New Digital Work and Digital Sovereignty at the Workplace – An Introduction

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Abstract. In this chapter, a framework will be presented for analyzing and designing work systems for digital sovereignty, based on sources from action regulation, control (in the psychological sense), and sociotechnical systems theories. The individual contributions of this edited volume are then classified on the basis of this framework. After discussing specific effects regarding the technology, people, and organization dimensions of digital sovereignty, some more overarching or cross-cutting aspects shall be presented. The chapter concludes with some background information on the history of this publication, which is part of a tradition of contributions on the future of (digital) work.

Keywords: Digital sovereignty · Sociotechnical systems · Action regulation theory

1 New Work and Digital Sovereignty

In an introduction to a volume called 'New Digital Work – Digital Sovereignty at the Workplace', two concepts should be clarified in advance:

- What is 'new' about New Digital Work, since digital work has been with us for more than half a century (Myers 1998; Petrick 2020)?
- How can the concept 'sovereignty' be connected to the digital world, and especially to the world of work (Couture and Toupin 2019; Hartmann 2021a)?

The history of digital work, and also of scientific and practical endeavors to analyze, understand, and design digital work, reaches back until immediately after the Second World War (Shackel 1997). Features like direct manipulation interfaces and gesture recognition were conceived of and prototypically realized in the 1960s (Newman 1968).

What, then, is new? Three aspects appear to bring about new qualities of working with digital technology:

- Immersion, the experience of direct interaction with a digitally mediated or (in parts) digitally created world, and the corresponding tendency towards 'invisible', 'vanishing' human-computer interfaces (Dede 2009; Fishkin et al. 1999; Mayer et al. 2023, this volume).

A. Shajek and E. A. Hartmann (Eds.): *New Digital Work*, pp. 1–15, 2023.
https://doi.org/10.1007/978-3-031-26490-0_1

- The use of Artificial Intelligence (AI) at the workplace, with its potentials to substitute as well as enhance human intelligence, and its effects on a growing lack of transparency of the inner structure and workings of the technology itself (High-Level Expert Group on AI [AI HLEG], 2020; Mueller et al. 2019; Pentenrieder et al. 2023, this volume; Staneva and Elliott 2023, this volume; Zhou et al. 2021).
- Digital labor platforms transforming access to labor markets, contract and working conditions, and workers' rights and opportunities to associate and organize themselves (Harmon and Silberman 2018; ILO – International Labour Organization, 2018, 2021; Yan et al. 2023, this volume)

All these aspects will be addressed in the present volume: Immersion in the context of (global) working environments (Kreuzwieser et al. 2023, this volume; Mayer et al. 2023, this volume), AI in working (Kreuzwieser et al. 2023, this volume; Staneva and Elliott 2023, this volume) and work-related learning (Kimmig et al. 2023, this volume; Windelband 2023, this volume) environments, digital labor and work platforms on a larger scale referring to national or regional labor markets (Yan et al. 2023, this volume).

Regarding the second aspect besides New Work, digital sovereignty, the general discussion covers a broad range of aspects and domains. In their review article, covering scientific literature as well as informal media or publications from social movements, Stephane Couture and Sophie Toupin (Couture and Toupin 2019) identify the following contexts for digital sovereignty:

- Cyberspace sovereignty, referring to the notion that cyberspace itself may be regarded as a sovereign virtual territory, not (necessarily) subject to the sovereignty and authority of national states
- Sovereignty of national states, closely related to the concept of technological sovereignty, which is also discussed as a property or desideratum of national states
- Indigenous digital sovereignty, the use of digital resources by indigenous nations lacking national states and national sovereignty
- Sovereignty of social movements, employing digital technologies to empower themselves facing the power and digital sovereignty of states and big companies
- Sovereignty of the individuals, harnessing digital tools competently for their own purposes

This last aspect, digital sovereignty of the individual, refers to all roles and life domains of humans. Digital sovereignty at the workplace should be a specific part of that, taking into account the specific qualities, structures, and dynamics of work systems and work processes.

