

What does it take to make a workplace just and green? – Systemic human factors approach

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Abstract

Halting environmental degradation requires workplaces to undergo a profound shift towards ecologically sustainable work that challenges customary growth-oriented thinking and holds justice and the well-being of workers as a core value. Structures and practices of workplaces provide a critical link through which this transition could be achieved. However, there is a lack of clear and systemic definition and an easily applicable model to guide workplaces to become both just and green. In this paper, we aim to define the key characteristics of a just green workplace by using human factors/ergonomics (HF/E) as the underlying theoretical approach. Humans are positioned as the core component across all system levels. Thus, we posit that the HF/E approach can serve as a fundamental building block for just green workplaces. It helps shift the focus of the currently prevailing technology-, administration- and (de)growth-oriented green transition towards one that is more human-centric, contextually aware, as well as competence- and developmentally oriented. We apply a HF/E Tool to two case examples from different sectors to demonstrate the systemic, underlying factors of just green work at the individual, work, group, and organisational levels. Based on the findings, we present criteria and recommendations for a just green workplace. In addition, the value and development needs of the HF/E approach in fostering sustainability are discussed.

Keywords: just green transition; human factors; systemic thinking; change; environment; sustainability; organisational development

Introduction

Climate change, biodiversity loss, and resource scarcities are examples of environmental degradation that requires many workplaces to undergo a profound shift towards ecologically sustainable work that goes beyond short-term profit-making and holds justice as a core value (EU-OSHA, 2023; OECD, 2018). Structures, roles, and processes of workplaces offer a potential linkage by which such just green transition may be managed. However, in accelerating activities towards a rapid and large-scale societal just green transition, workplaces play very different roles. Some workplaces already consider themselves as 'green' and their core challenge may be to upscale from niche actor to serious competitor against established market actors. Others need to rethink their whole business model, and in cases like coal mining, they may face complicated issues of justice due to the inevitable downfall of their entire industry.

In practice, most workplaces face a double challenge of change and stability. First, rethinking and renewal is needed to change current work processes and products to become 'greener'. Second, workplaces need to maintain and support the safety and well-being of workers, to assure a just transition (SDGR, 2023; Thatcher, et al. 2018; Schulte et al., 2016). A *green transition* in workplaces is often interpreted as business or service innovations for degrowth (Smith & Sharicz, 2011), and an issue handled by applying environmental management systems to address industry-induced pollution (Zhu et al., 2013). However, to realize a *just green transition* in workplaces we need to define the key characteristics of implementing just and green work, and to understand the systemic nature of the underlying factors that contribute to the success of 'just greening of work'.

The definition of a green workplace is still not established and is vague, with many different characterisations aimed at adapting to and mitigating environmental change, as well as anticipating environmental policies or market demands (e.g., UN 2015; EC, 2019; EC 2020). In this paper, we highlight environmental and social sustainability and define a '*just and green workplace*' (*JGW*) as an organisation that focuses on ecological values (e.g. reducing harmful environmental impacts) while simultaneously addressing the social sustainability of workers (e.g. their sustainability competency as well as wellbeing and work continuity). (Raworth, 2017; EU, 2023; EU-OSHA, 2023; Bianchi et al. 2022). While the ESG (Environmental, Social, Governance) literature on corporate responsibility mostly focuses on large private firms, here we aim to cover all types of workplaces. In this paper, we also define work as (mainly) permanent and paid employment.

It is well known that a just green transition, with all the multilayered and multi-scale phenomena (e.g., climate change, biodiversity, employment, social security (e.g. Mechler et al., 2020), requires a systemic view to be appropriately addressed (Thatcher et al., 2018). However, in addressing many complex problems, there is a tendency to create an overall

view at an abstract or theoretical level, which does not serve well for implementing practical actions in workplaces (Teperi et al., 2023).

For example, this is an issue that includes broad frameworks such as a Corporate Social Responsibility Directive (CSRD) (EU, 2022; 2024), which push companies to embed sustainability targets into their management strategies and to report their sustainability efforts more clearly. Although CSRD provides a comprehensive overview of the necessary actions, it cannot ensure that strategies are implemented as effective practical actions. Another option is Industry 5.0 (EC, 2021), which, as an EU-level guideline, offers an overarching perspective on the actions needed for more sustainable and resilient operations. However, it is more focused on technological development and does not provide a broad view of greening actions in the workplace or for work communities as interactive systems. Both CSRD and Industry 5.0 offer sound reasoning for change but do not necessarily provide instrumental steps for operationalizing change in practice, which is the focus of this article.

Occupational safety and health (OSH) research provide knowledge on current threats posed by environmental changes, such as heat stress and extreme weather conditions caused by climate change, chemical risks related to agrochemicals, and UV radiation (ILO, 2024). However, OSH research is typically risk-based and tends to evaluate issues narrowly from one perspective at a time, most commonly from the perspective of natural sciences, such as physiological or physical aspects (Dekker, 2016; Leveson, 2020). In this study, we adopt a systemic, multidisciplinary view, including behavioural science (Assmuth & Lyytimäki, 2015; Teperi et al., 2023). We assess practical details necessary to achieve JGW solutions, considering the required competencies and developmental steps at the workplace.

Thus, in this study we apply the systemic, multidisciplinary Human Factors and Ergonomics (HF/E) (Wilson, 2014; IEA, 2024) approach to explore what a JGW might be like. By selecting HF/E as our view we aim to focus on the 'how', in order to realize the greening of work, instead of the 'what' of green work or 'what are risks or consequences of not greening work'. HF/E is operationalised using the HF Tool (Teperi, 2012), which has previously been shown to develop a mindset in people at work by improving safety awareness, competence, and practices in several industries through the implementation of a stepwise program (Teperi et al., 2015; 2017; 2023).

The HF Tool owes much to organisational and work psychology and system safety research, including themes such as resilience, adaptive capacity, organisational culture and learning, and management and leadership, to recognize contextual factors as specific themes. In this study, the HF Tool is used to describe how JGW can be realised, and which kind of contextual factors contribute at the individual, work, group, and organisational levels. The second aim is to reflect on the usability and development needs of the HF/E framework as operationalised through an HF Tool. Through the examination of JGW the study aims to contribute to wider

debates of the eco-welfare state and the eco-social contract that can also provide criteria for JGW (Hirvilammi et al., 2023).

