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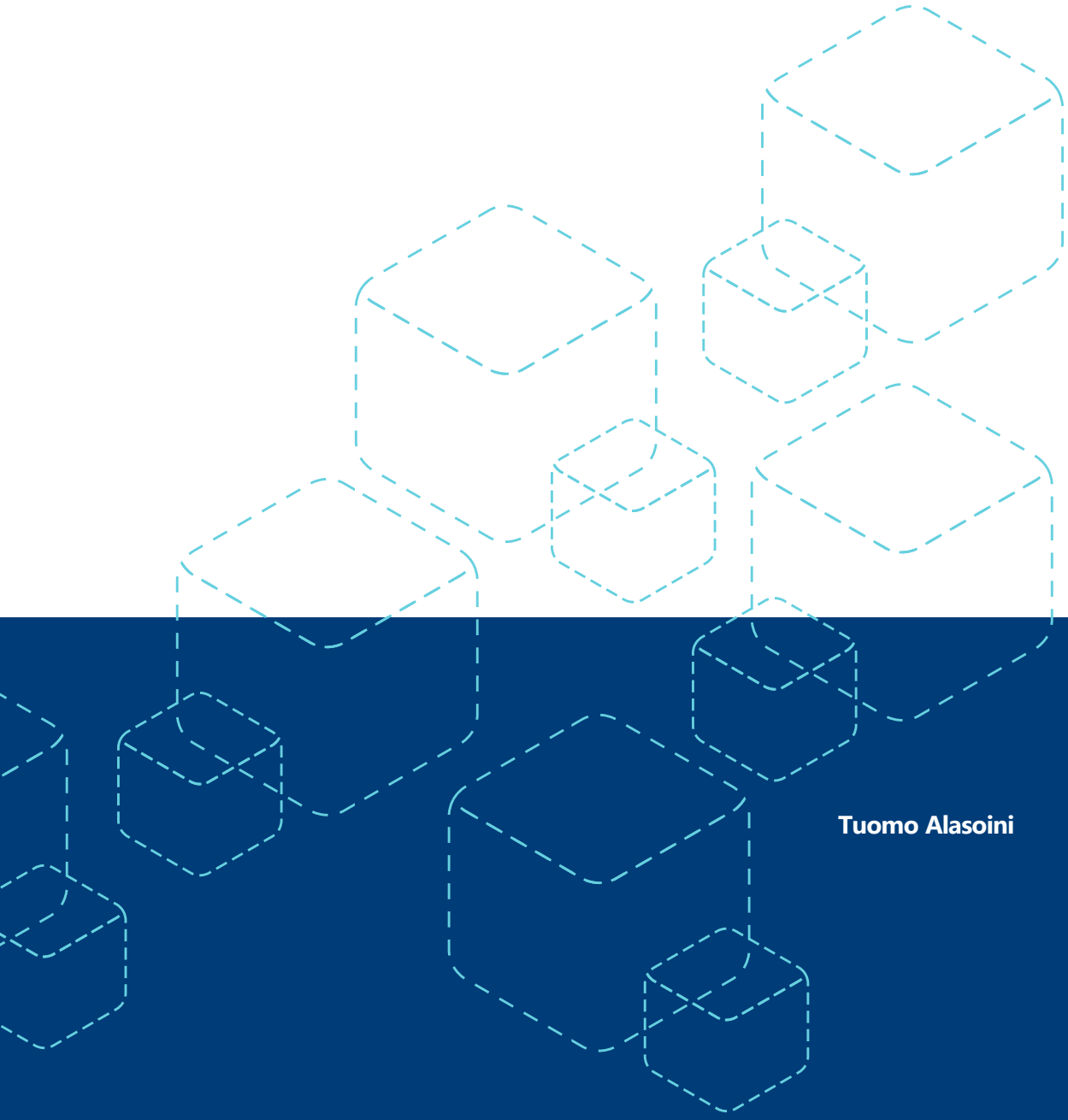
Twin Transition as a Transformer of Work and an Opportunity for Development



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Tiivistelmä

Julkaisu tarkastelee, kuinka digitalisaatio ja vihreä siirtymä integroituvat työelämässä toisiinsa digivihreäksi siirtymäksi, ja millaisia yhteisvaikutuksia digivihreällä siirtymällä voi olla työelämässä. Digivihreä siirtymä mielletään kokonaisvaltaiseksi sosiotekniseksi muutokseksi, joka avaa mahdollisuuksia työn ja työelämän laadun kehittämiseksi. Kirjoitus esittää myös erilaisia tapoja, joilla työelämän tutkimus voi asemoida itsensä siirtymässä ja olla muutoksessa osallisena.

Julkaisu tuo esiin digivihreän siirtymän mahdollisuuksien lisäksi myös sitä koskevia jännitteitä ja ristiriitaisuuksia. Näitä syntyy yhtäältä siitä, että siirtymä koskee suurta joukkoa toimijoita, joilla voi olla keskenään risteäviä, erilaisia ja erisuuntaisia tavoitteita ja intressejä. Toisaalta myös itse digitaalisen tietotekniikan kehityksen suhde vihreään siirtymään on jännitteinen ja ristiriitainen. Samalla, kun tekoälyn ja muiden teknologioiden avulla on mahdollista edistää vihreää siirtymää, voi teknologisella kehityksellä olla merkittäviä energian ja luonnonvarojen kulutusta lisääviä sivuvaikutuksia.

Digivihreän siirtymän kokonaistaloudelliset vaikutukset työllisyyteen ovat ennusteiden mukaan maltillisia ja pikemminkin positiivisia kuin negatiivisia. Työllisyyttä lisäävät ja vähentävät vaikutukset voivat kuitenkin kohdistua eri toimialoille, eri alueille, eri ammatteihin ja eri organisaatioihin hyvin eri tavoin. Digivihreä siirtymä todennäköisesti vauhdittaa edelleen jo pitkään jatkunutta asiantuntija-ammattien kysynnän kasvua. Digivihreän siirtymän edellyttämät infrastruktuuri-investoinnit voivat myös lisätä työvoiman kysyntää teollisuudessa, rakentamisessa ja erilaisessa huoltotoiminnassa.

Digivihreässä siirtymässä ei ole kyse vain ekologisen kestävyyden vahvistamisesta uusia teknologisia mahdollisuuksia hyödyntämällä, vaan siihen kytkeytyy myös tärkeä sosiaalinen ulottuvuus. Sosiaalinen ulottuvuus koskee erityisesti sitä, kuinka eri sidosryhmät kykenevät osallistumaan siirtymän toteuttamiseen ja kuinka oikeudenmukaisina siirtymän vaikutukset työelämässä ja yhteiskunnassa koetaan. Julkaisussa tuodaan esiin työelämän tutkimuksen teemoja, joilla tutkimus voi omalta osaltaan edistää digivihreän siirtymän toteutumista myös sosiaalisesti kestävällä tavalla.

Abstract

This paper examines how the digital transition and the green transition together constitute a twin transition, and looks at the potential effects of this twin transition on working life. The twin transition is considered a comprehensive socio-technical change, which brings opportunities to develop the quality of work and working life. The paper also presents various ways in which working life research can increase our understanding of the transition and contribute to it.

Besides opportunities, the paper also highlights tensions and contradictions regarding the twin transition. These arise, on the one hand, from the fact that the transition concerns a large group of actors who may have intersecting, different and divergent goals and interests. On the other hand, the relationship between the development of digital information technology and the green transition is also tense and contradictory. While it is possible to promote the green transition with the help of artificial intelligence and other technologies, technological development can have significant side effects that increase the consumption of energy and natural resources.

According to forecasts, the overall effects of the twin transition on employment at the level of the national economy are expected to be moderate, and rather more positive than negative. However, the positive and negative effects on employment can impact different industries, different regions, different occupations and different organizations in very different ways. The twin transition will probably further accelerate the ever-increasing growth in demand for professionals. The infrastructure investments required by the transition will likely also increase the demand for labour especially in manufacturing, construction and various maintenance activities.

The twin transition is not only about strengthening ecological sustainability by utilizing new technological possibilities, but also involves an important social dimension. The social dimension particularly concerns different stakeholder groups' opportunities to participate in the transition and how just the effects of the transition are perceived to be in working life and in society at large. The paper highlights the themes of working life research, with an additional focus on how research can contribute to the implementation of the twin transition in a socially sustainable way.

Foreword and thanks

This publication is a study commissioned through the Finnish Institute of Occupational Health's research project "Understanding and supporting the twin transition as part of well-being at work". This project produces information and increases understanding of the opportunities, challenges and impacts of the twin transition on work and employment. Funding for the project was graciously received from the Finnish Institute of Occupational Health, to whom I extend my deepest thanks.

I would also like to thank everyone who commented on the manuscript or otherwise supported the completion of the work at different stages of the writing process. Within the Finnish Institute of Occupational Health, I would particularly like to thank Arja Ala-Laurinaho, Päivi Husman, Jere Immonen, Fanni Moilanen, Sara Malve-Ahlroth, Vaula Siltala and Jarno Turunen. I would also extend an additional thank you to Vaula for the layout of the publication.

Responsibility for the final content of the report lies, however, solely with the undersigned.

Helsinki, October 2024

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1 Introduction

This report examines the twin transition as a transformation of work and an opportunity for its development. The report's starting point is the view that, in the future, the two major drivers of change in work – digitalisation and the green transition – will overlap more closely both at the industry and the organisation level. As drivers of change, digitalisation and the green transition not only shape current ways of working, but also enable and create new ways of thinking and acting. In this sense, it would be right to talk about the simultaneous *transformation* of work and the *opportunity of its development* linked to the twin transition.

It is possible to observe the twin transition as a comprehensive sociotechnical change in the ways of work. It may apply to both the ways in which work is managed and organised, and the ways in which employee competence is developed, how employee health, safety and well-being are ensured, as well as how the terms of employment are settled. However, the impacts of the twin transition on, for example, the organisation of work, the contents of work tasks, competence requirements or working conditions are difficult to predict due to the diversity of factors that affect the transition. They largely depend on the visions that guide the changes – i.e. digitalisation, the green transition, and the way in which they are integrated – as well as the competence utilised to implement the changes, not to mention the group of actors involved in and affecting the changes and their role therein.

There have been extensive studies on the impacts of digitalisation on work and employment in recent years. Interest in the impacts of the green transition on work and employment is also rising. The twin transition is instead a new matter from a research perspective, and existing literature on it, especially from the perspective of work and employment, remains limited. Thus, this report responds to this shortcoming by going through the existing discourse, by highlighting the opportunities and challenges of the twin transition and by analysing possible development paths and their requirements.

Before a more detailed examination of the content of the green and digital transitions and the twin transition that integrates them, this report will elaborate on the content of the term *transition* itself. In research literature on sustainability transitions, the term, transition, has referred to fundamental changes in society's key systems, such as the energy, transport or food production system, that take several years or even decades to be realised (Geels & Schot 2007; Markard et al. 2012). However, systems on this level are not typical targets for working life research, in which the analysis units typically include work organisations, work communities and individuals. The starting point of the report is that individual work organisations can also implement their own (micro-level)

transitions as part of larger system-level (macro-level) transitions or sometimes, independently thereof. In work organisation-level transitions, the timelines may be considerably shorter than in system-level transitions.

This report is part of a research project carried out by the Finnish Institute of Occupational Health in 2024–26, entitled *Understanding and supporting the twin transition as part of well-being at work*. The aim of this project is to produce information and further the understanding of the opportunities, challenges and impacts of the twin transition for use in political decision-making, large-scale development programmes and development work by work organisations, and also to make the information available to a wider audience. As parallel publications of this report, the project will produce publications with key themes on green work and the quality of working life, as well as the opportunities and impacts of generative artificial intelligence, especially from the perspective of the green transition.

This report is structured in a way that in *chapter 2*, I review the key concepts of the green transition, the digital transition and the twin transition that integrates them. With regard to the twin transition, I provide a more detailed examination of the promises, tensions and contradictions therein.