To provide a conceptual and theoretical basis, it has been suggested to draw on theories and concepts from work psychology and sociotechnical systems (Hartmann 2021a).

From work psychology, we chose the Dresden School of action regulation theory (Hacker 2005) as a suitable framework for our purposes, because it has been widely applied in ergonomic research and practice in the German-speaking world, provides a broad perspective on human action in work settings, and has also been successfully applied to designing digital work for decades (Hacker 1987).

Furthermore, within the context of action regulation theory, a suitable concept can be identified to conceptualize sovereignty with respect to individuals in work settings. A core meaning of sovereignty – across all domains as described above (Couture and Toupin 2019) – deals with *control*, in the sense of individuals – or groups, movements, corporations, states – having control over their environments. In the context of human work this means: Their working conditions, tasks, tools, working methods.

Rainer Oesterreich has provided a theory combining action regulation and control, which has been used to construct methods for the assessment of working conditions (Oesterreich 1981). This theoretical work may also be fruitful for the description, analysis, and design of digital sovereignty at the workplace, as will be shown in the following section.

To describe human action in work settings appropriately, the whole systemic context, in which human action is embedded, needs to be taken into account. For this purpose, the sociotechnical systems approach is especially well-suited (Cherns 1976; Mühlbradt et al. 2022; Mumford 2006; Trist and Bamforth 1951). Sociotechnical systems consist of technology, people, and organization, being interdependent on and interacting with each other. In designing sociotechnical systems, a joint optimization of all three subsystems is required.

In the following, a framework will be presented for analyzing and designing work systems for digital sovereignty, based on sources from action regulation, control (in the psychological sense), and sociotechnical systems theories.

2 Dimensions of Digital Sovereignty at the Workplace

Following concepts from work psychology, a conceptual matrix for analyzing and designing work systems for digital sovereignty was developed, consisting of three columns and three rows (Hartmann 2022a).

The three columns describe three aspects of digital sovereignty at the workplace:

- Transparency and Explainability: Transparency of the work system as a whole and of the technological system in particular is a prerequisite for humans being able to exercise control. Complex algorithmic and AI-based systems, however, are inherently complex and intransparent – even for the designers of these systems. Thus, transparency must be provided with extra effort. For Machine Learning algorithms like neural networks, the internal structures and processes are principally not accessible for human inspection and understanding; especially in these cases, the inner workings of the algorithm can only be approximated – by other algorithms tuned at describing these inner workings to humans. These are aspects within the domain of Explainable AI, or XAI (AI HLEG, 2020; Mueller et al. 2019; Pentenrieder et al. 2023, this volume).
- Confidence of action – or efficiency (Effizienz) in the sense of Oesterreich (Oesterreich 1981) – refers to the fact that humans, when acting in sociotechnical systems, can be confident that the effects of their action are those which they expected when selecting these actions. Referring to technical systems, this concerns issues like reliability and technical resilience (Hartmann 2021a).

- Finally, freedom of action – divergence (Divergenz) as it is called by Oesterreich (Oesterreich 1981) – describes situations offering humans a range of different courses of action from which they may choose with discretion. This is close to the concepts 'degrees of freedom' (Freiheitsgrade) and 'scope of action' (Handlungsspielraum) as used in action regulation theory (Hacker 2005; Hartmann 2021a).