As policies for JGW provide possibilities and demands for new ways of thinking and action, workplaces are places where creative destruction – possible tensions within green business and sustainability - are faced. The need for solving tensions puts pressure on workplaces to clarify their values, activities, and operations in a conscious and clear way. The core focus of this paper is concentrated on developed, Western countries, and especially Nordic countries. Although these countries have tackled essential targets for sustainable development such as water, sanitation, and training facilities (SDGR, 2023) their major risk is overconsumption of natural resources that pose a risk to breaching several planetary boundaries (World Economic Forum, 2023; Rockström et al., 2023). This highlights the need for immediate attention such as adapting to and mitigating climate change and avoiding overuse of natural resources. An essential cornerstone of implementing this is through the mechanisms of working life. Practically this begins with workplaces. The innovativeness of our paper lies, first, in presenting the theoretical and practical possibilities of HF/E as one approach to sustainability science; second, in helping workplaces take an active role in realising JGW; and third, in addressing the critical contributing factors for implementing JGW in practice. Furthermore, this paper represents the integration of behavioural, environmental, and engineering perspectives to achieve a comprehensive approach to the fair greening of work.

The aim of this study is to define the key characteristics of implementation for a just and green workplace (JGW); what it entails, and the actions that need to be undertaken.

Our specific research questions are:

- 1) Which factors facilitate or hinder the implementation of just greening activities of the workplace?
- 2) How does the HF Tool work in analyzing contributing factors of just greening of work?

What is a just and green workplace like? An overview to the legislation, guidelines and knowledge

Green work (or green jobs as a synonym) covers a wide range of different occupations in different sectors. Green jobs can be understood as contributing to the preservation or restoration of the environment. They can include jobs that help to protect ecosystems and biodiversity, or reduce consumption of energy and raw materials, or reduce waste and pollution (EU-OSHA, 2023; UNEP, 2008). Green is also seen as a spectrum, not as a binary category indicating that only a few skills are specific to green jobs, and many non-green jobs use similar skills to green jobs (Bowen et al. 2018; Bowen & Kuralbayeva, 2015). Green work may also be defined as actions that change workers' and management's work actions and their sustainability competency to be more sustainable (e.g. workplace practices and choices, the use and recycling of resources) (Ala-Laurinaho et al., 2023; Finnish panel for OSH, 2022).

These may, for example, include green HR practices in the workplace which defines green workplace design, sustainability education, OHS, green organisational design (e.g. incorporating circularity, only using renewable energy, greening the supply chains), and green workplace/equipment such as greening actions at work (Yong et al., 2020). Also, behaviours might extend beyond the working environment to the general living environment (e.g., encouraging public transport, encouraging recycling, changing diets, etc.) (e.g., Finnish Panel for OSH, 2022).

Just green work is an elusive concept that has been framed by international declarations and agreements, national legislation, sector-based standards, and voluntary guidelines as well as by research-based definitions (Bowen & Kuralbayeva, 2015). Different aspects of just green work can be highlighted or omitted by entrepreneurs, employees, or labour unions, and the dynamics of news and media, social media, and marketing which does not always help to build better public awareness of the concept. In this section, we aim to clarify the key categories that compose just green work.

Universal visions. In visions of the future that emphasise responsibility, people and people's well-being are placed at the centre of sustainable and responsible economic thinking (EC, 2021; UN, 2015: SDG8 for decent work, SDG3 for good health and wellbeing; EU, 2023). These seemingly inevitable European (e.g., EC, 2019; EC, 2012) and global development trends (SDGR, 2023; UN, 2015 for Agenda2030; ILO, 2016; 2017), combined with the rapid development of technologies such as wind and solar energy, green construction, and novel food products (EU-OSHA, 2013; Lorenz et al. 2024), open entirely new opportunities for workplaces – but also set targets for workplaces and their stakeholders (such as authorities and trade unions) to be implemented.

Mandatory legislation. The role of national states is crucial for JGW since states set and enforce laws and regulations that limit the power of private actors. More recently, international law has appeared as a response to the requirements of increasing globalisation and long production-consumption chains. The EC Conflicts Minerals Regulation (2017/821) is a concrete example combining environmental and social aspects in an international setting. However, most of the international management of sustainability comprises “soft law” type of agreements and treaties (e.g. UN Agenda 2030 and the Sustainable Development Goals).

OSH standards. Environmental management systems such as ISO 14000 provide an example of widely applied standards aimed at helping organisations to comply with legislation, which minimise the harmful environmental impacts and improve their performance. Requirements of just green work have been brought together by early sector-based initiatives such as the Responsible Care program in chemical industries (Gunningham, 1995) or more recent concepts such as sustainable mining (Renn et al., 2022), endorsed by extractive industries, both highlighting environmental and social responsibility as well as work safety. On a more general level, the concept of the “triple bottom line” emerged in the 1990s (Elkington, 1997)

to simultaneously emphasise economic, social, and ecological concerns. More recently, this has evolved towards more standardised forms of environmental, social, and governance (ESG) programmes and formalised sustainability reporting under the European Commission's 2023 Corporate Sustainability Reporting Directive (CSRD).

Marketing. Green marketing with different labels and claims aimed to convince customers about the environmental friendliness of a product or service have been widely used as a response to public worries about environmental threats such as chemical pollution, ozone depletion, biodiversity loss, or climate change. For example, various "organic" labels are used to advertise food. Likewise, labels such as "Fair Trade" are aimed to convince potential buyers about decent working conditions. Some of these labels are verified by independent parties while others are self-regulated and published without any external control. A critique of misleading marketing such as white-washing, greenwashing and, more recently, rainbow-washing or SDG-washing have been presented (Gatti et al., 2019; Todaro & Torelli, 2024). As a response, the European Parliament has introduced measures aimed at banning greenwashing and making durability information clearer and easily accessible to consumers. Perceived green washing by companies has also been shown to affect negatively on both employees' work performance (Li et al., 2022) and companies' financial performance (Walker & Wan, 2011).

Education and (vocational) training. Creating JGW requires a holistic approach to integrate various competencies to address complex socio-environmental challenges. EU's GreenComp framework defines sustainability competence in terms of four pillars: "embodying sustainability values", "embracing complexity in sustainability", "envisioning sustainable futures" and "acting for sustainability" (Bianchi et al., 2022). The idea of a sustainability competence framework is to foster European policy to promote learning on environmental sustainability. To attract people to develop JGW, sustainability education needs to be developed especially in the vocational sector as well as at workplaces. For example, Ratinen and Linnanen (2022) have developed a model of sustainability competence with an emphasis on systemic competence. On the other hand, research has shown that there are complex linkages between, for example, individuals' carbon footprint knowledge and their sustainability skills, which challenges sustainability education (Ratinen et al., 2023).