In *chapter 3*, I discuss the twin transition in the context of work and employment, such as its targeting, anticipated impacts and examples of its practical manifestations. In the theoretical part of the chapter, I make use of the discussion on sustainability transitions and the research carried out thereof.

In *chapter 4*, I discuss the opportunities, roles and development challenges of working life research in the twin transition. As examples, I highlight some themes related to working life research that are linked to the transition.

In *chapter 5*, I examine the promotion of the twin transition as part of socio-political decision-making. The chapter highlights the nature of the twin transition as a systemic, long-term and policy-driven change and examines the challenges arising thereof.

Chapter 6 contains the summary and conclusions.

2 Green transition, digital transition, and their relationship

2.1 Green transition: the concept

Over the past decades, economic growth in developed countries has been based on the overconsumption of natural resources. Among other things, this has served to accelerate global warming and led to the loss of natural resources and biodiversity. As a political solution to the risks and issues caused by the overconsumption of natural resources, we have started to talk about the green transition. Slightly different definitions exist for this term. According to the Ministry of the Environment of Finland, "The green transition towards an ecologically sustainable economy /…/ leans on low-carbon solutions that promote biodiversity and on the sustainable use of natural resources".[1]

Finland has set halting biodiversity loss by 2030 and achieving carbon neutrality by 2035 as its policy objectives. Carbon neutrality means that no more carbon dioxide emissions are produced than what is possible to capture from the atmosphere into carbon sinks. The most significant carbon sinks are seas and forests.

The objective of halting the loss of biodiversity and reversing this development back onto the path to recovery is based on the national biodiversity strategy, which was completed in 2024. The carbon neutrality objective is part of the Climate Act (423/2022)[2], which was enacted in 2022. The Act sets the greenhouse gas emission reduction targets as 60 per cent by 2030, 80 per cent by 2040 and 90 per cent, aiming for 95 per cent, by 2050, compared to 1990 levels. Finland's national political objectives reflect UN conventions and obligations arising from EU regulation. For example, the European Climate Law, enacted by the EU in 2021, aims for EU-level climate neutrality by 2050. One milestone is to achieve a 55 per cent reduction in greenhouse gas emissions by 2030 compared to 1990 levels (Fit for 55 policy package).[3]

[1] https://ym.fi/en/what-is-the-green-transition (accessed on 11 March 2024)
[2] https://www.finlex.fi/fi/laki/alkup/2022/20220423 (accessed on 11 March 2024)
[3] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal/fit-55-delivering-proposals_en (accessed on 11 March 2024)

There are also many ways that the green transition will influence work and employment. The green transition manifests as ways in which work organisations aim to a) directly *mitigate* global warming, overconsumption of natural resources and loss of nature, or b) otherwise *adapt* to the requirements of ecologically sustainable economy and growth. In a work context, the change applies to products and services as well as operating processes, working methods and working environments. In this way, the change will also have a spillover effect on the occupational structure, work content, competence requirements, occupational safety and health, and terms of employment. Among other things, the change manifests itself in the increasing efficiency around the use of energy, raw materials and other resources, carbon-neutrality of operations, as well as the recyclability of products, components and materials.

Global warming and the loss of natural resources can be thought of as 'wicked problems'.[4] What makes them particularly 'wicked' is their complexity (diversity of the interactive relationships involved), dynamism (their constantly changing nature), uniqueness (historical specificity) and high risk (potentially fatal effect on nature and humanity if left unresolved). There are no simple and clean solutions to these problems.

It is also not a given that humankind even has an understanding and ability to solve these problems in a sustainable manner with its *current* knowledge, competence or other available resources. This observation has led to the need to boost investments in research, development and innovation, the focus of which is on new technological solutions, such as the development of digital information technology – artificial intelligence in particular – and on the impacts of climate change on nature, people and society. In this way, efforts have been made to expand and deepen people's understanding of different phenomena and to find new solutions to the challenges related to them.

2.2 Digital transition: the concept

The *digital transition* can be defined as the comprehensive integration of digital information technology into everyday activities. In recent years, literature related to the digital transition typically mentions technological change factors like the mobile internet, cloud technology, the Internet of Things, robots, autonomous transport, big data, artificial intelligence (AI), machine learning, augmented and virtual reality, digital platforms, 3D printing and blockchain technology, which is utilised, among other

[4] https://en.wikipedia.org/wiki/Wicked_problem (accessed on 11 March 2024)

things, in the development of cryptocurrencies. In work contexts, the digital transition has manifested in, for example, task automation, the increasing transformation of physical objects and documents into bits, the increasing number of 'smart' machines and equipment, and the spread of algorithm-based guidance. (Eurofound 2020; World Economic Forum 2016.)

The digital transition affects work and employment in many ways, just like the green transition. The discourse around the digital transition contains both great hopes and concerns. The hopes focus particularly on the qualitative development of the work content, the replacement of physically or mentally detrimental tasks with technology, newly emerging occupations, and the additional employment and well-being created through accelerated growth in productivity. Concerns, on the other hand, focus in particular on the loss of jobs, fragmentation of work and forms of employment, loss of meaning in work, the increasing polarisation and inequality of working life and society as a whole, and the growing fears of universal technological surveillance enabled by the growing digital footprint of human activities. (Alasoini et al. 2020.) Some of the more far-flung futuristic visions include horrors about the qualitative change in relationship between humans and machines. For instance, the hypothesis of the technological singularity suggests that technological developments could accelerate at some point to be so fast and uncontrollable that their consequences become completely unpredictable and irreversible for humans.[5]

Digitalisation is advancing on a broad front. It is expected to contribute to the development of work and society as a whole in the future, both as a wide range of new, radical technologies and as a wide range of new combinations of existing technologies (Linturi & Kuusi 2018). In the 2020s, the discourse on the impacts of the digital transition on society and work has been dominated by the recent and anticipated development of artificial intelligence. Many researchers consider artificial intelligence to be a general-purpose technology that may have long-term impacts on different industries and society as a whole, similar to, for example, the steam engine, electrification, the combustion engine or computerisation in and of itself (Elondou et al. 2023; Lane & Martin 2021).

For a long time, the spread of the use of AI was based on the rapid development of 'predictive AI' applications. Predictive AI refers to systems that are able to produce predictions based on the data entered into them, while possibly making decisions and learning in accordance with certain rules that govern the system (Agrawal et al. 2018).

[5] https://en.wikipedia.org/wiki/Technological_singularity (accessed 15 March 2024)

In the early 2020s, large language models and the generative AI applications based on them, such as ChatGPT, have been an important new stage in the development of artificial intelligence. Generative AI has been characterised as a step forward from 'weak AI', where the applications can only perform predetermined and often relatively narrow tasks based on its programming logic, towards 'strong AI'. Generative AI is also capable of producing new and human-like outputs and is not limited to describing or interpreting existing information. The concept of 'generative' itself refers precisely to this property of artificial intelligence. Joseph Briggs and Devesh Kodnani, economists at Goldman Sachs Investment Bank, suggested in 2023 that the ease of use of generative AI is an important new quality feature in itself, which can lower the barriers to human-machine communication and thus significantly accelerate the spread of AI use at work. At the same time, the ability of generative artificial intelligence to produce new and human-like outputs and its anticipated rapid development make it difficult to assess all its potential applications and impacts in the next few years at this stage.

2.3 Twin transition: promises, tensions and contradictions

Recognising global warming and resource depletion as 'wicked problems' has boosted interest in finding solutions from emerging technologies, such as digital information technologies, to promote the green transition. Alongside the green transition, discourse around a digital, green, twin transition is beginning (Muench et al. 2022; Müller et al. 2024; Ortega-Gras et al. 2021). In a work context, the twin transition refers to the implementation of the green transition by making use of the opportunities of digital information technology in the development of products, services, operating processes, working methods and working environments. Linking the development of digitalisation to the promotion of sustainability targets in line with the green transition introduces a new important dimension to digitalisation, directionality. This is a concept that has been used in innovation policy studies to refer to the fact that sustainability goals or possible non-economic goals (social, etc.) strategically guide innovation policy decision-making (Mazzucato 2021; Schot & Steinmueller 2018; Weber & Rohracher 2012). Using new digital solutions – such as increased computing power, advanced machine learning algorithms, data analytics, the Internet of Things, augmented and virtual reality applications or continuously growing data sources – enable us to promote operating methods that support the green transition. Examples of this include:

- measuring, monitoring and evaluating the ecological sustainability of activities and processes and identifying new solutions
- measuring, monitoring and evaluating the functionality of products and services

- monitoring and predicting process deviations, disruptions and faults
- monitoring and optimising the energy and resource efficiency of facilities
- monitoring and predicting demand for products and services
- virtualisation of products and services and their production methods
- introducing new types of virtual information and communication methods
- comprehensive analysis and optimisation of complex systems (see chapter 3.3 for more details).

It is possible to approach the role of technological solutions as part of the green transition from perspectives that differ in principle. Technological solutions can be viewed in relation to the green transition as compensatory, reinforcing or subordinate:

- a *compensatory* relationship is in question if the technological solutions are primarily used to compensate for the negative climate or other impacts of some measures on nature. For example, by developing different carbon capture methods, such as geological storage, it is possible to achieve a positive impact on carbon sinks, thus compensating for the loss of the carbon sink of forests caused by increasing felling. This can be thought of as the narrowest perspective on the twin transition.
- a *reinforcing* relationship refers to a perspective in which the objectives of the green transition guide, or at least influence, the purpose and design of technological solutions. New solutions are created to replace technological solutions with more negative climate or nature impacts, thus reinforcing other measures that promote the green transition. *This report approaches the twin transition from this perspective.*
- a *subordinate* relationship means that the objectives of the green transition directly guide new technological solutions. This is the most radical perspective that signifies a revolutionary change in the current ways to develop technology. In public research, development and innovation policy, it is also possible to direct investments or launch and fund programmes from this perspective.

The twin transition can be considered to include the three promises in Figure 1.

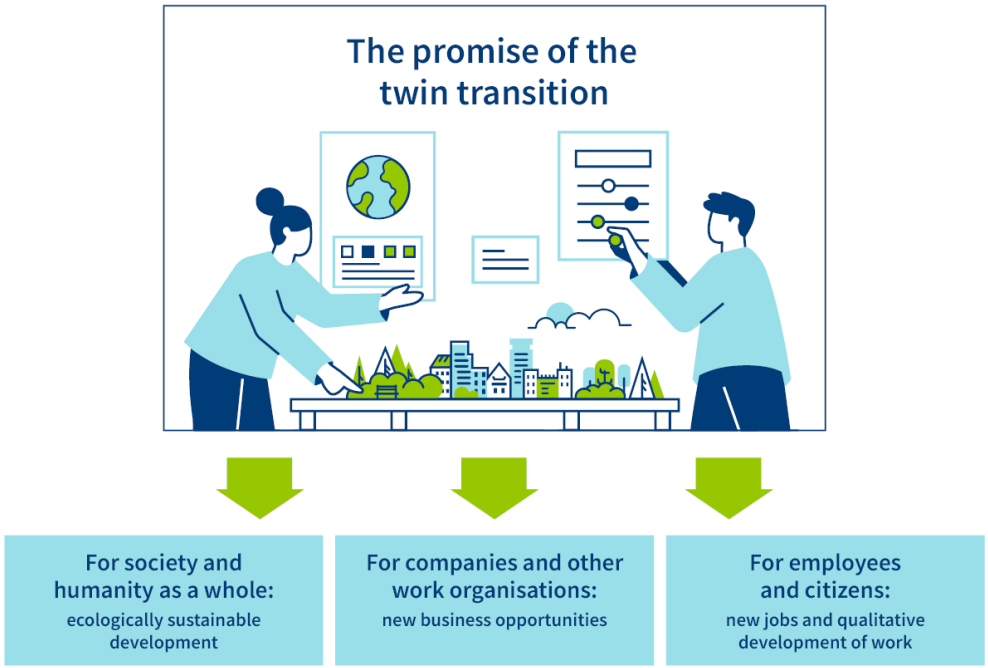

Figure 1. The promise of the twin transition.

