Swedish Agency for Work
Environment Expertise

Work environment of the future – trends, digitalization and employment forms: three systematic reviews

REPORT 2020:1

WORK ENVIRONMENT OF THE FUTURE – TRENDS, DIGITALIZATION AND EMPLOYMENT FORMS
Government mandate to compile knowledge about working life in the future A2018/00929/ARM
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Swedish Agency for Work Environment Expertise
Box 6051, SE-800 06 Gävle
Telephone: 00 46 2614 84 00, Email: info@mynak.se
www.sawee.se

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This report is written by:

Jörgen Eklund	(Part 1)
Kristina Palm	(Part 2)
Ann Bergman	(Part 2)
Calle Rosenblad	(Part 2)
Gunnar Aronsson	(Part 3)

Foreword

In its 2018 letter of appropriation, the Swedish government mandated the Swedish Agency for Work Environment Expertise (SAWEE) with the task of compiling national and international research on working life in the future. Based on this compilation and analysis, the assignment was to formulate in-depth literature reviews in selected fields. The mandate also includes identifying knowledge gaps A2018/00929/ARM, A2018/00212/ARM (partially), A2018/00498/ ARM (partially).

In order to carry out the government mandate, the agency tasked a number of researchers from various universities and colleges with formulating literature reviews in a total of four areas: work environment trends, digitalization, employment forms and organizational change expertiseThis report presents the literature review Work environment of the future – trends, digitalization and employment forms. The literature review includes three independent sub-compilations:

The literature review on work environment trends was written by Jörgen Eklund, Professor Emeritus at the Royal Institute of Technology (KTH). Professor Emeritus Roland Kadefors at the University of Gothenburg has reviewed the quality of the synthesis at the behest of the agency. The librarians Malin Almstedt Jansson at the University of Gävle and Maivor Hallén, library manager at Lund University's Faculty of Engineering, as well as Lina Andrén at KTH assisted our external experts in identifying and developing a scientific basis for this literature review.

The literature review on digitalization was written by Associate Professor Kristina Palm at Karolinska Institutet, KTH and Karlstad University, Professor Ann Bergman at Karlstad University , and PhD Calle Rosengren at Lund University. Professor Mattias Elg at Linköping University has reviewed the quality of the compilation at the behest of the agency. The librarians Malin Almstedt Jansson at the University of Gävle as well as Berit Hjort and Annelie Ekberg-Andersson at Karlstad University Library have assisted our external experts in identifying and developing a scientific basis for this literature review.

The literature review on employment forms was written by Professor Emeritus Gunnar Aronsson at Stockholm University. Professor Emeritus Bengt Furåker at the University of Gothenburg has reviewed the quality of the synthesis at the behest of the agency. The librarians Malin Almstedt Jansson at the University of Gävle and Maivor Hallén, library manager at Lund University's Faculty of Engineering have assisted our external experts in identifying and developing a scientific basis for this literature review.

In the literature review Work environment of the future – trends, digitalization and employment forms, it is clear that mapping and presenting the consequences of changes using a scientific approach is difficult, because it takes time for the effects of change processes to be noticed, established and researched. Still, the literature review successfully demonstrates that the impact of digitalization on organizational and social work environments is highly complex. The effects can be both positive and negative, depending on other factors in the relevant work environment. Furthermore, the literature review identifies several new employment forms and assesses them with respect to the work environment. The literature review demonstrates indications of a connection between temporary employment and illness.

The authors of the literature reviews have chosen the theoretical and methodological starting points themselves and are responsible for the results and conclusions presented in the literature review.

I wish to thank our external researchers and quality reviewers as well as employees at the agency who have contributed to producing this valuable literature review.

The literature review is published on the agency's website and in the Literature Review series.

Gävle, February 2020

Nader Ahmadi
Director-General

Our process model for systematic reviews

To support the researchers in their preparation of this literature review, the Swedish Agency for Work Environment Expertise developed a system for the systematic creation of literature compilations in its area of responsibility. It contains systems of preparation, literature search, relevance assessment, quality assurance and the presentation of studies and results. It also includes the Agency's process management and university library support, as well as external quality assurance.