Organisational culture. Changes in production and work processes and industrial/service practices affect both work and employees (Xu et al., 2021). Corporate sustainability activities need to affect the core business efficiently to be successful (Baumgartner, 2009). Workplaces need to find feasible measures to integrate just green work into their policies, procedures, and practices in such a way that they are inherently embedded in everyday operations. For this, the aspects of just green work need to be part of the organisational culture and mindset of leaders and members of the organisation, aligning lessons learnt from organisational studies (Schein, 2010; Senge, 2006). Thus, just green work demands workers to have knowledge, sustainability competency to renew culture that is reflected as deeply rooted and espoused values and underlying assumptions, as well as ways of thinking, feeling and acting

(basic assumptions; Schein, 2010; unexamined rules by which people think feel and act; Hofstede et al., 2005).

Adaptation and innovation. The creeping crisis of environmental change requires adaptive measures and resilient performance, encompassing mitigation, adaptation, learning, and recovery skills (Nemeth & Hollnagel, 2022). Increasing demands for workplace learning and sustainability competence management may challenge worker well-being. Proactive, long-term support is essential for future-oriented well-being. (Collin et al., 2024). Innovativeness, the ability to think and act in new ways, is crucial. New thinking and action can be seen as something that is emergent but co-created in wide collaboration among a variety of actors and perspectives. (Sannino, 2010). Workplace innovation involves co-creational, participatory, and inclusive processes, becoming embedded as workplace practices. (EUWIN, 2024; Carayon, 2010). This emergent, co-created approach fosters collaboration among diverse actors and perspectives. Successful innovation reflects continued reflection, learning, and improvements in organisational understanding, leadership, employee management, work organisation, and deployment of new technologies. It involves building bridges between leadership knowledge, frontline employee knowledge, and system design expertise (Dul et al., 2012; Carayon, 2010).

Methods

Human factors as a systemic, solution-based approach

Humans are at the core of JGW across all system levels. Therefore, we explore JGW using a systemic approach from HF/E that aims to improve the safety, health, and efficiency of work systems, and recently also their sustainability (Richardson & Thatcher, 2024; Thatcher & Yeow, 2019). Extending the use of HF/E seems promising since the HF/E approach has already been shown to be useful in the design and development of work (Dul et al., 2012; Wilson, 2014). Applying HF/E has also shown promising results in helping organisations under crisis to move from mutual tensions to joint development of work and organizational structures (Teperi & Leppänen, 2011; for example, during a strike in aviation). Furthermore, when applied long-term and systematically, the use of the HF/E approach has helped to renew ways of action and thinking from mandatory elements in safety management systems in safety-critical industries to an improved and inherently emerging mindset for more human-oriented safety (Teperi et al., 2023).

We deem HF/E as a fundamental building block in JGW, as it is beneficial to redirect the attention of currently dominant technology, administration, and growth-oriented sustainability efforts towards a more human-centred, contextually aware, and competence- and development-focused approach. Prior research shows that applying a systemic, participative, and solution-based HF/E approach has helped workplaces to reshape their

mindset and innovate safety practices by improving the understanding of contextual factors behind every-day-operations (Teperi et al., 2015; 2017; 2023).

Despite the potential for innovative solutions that HF/E might offer for JGW, the science and practice of HF/E has not been extensively defined or practically applied in sustainability transitions (Thatcher et al., 2020; Richardson & Thatcher, 2024). As inherently systemic, HF/E offers an approach that recognises and elaborates on the systemic nature of sustainability challenges and sustainability competency in the world of work (SDGR, 2023).

In earlier research, the HF/E approach has shown to be a beneficial way to promote new thinking and practices, especially in safety-critical industries (Nemeth & Hollnagel, 2023). Safety thinking and practices have been improved by applying new, systemic, and human-oriented safety thinking (resilience) through the use of practical models and tools, such as the HF Tool (Teperi, 2012). The HF Tool has been implemented as part of real-world practices, including safety training, raising awareness, and incident reporting and analysis in organisations such as air traffic management, aviation maintenance, the nuclear industry, and rail transport (Teperi et al., 2015; 2017; 2023). Reforms in mandatory, technical-authoritarian legislation and guidelines have been necessary, as traditional safety practices have not adequately addressed the human-centric nature of performance, necessitating a rethinking of how to reduce incidents and injuries at work.

Earlier research has also shown that systemic thinking can promote sustainability (Ratinen et al., 2022) and that awareness and competencies are the focus of sustainability development (Ratinen & Linnanen, 2022). Furthermore, it is known, that the renewal of safety thinking (from technical and normative towards more systemic and human-oriented) develops in a step-wise-process that has time-based and spatial phases from raising awareness and improving competence towards renewal of safety and workplace practices (Teperi et al., 2023). Awareness and competence are the cornerstones without which the next development phases cannot evolve. Concrete actions for change are then needed. These pragmatic steps are the focus of this paper.

In this paper, we argue - aligning with earlier findings in safety research (Teperi et al., 2023) - that addressing sustainability transitions through the lens of HF/E can drive change. This process starts from strategic, organisational decision-making and progresses step by step throughout the workplace, enabling a solution-based and participative orientation to ensure commitment and motivation for true transformation towards JGW. By fostering transformative qualities among work organisations (including employees, supervisors, middle and top management, boards, safety and quality professionals, HR, and occupational health care services), they can accelerate their progress toward sustainable practices and outcomes.

HF Tool used for analyzing eco-usability observations

The steps for JGW do not evolve in a vacuum; rather, they need to be facilitated with a concrete model in workplaces, where the actual work is done. Therefore, in this study, we operationalise contributing factors for JGW by using an HF Tool (Teperi, 2012) to analyse findings of eco-usability observations conducted by two of the authors. The hybrid use of these two methods is described as follows.

The HF Tool provides holistic system coverage and addresses interactions among four system levels (inter- and intra-organisational, group, work, and individual levels), specifying items to describe each level in detail (for example, vigilance or well-being at the individual level; work atmosphere and communication at the group level; decision-making and use of resources at the organisational level). The HF Tool is used not only as a set of separate items but as a theoretical framework and practical tool to raise awareness, enhance understanding, and facilitate learning about the systemic reciprocal relations between and among the system levels and their practical representations (Teperi et al., 2023). A figure illustrating the HF Tool is presented (Figure 1).