This win-win-win proposition illustrates the implementation of the twin transition in an ideal world, where different goals and interests can be easily reconciled. In the real world, however, the twin transition is a tense process. It applies to a large number of actors who may have coinciding, different and divergent objectives and interests. The twin transition is not a mechanical or linear process; it is an interactive process with its own economic, social, cultural and political dimensions alongside its environmental and technological dimensions (Figure 2). These apply to, for example, the transparency of the twin transition, the implementation of the required investments, the distribution of its benefits, costs and risks, its diverse path dependencies, or its impacts on lifestyles. Therefore, to promote the twin transition requires long-term, systemic guidance that is based on broad societal acceptance, in which the overall impacts of this multifaceted nature can be taken into account (Dixson-Declère et al. 2022; Muench et al. 2022).

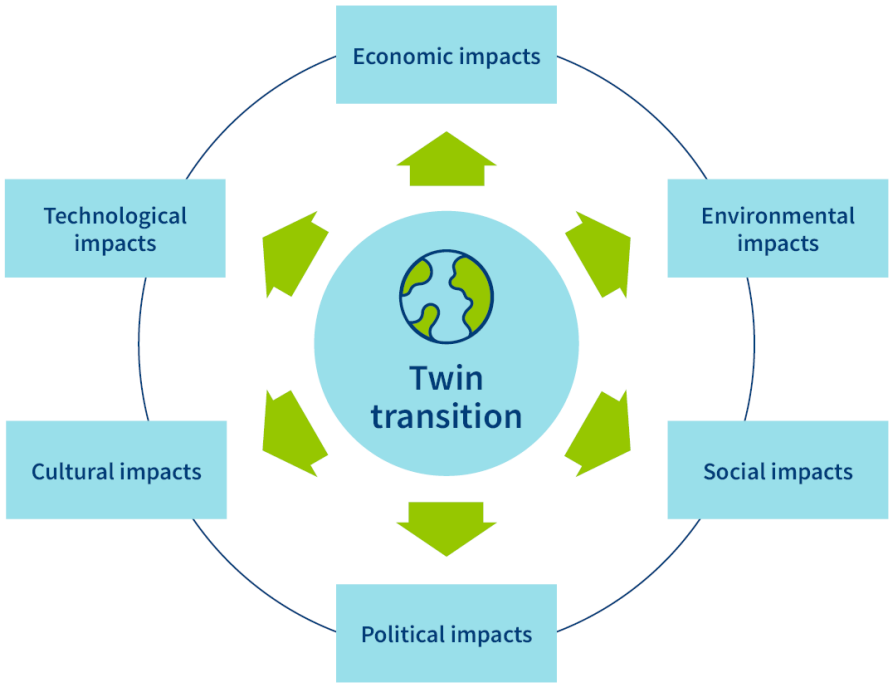

Figure 2. The multifaceted nature of the twin transition's overall impact.

The tension between the political level of society and the work organisation level of the twin transition can be examined as shown in Figure 3. Accordingly, the green transition is largely a policy-driven process, while digitalisation (digital transition) is more market-driven. When we talk about the twin transition, digitalisation is seen, at the policy level, as a means of promoting the green transition. On the other hand, there is no similar hierarchical relationship on the work organisation level, where both digitalisation and the green transition are intertwined means by which organisations can strive to promote their own strategic and business objectives. The policy-level challenge is not only to accelerate the digital transition in work organisations as such, but also to strive to steer it in a direction that can be used to create new opportunities and solutions that promote the green transition.

The policy-driven nature of the green transition and, consequently, the twin transition, sets requirements for the methods in which the transition is implemented. For this reason, in a work context, the twin transition is linked to an important social dimension. This applies to what kind of participation the transition will enable in a change

situation, how the transition as a whole will reflect in the well-being of the workforce (both well-being at work and well-being enabled by work in a wider sense) and how fairly the implementation of the transition and its impacts are seen in work as a whole. Success here is affected by the important intermediary role of different work-related actors (such as the management and personnel of organisations) and institutions (such as employer associations, trade unions, research and development organisations, and educational organisations) (Bednorz et al. 2022; Dixson-Declère et al. 2022; Eurofound 2022; 2023b; Galgóczi 2024).

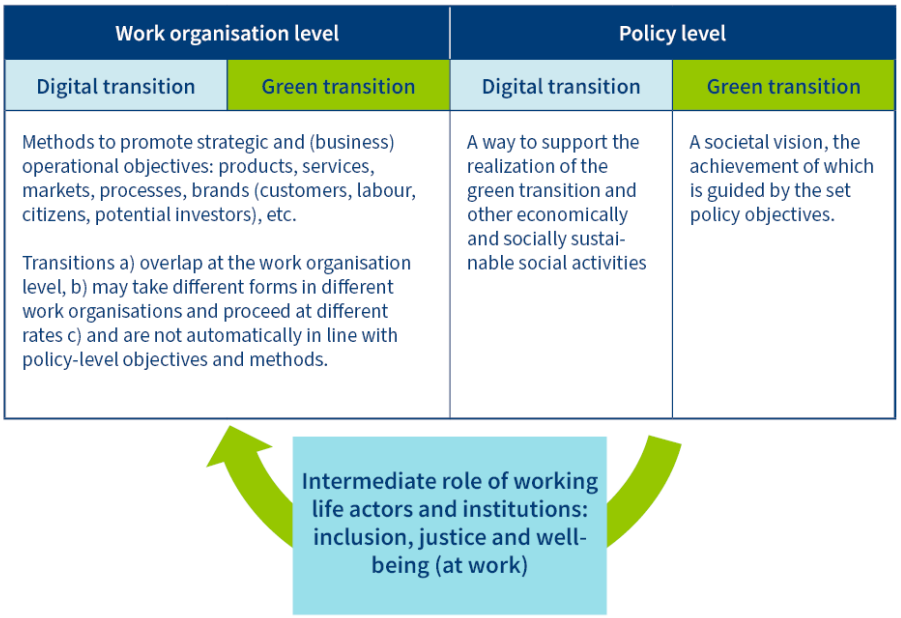

Figure 3. The relationship between the digital and the green transitions at the political level of society and the work organisation level.

The tension between the digital and the green transition can manifest in many ways. For example, AI systems can, as part of the digital transition, create opportunities that are important for the green transition to solve the 'wicked problems' (see above). At the same time, artificial intelligence and other new technological solutions promoting

the green transition may involve many conflicting side effects, such as increased consumption of energy and natural resources. Known examples include the huge electricity consumption and greenhouse gas emissions required for the data centres that transmit data traffic around the world and the mining of cryptocurrencies that use blockchain technology (Crawford 2024; Heikkilä 2023; Jin et al. 2020; Kohli et al. 2023). For example, the energy consumption required for one ChatGPT query is approximately tenfold compared to one Google search, and it has been estimated that the use of generative artificial intelligence, combined with other increases in the use of digital devices and applications, will require a significant boost in electricity production capacity in the future (Gandolfi 2024). Similarly, the production of so-called green energy, such as solar or wind power, has its own carbon footprint (Dammeier et al. 2023; Sharif et al. 2021). Digging metals from the soil for use in smart devices and electric vehicle batteries, such as cobalt or lithium, have significant negative impacts on nature (Kallitsis et al. 2024). The development of more energy and resource-friendly digital solutions can also be seen as one important perspective on how digitalisation can promote sustainability goals in line with the green transition (Christmann et al. 2024; Meinhold et al. 2024).

Furthermore, progress in technological development does not happen on its own, as it depends on the vision behind the technological development and the interests behind the vision. American economists Daron Acemoglu and Simon Johnson (2023, 96) describe this as follows: "Technological choices are themselves defined by dominant visions and tend to reinforce the power and status of those whose vision is shaping technology's trajectory". The core questions in terms of technological development concerning their social impact are, therefore:

- Who or what develops the technological solutions? How much of the development of new solutions is in the hands of some individual large companies or so-called tech giants? To what extent are wider groups of organisations or various open-source developer communities active participants? How diverse are the developers of new solutions?
- What kinds of visions, narratives and purposes guide the development and use of technologies? To what extent is the development guided solely or primarily by the business motives? What is the significance of a broader vision of socially desirable development and the needs behind it?
- How is the development and use of technologies regulated or otherwise steered politically? To what extent do the public authorities steer development legislatively or financially? How does the significance of different motives

(economic, social, military, control-related, etc.) reflect on the steering and support of technological development by public authorities?

In addition to identifying the opportunities of artificial intelligence and other technological solutions that promote the green transition, it is also important to be aware of the potential crossover impacts that may arise from the divergent direction of the objectives and interests of different actors.

3 Focus and impacts of the twin transition in work contexts

3.1 Industries, functions of society, and socio-technical systems

In its different forms, digitalisation applies to all industries, reflecting the deeper integration of digital information technology as part of the structures, processes and all activities of organisations. In the actual digital transition, the most data-intensive industries have the most significant head start, who provide products and services that can also be distributed through digital channels. Examples of these industries include software, financial and insurance, media and communications, and the production of various expert services.

On the one hand, the industries responsible for the majority of climate emissions and, on the other hand, ones that play a crucial role in producing new technological and other solutions to reduce emissions can be considered to be at the centre of the green transition and thus also the twin transition. Based on Statistics Finland's emissions reports, manufacturing (NACE C), energy production (NACE D) and transport and storage (NACE H) accounted for more than 84% of the carbon dioxide (CO2) emissions of different industries in Finland in 2022.[6] In Finland's manufacturing sector, emissions are strongly concentrated in capital-intensive process industry, such as the chemical wood-processing industry, chemical industry and manufacture of basic metals.[7] The percentages in Figure 4 do not include households, which account for 10 per cent of the total emissions.

[6] The percentages have been calculated (8 October 2024) from the database maintained by Statistics Finland: https://pxdata.stat.fi/PxWeb/pxweb/fi/StatFin/StatFin__tilma/statfin_tilma_pxt_11ig.px/

[7] The steel, cement, aluminium and chemical industries account for the largest share of the global share of industrial carbon dioxide emissions (Sweco 2024).

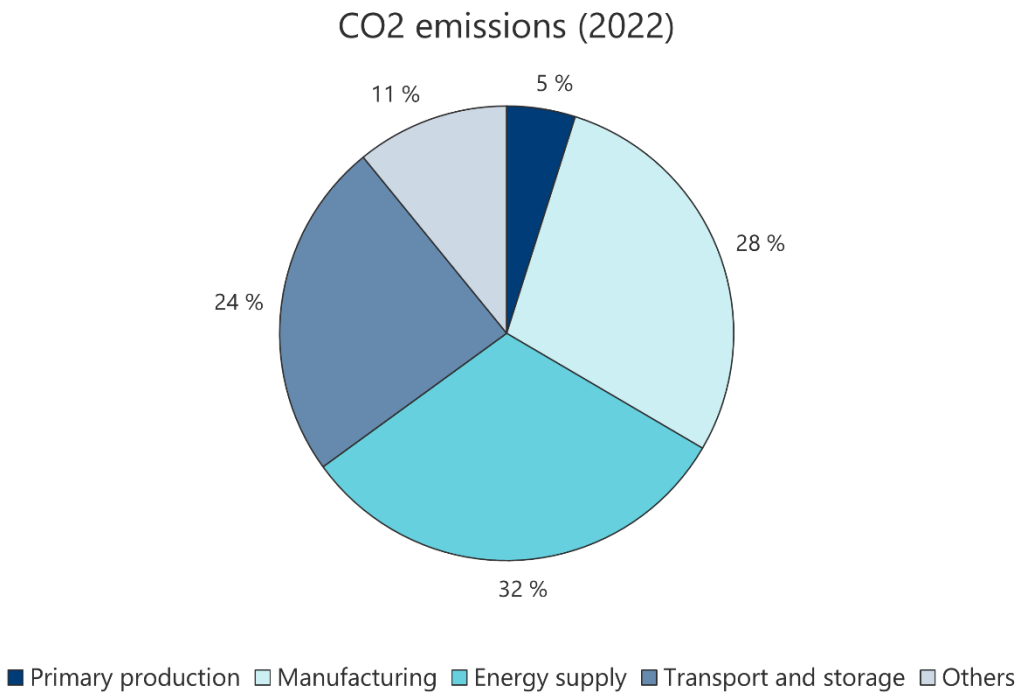

Figure 4. Carbon dioxide emissions by industry in Finland in 2022.

