-driven approach was employed to select, group, and prioritise competencies, focusing on those that align closely with the design-based learning characteristic of design education. In particular, the skills outlined in this framework have been redefined

DESIGN PROCESS FOR SUSTAINABILITY	3.1. Framing Complex Problems	The competent person designs the current or potential challenges of the organisation, starting from sustainability problems and considering factors such as difficulty, people involved, time, and geographical scope. Can identify suitable approaches for the organisation to anticipate and prevent problems that might be encountered in the future and to mitigate and adapt to already existing ones.
	3.2. Envisioning Preferable Futures	The competent person anticipates preferable futures for the organisation and their implications by imagining and developing alternative scenarios and designing the steps needed to achieve a preferable sustainable future with a creative and participatory approach.
AGENCY FOR SUSTAINABILITY	4.1 Nurturing Individual Agency	The competent person identifies one's potential for the organisational transformation toward sustainability and actively contributes through actions to improve prospects for the organisational ecosystem and the planet.
	4.2. Nurturing Collective Agency	The competent person acts for change toward organisational actions for sustainability in collaboration with culturally plural stakeholders within the organisational ecosystem.
	4.3. Nurturing Political Agency	The competent person understands and navigates the political system within and outside the organisation, identifying political responsibility and accountability for unsustainable behaviour and demanding effective policies for sustainability.

Fig. 5 (cont.)
Condensed visualisation of ST Comp competencies and their descriptions.

to be more applicable and effective for training learners within manufacturing organisations. The development of the ST Comp proposed a new combination of the GreenComp competencies following two main lenses: organisational culture and design lens. Differently to the GreenComp, which includes 12 competencies, the ST Comp encompass 11 competencies, organised under 4 interrelated areas of equal importance, which should be regarded as parts of a whole, being developed and encouraged. One of the GreenComp competencies, Adaptability — defined as "To manage transitions and challenges in complex sustainability situations and make decisions related to the future in the face of uncertainty, ambiguity, and risk" (Bianchi et al., 2022) — was omitted and merged with other competencies. The team considered that Adaptability represented an attitude already contained within several of the competencies of the ST Comp. One of the main challenges encountered while rewriting the GreenComp framework to develop the ST Comp, was to create a comprehensible language tailored for manufacturing companies. This ensured that the competencies and principles outlined in the framework were easily understood and applicable within the organisational context. By using clear and practical language, the authors aimed to facilitate the integration of sustainability concepts into business processes, making it accessible for instructional designers and for professionals at all levels within manufacturing companies, and beyond, to adopt and implement sustainable practices effectively. A connected result has been the creation of a Glossary to support the comprehension of ST Comp. The comprehensive nature of the ST Comp ensures that essential aspects of sustainability are covered, promoting a well-rounded competence set among different organisational levels and adaptable to daily work in diverse