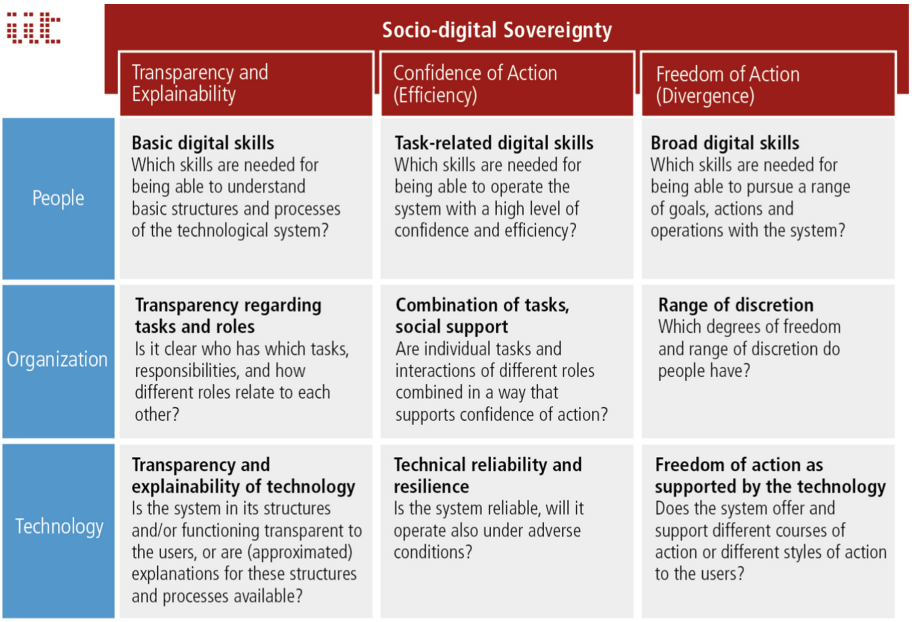

Fig. 1. Dimensions and facets of digital sovereignty at the workplace (Hartmann 2022a)

The three rows correspond to the three sub-systems of sociotechnical systems – technology, people, and organization.

The combination of these three columns and rows yields nine cells of the matrix, facets of digital sovereignty at the workplace. Figure 1 shows leading questions for each of these facets, to illustrate the meaning of these nine facets. To develop this approach further into a tool for assessing digital sovereignty in practical work settings, a set of in total 40 questions has been provided and tested to cover more details of all these aspects and to be applied in the qualitative assessment of work systems. At the moment, this material is developed further towards a methodology suited for the practical analysis and design of work systems in industry. To this end, the questions will be refined, and these qualitative questions will be supplemented by quantitative rating scales.

In the following, the chapters of this volume will be presented referring to this matrix.

3 The Technology Dimension

A very basic and profound aspect of digital sovereignty at work is captured by Liane Bächler and Hauke Behrendt (Bächler and Behrendt 2023, this volume). They have devoted their research to work participation for people with intellectual disabilities and high support needs, and they investigate the potentials of digital technology – specifically: digital assistance systems – for improving the labor market and work participation of this target group.

In their research, they recorded the following statement of one of these people, having experienced a digitally assisted work environment:

"I did that very well. Made it myself."

It is hard to conceive of a statement describing the experience of digital sovereignty in a more apt and concise way. Digital sovereignty refers here to the opportunity to participate at all in 'normal' work settings, in the regular labor market. The special emphasis is here on the confidence of action aspect: the confidence users have in successfully achieving the results they intended. It also fits nicely into a decades-long discussion of the potentials of digital technology to enhance human intelligence and capabilities, a discussion that has gained new impetus with the advent of AI (Petrick 2020; Rheingold 2000; Zhou et al. 2021).

The dark side of this phenomenon, the replacement of human intelligence and human work by AI, is an issue discussed by Mila Staneva and Stuart Elliott (Staneva and Elliott 2023, this volume). They describe five methodological approaches to assess the impact of AI on workplaces: 1) an approach that focuses on occupational tasks and analyses whether these tasks can be automated; 2) an approach that draws on information from patents to assess computer capabilities; 3) indicators that use AI-related job postings as a proxy for AI deployment in firms; 4) measures relying on benchmarks from computer science; 5) and an approach that compares computer capabilities to human skills using standardized tests developed for humans. They present prototypical results from studies using the respective measurement methodologies and discuss their relative strengths and weaknesses.