The responsible process manager for developing the literature review at the Swedish Agency for Work Environment Expertise was Helena Jahncke, first, followed by Annette Nylund. Susanne Lind administered the process and a team of communications officers comprising Pernilla Bjärne, Sverre Lundqvist, Liv Nilsson, Joakim Silfverberg and Camilla Wengelin were responsible for managing the text, layout and accessibility as well as for planning webinars and podcasts.

Introduction

The overarching purpose of this literature review is to provide a summary and overview of knowledge derived from research literature on work environment trends, particularly digitalization and new employment forms, with an emphasis on consequences for the work environment. While Swedish work environments comprised the point of departure, research conducted in other European countries was also included, as much of the research that is relevant for European conditions may also be relevant for Swedish conditions.

To clarify the structure of this literature review, the three areas have been divided into three separate parts: the first covers work environment trends; the second covers digitalization; and the third covers employment forms and health. The report concludes with final comments from the authors.

The three literature reviews were written as rapid reviews. In addition, the literature reviews on work environment trends and employment forms were written as umbrella reviews, in which the goal was to compile knowledge primarily from completed literature reviews, if possible.

The literature review on digitalization was based on a compilation of original studies.

Another goal of the literature reviews was to pinpoint gaps in the research and future research needs.

The target groups for the literature reviews are employers, employees, decision-makers, union representatives, politicians, researchers, research financiers, experts, occupational health service and students, i.e. people who have contact with work environment issues. Efforts have therefore been made to ensure the language in the report is accessible to all and that complex terminology is avoided or explained.

The five experts who worked on the literature reviews collaborated on the purposes and questions of the various parts, discussed search strategies and the framework of the report together, and co-wrote the introduction and final comments. The three literature reviews were written by each respective expert/expert group. After their completion, the different parts were reviewed by external expert researchers in each field, and the reviewers' comments were factored into the final version. The authors are responsible for the syntheses and their wording.

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Part 1 – Work environment trends

Summary

The purpose of this report is to compile knowledge about changes and trends with regard to work environments in Sweden, and knowledge about how these work environment trends are related to changes and trends in the surrounding world (at the societal, organizational and individual levels) in cases where such relationships could be identified. The purpose is also to point out knowledge gaps in the research and future research needs. Systematic literature searches were conducted in the Scopus, Web of Science and Ergonomics Abstracts databases. Of the 3,049 hits that were reviewed based on the inclusion and exclusion criteria and also for quality, 20 articles published from the year 2000 and later were included.

The results show the scientific literature contains a limited number of studies on the work environment of the future and work environment trends, and they vary with regard to content, focus, method use and areas of application. Thus there is no established research tradition within the field and the quality of the studies varies. The included studies were different kinds of literature reviews, interview studies, survey studies, register studies and studies of publication traditions. Only a few studies are from Sweden and Scandinavia. The review therefore does not claim to be comprehensive.

Rapid technological development means that technology will take over certain work tasks to an increasing degree, but the development will also create new jobs and sometimes improved work environments. Technology will also change the nature of the remaining jobs and thus the work environment as well. People who are currently employed are not particularly concerned about the possibility of new technology taking over their jobs, but increased awareness of this development may have negative consequences on perceptions of one's job situation. More knowledge and research is needed on technological changes and their consequences for people in the workplace, and especially on how technology can be designed to contribute to a better work environment. Research on psychosocial and organizational work environments has increased with time, especially on issues related to stress and exhaustion. Societal trends such as globalization, flexibilization and international competition have been assessed as potentially leading to a worse work environment and safety, increased demands, worse working hours, lower pay, and centralized power and control, as well as lost jobs. Other studies have pointed to the possibilities of expanded collaboration in team-based organizations, more organizational collaborations in networks, less hierarchical organizations and reduced managerial control, as well as greater control among individuals over their work and workplace. The positive development has been observed primarily in advanced, highly technological and knowledge-intensive jobs, while the negative development has been observed primarily in labour-intensive service jobs, including schools, health care and social services. More research and knowledge is needed about how new organizational forms influence the work environment, and especially about how to implement improvements.