The HF Tool aims to represent a new era in HF/E and OSH research (Teperi et al., 2023; Hamer et al., 2021) and has three main targets. Firstly, it fulfils the ideas of solution-based orientation and positive psychology (Seligman, 2011) to refocus scientific energy to understand and build factors that enable individuals and communities to flourish. This view is emergent in the new view of OSH research, recognising aspects that work well (Hollnagel, 2014) and seeing people as a presence of positive capacity (Dekker, 2016). Secondly, the HF Tool aims to represent a holistic, sociotechnical, and systemic approach to OSH, aligning Rasmussen's individual, work, group, and organisational levels of system safety (1997). Thirdly, the tool is used in a participative manner at all organisational levels, establishing the core idea of HF/E as art and practice (Wilson, 2014; Dul et al., 2012). The HF Tool has been designed and studied in safety-critical fields for the last 20 years. In practice, it has been used as a model in human-centred safety/OSH trainings, in incident investigation, risk assessments, and for incident reporting to analyse contributing and interrelating factors of sudden mishaps. The application of the HF Tool has already been studied and published in ATM (Teperi, 2012; Teperi et al., 2015), in the maritime industry (Teperi et al., 2017), and in the construction industry (Nykänen et al., 2020).

It is worth noticing that the HF Tool includes items that make the work 'just', i.e., to support health, safety, and well-being of the workplaces. It has not been earlier used for learning or analysing factors for green work. When using the HF Tool, it does not mean that all points presented in the model support JGW, but that the levels and items of the HF Tool may help to map contributing factors that can support and strengthen or weaken activities for a JGW. Figure 1.

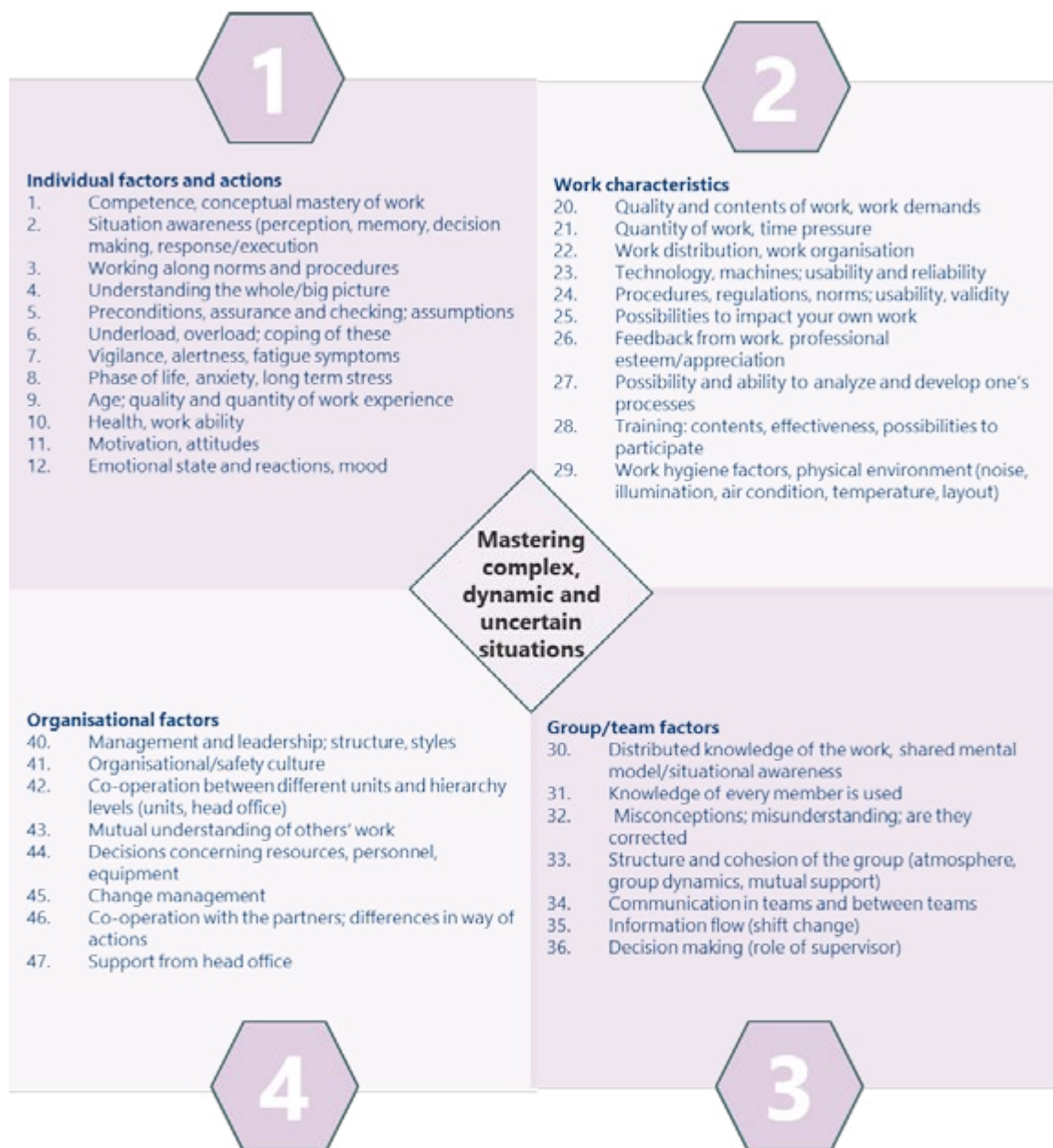


Figure 1. The HF Tool (Teperi, 2012)

To make the JGW more concrete and contextual, we conducted observations at two workplaces that represent different contexts, namely a school (public sector with an educational target), and a laundry (large private company with a wide client focus). During the observation of these workplaces, practical possibilities for workers to implement green actions were considered, and the special focus was on 'eco-usability' meaning the possibilities for the workers to work in a green way. The concept of eco-usability is a novel application, based on the framework of usability of buildings (e.g. Bittencourt et al., 2015). The method used in the observations in this study was an eco-usability walkthrough. Its' origin is in the usability walkthrough method that has been developed for assessing usability qualities of the

built and work environment (Babapour & Cobaleda Cordero 2022; Alexander 2006). It has been applied in the healthcare sector (Aalto et al., 2017; Haron et al., 2012) and in office buildings (Windlinger et al., 2016). In this study, we modified the basic usability framework to fit the aims of ecological sustainability and to support possibilities for 'greening the work'. Based on literature, we decided to use these five usability dimensions: safety, functionality, comfort, orientation, and interaction (Aalto et al, 2017). Using the environmental goals of the studied organisations, we added cross-cutting environmental sustainability zones (energy, water, recycling, logistics, and food choices) into the new framework that we called eco-usability. These environmental sustainability zones might vary with different organisations and sectors.