Among the research discussed in this chapter, there is – of course – the well-known study by Carl Benedikt Frey and Michael Osborne (Frey and Osborne 2013), which was perceived as indicating a huge potential for AI to replace human labor. Later studies, however, find much smaller impacts of AI on the replacement of jobs (Arntz et al. 2016; Nedelkoska and Quintini 2018). Additionally, all these approaches focus on the potential replacement of existing jobs, less so on the generation of new jobs as stimulated by the same technologies.

In the beginning of this introduction chapter, three phenomena were described as bringing about new qualities to New Digital Work: Immersion, AI, and digital labor platforms. Simon Kreuzwieser, Andreas Kimmig, Felix Michels, Rebecca Bulander, Victor Häfner, Jakob Bönsch, and Jivka Ovtcharova cover the first two of them, immersion and AI (Kreuzwieser et al. 2023, this volume), and additionally Robotic Process Automation. Whereas, due to their field of work, Mila Staneva and Stuart Elliott (Staneva and Elliott 2023, this volume) focus on the effects of technology – AI in this case – on the labor

market, the number of jobs affected or potentially replaced, Kreuzwieser and co-authors do not look at the labor market, but rather at the world of work within the companies, and describe the possibilities to improve working conditions by harnessing these three technologies. Regarding AI and Robotic Process Automation, they find that these technologies can relieve employees of repetitive and manual tasks, whereas Virtual Reality is perceived as offering employees new opportunities to collaborate in virtual environments. Similar to Liane Bächler and Hauke Behrendt (Bächler and Behrendt 2023, this volume), they emphasize the potential of advanced digital technologies to improve digital sovereignty, with a special focus on the freedom of action aspect, brought about by new, flexible forms of interaction – human-machine and human-human, mediated through technology –, enabling users to move more freely in time, space, and across different modes of visualization and representation. Additionally, the deliverance from repetitive work opens up new spaces for creativity.

The aspects of confidence of action (Bächler and Behrendt 2023, this volume) and freedom of action (Kreuzwieser et al. 2023, this volume) have now been addressed, remains the aspect of transparency and explainability. A specific and crucial aspect of transparency is the quantification and display of uncertainties regarding the results of algorithmic systems, especially neural networks. Besides giving explanations or approximations of the functional logic of these systems, it is important for the user to know how certain this result is, how big the margin of error, to be able to put this result into context and to decide whether or to which extent to rely on this. Xinyang Wu, Philipp Wagner, and Marco F. Huber investigate methods for this quantification of uncertainty (Wu et al. 2023, this volume). Classical artificial neural networks only compute point estimates and do not provide the user with information regarding the confidence of the estimate, the result of the information processing. Bayesian neural networks extend classical deep neural networks with a probability component and allow the user to view the probability distribution over the prediction. Because of the large number of parameters to be learned, this calculation can only be performed approximately. Several methods have been developed to efficiently learn the parameter distributions for Bayesian neural networks. The respective advantages and disadvantages, as well as the different application areas of these approaches, are discussed in this chapter.

4 The People Dimension

The people dimension of the matrix (Fig. 1) deals with skills, knowledge, competences of people in sociotechnical systems. However, these skills are not only a matter of education or pedagogy. Rather, they are highly contingent on the other two sub-systems: Organizational philosophies define the level and scope of skills needed in every specific position, and technology may contribute decisively to either replacing or enhancing human skills, as was discussed in the previous section. All these organizational and technological factors are subject to choice, to deliberate design.

Taking into account these systemic inter-dependencies, Lars Windelband (Windelband 2023, this volume) refers to three fundamental scenarios for the organizational-technological context, before addressing issues of education:

- Tool scenario/assistance scenario: Design of digital systems with tool character for skilled work. The core idea here is not to replace human work with technology, but rather to use technology in an assistive role to support and enhance skilled human work.
- Automation scenario: Here, conversely, the core idea is to use technology as a tool for the replacement of human work, the effects often being the reduction of the freedom of action of skilled workers and a general devaluation of qualification
- Hybrid scenario: Here, elements of both tool and automation scenario are implemented, and new forms of interaction and cooperation in monitoring and control tasks are leading to new requirements for skilled workers.