organisations. The framework arranges competencies into clearly defined areas, aligning with the specific needs and challenges of the manufacturing sector, making training more relevant and impactful. Focusing on sustainability values, critical and systems thinking, and design processes, the framework equips the person to tackle complex organisation-specific issues effectively. Encouraging competencies such as exploratory thinking and envisioning preferable futures fosters a culture of innovation within the company, training individuals to think creatively and proactively and leading to innovative solutions to sustainability challenges. Emphasising competencies like promoting sustainable values and supporting fair and ethical practices helps cultivate a strong ethical foundation within the organisation, improving reputation, ensuring compliance with regulatory standards, and enhancing stakeholder trust. Training people in framing complex problems and adopting systems thinking enhances their ability to analyse and address multifaceted issues, a competency particularly valuable ein the manufacturing sector, where problems often involve multiple interrelated factors. By nurturing individual, collective, and political agency, the framework empowers individuals to take initiative and drive sustainability efforts at various levels, leading to a more engaged and proactive workforce capable of leading sustainability initiatives and influencing positive change within the organisation. The structured approach of the ST Comp aids in systematically integrating sustainability into the organisational culture, supporting the development of targeted training programs that facilitate change and drive the transition towards more sustainable practices. The framework's emphasis on critical and systems thinking promotes training aimed at continuous evaluation and improvement of processes, encouraging individuals to iteratively question and refine their practices, leading to ongoing enhancements in sustainability performance. By nurturing collective agency, the framework fosters a collaborative environment where people work together towards common sustainability goals, enhancing the effectiveness of sustainability initiatives and driving cohesive action across the organisation. To conclude, the authors envision that the ST Comp can enhance the development of instructional projects to empower individuals across various levels of the organisation to become change agents. This is the goal of the ECODeCK project, which will adopt the ST comp to create a capacity-building training program, to promote transformation and circular sustainable innovation within manufacturing companies through design-based initiatives. The competencies included in the framework will be used to define the specific learning objectives of the training activities, helping individuals in developing an understanding of the ethical foundations of sustainability, and translating these principles into practical actions into organisations. These individuals would integrate sustainability as a success factor in the working environment, cooperate across different organisational levels, embed sustainability criteria into business processes, and effectively communicate the vision of sustainable development to society. The ST Comp's adaptability allows it to customise its adoption within multiple training activities to meet the specific needs of different manufacturing companies, ensuring that training programs remain relevant and can be tailored to address unique challenges and objectives within various organisational contexts. By doing so, the framework aims to increase sustainability transitions and foster a culture of sustainability throughout the organisation. Future research will encompass the application and validation of the framework in specific furniture and fashion organisational contexts through the ECODeCK training model.

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GLOSSARY

While developing the ST Comp, it became evident that creating a glossary was essential to ensure alignment both within the team and externally. Establishing a common language helped simplify the description of competencies, facilitating clearer communication and mutual understanding among team members. This glossary proved crucial for internal coherence and enabled companies to easily comprehend and implement the competencies outlined in the framework. By standardising terminology, the team could effectively convey complex sustainability concepts in a way that was accessible and actionable for manufacturing organisations.

Organisation - An organisation is a structured group with a common goal or purpose, typically working together to achieve specific objectives. It can take various forms: a business, government agency, non-profit entity, or any structured group with defined roles, responsibilities, and a shared mission. Organisations often have established rules, processes, and structures to facilitate efficient operation and the pursuit of their objectives.

Organisational ecosystem - An organisational ecosystem refers to the complex and interconnected network of entities, both internal and external to an organisation, that interact and influence one another in various ways. It encompasses the dynamic relationships between the organisation and its environment, including employees, customers, suppliers, competitors, regulatory bodies, and other stakeholders.
The concept of an organisational ecosystem emphasises the interdependence and mutual influence among these internal and external elements. It recognises that an organisation is a structured group of individuals that is part of a broader system where changes or events in

one part can have cascading effects throughout the entire ecosystem. Also, by adopting the term, the aim is to empathise that, as well as externally, the organisation can be conceived internally as an ecosystem of individuals and teams.
The organisational ecosystem comprises the organisation's stakeholders, individuals or entities interested in it. Sustainability stakeholders focus on an organisation's sustainable practices; key stakeholders include employees, customers, investors, suppliers, local communities, regulators, NGOs, competitors, media, and future generations. Engaging with these stakeholders is essential for developing and enhancing sustainable strategies, considering social and environmental impacts.

Organisational levels - The term organisational level is used in the framework to represent the different intra- and inter-organisational levels of the ecosystem. Inside the organisation (intra-organisation), we can consider the individuals as the micro level, the teams or departments as the meso level and the organisation itself as the macro level. Outside the organisation, we can consider the organisation itself as the micro level, other organisations as the meso level and society as the macro level.

Organisational actions - Organisational actions are an organisation's collective activities and behaviours to achieve its goals and objectives. The term is here used as an umbrella term that encompasses the various activities, initiatives, operations, practices and products that the organisation produces, or in other words, that employees, teams, and leaders put in place to contribute to the overall functioning and success of the organisation. Organisational actions are dynamic processes that drive the organisation forward.