One trend in the field of safety is a greater focus on safety management systems as well as safety culture. The best results are obtained when these systems are integrated into an organization's decision-making processes. Additional needs include engagement from top management, actively participating and involved employees, trained and motivated managers and supervisors, and a management system that is relevant and adapted to suit the organization. Regulations have been developed for a systematic, process-based self-con-

trol model. More systematic forms of cooperation are needed in the future.
Demographic changes and a higher retirement age generate a need for more research in order to develop organizations and technology to provide support for older people to carry out their work duties, and to leverage their skills and experience. Furthermore, more research is needed into why violence, threats and harassment have increased.

In general, most studies have involved risks and work environment problems. More research is needed on factors that create a positive, stimulating work environment that promotes development, health and learning. Moreover, outcome measures are often used that describe effects on safety, health and well-being. Future studies must also include organizations' system effects, such as efficiency, quality, innovation and learning. Work environment issues must be taken from the individual level to the organizational and societal levels for them to be able to strategically support operations. Moving forward, research studies must be designed to establish causal relationships. Statistical correlations are insufficient. Furthermore, intervention research that can provide insight into the effects of various work environment measures is needed at the work environment level and at the organizational and societal levels. These studies should include financial consequences and system efficiency.

1. Introduction

This section of the report presents the literature review on work environment trends. The underlying approach is that societal changes and trends can influence work environments. The opposite can also occur, i.e., changes in the work environment can influence societal changes, and research findings can influence work environments. By identifying societal trends, a basis can be created for potential development of the work environment. Numerous societal trends have been identified in various reports and studies, and these can provide a basis for potential work environment developments. For example, EU-OSHA identified 92 societal trends in one report. It is also possible to monitor the evolution of work environments via different kinds of indicators, such as statistics or research publications. Two relevant trends include new employment forms and digitalization, which are addressed in two separate literature reviews within the framework of this report.

Trends

According to the Swedish National Encyclopaedia, a trend is "a stable, long-term societal change regarding economics, demographics, values, interests or consumption patterns". With time, something that was thought to be a trend may turn out to be a temporary change. "Stable" and "long-term" mean there are clear signs that this change is underway, it has lasted for an extended period of time, and it has evolved in a given direction. Another variation is a new emerging trend. Only after a period of time has passed is it possible to see if a trend is long-term or fleeting.

Work environment

The WHO defines the work environment in accordance with the following: work environment is an overarching term for biological, medical, physiological, psychological, social and technical factors affecting individuals at work or in the workplace environment. Another approach is to include work environment factors such as noise; lighting; ventilation; climate; vibrations; physical ergonomics; work physiology; psychosocial and organizational work environment; safety; radiation, as well as chemical and biological health risks. In other words, the concept encompasses various kinds of influences that can have positive or negative consequences for health and well-being among the people who work in different kinds of work environments. The concept can be broadened to include effects, not only on safety, health and well-being, but also system effects, including organizational performance.

A salutogenic perspective

One change in the approach to the significance of the work environment on health and illness is that older studies focused on causes of illness, for example by identifying risk factors in order to eliminate them. More recently, a salutogenic perspective has become more common, i.e., focusing on factors that contribute to health, known as wellness factors, and then focusing on reinforcing their presence. The basic premise is that different factors contribute to illness and health, respectively, and both approaches therefore complement one another.

Purpose and limitations

The purpose of this report is to compile knowledge about changes and trends with regard to work environments in Sweden, and knowledge about how these work environment trends are related to changes and trends in the surrounding world (at the societal, organizational and individual levels) in cases where such relationships could be identified. The purpose is also to point out knowledge gaps in the research and future research needs. The literature review is limited to identifying overarching work environment trends. This means that the review does not include trends at the detail level, such as changes among individual professional groups or specific kinds of exposure, such as exposure to particular chemical substances or heavy lifting. In addition, the material is limited to relevant factors for Sweden and Europe. The literature review was written as a rapid review and an umbrella review, compiled primarily from previously completed literature reviews if possible.