The method of an expert-driven eco-usability walkthrough included: an initial assessment of facilities and functions by experts, participatory eco-usability walkthrough in the facilities including recording and photographs, and visual summary and feedback based on observations, discussions, and special knowhow of the experts. Each observation round lasted two to three hours, during which two researchers walked through the facilities with study participants who were representatives from different user and occupational groups (e.g. management, facility maintenance, cleaning, employees). The number of study participants was five in both cases. At the end of the walkthrough, the study participants discussed their observations. Afterwards, researchers compiled a summary of the walkthrough results.

After two researchers (third and fourth author of this paper) had conducted the eco-usability observations, the collected data were discussed and reflected with the third researcher (the first author of this paper) who used HF/E approach as a perspective. Based on the discussions and aligning with the four levels of the HF Tool, the observation data were first classified into tables and split into findings concerning the individual, work, group, and organisational level actions for JGW (main rows, Table 1, Table 2). Furthermore, the tables were split to describe the starting point, currently applied actions at the school/laundry, experienced obstacles in JGW actions, and finally, the system-level solutions suggested by the researchers (four columns, Table 1, Table 2). Finally, the third researcher analysed each action for JGW (cells of the tables) by reflecting it through the lenses of the HF Tool items, using "+" and "-" marks to indicate which actions for JGW were regarded as positive, strengthening factors (+) or as negative, hindering factors (-) (Teperi, 2012).

After classifying the contributing factors of implementing JGW using the HF Tool, three researchers (two conducting the observations and one conducting the HF analysis) had discussions to evaluate the use and usefulness of the HF Tool in perceiving contributing factors and structures for JGW. These discussion findings are used to elaborate the results.

Results: Defining the characteristics of implementation for a just green workplace

Next, we aim to identify contributing factors that may facilitate and/or hinder the implementation of JGW, using the HF Tool. After this analysis, we will contemplate how the HF Tool works in analysing the contributing factors of just green work.

Factors facilitating or hindering the implementation of JGW

The school was selected as an example representing proactive measures for JGW, as they had already conducted greening activities (waste separation) when considering the impacts of climate change in their work.

Table 1. Case example: Waste separation at school; implemented actions, their obstacles and solutions (proactive measures for JGW)

Level I-IV	Starting point	Implemented actions at school	Obstacles	System-level solutions suggested by researchers (regarded as positive efforts)
Individual level				
	Motivated forerunners who want to recycle (+11)	Individuals led by example and encourage others so that everyone gets motivated to join the experiment in waste separation at work (+11, +26, +27)	Coping with the stress of daily work life and feelings of frustration (while others are not committed to recycling); how to stay motivated in the long run? (-8, -11, -12)	Directorate support, peer support for challenging emotions, joint experiment for waste separation, feedback loop between individuals, waste sorting system and support at the organisational level (+40, +25, +26, +23)
Work level				
	Lack of circular economy competence in the experiment team (-27, -28)	Developing competence for circular economy through multi-channel communication (+1, +34, +35)	Lack of circular economy competence in external operator's staff (-46)	Closer interaction and encounters between individuals from different occupational groups (+30, +31, +33)

	Non-functioning waste sorting facilities indoors (-23)	Waste repairation containers and instructions for separation at source indoors (+23)	Separated waste not transferred to waste station appropriately by external actors (-46)	Developing external actor's processes and equipment for waste logistics, closer interaction with external actor (+46)
	Poor winter maintenance of waste station surroundings creates slippery conditions outdoors (-29)	Quick fix: studded shoes for taking separated waste into the waste station in winter (+23)	Wearing the shoes harms the fluency of the work and does not fix the original challenge (-20, -22; core of the HF Tool)	Rebuilding waste station, agreement on maintenance measures (+44)
	Waste station does not support changing needs for waste separation (e.g. dimensioning of waste containers, ergonomics, lighting) (-29)	No actions implemented (not applicable item in the HF Tool)	Waste station does not support changing needs for waste separation (-29, -44)	Rebuilding waste station, agreement on maintenance measures (+40, +44, +45)
Group level				
	No systematic agreed approach for waste sorting in the classrooms (-30)	Waste sorting in some classrooms, waste sorting bags that are easy to transfer and easy to clean (+25, +29)	Lack of shared awareness and practices (-24, -30)	Systematic approach for labelling and colour coding of classroom waste bags for all classrooms (+23)
	No shared awareness how to act in the teacher breakroom regarding the waste sorting (-30, -35)	Shared awareness how to act in the teacher breakroom regarding the waste sorting (+30)	Shared awareness does not include all occupational groups or alternate staff (-30, -42, -43)	Orientation and engagement of all occupational individuals (+11) and groups and (+30, +40)
	No shared sustainability agency (no applicable HF Tool item)	Co-creation experiments as part of a project (+31, +32)	Lack of systematic agreed communication channels, practices and informal encounters between	Scheduled and regular (eco-usability) facilities walkthrough with representatives from different

			different occupational groups (-23, -24, -30, -33)	occupational groups; visual round-up from the walkthrough available to everyone (+43, +45)
Organisational level				
	Challenges in the communication with new external operator (-34, -46)	Giving corrective feedback to the cleaning company regarding problems with waste processes (+26, +27, -46)	Quality of cleaning operations does not support waste separation actions and the needs of the users of the premises (-46)	Re-examination of contract and quality criteria; regular interaction with all parties (+44, +45, +46)
	Organisational level actors who are motivated to drive greening of the school (+11, +40, +41)	Sustainable development strategy of the school is made (+40, +41, +44)	Lack of well-functioning channels of cooperation and development with key stakeholders (e.g. owners, waste management company, maintenance) (-27, -44, 46)	Social debate on local level; exploiting networks and social media; well-functioning channels of cooperation with key stakeholders (+44, +45)

The markings in the table (e.g., “motivated pioneers/forerunners who want to recycle (+11)” in the first cell of the Table 1. The text refers to the HF Tool items from 1 to 47 or to the core of the HF Tool and the +/- means whether the mentioned issue is a facilitating (+) and/or hindering (-) factor in the implementation of JGW. (see Figure 1 for details)

At the individual level, motivated individuals led by example and encouraged others to join the waste separation experiment at work. Coping with the stress of daily work life and feelings of frustration posed a challenge. Proposed solutions included directorate support, peer support for challenging emotions, joint waste separation experiments, and a feedback loop between individuals, waste sorting system, and support at the organisational level.