Organisational values - Organisational values refer to the fundamental beliefs, principles, and ethical standards that guide the behaviour, decisions, and actions of individuals within an organisation. These values are a foundation for the organisational culture and influence how employees interact with each other, stakeholders, and the broader community. Organisational values are often articulated in a formal statement or document and are meant to shape the identity and ethical framework of the organisation.
In the framework, organisational values for sustainability are often mentioned, intending the set of values that emerge as closely related to sustainable development. Also, in the framework, organisational values at different levels are mentioned, referring to the fact that different levels of the organisational ecosystem might inform actions based on different values.

Organisational narratives - Organisational narratives refer to organisations' stories, accounts, or descriptions to communicate their identity, values, history, purpose and actions. These narratives are crucial in shaping the organisational culture and influencing how internal and external stakeholders perceive the organisation. These narratives often include claims and arguments to support and reinforce specific messages or perspectives.
Within the organisational narrative, claims are statements or assertions made to convey specific information or messages. These claims often highlight achievements, values, or unique selling points the organisation wants to emphasise. Arguments involve presenting a series of reasons or evidence to support a particular point of view and are used to persuade their audience, whether it be employees, customers, investors, or the public. Arguments in narratives may include logical reasoning, statistical data, or emotional appeals to build a compelling case for the organisation's stance or perspective.
The main interest in the context of the competence framework is about all the organisational narratives related to sustainability; these are often influenced by prevailing sustainability narratives, the predominant stories, discourses, or perspectives that currently shape discussions and perceptions around sustainability.
Prevailing sustainability narratives often reflect the dominant themes, values, and priorities within a given context, and they can vary across different sectors, regions, and periods. They influence how individuals, organisations, and societies understand and engage with sustainability.

Organisational problems - Organisational problems refer to obstacles and issues an organisation encounters in its day-to-day operations, hindering its ability to function effectively or achieve its goals. These problems can arise from various sources, including internal processes, external factors, structural issues, communication breakdowns, and organisational human interactions.
In the framework, organisational problems toward sustainability are also mentioned, meaning all those organisational problems in the context of sustainability, those that impede an organisation's efforts to adopt and maintain environmentally, socially, and economically responsible practices.

Organisational status quo - Organisational status quo refers to an organisation's existing state or condition at a particular point in time. It represents the organisation's current situation, practices, structures, and processes. The term often describes the prevailing situation or how things are currently done without significant changes or disruptions.

Organisational opportunities - Organisational opportunities refer to favourable and external conditions or situations an organisation can leverage to achieve its goals, enhance performance, or gain a competitive advantage. These opportunities arise from various sources, including changes in the market, emerging trends, technological advancements, partnerships, regulatory developments, and shifting consumer preferences. Identifying and capitalising on these opportunities is crucial for organisational growth, innovation, and sustained success. Effectively seizing opportunities requires strategic thinking, adaptability, and aligning organisational capabilities with external possibilities.

Organisational transformation - Organisational transformation refers to a significant and fundamental change in an organisation's structure, culture, processes, or strategies. It often involves a deliberate and comprehensive effort to redefine and reshape various aspects of the organisation to adapt to new challenges, improve performance, and stay competitive in a rapidly changing environment. Organisational transformation can encompass changes in leadership, technology, business models, employee roles, and overall organisational mindset. Specifically, organisational transformation towards sustainability involves a purposeful shift in an organisation's practices, policies, and values to prioritise environmental, social, and economic sustainability. This transformation is driven by a commitment to minimising negative impacts on the environment, fostering social responsibility, and creating long-term economic value. It may include adopting eco-friendly practices, incorporating social responsibility into business operations, enhancing supply chain sustainability, and aligning strategies with principles of sustainable development. The goal is to create a business model that meets present needs without compromising the ability of future generations to meet their own needs.

Preferable futures - The term futures refer to potential or anticipated events, developments, or conditions that may unfold. It encompasses various possibilities and outcomes that can arise based on current trends, decisions, and external factors. Among futures, the term preferable futures refer to the envisioned, desired, or sought-after outcomes that individuals, organisations, or societies aspire to achieve. It involves deliberately shaping and working towards a future that aligns with values, goals, and positive aspirations. In the case of the framework, preferable futures are those oriented toward sustainable development. To envision preferable futures, individuals and organisations engage in strategic planning, goal setting, and decision-making that fosters sustainability, well-being, and positive societal impact.