Depending on these scenarios, very different challenges and approaches for (continuing) vocational and technical education emerge.

Lars Windelband also provides in-depth information regarding prototypical skills needed for the three facets of digital sovereignty in the first row, the people dimension in Fig. 1, with a focus on task-related digital skills supporting confidence of action.

Furthermore, he discusses a range of digital educational technologies in general, and work-integrated digital assistance systems specifically, regarding their potential for enhancing vocational and technical education. In doing so, he takes up the discourse propagated by Liane Bächler and Hauke Behrendt (Bächler and Behrendt 2023, this volume) and generalizes it towards non-disabled people.

Roman Senderek complements this generic description with a case study from the Mexican automotive industry (Senderek 2023, this volume). In a Mexican-German cooperation, Mexican automotive workers are prepared for new tasks and work environments as brought about by Industry 4.0 (Botthof and Hartmann 2015). The curriculum consists of the following modules:

- Knowledge about new technology-supported and classic concepts of work-related learning in Industry 4.0
- Competence development in the field of productivity management and industrial engineering
- Further training in the field of repair and new production of tools for OEMs and suppliers
- Advanced training in Lean Management methods for Industry 4.0

These competences have a more general orientation than those described by Lars Windelband (Windelband 2023, this volume), and thus refer to broader digital skills, reflecting the freedom of action facet of digital sovereignty (Fig. 1).

When considering skill development and education for New Digital Work, the digital working conditions of the educators have also to be taken into account. Modimowabarwa Kanyane opens this perspective, using the example of the South African higher education system (Kanyane 2023, this volume). Like in other countries, both the Covid-19 pandemic and the fourth industrial revolution (Industry 4.0) have required a digital transformation of the education landscape to offer quality education using digital learning environments. Consequently, many universities have adopted technological tools and

applications as part of their teaching and learning environments. In South Africa, however, the society at large and also the higher education system specifically are characterized by tremendous inequalities, reflecting the wide gap between privileged white and disadvantaged black environments. As a consequence, students as well as teaching staff, especially at black universities, are struggling to get sufficient access to the resources and tools for digital learning, in some cases and regions extending to the precarious or lacking access to radio, television, electricity, or internet connectivity. The South African government has initiated several measures to support academic staff as well as students in coping with the challenges of transformation, like Staffing South Africa's Universities Framework (SSAUF), the New Generation of Academics Programme (nGAP), the University Capacity Development Programme (UCDP), and the University Capacity Development Grant (UCDG). Regarding the sharp inequalities, however, much remains to be done to give all academic staff a fair opportunity to teach, and all students to learn with digital tools in South Africa.

Andreas Kimmig, Jieyang Peng, and Jivka Ovtcharova (Kimmig et al. 2023, this volume) also address capacity building and education for digital work. Their aim is to provide a research and education environment suited for the development of capacities and skills for Industry 4.0.

Therefore, Karlsruhe Institute of Technology (KIT, Germany) and Tongji University (Shanghai, People's Republic of China) have initiated the collaborative 'Construction, Reference Implementation and Verification Platform of Reconfigurable Intelligent Production Systems' or the 'Factory Automation Platform', which provides a functional, advanced technical environment for research and education in intelligent reconfigurable and self-configuring production systems. Core technologies like the Industrial Internet of Things (IIoT), digital twins, and AI algorithms (in this case used to identify detrimental vibrations of machine, tool, and workpiece – chatter – in the production process) are included to provide a technical system with powerful functions, thus establishing a learning environment for advanced technical skills in the Industry 4.0 context.