At the work level, challenges included a lack of circular economy competence, non-functioning waste sorting facilities indoors, and poor winter maintenance of waste station surroundings. Solutions proposed include developing competence for the circular economy through multi-channel communication, providing waste separation containers and instructions for separation at the source indoors, and implementing quick fixes such as studded shoes for taking separated waste into the waste station in winter. Additionally, rebuilding the waste station and reaching agreements on maintenance measures are suggested as solutions.

At the group level, challenges included the absence of a systematic agreed approach for waste sorting in the classrooms, lack of shared awareness and practices, and there was no shared sustainability agency. Proposed solutions included implementing a systematic approach for labelling and colour coding of classroom waste bags, creating shared awareness and practices for waste sorting in the teacher breakroom, and engaging in co-creation experiments. Scheduled and regular facilities walkthroughs with representatives from different occupational groups and the availability of a visual round-up from the walkthrough were suggested as corrective actions.

At the organisational level, challenges in communication with a new external operator, cleaning operations did not support waste separation actions and the needs of premises users, and lack of well-functioning channels of cooperation and development with key stakeholders were identified. Solutions suggested included giving corrective feedback to the cleaning company, re-examining contracts and quality criteria, creating a sustainable development strategy for the school, and engaging in social debate at the local level and exploiting networks and social media for establishing well-functioning channels of cooperation.

The laundry was selected as a next example to describe reactive measures for JGW because they had already faced challenges with heat conditions at work and had contacted external experts to help with the heat stress (changing thermal environment in a laundry). (Table 2)

Table 2. Case example: Adjusting to the changing thermal environment in a laundry; implemented actions, their obstacles and ways for solutions (reactive measures for JGW)

Level I-IV	Starting point	Implemented actions in a laundry	Obstacles	System level solutions suggested by researchers
Individual level				
	Excessive heat load (-7, -29)	Thermal breaks, individual fans (+23, +24)	No cool space available indoors for thermal breaks (-29)	Investment requirement to build a cool space (+44)
	Individuals spend their thermal breaks outdoors in the sun (-7)	Oral instructions in workstation meetings (+24)	Lack of understanding of the impacts of heat load on well-being at work (-41, -42, -43)	Orientation of employees, visual instructions at the workstations (+1, +3, +24, +28)
Work level				
	Thermal conditions	Thermal and air humidity level	No historical data or comprehensive	Systematic and comprehensive

	monitored in real time pointwise indoors (+2)	monitoring in two-week measurements twice (winter and summer) (no applicable item in the HF Tool)	monitoring of thermal and air humidity levels indoors (no applicable item in the HF Tool)	monitoring system of thermal and air humidity conditions, to produce work environment data (+30, +43). Need for policy and management (+44)
	Individuals spend their thermal breaks outdoors in the sun (-2, -7)	Initial plans by employees to create a cool and shady break area outdoors (+1, +2, +11, +25, +27)	Purchasing decision processes do not support this kind of employee initiatives (-40, -41, -44)	Need for organisation level solutions to enable employee agency (+40, +44, +45)
Group level				
	No group for climate change co-creation (-25, -27)	Forming a new group with representatives from different levels of organisation to deal with climate related issues and ideas (+25, +27)	Group does not have comprehensive representation (e.g. property maintenance). Status of the group not established in the organisation (-31, -36, 43)	Need for organisation level solutions, support from top management and linking to company strategy (+40, +41, +42, +44, +45, +47)
	The new group does not have agreed policies (-24)	Agreement on basic group policies that support group's agency (e.g. frequency and implementation of meetings) (-24, -44)	Lack of group's visibility and poor flow of information within the company (-35, -43)	Support from all levels of management (also top management), Updating internal communication policies and practices (+24, +40, +41, +42)
Organisational level				
	Operating environment in constant change (e.g. increase in production, energy saving targets) that	Reacting to and solving single situations and changes (e.g. production machinery renewal, window foils) (-27, -45)	Needs for too costly investment to renew and optimise the whole ventilation system Need for changes in production facilities to adjust	Re-investments in production property (+44, +45)

	effect thermal conditions (core of the HF Tool; -45)		to increase in production (-44, -45)	
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The markings in the table (e.g., "Individuals spend their thermal breaks outdoors in the sun (-7)" in the first cell of Table 2. The text refers to the HF Tool items from 1 to 47 or the core of the HF Tool. The +/- means whether the mentioned issue is a facilitating (+) and/or hindering (-) factor in the implementation of JGW. (see Figure 1 for details)

At the individual level, the excessive heat load was addressed with the implementation of thermal breaks and individual fans, but a lack of cool indoor space for the breaks posed an obstacle, which necessitated an investment in building a cool space. Additional challenges included individuals spending their thermal breaks outdoors in the sun, leading to an orientation of employees and visual instructions at the workstations as a potential solution.

At the work level, the monitoring of thermal conditions in real time indoors was implemented, but there was a lack of historical data or comprehensive monitoring of thermal and air humidity levels indoors. This obstacle called for a systematic and comprehensive monitoring system of thermal and air humidity conditions to produce work environment data, as well as the need for policy and management. There was also an obstacle related to the lack of support for employee initiatives, highlighting the need for organisational level solutions to enable employee agency.

At the group level, challenges included the absence of a group for climate change co-creation, lack of comprehensive representation in the newly formed group, and the absence of agreed policies. To address these issues, there was a need for organisation-level solutions, support from top management, and the establishment of basic group policies that support the group's agency.

Finally, at the organisational level, the operating environment was in constant change which had implications for thermal conditions, necessitating reactive measures and solutions. The need for costly investment to renew and optimise the whole ventilation system and to make changes in production facilities to adjust to an increase in production reflected the need for re-investments in production property.

The analysis of the eco-usability observations with the HF Tool showed that the currently conducted actions may be limited to the individual, work, and group levels. However, the final steps needed for successful implementation of JGW are mainly at the organisational level. For example, this includes building a strategy for JGW and establishing physical facilities and equipment for successful actions in green work, as well as collaborative learning and shared knowledge and awareness of the suggested actions for JGW such as recycling and coping with heat stress.

Evaluation of the HF Tool in analyzing contributing factors of just greening of work

The benefits of using the HF Tool were evident in identifying several key points, particularly the essential role of organisational factors, in implementing JGW. The HF Tool facilitated the mapping of a comprehensive view of contributing factors for the greening of work, enabling the perception and recognition of potential obstacles in future implementation of JGW actions. Additionally, the tool assisted in forming a mental model for JGW actions, understanding weak signals in the system that require short- and long-term actions, and visualising items to be addressed.