Scenarios - Scenarios are intended as plausible and coherent narratives or descriptions of situations or events in a preferred sustainable future. These narratives are typically constructed to explore potential outcomes, uncertainties, or developments that may impact a particular context, such as the organisational ecosystem and society.

Policies - Policies refer to principles, guidelines, rules, or plans established by an organisation, government, or other entities to guide decision-making and actions consistently and coherently. Policies are designed to provide a framework for individuals within the organisation or governed by the entity, helping them understand what is expected and acceptable behaviour within a given context. Policies are made and affect several relevant stakeholders (social, political and economic) of the organisation.

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APPENDIX

AREA	COMPETENCE	DESCRIPTOR
3. *Envisioning sustainable futures*	3.1 **Futures literacy**	To envision alternative sustainable futures by imagining and developing alternative scenarios and identifying the steps needed to achieve a preferred sustainable future.
	3.2 **Adaptability**	To manage transitions and challenges in complex sustainability situations and make decisions related to the future in the face of uncertainty, ambiguity and risk.
	3.3 **Exploratory thinking**	To adopt a relational way of thinking by exploring and linking different disciplines, using creativity and experimentation with novel ideas or methods.
4. *Acting for sustainability*	4.1 **Political agency**	To navigate the political system, identify political responsibility and accountability for unsustainable behaviour, and demand effective policies for sustainability.
	4.2 **Collective action**	To act for change in collaboration with others.
	4.3 **Individual initiative**	To identify own potential for sustainability and to actively contribute to improving prospects for the community and the planet.

Appendix 1
GreenComp (Bianchi et al., 2022) areas and competencies.

AREA	COMPETENCE	DESCRIPTOR
1. *Embodying sustainability values*	1.1 **Valuing sustainability**	To reflect on personal values; identify and explain how values vary among people and over time, while critically evaluating how they align with sustainability values.
	1.2 **Supporting fairness**	To support equity and justice for current and future generations and learn from previous generations for sustainability.
	1.3 **Promoting nature**	To acknowledge that humans are part of nature; and to respect the needs and rights of other species and of nature itself in order to restore and regenerate healthy and resilient ecosystems.
2. *Embracing complexity in sustainability*	2.1 **Systems thinking**	To approach a sustainability problem from all sides; to consider time, space and context in order to understand how elements interact within and between systems.
	2.2 **Critical thinking**	To assess information and arguments, identify assumptions, challenge the status quo, and reflect on how personal, social and cultural backgrounds influence thinking and conclusions.
	2.3 **Problem framing**	To formulate current or potential challenges as a sustainability problem in terms of difficulty, people involved, time and geographical scope, in order to identify suitable approaches to anticipating and preventing problems, and to mitigating and adapting to already existing problems.

Appendix 1 (cont.)
GreenComp (Bianchi et al., 2022) areas and competencies.