5 The Organization Dimension

Smart Production Systems are a core concept within Industry 4.0 settings, incorporating technologies like Cyber-Physical Systems (CPS), the Internet of Things (IoT), AI. At the same time, Smart Production Systems are a new way of organizing industrial production. Jochen Deuse, René Wöstmann, Vanessa Weßkamp, David Wagstyl, and Christoph Rieger address these issues in their chapter (Deuse et al. 2023, this volume), and expand the topic from operation to planning of Smart Production Systems. Both operation and planning require new forms of flexible, interdisciplinary organization and collaboration. Technologies like cobots enable new forms of flexible coexistence between human and machine in production. The increasing complexity of products and production systems brings conventional improvement approaches from the fields of Lean Management and Six Sigma to their limits. Data science methods allow the analysis of large volumes of data to identify multivariate patterns and correlations in production systems and processes. All of this leads to new requirements for competences, roles, and work organization.

A specific aspect relates to backlog tools informing all team members about tasks, responsibilities, and the current degrees of fulfillment, providing an excellent example of the transparency/organization facet of the analysis and design matrix for digital sovereignty at the workplace (Fig. 1).

Organizational processes on higher management levels refer to strategic thinking and decision-making. Scenario-based foresight, employing data science and AI methods, is a promising tool to support this strategic thinking and decision-making. Scenario-based foresight rests on two assumptions: 1) Networked thinking, i.e., the consideration of the interconnectedness of influence factors, and 2) multiple futures, i.e., it is not possible to predict the future and therefore different development paths must be considered. Patrick Ködding, Christian Koldewey, and Roman Dumitrescu describe and discuss 14 use cases of corporate scenario-based foresight (Ködding et al. 2023, this volume). These use cases can be realized using 23 different digital technologies. Currently, digital technologies (still) play a minor role in scenario-based foresight. Digital technologies primarily provide support for tasks in which large volumes of data are processed and analyzed, e.g., in the context of identifying influence factors. Text mining approaches are particularly suitable for analyzing large amounts of data in order to generate suggestions for influence factors. Other use cases aim at reducing the evaluation effort in determining scenarios or refer to the elaboration of the scenarios. Digital technologies can provide the input for this activity, e.g., by means of a classification of useful documents by a dictionary algorithm; the creative elaboration itself is ultimately carried out by humans. Scenario-based foresight enhances specifically the freedom of action facet regarding the organization (Fig. 1), as it opens up new pathways of thought and action.

Immersive technologies allow organizations to arrange collaboration not only across time and space but also across the reality-virtuality continuum. Anjela Mayer, Jean-Rémy Chardonnet, Polina Häfner, and Jivka Ovtcharova investigate global collaboration in the context of digital transformation and discuss the role of Collaborative Virtual Environments (CVEs) within this transformation process (Mayer et al. 2023, this volume). Like in the educational case discussed above (Kanyane 2023, this volume), Covid-19 as well as Industry 4.0 increased the pressure, and also the opportunity, for organizations to shift towards remote interaction and collaboration.

Challenges for CVEs include the acceptance of these technologies by employees, which in turn is influenced by the convenience and ease of visual perception in VR, avoiding e. g. misperception of distances and scales, the (absence of) cybersickness, and the quality of interaction modalities (e.g. interacting by natural movement, like walking).

CVE application domains include business, engineering, and education, which provides a suitable cross-reference to the topics discussed in the previous section. There are many possible effects of CVE on working conditions, positive ones like meetings being more consistently structured, and negative ones like feelings of being socially disconnected. Regarding the matrix in Fig. 1, the most prominent aspect is the freedom of action/organization facet, because many qualitatively new possibilities for designing collaboration become available.

6 Overarching and Cross-Cutting Aspects

After discussing specific effects regarding the technology, people, and organization dimensions of digital sovereignty, some more overarching or cross-cutting aspects shall be presented. Annelie Pentenrieder, Peter Hahn, Scarlet Schaffrath, Benedikt Krieger, Stefanie Brzoska, Robert Peters, Matthias Künzel, and Ernst Hartmann present an approach that uses the whole matrix as depicted in Fig. 1 as a tool for analyzing and designing the implementation of algorithmic and AI-based technology in sociotechnical systems (Pentenrieder et al. 2023, this volume). As described above, leading questions were formulated for each of the nine facets of digital sovereignty at the workplace.