Carbon dioxide is by far the most significant source of greenhouse gas emissions. The combined amount of fossil CO2 emissions in Finland in 2022 was slightly under 35 million tonnes, compared to just under 44 million tonnes when considering all greenhouse gases. When greenhouse gases other than CO2 are also taken into account, the overall picture changes in a way to increase the share of primary production to a degree. The majority of primary production's greenhouse gas emissions come from agriculture. The manufacturing, energy production, and transport and storage sectors account for slightly under 69 per cent of all greenhouse gas emissions (Figure 5).[8]

[8] The percentages have been calculated (8 October 2024) from the database maintained by Statistics Finland: https://pxdata.stat.fi/PxWeb/pxweb/fi/StatFin/StatFin__tilma/statfin_tilma_pxt_11ig.px/

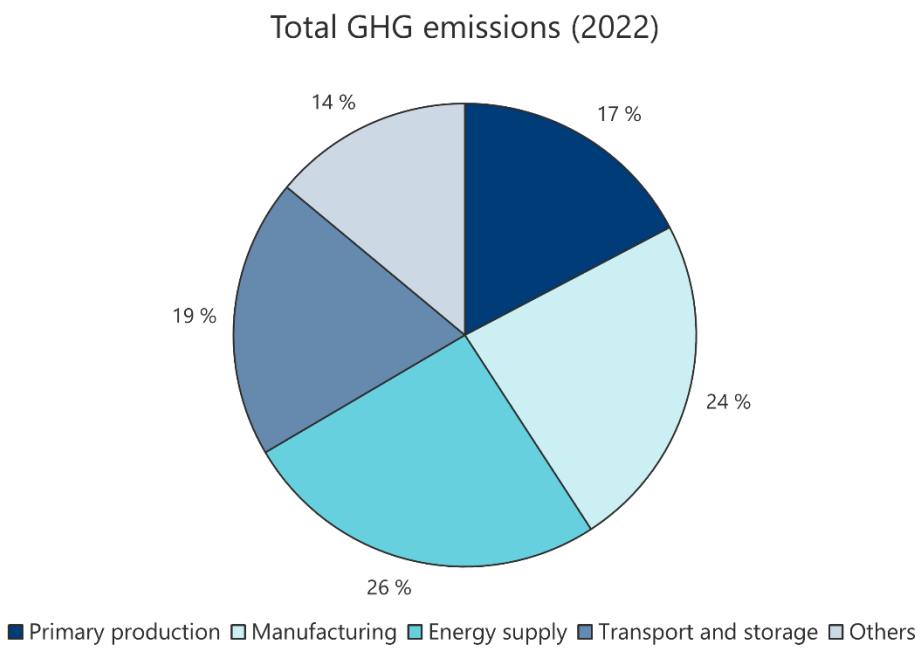

Figure 5. Total greenhouse gas emissions by industry in Finland in 2022.

The industry-specific distribution of greenhouse gas emissions in the EU27 is quite similar to that of Finland. The aggregated share of employment in the four industries with the highest emissions (energy supply, manufacturing, primary production and transport and storage) in the EU27 as a whole is about one quarter, i.e. significantly lower than their share of emissions (Eurofound 2024).

Information and communications (NACE J) and professional, scientific and technical activities (NACE M), including the expert positions in both, are the industries that play a key role in creating new solutions, especially in software design and manufacturing, scientific research and development, and management consulting.

However, when highlighting particular industries, it is also important to understand that individual industries are not islands separate from other economic and social activities. The targets in the twin transition are not so much individual sectors as *functions* that are vital as a whole for a society. These include energy production, food production,

traffic and transport, health and well-being services, education, construction and financial services. These functions cut across boundaries between industries as diverse value chains and networks and other organisational interdependencies. Thus, many innovations and other reforms promoting the twin transition that are targeted at the ways in which the different functions of society are implemented are cross-cutting in terms of work and employment and other impacts.

The implementation of vital societal functions has been explored in discussions and research on sustainability transitions through the concept of the *sociotechnical system*. In the literature, a sustainability transition refers to a fundamental change towards more sustainable production and consumption methods (Markard et al. 2012). Regarding sociotechnical systems, the idea is that society has a dominant operating model that guides the way in which each vital societal function is implemented (e.g. a transport system based on internal combustion engines and cars, or an energy system based on fossil fuels). The operation of sociotechnical systems is governed by certain rules – partly explicit, partly tacit – which manifest as everyday practices, routines and procedures, beliefs, ways of thinking and values, and institutional, physical and economic structures.[9]

Dominant sociotechnical systems are maintained by factors that stem from policies, science, existing technology, user needs and market demand as well as socio-cultural factors. In a normal situation, sociotechnical systems are strong and stable. However, they are never completely immutable, as they are 'dynamically stable' even under normal circumstances, as stated by Frank Geels and Johan Schot (2007, 406).

Changes in sociotechnical systems are characterised by the intertwining of social and technological phenomena. This means that such changes typically take place over an extended period, are non-linear, dynamic and complex, occur through interaction between processes at different levels, and require system-level innovations and broad acceptance. According to a widely-used multi-level perspective in the study of sustainability transitions, sociotechnical changes take place through interaction between three levels of factors. These include new emerging niche innovations that

[9] Sustainability transition researcher Frank Geels (2011, 31) has made a distinction between the sociotechnical system and the sociotechnical regime. With the former, he refers to the visible and measurable aspects of the dominant operating model, while in the latter, he refers to the invisible, underlying issues of the operating model, such as visions, beliefs or social expectations. However, in this report, I will consistently use the term sociotechnical system to refer to both concepts.

challenge the system, external pressures on the system from changes in the wider operating environment (such as climate change or digitalisation) and internal system tensions (Geels & Schot 2007). Internal tensions in sociotechnical systems arise from incompatibilities between different system elements, such as weaknesses in the current production methods of products or services, changing user needs, or growing criticism of existing products or services in the market.

One important contribution of the research on sustainability transitions to the discourse on the impacts of the twin transition on work and employment is an understanding of the dynamics and complexity of the transition. Under normal circumstances, the dominant operating models included in sociotechnical systems are strongly institutionalised, which creates path dependency i.e. difficulties in abandoning models that are established and self-reinforcing over time. On the other hand, the challenging innovations and other solutions are less sturdy in structure, and the social networks that support them are more fragile. The competition between dominant operating models and the innovations that challenge them is not only based on the functional characteristics of both, but also on the institutionalised characteristics of both. Therefore, even promising innovations outside the dominant system will find it difficult to develop into mainstream practices without favourable economic, technological, political, social, cultural, demographic, etc. changes in the operating environment and the simultaneous opening of the dominant system for change. However, socio-political decision-making can promote the breakthrough of new, emerging innovations in different ways – a topic that is discussed in more detail in chapters 4 and 5. (Berninger et al. 2017; Geels 2004; Geels & Schot 2007; Smith et al. 2005.)

The concepts of sustainability transition research also contribute to creating an understanding of the important role that digitalisation has in promoting the green transition. According to the definition of the digital transition above (chapter 1.2), it is a *comprehensive* integration of digital information technology into *everyday* activities. Digitalisation can be seen as a *systemic* force of change that simultaneously influences many of its elements within sociotechnical systems. In addition, digitalisation simultaneously affects several different sociotechnical systems. The latter mechanism is important when considering the wide-scope sustainability transition of the economy, because – as Berninger et al. (2017, 17) point out – systems have interdependencies. Pressures to change and changes in one system also challenge other systems. For example, the benefits of digitalisation in society largely depend on how many actors in different sectors are able to communicate effectively with each other using the same electronic tools.

Typical targets for research of working life include employees, teams and other work communities, work organisations as a whole, and networks formed by work organisations. The transitions examined in this report will ultimately also be realised in individual work organisations. Although the transitions may progress at different speeds and in different ways in different industries, the position of work organisations in relation to them may also differ greatly *within* the industries.

The digital development of work organisations (their state of digital transition) can be assessed, for example, through the versatility of their use of data analytics. Data analytics refers to the creation of various data models and analyses, which are used to support the organisational development and decision-making (Lehrer et al. 2017). Digital data is produced in increasing quantities by various navigation services, website logs, smart power grids, sensors that monitor device operation, and social media. Data has been called 'the new oil', and that also forms the basis for the development of artificial intelligence solutions. For example, organisations can be classified as trendsetters, followers, users and adaptors, based on their digital development (Selander & Alasoini 2022).

UK researcher Richard Adams and his associates (2016) have proposed a three-dimensional model for assessing the position of work organisations in respect to ecological sustainability and the green transition. The first dimension of the model is the extent that the sustainability-oriented innovation (SOI) adopted by a work organisation focuses solely on new technological solutions in products and services, and to what extent it focuses on business models with different connections. The second dimension concerns the extent to which the SOI is limited to a specific unit, product, service or function of the organisation and the extent to which it spreads as a cultural change throughout the organisation. The third dimension of the model is about how much of the SOI is limited to the organisation internally and what kinds of wider impacts it has outside the organisation, on the stakeholders and ecosystem in which the organisation operates. Based on these dimensions, the authors propose a classification for the strategic positions of organisations: operational optimisation that aims for at ecological efficiency, organisational transformation that seeks new market opportunities, or a systemic change that aims to create a new kind of business ecosystem. The requirements of the different positions on the need to develop a work organisation differ from one another, which also creates different needs for working life research (see chapter 4).

3.2 Occupations and tasks

Extensive studies on the impacts of digitalisation on occupations and tasks have been carried out in recent years. Employment impacts of digitalisation cannot be directly derived from the applied technologies; these impacts depend on many intervening factors. One of these factors is the extent to which digital information technology is mainly used for the automation of operations and the replacement of existing work with technology, and the extent to which it is used to augment work and increase the marginal productivity of employees. The positive impacts of digitalisation on employment in the national economy are caused by positive productivity impacts. (Acemoglu & Johnson 2023.)

In recent years, technological development has also been thought of as the most important change factor for the occupational structure. However, researchers disagree on the dynamic in which the change takes place. The discourse is dominated by two alternative hypotheses. The *Skills-biased Technological Change* (SBTC) hypothesis states that technological development unambiguously leads to an increase in competence requirements, resulting in more high-skill occupations and fewer low-skill occupations. According to the *Routine-biased Technological Change* (RBTC) hypothesis, the number of high-skill occupations will increase, but the decrease will largely focus on medium-skill occupations. According to the RBTC hypothesis, these occupations are what have the largest amount of relatively predictable tasks related to, for example, the acquisition and processing of data that can be replaced with digital information technology. Thus, the result is the polarisation of the occupational structure. (Alasoini & Tuomivaara 2023.)

In Finland, the most recent, significant changes in the occupational structure can be summarised in the following sections:[10]

- Highly educated professionals are the only major occupational group in the international ISCO classification that has clearly grown in Finland (27% growth in 2010–22). In accordance with the occupational classification of Statistics Finland (2011), these occupations require the ability to solve complex problems and make decisions based on comprehensive theoretical knowledge, as well as competence in the context of a specific expertise. These occupations usually

[10] The percentages have been calculated (8 October 2024) from the database maintained by Statistics Finland: https://pxdata.stat.fi/PxWeb/pxweb/fi/StatFin/StatFin__tyokay/statfin_tyokay_pxt_115q.px/

require very good written language skills and high-level mathematical thinking, as well as excellent interpersonal skills. In recent years, the increase in the number of professionals has focused particularly on professionals in information and communications technology (increase of 90%), business and administration (increase of 53%) and science and engineering (increase of 37%).