VALUES PILLARS FOR SUSTAINABILITY		
	1.1. Promoting sustainable values	The competent person reflects on organizational values at the different levels and can identify and explain how values vary among people and over time while critically evaluating how they align with organisational narratives, actions and values for sustainability.
	WHAT THE PERSON KNOWS	Knows the main views on sustainability, particularly sustainable production and consumption, and how they impact organisational narratives, actions and values.
	WHAT THE PERSON CAN DO	Critically assesses how the main values and principles driving the actions at different organisational levels can match and mismatch sustainability.
	WHAT ATTITUDE THE PERSON HAS	Strives to include the plurality of visions about sustainability in organisational decision-making to build coherent organisational narratives, actions, and values.
	1.2. Supporting fair and ethical practices	The competent person supports equity and justice in the organisational actions to respect the interests of current and future generations and learn from past traditions and actions for sustainability.
	WHAT THE PERSON KNOWS	Knows ethical and environmental justice principles as criteria for defining present and future organisational actions that preserve the environmental ecosystem and the use of natural resources.
	WHAT THE PERSON CAN DO	Critically assess how the different organisational actions at the different levels pursue ethical longer-term goals, considering the interests of all the species and the importance of preserving nature for future generations.
	WHAT ATTITUDE THE PERSON HAS	Strives to include the plurality of visions about sustainability in organisational decision-making to pursue ethical and fair practices inclusively.
	1.3. Embracing environmental stewardship	The competent person acknowledges that the organisational ecosystem are part of nature, being committed to respecting the needs and rights of other species pursuing the goal of restoring and regenerating healthy and resilient natural ecosystems.
	WHAT THE PERSON KNOWS	Knows the interdependence between the organisation - with its living organisms and non-living components - and the natural environment, acknowledging that our wellbeing depends on their healthy relationship.
	WHAT THE PERSON CAN DO	Critically assess the impact of organisational actions at the different levels on natural ecosystems and define processes and actions that reduce natural resource exploitation.
	WHAT ATTITUDE THE PERSON HAS	Strives to promote a shift from anthropocentrism to ecocentrism, imaging the organisation as a natural component that respects other life forms.

Appendix 2
STComp extended competencies descriptions.

THINKING STYLE FOR SUSTAINABILITY	2.1 Adopting System Thinking	The competent person approaches the organisational problems on sustainability as a system comprehending their interrelations with the organisational ecosystem, and simultaneously considering the elements interacting within it, such as the problems' context and different scales of time and space.
	WHAT THE PERSON KNOWS	Knows that the organisation, its sustainability problems, goals, and actions are a complex system encompassing time, space, and context and relating to the diverse sustainability fields (environmental, societal, cultural, and economic).
	WHAT THE PERSON CAN DO	Can holistically assess frictions, tensions and connections among the elements that characterise the organisational complex system and their impact (positive, negative, neutral) on the diverse sustainability fields.
	WHAT ATTITUDE THE PERSON HAS	Strives to identify the promising organisational challenges and opportunities to trigger sustainable change through systemic observation, being aware and concerned about the unpredictable effects of each single action.
	2.2. Adopting Critical Thinking	The competent person practices an intense cognitive process to assess information and identify assumptions to question the organisational status quo. Can reflect on how the personal, social, and cultural backgrounds within the organisational ecosystem influence the understanding and actions in the sustainability realm.
	WHAT THE PERSON KNOWS	Knows that biases in reasoning, communication, and political statements shape prevailing sustainability narratives that influence organisational problems on sustainability.
	WHAT THE PERSON CAN DO	Critically assesses the organisational narratives and actions, reflecting on whether they align with evidence and values regarding sustainability, and recognising organisational narratives on sustainability lacking solid evidence (i.e., greenwashing, pinkwashing, rainbowashing).
	WHAT ATTITUDE THE PERSON HAS	Strives to embrace a critical attitude of observing and analysing the organisational narratives on sustainability, developing a set of reliability criteria that must constantly evolve to guarantee a trustworthy source of information in taking decisions and actions.
	2.3. Adopting Exploratory Thinking	The competent person explores sustainable challenges by connecting the various expertise in the organisational ecosystem and combining different points of view with a hands-on and experimental pioneering approach.
	WHAT THE PERSON KNOWS	Knows that coping with organisational sustainability problems means combining multiple disciplines, cultural perspectives and contexts, and understands the critical role of experimentation in approaching this complexity.
	WHAT THE PERSON CAN DO	Can creatively combine and synthesise the multiple knowledge and resources, starting the experimentation from evidence and research and leaving the door open to unusual choices, results, and proposals for the organisational ecosystem.
	WHAT ATTITUDE THE PERSON HAS	Strives to activate experimental processes without fear of failure, embracing multifold internal perspectives that can lead to alternative thinking when facing organisational problems on sustainability.

Appendix 2 (cont.)
STComp extended competencies descriptions.