In co-creation workshops, potential users are presented with design solutions for industrial work systems. The cases investigated so far were taken from automotive industry, brewery, and machine building. When presented with the design of the work systems, participants were encouraged to discuss these solutions, using their own ideas and questions as well as the leading questions from the matrix. Besides asking questions, the participants also suggested improvements to the solutions presented. As a special feature of the workshop, artists trained in Graphic Recording were present to turn the participants' ideas into visual presentations of improved design solutions. In this chapter, the method is described in detail, and recommendations for future applications and further developments are given. The approach, obviously, addresses all facets of the digital sovereignty matrix in a holistic analysis and design methodology.

New Digital Work is embedded in a broader digital transformation process affecting national economies and societies as well as global cooperation and competition. The next two chapters to be discussed here refer to these encompassing transformation processes.

Over the past decades, globalization has continuously increased, supported by advanced digital communication and production technologies, leading to integrated global supply chains. Thorsten Lammers, Matthias Guertler, Nathalie Sick, and Jochen Deuse (Lammers et al. 2023, this volume) consider Australia's position in this context.

In Australia, due to its remote geographic location and specific socioeconomic conditions, globalization has resulted in a loss of domestic manufacturing capabilities. With recent changes in the geopolitical environment (trade wars, actual wars, Covid-19, climate crisis, etc.) local production is becoming more attractive. The authors explore the potential of digital technologies to improve Australia's capabilities for reshoring manufacturing. Findings indicate that a highly skilled digital workforce is needed to leverage the country's potential in world-leading niche manufacturing. The Associate Degree of Advanced Manufacturing, developed and delivered by the Centre for Advanced Manufacturing at the University of Technology Sydney (UTS), is presented as an example of how to upskill the manufacturing workforce.

East Asia – and the neighboring Pacific and South East Asian regions – is a very large and diverse region, including frontier, emerging, and developed markets, among them worldwide leading economies in terms of digital transformation. Min-Ren Yan, Alexandra Shajek, and Ernst Hartmann give an overview of the situation regarding New Digital Work in the region and provide an in-depth analysis of developments in Taiwan (Yan et al. 2023, this volume). Issues relevant across East Asia – in different forms for the individual countries, but important for all – include occupational health, and gender inequalities when it comes to labor market participation and career development.

An important factor of digital transformation in Asia is the emergence of digital labor platforms, affecting especially India, the Philippines, and Pakistan in terms of inflow of work and earnings from abroad, via freelance platforms. The People's Republic of China is one of the world's largest platform economies, and labor platforms have been actively promoted by the government and media. There is some concern regarding the working and contract conditions, and workers' rights, within digital platform work (ILO – International Labour Organization 2018, 2021).

In Taiwan, as a leading technology developer and manufacturer, especially in the semiconductor branch, the government has been busy providing conducive conditions for Taiwan to keep its competitive edge. In inter-departmental cooperation, programs have been implemented addressing the development of AI talents, international cooperation in AI research, fostering startup foundations, and academia-industry cooperation, especially with respect to SMEs.

A final contribution to this volume gives a critical reflection on the notion of digital sovereignty itself. The concept of digital sovereignty may be (mis-)understood as an approach to 'make things simple', to generate environments where humans may act as they like, and always achieve the results they wanted and predicted, by employing simple, clear, and straightforward actions. (Un-)fortunately, the world is not like this. As Thomas Mühlbradt (Mühlbradt, 2023, this volume) points out, sociotechnical systems are inherently complex systems, at least most of them. As a prototypical example of complex sociotechnical systems, he considers work in the healthcare system. One consequence of this complexity is that appropriate methods for analyzing, modeling, and designing – or better: developing – sociotechnical systems will always preserve this complexity in some way, thus not yielding very neat and simple results, but rather results that require some effort to (fully) understand and put into context and practice. In fact, the results yielded by the digital sovereignty matrix as shown in Fig. 1 (Pentenrieder et al. 2023, this volume) are rather complex, but domain experts seem to like this quality, because it gives them the information they need to understand what is the situation in a given case. Conversely, these experts would rather be worried by approaches they would feel to be overly simplistic or reductionist.