- In production-related blue-collar occupations, the number of people working in the manufacturing and construction sectors in particular has been on a slight but consistent downward trend (a decrease of slightly under 10% in 2010–22). Based on the ISCO classification, these occupations can mainly be considered to require medium-level competence.
- The number of people working in clerical support occupations and primary production occupations has decreased significantly (down by almost 30% in the first group and by more than 30% in the latter between 2010 and 2022). In the ISCO classification, these occupations also mainly fall into requiring medium-level competence.

In addition to technological development and climate change, the impacts of the green transition and thus, the twin transition, on employment and the occupational structure largely depend on political decision-making. This makes it difficult to provide an unambiguous prediction of the impacts. The general view among experts on the employment impacts is that, as a whole, they will be moderate and more likely to be slightly positive than negative in terms of total employment (Busk et al. 2023; Eurofound 2023a; 2023b; ILO 2018; Kauhanen & Kuusela 2023; McKinsey & Company 2022; World Economic Forum 2023). In Finland, the views of the workforce seem to be similar: the overall impacts of the transition on employment are not considered to be significant, and the overall impacts are believed to be more positive than negative (Moilanen et al. 2024; Seppälä et al. 2023). However, any impacts that increase or decrease employment may affect different industries, regions, occupations and organisations in very different ways, and for this reason, they may be very different in terms of direction and scope. Alongside general eco or climate anxiety (Coffey et al. 2021), this may result in anxiety, tensions and resistance to the transition due to the anticipated labour market impacts of the transition.

In order to anticipate the impacts of the twin transition on occupations and tasks, it is important to strive to understand the key mechanisms that drive changes in the transition. The first one of them is the fact that the twin transition needs new kinds of expertise and new technological and other solutions based on it that promote better

resource efficiency, zero emissions and recyclability. The second mechanism is that the twin transition requires industrial and other new and replacement investments in infrastructure that promote the achievement of its objectives. Thirdly, the aforementioned twin transition objectives are reflected as changes in operating methods in all kinds of organisations across industries.

Based on these mechanisms, we can anticipate the following changes in the occupational structure:

- The need for new expertise and innovations required by the twin transition will further strengthen the long-standing growth in the demand for experts in Finland, especially highly educated professionals. In the future, the development of generative artificial intelligence can respond to the growing need for expert professions in some respects, especially by automating the professions' most routine tasks. However, artificial intelligence is expected to become a factor that mainly complements or augments – not replaces – the work of people in these occupations (Briggs & Kodnani 2023; Eloundou et al. 2023; Gmyrek et al. 2023; Kauhanen et al. 2023).
- The infrastructure investments required for the twin transition are particularly targeted at industries that are central to the transition due to their high greenhouse gas emissions. The construction of new infrastructure will increase the demand for labour in (typically male-dominated) blue-collar positions, especially in the manufacturing sector (NACE C), various maintenance operations (NACE D-E) and construction (NACE F), but may also lead to reductions and closures of local operations and thus negative employment impacts in manufacturing and energy production businesses with strong ties to the exploitation of fossil energy sources. At best, however, this may lead to a halt in the long-term decline in the *total demand* of production-related blue-collar tasks.
- The aim of the twin transition is to make resource use and recycling more efficient, applying to all industries and occupations. As a whole, improvements in efficiency may reduce, rather than increase, the demand for labour. This may be reflected as negative employment impacts to a degree, especially in service-intensive sectors and the non-specialist positions therein, which are also not targets of the investments into twin transition infrastructure, such as trade, transport or tourism (Eurofound 2023b). Concurrently, services linked to investments in the green transition and the circular economy may have some

positive employment point impacts in some service-intensive sectors alongside manufacturing sectors.[11]

3.3 Digital solutions as facilitators of the green transition in work contexts

Chapter 2.3 listed various opportunities for using new digital solutions to promote the green transition. These opportunities will be explored in more detail below.

Measuring, monitoring and evaluating the ecological sustainability of activities and processes and identifying new solutions. For example: Digital information technology can be used to measure greenhouse gas emissions generated by operations and processes and to compare the ecological sustainability of alternative solutions. The accumulation of information also helps to design new solutions that are more sustainable ecologically.

Measuring, monitoring and evaluating the functionality of products and services. For example: Digital information technology enables real-time data collection on the current status of the products and services in use, regardless of their location. This data can be used to predict service, repair or other renewal needs of products and services and to improve their availability and durability, thus extending their uptime.

Monitoring and predicting process deviations, disruptions and faults. For example: Digital information technology can be used to improve process controls, prevent disruptions and faults, and increase understanding of the factors that affect the fluctuations in process statuses. This helps to optimise the process flows and improve the efficiency of using the resources required by the processes.

Monitoring and optimising the energy and resource efficiency of facilities. For example: Digital information technology can automatically regulate facility parameters, such as temperature, ventilation, humidity, or lighting, based on predictive models on human usage patterns and weather conditions. By regulating these parameters, it is possible to optimise the suitability of spaces for work combined with energy efficiency.

[11] Statistics Finland has a list of industries that can be considered as circular economy industries in particular: https://www.stat.fi/tup/kiertotalous/kiertotaloustoimialat_en.html (accessed on 22 April 2024)

Monitoring and predicting demand for products and services. For example: Digital information technology can be used to develop predictive models of factors that influence fluctuations in demand for products and services. Increased predictability of market demand helps to improve supply chain management, reduce the carbon footprint of storage, and reduce unnecessary use and waste of various resources.

Virtualisation of products and services and their production methods. For example: Using digital information technology, more and more products and services can be transformed into an electronic format and delivered online. This can improve the availability of products and services, reduce delivery times and reduce the carbon footprint associated with delivery.

Introducing new types of virtual information and communication methods. For example: Digital information technology can be used to increase the opportunities organisations have to carry out their different activities independently of location, and to enable employees to work remotely and encounter each other without moving physically from one place to another. This opens up new opportunities for organisations on geographical relocation and to improve their employees' work-life balance, while reducing the environmental burden caused by facilities and commuting.

Comprehensive analysis and optimisation of complex systems. For example: With increasing computing power, digital information technology enables us to discover highly complex interactive relationships between different things and phenomena that are not accessible to the human mind. By better understanding and management of interactive relationships, complex systems can be optimised for their economic, social and ecological sustainability characteristics.

Digital solutions such as, but not limited to, these that promote the green transition have many easily perceived impacts on the labour market and work, as already mentioned above. New solutions increase the demand for expert work, require investments in infrastructure and emphasise the importance of more efficient use of resources, zero emissions and recyclability. They all also require new kinds of competence. New competence requirements related to the green transition will be discussed in more detail in the parallel publication of this report. In addition to these impacts, at their best, digital solutions that promote the green transition can create opportunities to achieve a wide range of other valuable impacts for society through determined socio-political decision-making that promotes these opportunities. Next, I will present three examples of these opportunities.

Meaningful work. In research literature, one of the key dimensions of meaningful work is that it should contribute to the achievement of a broader purpose (Martela & Pessi 2019). Due to the significance of a broader purpose, work that appears to be outwardly similar may mean something completely different to the person doing it, depending on the purpose. For example, piling rocks on top of each other can mean simply that or the building of a cathedral. At its best, the promise of the twin transition, of more ecologically sustainable development through your own work, can be seen as a goal similar to building a cathedral. It can be an important factor in increasing the meaningfulness of work on its own – even without any significant changes in the content of work – and at the same time an important motivating factor that helps to extend careers or prevent work-related mental health problems.

Prevention of marginalisation. Recycling and new energy solutions can create new types of local business and other activities, strengthening the social cohesion of local communities (Muench et al. 2022). It can reduce the dependency of local communities on external material sources or other resources and may supplant them through local business or voluntary activities. Similar opportunities are included in local independent electricity grids, i.e. microgrids.[12] Microgrids also enable local communities in remote areas to improve the efficiency, redundancy and environmental friendliness of their energy use with green sources of energy. Solutions that boost local, self-sufficient economies and communities through technological development can be consciously promoted to act as factors that prevent regional and other marginalisation.

Gender equality in the labour market. The labour market in Finland is strongly segregated by gender. For example, in 2021, only one in ten Finnish employees worked in a so-called equal occupation, i.e. occupations in which the share of either men or women was at least 40%.[13] In recent years, there has been a great deal of discourse on breaking glass ceilings, which refers to the progress of women in traditionally male-dominated, highly paid occupations (dismantling of vertical segregation). As labour supply continues to decline and in the course of the twin transition, the possibility of breaking glass walls, i.e. reducing horizontal segregation in the labour market, will also become equally important. Digital solutions can be used to shape the contents an occupation in a new way, to mitigate gendered competence requirements and existing cultural perceptions, and thus dismantle the rigidity of a strongly gendered labour

[12] https://en.wikipedia.org/wiki/Microgrid (accessed on 6 May 2024)
[13] https://thl.fi/aiheet/sukupuolten-tasa-arvo/tasa-arvon-tila/tyo-ja-toimeentulo/ammattialojen-sukupuolen-mukainen-segregaatio (accessed on 6 May 2024)

market. Breaking glass walls may also contribute to the share of women in the types of production-related occupations created by infrastructure investments in the twin transition.

4 Opportunities and role of working life research in the twin transition

4.1 Strategic requirements for working life research

The importance and significance of trying to find new ways of thinking come to the forefront during a societal change. This creates new opportunities as well as poses new challenges for researchers. The relevance of research into working life in the twin transition is justifiable, particularly through the social dimension linked to the twin transition and, as part of it, through the perceived fairness of the transition – a matter I already referred to earlier, in chapter 2.3. Working life research has also produced a wide range of models, methods and tools that can be used to support the implementation of changes at different levels in working life contexts. Long-standing tradition of studies of participatory and dialogical organisation-level interaction processes that create understanding and accumulate information can be considered one added value for working life research in the promotion of the twin transition. At the same time, working life research is expected to renew itself conceptually, such as by mastering and developing new theories, models, methods and concepts.

In the twin transition, the impact of research is naturally influenced by the financial and other resources allocated to it, but also how research is *strategically positioned* in relation to the transition. The strategic requirements of working life research during the twin transition can be examined through the three criteria in Figure 6.

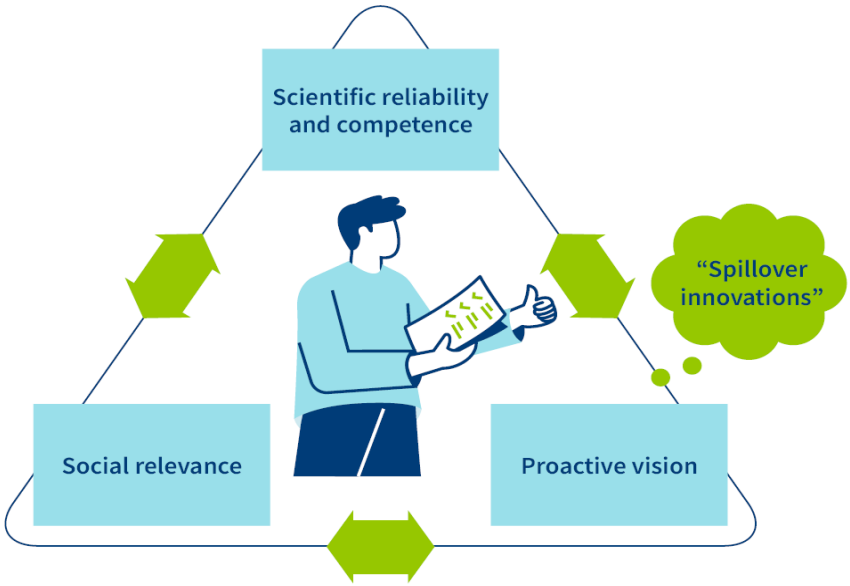

Figure 6. Strategic requirements for working life research in the twin transition and opportunities for 'spillover innovation'.

Scientific reliability and competence are universal requirements for all scientific research. There are established criteria and practices adopted by scientific communities to assess the scientific reliability and validity of both quantitative and qualitative research.