2. Method

Literature search

As a basis for this systematic literature review, a literature search was conducted in two international databases, Scopus and Web of Science, comprising extensive studies in English, published from January 2000 to June 2019. An additional search was conducted in the database Ergonomics Abstracts, which included research publications from January 2000 through October 2019.

The search process as well as inclusion and exclusion criteria are described in Appendix B, which also describes the quality criteria employed. The searches produced 3,808 articles and after eliminating duplicates and reviewing for relevance and quality, 20 articles remained that were included.

The 20 included articles are first described in a table to provide an overview. In the next step, the results are compiled in greater detail under seven headings. Efforts were made with this report of results to give consideration to the methodology and strengths of the individual publications as much as possible.

Appendix A has the complete references for the 20 included articles. Appendix B includes detailed descriptions of methodology and search strings, and describes the search processes for the three databases.

3. The result

Result compilation

Table 1: Descriptions of the studies included in the literature review in table format.

Reference	Type of study	Method	Conclusions
Brougham & Haar, 2018	Literature review and cross-sectional study with survey	A literature review was carried out in the field, but it was not systematic. A survey including open-ended questions was developed to capture these issues; it was sent to employees of 200 companies in the service sector, resulting in 120 responses (response rate: 26.8%).	Many researchers believe smart technology, artificial intelligence, robotics and algorithms (STARA) – in other words, new technology – may take over a large share of today's jobs. Figures of up to 40% by 2025 have been reported. But little research has been conducted on how employees perceive this technological development, especially relative to their own jobs. The overarching results showed that in general, employees are not particularly concerned about this development. The results also showed that a higher degree of awareness about the potential of technology to take over jobs was negatively correlated with organizational commitment and career satisfaction, as well as positively correlated with turnover intentions, cynicism and depression.
De Bruyne & Gerritze, 2018	Focus group, Delphi study and workshop	From a literature study, eight themes were defined for the study. Focus groups were held with 120 participants and two Delphi studies via survey with 82 participants. Finally, a concluding workshop was held.	The study aimed to describe how future office work may look. Automation, digitalization and more flexible jobs were deemed to be strong trends. More short-term jobs and need-adapted teams of self-employed workers are expected to be able to complete tasks faster and with greater flexibility. Attracting and hiring talent is expected to pose a large challenge. Greater control over one's work and workplace is expected, but balance between work and free time will simultaneously be harder to achieve due to increased demands for flexibility.
Burr et al., 2003	Register study based on the Danish Work Environment Cohort	Data were collected from interviews in 1990, 1995 and 2000, and analysed using cross-sectional comparisons. Respondents numbered 6,067; 5,454 and 5,404, and the response rates were 90%, 80% and 74% for the three rounds.	The work environment for Danish employees improved between 1990 and 2000, except for long working hours and noise. Fewer people reported low job control and skin contact with cleaning agents, but this can be explained by the fact that a reduced share of the population had this kind of job. The study suggests that work environment improvements were not caused by interventions, but by changes in the number of active people in various professional groups. Examples of professional groups that declined in number included clerks, cleaners and military personnel, while academics, computer professionals and salespeople increased in number.
Calzavara et al., 2019	Systematic literature review	A search in Scopus produced.4,061 publications, of which 86 studies were included.	The studies were grouped in different areas, primarily functional capacity among older workers, their capacity in industrial jobs, their expertise and experience, as well as potential to create support systems for them. Many studies show that the physical and cognitive abilities of older people decline with age, but this does not necessarily impact productivity. The knowledge and experience of older people can compensate for less energy and reduced physical abilities. There are many new technological opportunities for supporting older workers, such as collaborative robots, exoskeletons and VR glasses. Research is limited on the combination of support systems and older people in particular, which could have a positive impact on the work environment for older workers.