Several lessons were learned regarding missing items such as "no actions have been implemented," "no shared sustainability agency," or "weak relation to co-creation experiments" which would be valuable additions to the HF Tool. To better address social sustainability, OSH practices could be added to item 47, which currently only mentions HR and financial practices, to define all the relevant roles in actions for JGW. Additionally, physiological symptoms could be better described at the individual level as a new item, for example, number 13, to consider symptoms such as heat stress.

Currently, the HF Tool has only been used and applied in one organisation at a time and has not been tested in intra-organisational development processes in the context of JGW. Additionally, the original use of the HF Tool has been focused on safety-critical incidents, while sustainability transitions involve long-term processes with several slow changes in the functional environment. It may be beneficial to reformulate the core of the HF Tool ('mastering complex, dynamic, uncertain situations') to include "processes". Process orientation would help to direct attention both to short-term efficiency and long-term societal effectiveness. For example, there is potential to emphasise two aspects: resource efficiency (whether the workplace is using resources efficiently and reducing waste) and resource effectiveness (whether the workplace is using resources effectively to create value, e.g., in industrial ecology or to support the ongoing replenishment of resources).

In future, the HF Tool could be used not only in perceiving the current view, but also as a commitment tool for group discussions at work, for analysing 'just green' incidents or occurrences at work (e.g. which have been the obstacles, reasons and solutions for frustration), or following up the accurateness of solutions, or following up trends, motivating personnel and management for just greening of work. It could also serve as a proactive tool for planning JGW actions and revealing bottom-up ideas, ensuring joint commitment in implementing JGW actions at any workplace. Using specific indicators could help workplaces to proactively build a greener workplace. It would be worth testing whether the HF Tool helps to form these kinds of measurable indicators. The HF Tool could also be used to help workplaces to realise the accuracy of their green actions, which are the strengths and weaknesses of the system currently, and which are the ways forward. In this case, it does not

need to always be conducted as a walkthrough, as these inspections or collaborative audits could be incorporated as interviews or focus groups.

An interesting point is, who holds the “voice” of the environment in these engagements and data-gathering; is it employees, experts or managers? Or all these together? Using the HF Tool as a part of JGW activities probably serves as an intervention, as it forces the joint discussion and shared view for actions by several partners such as employees, management, HR, OHS representatives and OSH managers. Nevertheless, people with expertise in environmental issues may be necessary to include in the audit and solution processes.

Obviously, there can be obstacles to implementing the HF Tool, or any other tool, for JGW. Earlier barriers and hindrances have been found in aviation in the 2000's in Finland when old culture and structures hindered the fluent renewal of the culture; however, an organisational crisis with implementing new awareness, competence and tools and models helped to advance the organisational culture aspects. (Teperi 2012). This could probably be the case in those workplaces which are struggling with tensions and conflicts in fostering JGW.

Greening of work is like any other development action that just needs attention to human performance and their contextual factors: Do we help people to be green at workplaces, or are there too many obstacles? Do workplaces have enough stamina to continue, after encountering obstacles? Who leads the movement from actions - failed actions - obstacles – to solutions? Based on our findings, the HF/E approach is needed, to enable a a) holistic view, understanding systemic relations; b) solution-based, positive energy to proceed; and c) collaboration between several partners.

The most critical phase of the change is how to turn information from the HF Tool into an action plan for the organisation? After mapping the contributing factors of JGW the next steps need be building development phases in a systematic way. Aligning earlier study findings, successful implementation forms a spatially and temporally expanding performance that includes phases of raising awareness, building competence, developing and implementing sustainability practices to work and OSH practices and procedures, and fostering interorganisational collaboration (aligning Teperi et al., 2021; Teperi et al., 2023). It could be considered whether these phases could be similar when just greening the workplace. The HF Tool has earlier been found to be successful in facilitating these phases in the long term (follow up concerning 5 and 20 years of the use of the tool; Teperi et al., 2023). In this study we found that it could help in raising awareness and maybe it could work as a tool for sustainability competence, but further studies could show whether it has added value in implementing JGW, to instill them into the every-day-operations at work, as has been done earlier in ATM and railway (Teperi, 2012; Teperi et al 2023).

Discussion

In this paper, we aimed to define characteristics for implementing JGW. Workplaces pose a critical local linkage through which the globally targeted sustainability transformation can be applied (Rockström et al., 2023; SDGR, 2023). Each workplace needs to contribute by including environmental measures as core factors for just work. Thus, workplaces need frameworks, models and tools to map systemic, underlying factors of just green work to develop concrete steps for change. Our results indicate that linkage between green and just are reciprocal: greening of work (environmental sustainability) is not possible without social sustainability, ensuring that the workers are looked after, for example by including occupational health and safety. (EU-OSHA, 2023). Similarly, in the long term, just work is not possible without green actions ensuring sustained use of natural resources.

In this study, the HF Tool was used to uncover the facilitating and hindering factors for JGW, and to operationalise the potential of the HF/E approach in just greening of work. The facilitating factors were at individual, work, and group levels such as motivation and willingness to act on personnel and practical actions for recycling and managing the thermal conditions. The hindering factors of the JGW were how the systemic nature and concrete, interrelated levels and details of change could be identified at the selected workplaces. The applicable solutions may be produced only in such a way that workers themselves can be agents of the change as found earlier in work development research (Sannino, 2020).

As with any organisational change, the most crucial actions are from those at top and middle management level who determine whether socially and environmentally sustainable actions are supported in every-day-operations through joint commitment, to help workers to succeed in realising JGW in their daily actions (Schein, 2010; Flin, 2003). The other criteria for JGW – besides raising awareness and competence management – are instilling just and green practices into the every-day-operations of the workplace as well as to commit all organisational actors (including HR, OSH and other organisational structures) to form networks for solid and systematic implementation (Teperi et al., 2023)

There is a strong tradition in the Nordic countries for participatory approaches and for prevention when aiming to improve employee health, safety and well-being. Organisations typically struggle with designing and implementing such interventions (Waterson & Kolose, 2010; Teperi, 2012). Questions arise about how workplaces succeed in implementing actions for JGW, to improve work, human, and system performance through changing the way work is organised, designed and managed and how the value of these actions for the sustainable impact is evaluated. Skills and knowledge for how to develop, implement and evaluate interventions for JGW will be crucial in the future.