As the twin transition is largely (also) a policy-driven process, the *societal relevance* of research is emphasised as a requirement. For example, the extent to which and how directly research data can influence political decision-making, decisions made in work organisations, prevailing attitudes in society or public opinion can be considered a criterion for this societal relevance. It can also be thought to include the ways research can support the engagement opportunities for different groups as well as the interaction and cooperation between groups during the transition.

As societal changes often enable innovations that could not have been anticipated in advance as 'spillovers', the twin transition emphasises the importance of *proactively visionary* research data that can be used to find the space to create new products and services or to promote socially valuable objectives that do not need to be directly

related to the twin transition. These objectives may include, for example, as stated in the previous chapter, finding more meaning in work due to the rising focus on the environment, the mobilisation of local communities enabled by new digital solutions and prevention of marginalisation related to them, or the reduction in the gendered division of labour caused by changes in work requirements and the progress of gender equality in the labour market. Serendipity is a significant characteristic of research, development and innovation activities, i.e. unplanned lucky findings, of which there are several well-known existing examples.[14]

4.2 Ways to position working life research

There are different positions that working life research can take in the twin transition through different approaches and methods. These range from proactive ways of forecasting and influencing the future to reactive methods that measure and assess what has already happened. The methods between these two extreme ends of a timeline are ones in which research is influencing the change in one way or another, as shown in Figure 7.

[14] One of the best-known findings in scientific history is the invention of penicillin in 1928 https://en.wikipedia.org/wiki/Serendipity (accessed on 16 April 2024). Other well-known examples are the numerous technological and organisational innovations indirectly generated by the US Apollo space programme (Mazzucato 2021). 'Spillover innovations' of the twin transition are discussed in greater detail in chapter 5.

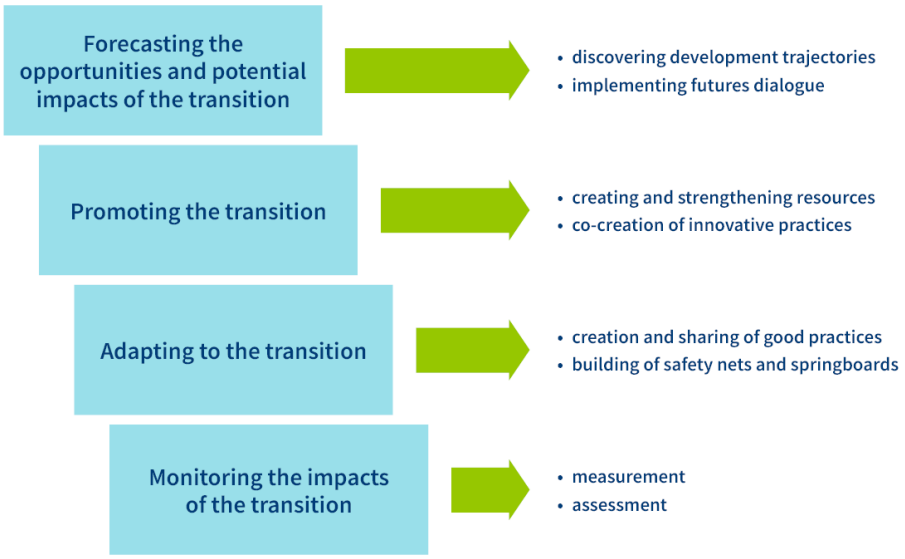

Figure 7. Different positions of working life research in the twin transition.

The importance of different types of knowledge and competence is empasised in different ways in different approaches.

Traditional *phenomenon-based research data* on, for example, well-being at work, work ability, occupational health, occupational safety, work organisation or management can also be thought to form a core research competence base in the twin transition. Phenomenon-based research data may play an important role in every position in Figure 7, however, with an emphasis on monitoring the impacts.

The transition emphasises the importance of *knowledge and competence related to changes in working life* further, especially in promoting and adapting to the transition. Finland has a long tradition in different approaches and methods of research-assisted development that combine working life research and the development of work organisations. Some of the best-known examples are participatory action research and developmental work research. At the same time, the twin transition also challenges

working life researchers and researcher-developers to broaden the conceptual and moral foundation of their own approaches, especially on ecological sustainability issues outside the more traditional economic, social or general humanist target-settings (Alasoini 2023). For example, will it still be all right to describe work that is economically productive, socially sustainable and involves many opportunities for development and influence as 'good' work if its carbon footprint remains particularly high?

The transition will further highlight the need to *strengthen foresight and related competence in work contexts*. This requires increasing multi- and interdisciplinary research approaches, such as complementing the traditional knowledge and competence base of working life researchers and combining it with innovation, sustainability and strategic foresight research in particular. Traditionally, the focus of working life research and the development of work organisations has been on creating methods for understanding and influencing changes that can be characterised as operational optimisation or organisational transformation based on the classification presented in chapter 3.1 (Adams et al. 2016). The importance of work-related foresight knowledge and competence as well as multi- and interdisciplinary approaches is emphasised in organisational changes, the aim and target of which are more ambitious system changes.

4.3 Themes of working life research in the twin transition

The introduction featured a quick reference to the way this report handles the concept of a transition. In the research on sustainability transitions, the focus has been on the dominant operating models of systems that meet the needs of society and the innovations and changes in the external operating environment that challenge them (multi-level perspective). Individual work organisations have been treated as either incumbent actors that are committed or adapted to a dominant operating model or as developers or early adopters of innovations that challenge that model. The distinction does not mean that work organisations in the former group cannot be innovative. Instead, it is based on the extent to which innovations challenge the dominant operating model (Magnusson & Werner 2023). In working life research, however, when researchers talk about individual work organisations, the focus has typically been on internal or inter-organisational processes, which have largely remained a 'black box' in research on sustainability transitions. Both levels of analysis are needed to comprehensively understand the impacts of the twin transition on work and employment. Research on sustainability transitions provides tools for seeing the bigger picture of the transition. Understanding the processes within and between work

organisations is important – not only to increase understanding of the requirements for affecting system-level change as such, but also to understand and influence the social dimension of the transition.

The following are examples of themes that working life research can tackle within the twin transition.

Sufficient employee competence and supporting opportunities for competence development. The twin transition affects work-related competence requirements in many ways. There have been many studies on the digital skills required by digitalisation in recent years, with different classifications that have been drawn up on them (Scheerder et al. 2017; Van Deursen et al. 2017), and calculations on how different occupations and tasks are 'exposed' to digitalisation in general (Özkiziltan & Hassel 2020) or, more specifically to the development of artificial intelligence (Briggs & Kodnani 2023; Eloundou et al. 2023; Gmyrek et al. 2023; Kauhanen et al. 2023). Researchers have made similar efforts to assess the scope of 'green' work and the changes in competence and the labour market caused by the green transition (Apostel & Barslund 2024; Bowen et al. 2018; Busk et al. 2023). So far, there have been fewer studies into the combined effects of the digital transition and the green transition (see, however, Christmann et al. 2024). The impacts on competence and the labour market of both transitions will also be realised in different ways in different industries, requiring more detailed analyses that are based on an understanding of concrete changes in products, services and operating processes.

Using the leeway opened up by the twin transition to improve the quality of work. The digital and green transitions create requirements for planning and organising activities and work in a new way. However, the transitions or their possibility do not, in and of themselves, yet trigger the need for a redesign and reorganisation of activities and work. Research can be used to boost understanding of the factors that can promote the utilisation of the leeway opened up by the transitions, including the qualitative development of work. Strategic foresight and innovation research has developed different methods for mapping such leeway and the solutions they require (Carleton et al. 2023). Research on sustainability transitions presents analyses of the factors required for the growth and development of new innovations in transitions (Schot & Geels 2008) and the measures that can be used to support the strengthening and mainstreaming of new innovations (Van den Bosch & Rotmans 2008). Organisational research, on the other hand, has created various frameworks and models for change management that can be utilised in implementing organisational changes at different levels (Phillips & Klein 2022). In addition, working life research has developed understanding and

competence, especially on how dialogical and inclusive changes and new solutions can be implemented in a way that supports a sense of community and the well-being at work (Alasoini 2023). By combining the views of different research traditions, it is also possible to find new ways to utilise the leeway opened up by the twin transition.

Opportunities for employees to participate in developing new solutions. Providing participatory opportunities for people affected by the change is one of the most common methods mentioned in the change management frameworks and models for implementing successful change (Phillips & Klein 2022). The advantage of employee participation is typically justified in the literature from two perspectives. The first perspective is it allows an organisation to make more versatile use of different types of knowledge and expertise during a change, thus creating better and more successful solutions. The other perspective is to drive better commitment to change among employees. However, providing employees with opportunities to participate is not a silver bullet. What's crucial is the extent that the opportunities for participation are channelled into genuinely perceived opportunities of influence. Lack of genuine experience of being included may fuel negative feelings among employees and lead to negative consequences for implementing the change in the work organisation, such as frustration and cynicism among employees and an increase in tensions and conflicts within the organisation (Alasoini & Selander 2023). As the twin transition inevitably also carries significant concerns for employees, it is important that work organisations have the competence and sensitivity to handle them.

Fair distribution of the outputs of the twin transition. In addition to its implementation method, the socially sustainable implementation of the transition also includes the perceived impacts of the transition on work and employment. Fair implementation of the green transition, i.e. a just transition, has been an important theme due to the political nature of the transition. Many international organisations have their own principles that they have developed to assess the justness of the transition.[15] In order to promote a just transition, the European Commission has also established its own financial support mechanisms for citizens, organisations, industries, regions and Member States.[16] The twin transition can largely be thought of as a policy-driven process, as mentioned previously (chapter 2.3). One perspective is that, in general, the twin transition cannot be considered sustainable without consideration for the justness

[15] https://en.wikipedia.org/wiki/Just_transition (accessed on 28 May 2024)
[16] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism_en (accessed on 21 May 2024)

of its impacts (Delbridge et al. 2024; Williams & Doyon 2019). Research can be used to produce information on the perceived justness of the different solutions required for the transition in different work contexts, to help build new solutions that have been found more just and to share information on successful solutions.

Financial, professional and psychological support for employees during significant changes in work tasks and the nature of work. The importance of lifelong learning and continuous personal growth and development comes to the forefront during changes in work. However, due to an increased knowledge intensity and networking in the economy, changes in work have become faster and more unpredictable, unique and uncontrolled in recent years (Baldwin 2019). This is also reflected in the increased concern among the Finnish labour force regarding unforeseen changes in work. At the same time, they feel that the traditional 'promise of education' – i.e. labour market security based on high education – no longer protects them from changes in work in the same way as it used to (Sutela et al. 2019). Even if the twin transition does not have significant impacts on total employment, as stated above (chapter 3.2), its impacts on individual industries or regions or individual work communities, occupations or organisations may be dramatic in very different ways, targeting different individuals, partly regardless of their existing position in the labour market. Research can boost the ability to anticipate changes caused by the transition and the impacts thereof on work and employment and to proactively develop new solutions to streamline the changes and soften their impacts.

Ground rules for privacy, transparency, information security, data protection and ethical use of data in digital solutions and data sources and compliance thereof. Promoting the green transition through digital solutions adds a wide range of risks and vulnerabilities to an organisation and its operating processes as well as to individual employees. In particular, competence and rules related to information security, data protection and ethics as well as compliance with the rules and the monitoring thereof will become increasingly important issues in organisations as the intelligence and mutual integration of digital solutions increases. In the future, these must become an essential part of the management systems of every organisation. In addition to the cognitive dimension, a significant social and cultural dimension is also a part of competence and rules, such as the fundamental question of what computers and artificial intelligence and all the opportunities thereof are suitable for in general (Smith & Shum 2018). The increasing use of digital solutions to promote the green transition is not a solution, as it may, if poorly implemented, instead strengthen employees' experiences of social injustice. Work that becomes greener with digital solutions does not automatically improve its quality. Risks of tensions between the social and ecological dimensions of

work can be reduced by making the digital solutions that promote the green transition more user-friendly in a way that comprehensively and diversely takes the requirements of different work tasks into account (Daugherty & Wilson 2018; Moniz & Krings 2016). Research can be used to boost competence and produce solutions that improve seamless interaction and cooperation between people and smart devices and systems in different operations.