As a second consequence, digital sovereignty in complex sociotechnical systems also requires complex competences, abilities to deal with dynamic, semi-intransparent, ambiguous situations. Thomas Mühlbradt gives an example of how these competences may be developed, by demonstrating modules from the Master of Science in Industrial and Organizational Psychology program at FOM University of Applied Science (based in Essen, North Rhine-Westphalia, Germany).

7 Concluding Remarks

Within the concluding remarks to an introduction chapter of an edited volume, it might be appropriate to give some background information on the history of this collaborative publication, of where all this came from, and how it was brought about.

Since early in the 2010–2020 decade, the Institute for Innovation + Technology (iit, Berlin, Germany) has been involved in accompanying research in the context of research and development programs in the domain of Industry 4.0, funded by the German Federal Ministry of Economic Affairs and Climate Action (abbreviated BMWK,

formerly BMWi). During this research, it became evident that the future of work would be a topic of outstanding public, political, and scientific interest, and that this issue should be addressed by the accompanying research, and also by the individual R&D projects, in their respective contexts. To start this discourse, a small-group, informal expert talk was organized, bringing together participants from industry – automotive, machine components, robotics, logistic systems – with researchers from Mechanical Engineering/Production Systems, Ergonomics/Work Psychology, Electronics and Communications Engineering, Industrial Sociology, and Computer Science. This discussion was very fruitful and it was decided to elaborate on the contents by making up a common publication on the future of work in Industry 4.0, which was published in German as a printed as well as an open access online publication (Botthof and Hartmann 2015), and turned out to become one of the most accessed among all of Springer's open-access publications (with more than 1.8 million accesses; November 2022).

A second volume followed (Wischmann and Hartmann 2018), providing practical examples of how the R&D projects took up these impulses in their research and development activities.

For quite a while it was discussed how a further publication in this line should look like. The final decision was: It should take up the core philosophy of the successful 2015 publication, but with major content updates, with a broader perspective beyond Germany, and in English.

Seven authors from the two former volumes – namely Liane Bächler, Hauke Behrendt, Jochen Deuse, Ernst Hartmann, Jivka Ovtcharova, Thomas Mühlbradt, and Roman Senderek – contribute again to this volume. The other authors are colleagues involved in research and discourses with one or the other of the former authors and editors.

Another relevant context for this publication is iit's project 'Digital Sovereignty in the Economy', funded by Dr. Johannes Heidenhain GmbH, a leading provider of industrial measurement devices and controllers for CNC machine tools. This project is explicitly not designed to provide individual services for Heidenhain, its goal is rather to stimulate a broad discussion on digital sovereignty in the economy, taking enterprises as well as employees into account. Regarding all content-related and scientific issues, iit operates within this project autonomously, without control or guidance by Heidenhain. Within this project, iit performs analyses on workplace and company level, a group of junior scientists/PhD candidates is supported in their research, symposia are organized, and edited books are published. Two of these books are already available (Hartmann 2021b, 2022b), the third one is the present volume. A fourth volume, addressing digital sovereignty on the company level, is planned for 2023, and will also be published in English.

Thus, this volume combines two lines of tradition. A relatively broad range of topics and global regions is addressed, by authors from a variety of academic disciplines. As described in the previous sections of this chapter, the contributions cover the domain of digital sovereignty at the workplace rather comprehensively, focusing on specific aspects for each sub-domain.

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