The transferability and applicability of these findings to the broader international context is still an open question. A lot depends on the ecological awareness of the workforce and management. In situations where they are mostly concerned about decent pay and decent

work conditions the “green” aspects of the work and workplace may get missed, unless they are introduced by the dedicated expert such as an HF/E practitioner or the people conducting the sustainability walkthrough. Also marginalised or exploited workers/groups (e.g., immigrants, indigenous groups) who don't always have full legal protection will be in vulnerable positions that need to be considered.

The innovativeness of our paper is in presenting the theoretical and practical potential of HF/E as one approach for sustainability science. Both sustainability science and HF/E hold a systemic view, are multi-disciplinary sciences, and encourage theory-to-practice as key principles (Wilson, 2014; Dul et al., 2012). The potential is already recognised (Richardson & Thatcher, 2024), but the connections have only recently been made. We see that HF/E findings presented in this paper may give practical value for bridging sustainability theory to enable JGW. The examples presented in this paper aim to represent a systematic approach to guide workplaces in setting proactive practices in a collaborative, systemic, and solution-focused way. Similarly, workplace innovation processes seek to engage all stakeholders in dialogue, by empowering high involvement practices and representative partnership structures at all levels of the organisation. (EUWIN, 2014)

When supporting or pushing employers and employees in the right direction, several stakeholders including trade unions (Stavis & Felli, 2015), authorities, clients and consumers have a role to play in actions for JGW. All these may have different power status, and interpretations and strategies in fostering JGW. This article focused on the application of the HF Tool in a single workplace at a time, but as is known, activities for a just green transition are systemic by nature (SDGR, 2023). To realize a just green transition in workplaces, comprehensive, systematic, and long-term intra- and inter-organizational development processes need to be conducted, as also found in safety research (Teperi et al., 2023; Waterson & Kolose, 2010). Thus, in the future, the use of the HF Tool could be expanded to map and facilitate intra- and inter-organizational processes, such as sharing awareness, best practices, and learning strategies among actors such as management, HR and safety and quality experts. Furthermore, the HF Tool could be used to improve communication within supply chains for just greening activities, if used by a dedicated expert who has competence in organizational development techniques and just greening activities at work.

Resilient performance of organisations is argued to be crucial (Nemeth & Hollnagel, 2022; Lyttimäki et al., 2023). Aligning this view, in addition to new understanding, employees and workplaces will be required to produce new kinds of capabilities and resilience (Nemeth & Hollnagel, 2022) in accordance with the requirements of the changing operating environment. It should be noted that not all kinds of resilience are desirable. In the future, activities, business, and lifestyles that are unsustainable for people and the environment must be reduced or eliminated. Several industries produce outcomes that are clearly against green transition (e.g. fossil fuel industry) (Lyttimäki et al., 2023). Unfettered economic growth is perhaps one of these unsustainable activities as has already been argued (Meadows et al., 1972; Meadows & Randers, 2012).

Sustainability competencies can be utilized for HF/E in JGW (Ratinen and Linnanen, 2022; Ratinen et al., 2023). Integrating these competencies into organisational practices and culture can help create workplaces that not only prioritise social and environmental justice but also foster collaboration, innovation, and resilience in the face of complex challenges. For example, systems thinking involves understanding the interconnectedness of various elements within a system and their dynamic interactions. Future-thinking involves anticipating and planning for future scenarios, trends, and uncertainties. In JGWs, workers as future-thinkers can help organisations envision and work towards more equitable and sustainable futures by reflecting on and aligning actions with core values such as equity, justice, and sustainability. Collaboration competence involves effectively working with others to achieve common goals. Workers in JGWs, are capable of addressing complex social and environmental challenges that require collective action. Action-oriented competence involves taking proactive steps to implement solutions and drive positive change. Action-oriented competence is crucial for translating values and aspirations into concrete actions and outcomes for making workplaces just and green (Ratinen et al., 2023).

As this study has presented only two cases, we offer some reflections on the broader learning derived from the study. HF/E could play a role in addressing greenwashing risks by providing guidance on implementing authentic JGW initiatives. The risks of different forms of greenwashing (Gatti et al. 2019; Todaro & Torelli 2024) need to be considered already when actions for JGW are planned. Basic starting points include full compliance with existing legislative frameworks and transparent and honest internal and external communication. Furthermore, willingness to implement real changes is needed, even when there are short-term commercial interests, technological difficulties, requirements for learning and unlearning, time pressures, and other factors that may limit acceptance of transitions to greener work. An important question of acceptance – falling outside of the focus of this study and our case study examples – is how to phase out unsustainable work or polluting jobs while facilitating just transitions for the workers involved in this work (Rosenbloom et al., 2020).

HF/E has long and systematically developed thinking and actions to enhance a just and fair culture at work by focusing on organizational factors and social processes (Waterson & Kolose, 2010; Dekker, 2016; Thatcher et al., 2018, 2020; Teperi et al., 2023). These HF/E principles could offer user-friendly tools for improving transparency and communication in workplaces, as well as enhancing accountability through better monitoring and reporting systems. Such systems have been found crucial for improving safety culture (Dekker, 2016). By making information about environmental practices clear and accessible, companies can accurately track, report and verify their environmental impact, thereby informing and educating both employees and customers and stakeholders in a trustworthy manner. Organisations are striving to achieve compatibility among multiple corporate responsibilities in their interactions with the environment and society. Merely reacting passively to external pressures does not integrate environmental and social responsibilities into the corporate

governance process, thereby creating a risk of widening gap between symbolic and substantial actions (Liu et al., 2023). HF/E could support the realisation of genuine actions more proactively and in a systemic, solution-based manner, which has been previously found beneficial in safety research (Teperi et al., 2023)

Conclusion

The current period presents a critical juncture for action, with workplaces serving as focal points for implementing globally required actions. However, the systemic view of practical actions has often been weak or narrowly focused on isolated short-term actions, posing risks to the relevance and efficiency of necessary measures. This paper demonstrated the application of HF/E through the operationalisation of an HF Tool, which was instrumental in identifying the contributing factors of JGW actions, particularly emphasising the significance of organisational factors, including management commitment and competence, in fostering collaborative, solution-based activities for JGW. While general level sustainability policies are important, the emphasis must be on enacting practical actions in workplaces. This paper highlights the need to consider what it takes to create a just and green workplace, showcasing how a systemic view, such as a collaborative, solution-based HF/E approach, can provide avenues for advancing procedures and practices for JGW.

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