5 Promoting the twin transition in work by means of public policy

5.1 Twin transition as systemic change

The twin transition exploits the potential of the development of digital information technology towards an ecologically sustainable economy and growth. Achieving ecological sustainability also requires paying attention to the social fairness of the impacts of the transition, as highlighted above. Without the experience of social fairness, the legitimacy of the solutions and measures that promote ecological sustainability will remain on an unsustainable foundation. Due to the importance of reconciling the multitude of simultaneous objectives (i.e. economic, ecological and social), the twin transition can be characterised as a systemic change.

Systemic changes are difficult to implement. Berninger et al. (2017, 13–18) have distinguished four categories of reasons for this.

The first concerns the identification of the need for change and possible solutions. It is often difficult to understand and think about the need for systemic changes, especially in situations where there are no turnkey or undisputed solutions (cf. previous references to global warming and natural resource degradation as 'wicked problems').

The second category concerns path dependencies. These refer to the effects that old structures have to hinder the change. These structures may be linked to the economy, the existing social infrastructure and past investments, but may also be informational or cultural.

The third category, according to the authors, is the diversity of options for progress. Achieving a sufficiently commonly accepted vision and strategy that guides change often requires a lot of effort and takes a lot of time. In many cases, new solutions are not even ready at the decision-making stage, but will only develop over time.

As the fourth category, the authors bring up the unpredictability of systemic changes and the difficulty of controlling them. As the change happens over a significant period of time, the understanding and rationale of the decisions made may change over time as well. This can force reviews, which serve to further slow the change down.

To promote systemic changes in society requires a comprehensive, uniform, long-term policy framework based on strong commitment. This sets requirements for cooperation, coordination and consensus between different policy sectors and different levels of political decision-making and governance (national, regional, local) as well as the different stakeholders in society (including political organisations, labour market organisations and other interest groups as well as various non-governmental organisations). Many of the policy measures are also reflected as needs for change in individual work organisations.

5.2 Mitigative, adaptive and compensatory measures

From the perspective of work organisations and employees, and when applied to the twin transition, the need for change manifests as three types of action (Eurofound 2023b):

- *Mitigative measures* refer to measures implemented by work organisations using digital information technology to reduce their carbon footprints and increase the ecological sustainability of their activities in general. In addition to measures that directly reduce the carbon footprint of their operations, work organisations may also strive to reduce the carbon footprint by more indirect means, such as promoting employees' climate agency by means of training, supporting initiatives, various competitions and campaigns, or other communication. Another important method for reducing the carbon footprint may be for a work organisation to systematically survey the carbon footprint of its different operations.
- *Adaptive measures* refer to measures by which work organisations aim to adapt their operations to climate change using digital information technology, public policy measures aimed at mitigating it, or other indirect changes resulting from these in the work organisation's operating environment. Actions that aim to adapt to climate change may concern, for example, a need arising from policy measures or directly from climate change to redesign workspaces, reform working methods or reduce work-related travel and mobility. An important indirect change factor can also be the increasing awareness of customers and consumers as well as changes in consumer habits, which forces work organisations to adapt their products, services and practices. In many respects, the boundary between adaptive and mitigative measures is flexible and largely related to how proactive the measures of work organisations are in nature.

- *Compensatory measures* refer to measures that aim to reduce or offset the risks and disadvantages to employees caused by the twin transition in work organisations. Compensatory measures may concern, for example, employee access to further training or retraining, relocation, changes in job descriptions, as well as dismissal or retirement arrangements. Compensatory measures are about how the twin transition can be implemented in a socially fair manner. As many changes that require compensatory measures at the work organisation level are either directly or indirectly caused by public policy measures, it is natural that society also participates in the financial support of such measures in some form.

There is no overview in Finland of the extent to which different measures related to the twin transition have been implemented in work organisations. However, a climate change and work survey conducted by the Finnish Institute of Occupational Health and Statistics Finland in 2022 examined mitigative and adaptive measures related to climate change in work organisations (Moilanen et al. 2024). Conclusions based on its results are limited by the fact that the information is based solely on the views of employees and does not specify the explicit role of digital IT as part of the activities.

According to a study covering all industries, slightly less than half of the employee respondents said that technology (such as energy-efficient devices) is used in their workplace to promote the mitigation of climate change. The use of these technologies was more common in the manufacturing and related industries such as construction as well as in traffic and transport, than in other industries, which also accounted for a large proportion of CO2 emissions (p. 35). Training and instructions on recycling, sorting and reuse, which had been received by nearly three out of four employees on the basis of the survey, had been clearly the most important of the mitigative measures in the employees' work. Especially in production-related fields, training and instructions related to material, raw material and energy efficiency had also been provided in general (p. 52–54). In the view of nearly one in three employees, joint actions by management and employees to develop climate-friendly practices had been implemented at their workplace (p. 42). No actual compensatory measures were surveyed in the study.

5.3 Project, programme and mission orientation

There are different ways research and development activities can be strategically linked to promoting the twin transition in work contexts. Therein, it is possible to distinguish three strategic levels. These are called the project, programme and mission-oriented

levels. These approaches are distinguished by the level of challenge and time span of the target level of the activities (Figure 8).

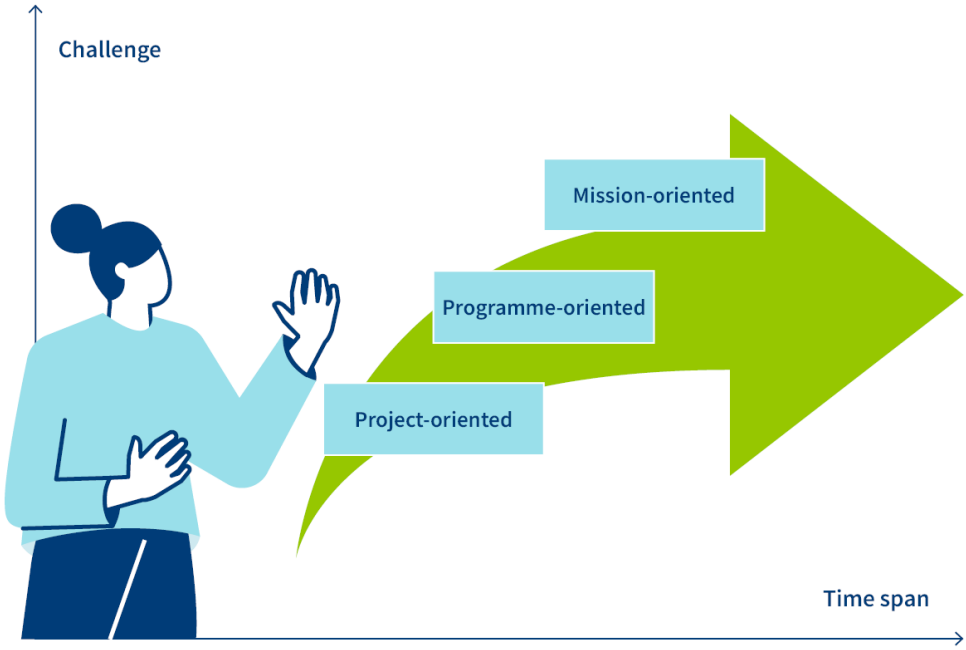

Figure 8. Target level and time span for project, programme and mission-oriented research and development

The most traditional way of promoting the achievement of policy objectives in work through research and development is with projects implemented in work organisations and their networks or ecosystems, which are supported by public funding. At its best, *project-oriented* research and development can produce significant insights, innovations or other reforms. However, the solutions created by the projects and the learning produced therein mostly benefit the participating work organisations. Learning and the diffusion of good practices across projects easily remain arbitrary without a specific diffusion strategy and resources. The diverse challenges of the diffusion of innovations and good practices are a widely discussed theme in innovation research (Rogers 2003), sustainability transition research (Schot & Geels 2008; Van den Bosch & Rotmans 2008) and management, organisation and working life research (Alasoini

2016; Ansari et al. 2010; Lillrank 1995; Wareham & Gerrits 1999). Diffusion may also be hampered by the fact that doing so is not necessarily in the interests of the work organisations that participate in the projects – much rather the opposite. For example, organisations participating in a project may try to make information and practices that provide their organisation with a competitive advantage confidential or see other work organisations that do not participate in the projects as a kind of free-rider problem for the adoption of new information and practices.

Efforts have been made to respond to the problems of project-oriented research and development by compiling individual projects into more extensive programmes. In *programme-oriented* research and development, the activities are guided by a common framework for several projects that are implemented more or less simultaneously. A large number of actors that are committed to the framework, such as work organisations and various expert organisations, typically participate in programme activities. In addition to the group of actors and the framework guiding the activities, the third key feature of programme-oriented activities is the promotion of coordinated exchange of information and experiences between projects, in addition to other, possible forms of cooperation.

The programme-oriented approach can overcome many of the limitations of project-oriented activities, such as better coordination of research and development carried out in work organisations, creation of networks and cross-project interaction between actors, and boosting the visibility and legitimacy of the activities in society as a whole. Programmes also have their own limitations concerning the diffusion of innovations and good practices (Alasoini 2016). One important factor limiting the impact of programmes is time. Programmes have a timeframe defined by the programme initiator or financier, during which the activities take place. Especially in short programmes, the administrative measures required to start and close one often take up a large part of the actual programme period, which wastes resources and makes it difficult to spread the results. Short programmes also include another factor that diminishes their effectiveness, even if the programme activities themselves have a continuity. In interruptions between programmes, there is a lot of information that is often lost, especially the experience-based tacit knowledge of the participants. Interruptions make it difficult for new programmes to take advantage of the lessons learned from previous programmes and to avoid mistakes made therein.

In recent years, research into innovation policy has brought up views that responding to the major societal challenges of our time (e.g. climate change, digital divides, poverty, exclusion or inequality) requires radically new approaches (Gronchi et al. 2023;

Janssen et al. 2021; Lemola 2021; Mazzucato 2021; Schot & Steinmueller 2018; Weber & Rohracher 2012). Among them, opinions of economist Mariana Mazzucato (2018; 2021) on a *mission-oriented* approach have received widespread attention in the public discourse. The core idea of her approach is that responding to major societal challenges requires ambitious and long-term societal missions. Ambitious missions feed open question setting and the need to rethink matters, which, at its best, promotes creative innovative thinking and the creation of new kinds of networks.

To achieve these missions, extensive cooperation between different actors and policy sectors, bold experiments and strong strategic steering are needed, in which an active and entrepreneurial state plays a key role. Mazzucato highlights the United States' Apollo programme, implemented between 1961 and 1972, as a model example of a mission-oriented approach and its potential. The Apollo programme did not only allow safe flights to and from the moon (for the first time in 1969), but led to many unforeseen technological and organisational innovations as its by-products (see the idea of 'spillover innovations' in chapter 4). Many of these innovations contributed to the revolution of information technology that began in the United States and especially in Silicon Valley in the 1970s.

A mission-oriented approach requires that a jointly approved vision of the desired state can be achieved through broad societal discussion (Figure 9). The actors whose measures play an important role in achieving the vision need genuine trust and faith in the ability to achieve the vision. In practice, this requires that they are able to see the opportunities in the twin transition that can be seized and promoted with determination. The transition will still require a roadmap and milestones, which can be used to create a realistic path towards the future vision. In addition, what is also needed is the long-term commitment of key work-related actors to the roadmap and the achievement of the vision. This commitment manifests as, for example, support for the legislative reforms needed to achieve the vision as well as various experiments or investments in education, development, research and innovation. One of the requirements is the creation of jointly approved procedures for making the necessary changes to the roadmap. Change needs may arise from changes in the operating environment or observed shortcomings in operations.