Reference	Type of study	Method	Conclusions
Cascio & Aguinis, 2008	Content analysis of publication trends in two journals in the field of industrial and organizational psychology	Content analysis of all articles (5,780) in the Journal of Applied Psychology and Personnel Psychology from the period 1963–2007 in 15 broad areas and 50 sub-areas.	Some publication areas became more popular over time, while other areas became less popular or barely changed. The most common areas were methodology and psychometric issues. "Human factors" and applied experimental psychology declined sharply throughout the time period, and now there are very few publications in these areas.
Chung & Williamsson, 2018	Content analysis of publication trends in the top three journals in ergonomics	A total of 425 articles were randomly selected from the period 1960–2010. They were analysed based on applicability in practice and content.	Applied research and collaboration between research and industry have increased. Larger research teams have worked with empirical research to a greater extent. There are indications that the gap between research and practice has declined somewhat over time.
Gallagher & Underhill, 2012	Literature review of developments and future directions of occupational health and safety.	The article focused primarily on the impact of labour market and organizational changes on occupational health and safety, the role of management systems and growing psychosocial risks at work (96 references included in this article).	Use of occupational health and safety management systems has produced mixed results and therefore faces future challenges. New methods are needed in which organizations focus on a systematic collaborative approach to identifying and controlling workplace risks, and on integrating occupational health and safety management into broader systems in the organization and everyday management.
Leka et al., 2016	A qualitative interview study	The article is based on individual interviews of 40 participants and two focus group interviews of 18 participants and their views on occupational health and safety. The data were analysed thematically.	The landscape of occupational health and safety has changed, for example with regard to regulations and standards, because the world has changed. According to current trends, occupational health and safety is thought to have too many rules relative to the risks. There is too much focus on safety and too little on issues of health. Poor financial resources reduce the inclination to permit occupational health and safety issues to have an impact. Future needs include a long-term approach that is decoupled from politics, and more education among key stakeholders. Furthermore, better collaboration among actors in the field is required.
Härenstam et al., 2005	Cross-sectional study, secondary analysis of data from the earlier MOA study	Data collected via interviews, surveys, observations and measurements among 210 representative employees.	Work environment conditions in three kinds of operations were studied and the results show that development differs in these different operations. Based on previous research, trends were identified in working life, including a worsened psychosocial work environment. Other trends included centralization of power and control in organizations, while responsibility has been individualized; and flexibilization, where employees work based on the needs of the organization.
Koukoulaki, 2010	Literature compilation	Literature was collected on new trends in the work environment and the article describes how these trends are related to safety (57 references included in this article).	New work environments may lead to negative effects on safety, but research on this relationship is limited. New forms of organization like "downsizing" (staff reductions) and "outsourcing" (hiring subcontractors) have been shown to have a negative impact on safety and health. This also applies to temporary employment, piece work and immigrants. Development towards more sustainable work systems could contribute to improved safety.