DESIGN PROCESS FOR SUSTAINABILITY	3.1. Framing Complex Problems	The competent person designs the current or potential challenges of the organisation, starting from sustainability problems and considering factors such as difficulty, people involved, time, and geographical scope. Can identify suitable approaches for the organisation to anticipate and prevent problems that might be encountered in the future and to mitigate and adapt to already existing ones.
	WHAT THE PERSON KNOWS	Knows that the organisation, its sustainability problems, goals, and actions are a complex system encompassing time, space, and context and relating to the diverse sustainability fields (environmental, societal, cultural, and economic).
	WHAT THE PERSON CAN DO	Can holistically assess frictions, tensions and connections among the elements that characterise the organisational complex system and their impact (positive, negative, neutral) on the diverse sustainability fields.
	WHAT ATTITUDE THE PERSON HAS	Strives to identify the promising organisational challenges and opportunities to trigger sustainable change through systemic observation, being aware and concerned about the unpredictable effects of each single action.
	3.2. Envisioning Preferable Futures	The competent person anticipates preferable futures for the organisation and their implications by imagining and developing alternative scenarios and designing the steps needed to achieve a preferable sustainable future with a creative and participatory approach.
	WHAT THE PERSON KNOWS	Knows the different types of futures and the implications of adopting a short-, medium- and long-term approach when defining future scenarios for the organisational ecosystem and making decisions.
	WHAT THE PERSON CAN DO	Can envisage alternative futures for the organisational ecosystems grounded in science, creativity and values for sustainability, and can evaluate their impacts in terms of opportunities, limitations and risks.
	WHAT ATTITUDE THE PERSON HAS	Strives to define actions, steps and initiatives that lead toward the realisation of future scenarios for the organisational ecosystem.

Appendix 2 (cont.)
STComp extended competencies descriptions.

DESIGN PROCESS FOR SUSTAINABILITY	**4.1 Nurturing Individual Agency**	The competent person identifies one's potential for the organisational transformation toward sustainability and actively contributes through actions to improve prospects for the organisational ecosystem and the planet.
	WHAT THE PERSON KNOWS	Knows the potential impact of own actions for organisational transformation toward initiatives that prevent damage to all life forms and reduce natural resources exploitation.
	WHAT THE PERSON CAN DO	Can take prompt personal initiative for achieving organisational objectives for sustainability, coherently with one's role, even in uncertain or unforeseen events.
	WHAT ATTITUDE THE PERSON HAS	Strives to persistently act for organisational transformation toward sustainability, inspiring others to care about sustainability, overcoming the resistance to change, and taking the initiative.
	4.2. Nurturing Collective Agency	The competent person acts for change toward organisational actions for sustainability in collaboration with culturally plural stakeholders within the organisational ecosystem.
	WHAT THE PERSON KNOWS	Knows the relevant sustainability stakeholders for the organisational ecosystem, how to build a coalition with them and collaborate democratically, recognising the strategic value of collaboration for a sustainable transition.
	WHAT THE PERSON CAN DO	Can create transparent, inclusive and bottom-up collaboration processes with a coalition of stakeholders and materialise joint action opportunities consistent with shared objectives based on each stakeholder's strength.
	WHAT ATTITUDE THE PERSON HAS	Strives to initiate and maintain collaborations with others to challenge the status quo, promoting increasingly sustainable collective initiatives for the organisational ecosystem.
	4.3. Nurturing Political Agency	The competent person understands and navigates the political system within and outside the organisation, identifying political responsibility and accountability for unsustainable behaviour and demanding effective policies for sustainability.
	WHAT THE PERSON KNOWS	Knows the political system components, functioning, and relevant stakeholders to co-create sustainability policies for the organisational ecosystem.
	WHAT THE PERSON CAN DO	Can propose alternative sustainable pathways for the organisational ecosystem, engaging in decision-making and civic activities with relevant stakeholders.
	WHAT ATTITUDE THE PERSON HAS	Strives to actively demand effective organisational policies for sustainability at the different level.

Appendix 2 (cont.)
STComp extended competencies descriptions.