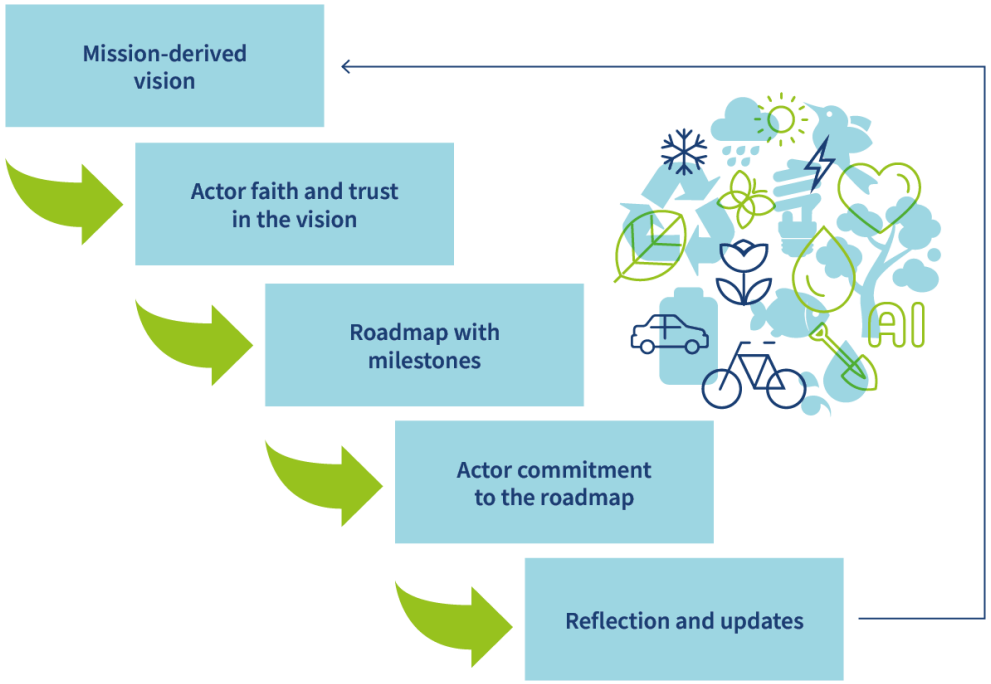

Figure 9. Mission-oriented approach and its stages.

A mission-oriented approach is significantly proactive. As Mazzucato (2021, 8) points out, the main focus is on creating new things rather than repairing existing ones. A proactive approach requires a realistic understanding of the changing operating environment, the opportunities and risks of that change, and the promising and potential developments and solution models that could be used to promote the achievement of the vision, on which the roadmap is based. Projects and programmes can also be utilised in a mission-oriented approach. The difference between a project or programme orientation alone is that the termination of projects or programmes does not mean that the activities end, but that projects and programmes can serve as tools for achieving certain milestones in the roadmap. This helps to avoid the aforementioned problems caused by the intermittent nature of programme-oriented activities, such as the inefficient use of resources and the loss of tacit knowledge.

The mission-oriented approach includes many elements that are necessary to promote systemic change. However, this approach comes with its own major challenges. These include the identification and definition of the mission, the complexity of building the roadmap required to achieve the mission, the long-term nature of the activities required for commitment to the mission and the vision, sufficient coordination of different measures, reconciling the views of stakeholders and political parties, and sufficient reflexivity of the mission to changes in the operating environment (Gronchi et al. 2023; Janssen et al. 2021; OECD 2021).

5.4 Societal challenges in realising the twin transition

The nature of the twin transition as a systemic, long-term and policy-driven change poses many challenges for its implementation. It is possible to analyse these challenges, for example, through the concept of a sociotechnical system used in research on sustainability transformations and by applying the factors highlighted in the research that affect the dynamics of systemic changes (see chapters 3.1 and 5.1). However, in the following, I do not commit directly to any specific framework.

The twin transition is about the intertwining of the green transition and the digital transition. Long-term, forward-looking international and national policy objectives have been set for carbon neutrality and halting biodiversity loss to promote the green transition. However, the commitment of the populace, employers, policy makers and various key societal stakeholders to the objectives may vary. There are many factors that affect commitment. The most important of them are, on one hand, the direct and visible impacts of global warming and biodiversity loss and, on the other hand, the perceived economic, social and other consequences of the green transition. As has already been pointed out in different contexts, the conditions for the green transition are greatly influenced by how it can be implemented in a just manner.

Discourse around the twin transition also includes the idea that digitalisation plays an important role in its realisation. This is influenced by, on the one hand, the new technological opportunities created by the advance of digitalisation and, on the other hand, the ways in which new technological solutions emerge.

The role of digitalisation as part of the green transition will be influenced by how the expectations set for generative artificial intelligence and artificial intelligence in general, the Internet of Things, or augmented and virtual reality applications are realised in the future as different technological leaps. In particular, the rapid development of generative artificial intelligence has generated significant interest in its different

applications. However, expert opinions differ significantly about the revolutionary nature of generative AI for work and for society at large (Goldman Sachs 2024). In particular, the differences of opinion concern the extent of the impacts in work, employment and society, the time span over which the impacts may be revolutionary, and the extent to which the impacts mainly concern more advanced automation of different functions vs. genuinely new business and other opportunities.

In addition to new technological leaps, another important factor for the role of digitalisation as part of the green transition is how new technological solutions are developed. Who develops the technological solutions? What kind of visions and uses guide development? How is the development and use of technologies regulated and steered? It remains to be seen how important the aspects of ecological sustainability and the green transition will become in the future development of digitalisation.

6 Summary and conclusions

The *twin transition* is a concept that has become more common in policy discussions in recent years, referring to the interactive effect and interdependency of the digital transition and the green transition. Research has already created various established approaches, networks and scientific publications around both digitalisation and ecological sustainability. However, digitalisation and ecological sustainability (and its driver, the green transition) have been largely researched separately, even though many thematic concurrences between phenomena have already been discovered, based on previous research (Müller et al. 2024). These include, in particular, discussions on the circular economy and smart manufacturing, or Industry 4.0.

In working life research and scenarios concerning the future of work, technological development has often been considered their most important change factor in the 2000s (Schulte et al. 2020; Shlogl et al. 2021). Instead, interest in ecological sustainability and the green transition as the key drivers of change in work has only started to grow in recent years. Similarly, working life research has not, so far, developed a strong link or research tradition between research on digitalisation and the ecological sustainability of work.

The relationship between the digital and green transitions can be examined from different perspectives. In this report, I separated two levels: the policy level and the work organisation level. My viewpoint was that, at the latter level, the transitions appear to be intertwining means by which organisations can strive to promote their own goals. However, the perspective for the policy level was that the green transition is more clearly a societal vision than the digital transition, and that the digital transition can be regarded largely as a means of promoting the green transition. It was a *value*-based perspective, starting from the assumption that the green transition and the resulting higher ecological sustainability is a more important goal from the point of view of humanity than the digital transition and the economic or other benefits it brings.

In the discourse around the twin transition in working life research, it is important to consider the following aspects:

The first is that the twin transition is linked to an important social dimension. Due to the systemic nature of the twin transition, the overall impacts of the transition are multidimensional. The twin transition can also be promoted by means and solutions that do not appear to be socially just, such as increasing inequality or deteriorating the quality of working life. It is important that both research and broader societal discourse

and decision-making pay attention to the implementation method and impacts of the twin transition in a sufficiently versatile manner, including the social dimension of the transition.

The second aspect is that, while the focus of the twin transition is understandably on industries with the highest CO2 and other greenhouse gas emissions, the transition applies to all industries and occupations. In a modern economy, industries and work organisations are interconnected as diverse value chains, networks and parts of ecosystems. Many of these dependencies and interactive relationships may be fairly invisible and difficult to understand in advance. It is important that both research and broader social discourse and decision-making – similarly to the social dimension – also examine the indirect impacts of the twin transition in a sufficiently versatile manner with regard to different industries and the work organisations and occupations therein.

The third aspect is that, despite the interconnected nature of digitalisation and the green transition, promoting the green transition at the work organisation level is much more than just introducing new technological solutions. At worst, blind faith in technology may even lead to blindness to complementary or alternative solutions. Through their strategy or level of competence, organisations can position themselves in different ways in promoting ecological sustainability as part of their (business) activities (Adams et al. 2016; Christmann et al. 2024; Magnusson & Werner 2023). Recently, there is an increasing amount of research interest in the green behaviour of employees in the workplace (Francoeur et al. 2021; Katz et al. 2022; Veit et al. 2024). This concept does not have a single definition. Generally speaking, green behaviour refers to deliberate and voluntary activities at work for the benefit of the environment that the organisation does not directly require from employees or for which they are not separately rewarded. Forms of green behaviour include reducing waste and environmental emissions in one's own work, taking initiative to promote environmental friendliness and ideas in one's work organisation, or influencing other members of the organisation to promote environmentally friendly activities.

The impacts of the twin transition on work and employment do not seem particularly radical in the next few years. In the longer term, however, they can be revolutionary. The impacts are diverse and are filtered through a wide range of mechanisms. Much of it is about the concrete impacts of global warming on nature and how it and loss of biodiversity directly affect the opportunities to operate for people and work organisations. It is also about the strength of political will to pursue the objectives set for the green transition to a significant degree. There is still much to be done about how the expectations set for technological development, such as generative artificial

intelligence and artificial intelligence in general, the Internet of Things, or augmented and virtual reality applications, will be realised in the future as different technological leaps. What's important for the requirements of the twin transition are also the questions presented at the end of chapter 2, concerning who and what are the developers of technological solutions, what kinds of visions and usage guide the development, and how the development and use of technologies are regulated and steered.

We can forecast that the twin transition will intensify the demand for high-skilled expert work. Expert work is increasingly needed in areas requiring both high technology and environmental expertise in the development of products, services and operating methods. It is a safe assumption that, in the future, there will be a growing need for competence, particularly where these two areas overlap. The growing need to combine technology and environmental expertise may also give rise to new kinds of teams and networks between the experts of different areas.

Another group who can be expected to be particularly affected by the twin transition are the ones that work with the required investments and those affected by the investments. Many of these are blue-collar occupations. The twin transition will lead to an increasing number of new and replacement investments, but it may also lead to selected closures and shutdowns of operations, such as in energy production and the manufacturing sector.

Both of these groups, which are at the centre of the twin transition, are traditionally male dominated. A worrying development is the foreseeable decrease in the supply of labour in Finland as the age groups diminish. In view of the anticipated competence and labour needs of the twin transition, the problem is further aggravated by the stagnation of the level of education and training as well as the growing education gap between men and women, both of which may create a further obstruction to finding workers for the occupations that are expected to grow as a result of the twin transition (Alasoini et al. 2022). The twin transition thus also challenges gender equality. How can we mitigate the educational gap, and how can we boost the share of women in traditionally male-dominated occupations, which are at the centre of the twin transition?

In the future, understanding and influencing the twin transition will enter the agenda of working life research. The most natural perspectives of working life research on the twin transition deal with the social dimension of the transition, such as its impacts and the justness of its implementation. However, justice should not be seen just a moral principle in terms of the transition. The perception of justice can have a significant

impact on the successful implementation of the transition at workplaces and can also reflect on the development of productivity and the well-being of personnel at work in the long term. The position of working life research in the twin transition is strengthened by how much more visionary and societally relevant results it is able to produce alongside more traditional knowledge based on measurements and assesses of impacts afterwards. What is important is not only to diversify the competence of working life researchers but also to engage in network cooperation with researchers, especially in the fields of innovation, sustainability transition and strategic foresight.

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Digitalisation and the green transition are two significant forces of change in work. Digitalisation plays an important role in promoting the green transition, which is why people have started talking about the twin transition in recent years. This publication anticipates the impacts of the twin transition on work and the opportunities it opens up for developing the quality of working life. At the same time, the challenges and tensions inherent in the twin transition are also highlighted. One of these concerns how the transition is implemented to be perceived as fair. The publication presents ways and themes in which working life research can contribute to the implementation of the twin transition in a socially sustainable way. The publication is part of the research project “Understanding and supporting the twin transition as part of well-being at work”, carried out by the Finnish Institute of Occupational Health in 2024–26.

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