Reference	Type of study	Method	Conclusions
Murphy & Sauter, 2004	Literature overview	Literature was collected on organization interventions, for the purpose of identifying knowledge gaps and pointing out future need for intervention research (49 references included in this article).	The interventions were classified based on four foci: legislative/policy, employer/organization, job/task and individual. The interventions were also categorized as primary, secondary or tertiary. The results show that most research studies are about individual interventions. In general, the results are mixed. The recommendation is that research should focus on organization interventions to a greater extent, and also on improving intervention methodology.
Oechsler, 2000	Compilation of previous research projects	Trend extrapolation, simulation and Delphi study in two previous research projects	Identified trends included flexibilization, decentralization and globalization. They are expected to have a large impact on employees, their work environment and occupational health services. New risks will arise, which will place new demands on occupational health professionals and work environment regulations.
Bendak, 2003	Literature review	Compilation of 53 studies on the consequences of 12-hour workdays for occupational health and safety	The compilation shows contradictory results when 12-hour workdays are compared to 8-hour workdays. Many employees prefer to work 12-hour shifts compared to 8-hour shifts. However, there are negative effects concerning fatigue, exhaustion, accident risk, sleep disturbances, impaired work performance and errors, especially in jobs with a heavy workload. There is very little knowledge about how long workdays impact physical and chemical risks.
Bliese et al., 2017	Literature review	Compilation of word frequency in the summaries of 606 studies of stress in the Journal of Applied Psychology 1917–2017	Research on stress and well-being at work has increased in scope over time. Theories, concepts and measurement methods have been developed in the field. Societal trends have been reflected in the research to a greater extent. More research is needed on causal relationships, not just correlations. Research is also needed on the mechanisms behind the development of stress-related illness.
Choudhry et al., 2007	Literature review	Compilation of 27 studies addressing safety culture between 1998 and 2006	The article presents an overview of definitions, terms and models used in the field of safety. The concept has evolved over several decades and in order to function well, a good safety culture must be integrated with the safety management system. Reactive initiatives that measure the outcomes of accidents, for example, highlight situations in which the systems fail. They are gradually being replaced by proactive initiatives, in which the safety climate is measured and safety-improving activities are in focus within the framework of a well-functioning safety management system.
Gallie, 2005	Survey study	Survey study of work pressure in 14 EU countries in 1996 and 2001, including employees and about 1,000 respondents per country	A reduction in work pressure was experienced between 1996 and 2001 in the EU and Sweden. However, Sweden was the highest of the 14 countries. The analysis indicated that reduced working hours could have contributed to the trend.
Oldham & Fried, 2016	Literature review	Review of research literature spanning more than 50 years on job design (220 references included in this article)	Different trends related to job design have included specialization, standardization, motivation, job satisfaction, work enrichment, the character of the work and demand-control. One interesting, relatively new direction is the tradition known as “job crafting”, which involves employees taking the initiative to shape their own work.
Radjiyev et al., 2015	Analysis of publishing trends	From 11 leading journals on ergonomics, 5,648 articles were identified-between 1992 and 2011 on ergonomics and sustainable development.	The number of publications in the field of ergonomics is growing with time, but their share of all scientific publication is decreasing. Both the number and share of publications within sustainable development are increasing. There are several fields where the disciplines overlap, such as safety and health.

Reference	Type of study	Method	Conclusions
Roetting & Luzak, 2001	Interview study	About 120 experts with a connection to occupational health and safety were interviewed about their views on the research between 1980 and 2000 as well as proposals for future research.	The article concludes that research in occupational health and safety in Germany prior to the turn of the new millennium focused primarily on the working individual and workplace, and that no major changes occurred over the years.
Sonntag, 2001	Content analysis and interviews	Qualitative content analysis of 216 research projects from two large programmes and interviews with 32 experts from 11 projects, from Germany between 1980 and 2000.	Occupational psychology and safety research used to be focused on individuals and behaviour. This focus expanded to include work, stress, resources and integrated models for safety and health. A focus on a combination of the individual and situation comprised the most common strategies.

Result and discussion based on subject areas

The articles that were ultimately included in the literature review vary significantly with regard to methodology, questions, content and focus areas. Of the 20 included articles, only one was authored by Swedish researchers; one article was authored by Danish researchers and one article had a Norwegian co-author.

It is also notable that the Swedish and Danish articles, and three other articles, were written by authors from a national occupational health and safety institute. It is thus thought that literature reviews on work environment trends have an important place among national institutes, even if universities also conduct these reviews. The structure of the result report below is based on subject areas or questions.

Technology

Rapid technological development has created new possibilities for technology to take over tasks that were once manual. This development includes smart technology, artificial intelligence, robotics and algorithms, and these new technological areas are referred to by the acronym STARA.

Many researchers believe the new technology could take over a large share of today's jobs. According to some estimates, up to 40 per cent of tasks could disappear by 2025 due to these developments. Other tasks will be created, and sometimes work environments will be improved. However, little research has been conducted on how employees perceive this technological development, especially in terms of possible changes to their own jobs. One literature review and one survey study address this issue. The overarching results showed that in general, employees are not particularly concerned that technological developments may take over their jobs. They also showed that employees with greater awareness of the potential of technology to take over jobs had lower organizational commitment and less career satisfaction. These individuals also had greater intention to change jobs, more cynicism and more depression than those who were less aware of the potential of technology (Brougham & Haar, 2019).

Work organization and the psychosocial work environment

Bliese et al. (2017) point out in their literature review that research on stress and well-being at work has increased in scope in the past 100 years. This field has evolved significantly, with the development of new theories, concept definitions and new measurement methods. The authors saw social trends reflected in the

research to an increasing extent in the analysis of published research articles in the Journal of Applied Psychology between 1917 and 2017. These trends included globalization, economics, market changes, and information and communication technology. Furthermore, the increased share of women in the labour market and the growth of jobs in the service sector have changed the conditions for stress at work. Developments have blurred the lines between work and free time, which elevates the risk of conflicts between work and family life. Issues such as role conflicts,

violence, threats and harassment as well as burnout and emotional exhaustion at work have become increasingly important in recent years. More research is needed on causal relationships, not just correlations. Research is also needed on the mechanisms of the occurrence of stress-related illness. Finally, the authors point to three trends for the future. First is the potential for greater understanding entailed by the use of new sensor technology to measure stress reactions in greater depth. The second trend is longitudinal databases focused on stress, in which connections to medical diagnoses can be established. The third trend is studies of interventions and measures for reducing the effects of stress at the individual level, and especially at the organizational level.

It is particularly important for future research to contribute action-oriented knowledge that can help organizations handle issues of stress (Bliese et al. 2017).

In their compilation, Oldham and Fried (2016) present various job design trends, including strong specialization, standardization, motivation, job satisfaction, work enrichment, character of the work and demand-control. An abundance of research addresses the balance between employee well-being and organizational efficiency. More recently, research has expanded to also include several different outcomes, such as creativity, bullying, voluntary actions and physical health. In addition, studies have explored the conditions under which autonomous teams can function well. One interesting, relatively new direction is the tradition known as "job crafting", which refers to employees taking the initiative to shape their own work. More research is needed into the effects of different kinds of "job crafting", especially based on how individuals and how teams work and interact. The effects of job design in different cultural and national contexts comprise another research focus requiring closer study (Oldham & Fried, 2016).

The trends covered by Oechsler (2000) were flexibilization, decentralization and globalization. These were predicted to have a large impact on employees and their work environment. Flexibilization was thought to lead to a core group of permanent employees and a larger group of workers with poorer-quality working conditions, such as worse working hours and increased customer demands. Decentralization was thought to increase responsibility for operational processes, leading to new stressors. This could mean performance-based pay and replacing management with market feedback. Globalization was considered to lead to a stiffer climate of competition internally and companies moving to countries with lower salary levels and safety requirements. New kinds of risks will arise that are more complex and less visible than before. Occupational health services was viewed as an important actor that will have broader responsibility for handling the new work environment problems moving forward, especially those related to stress and psychosocial matters. This situation will also place increased demands on work environment regulations (Oechsler, 2000).

De Bruyne and Gerritse (2018) focus on future changes at work, and more specifically on future office jobs and how they might look. Administrative routine-based jobs were assessed as likely to decrease in number, for example due to automation and digitalization. An additional assessment was that organizational forms will evolve towards more adaptable and flexible jobs that can respond to global changes with greater speed. All of these aspects were evaluated as strong trends. This will mean an increased rate of need-adapted

teams composed of self-employed workers or individuals with shorter-term positions, and they will be expected to handle tasks more quickly and with more flexibility. The nature of the work is also expected to become more collaborative, with fewer individual tasks. Work organization is expected to be less hierarchical and to involve less managerial control, and management may work to a greater extent with strategic issues and teambuilding, facilitating their practices and building network collaborations.

Meanwhile, teams are expected to lead themselves to a higher degree. Work will be carried out independently of time and space to a greater extent. Attracting and retaining employees is expected to be

a huge challenge for organizations, which will require internal reforms. Employees are more motivated by interesting tasks in organizations with which they identify based on their values. Greater control over one's work and workplace is expected, but balance between work and free time will simultaneously be harder to achieve due to increased demands for flexibility. One alarming sign from the Delphi group was that two thirds of respondents expected symptoms of burnout to increase in the next 10 years (De Bruyne & Gerritse, 2018).

Härenstam et al. (2005) point out that work environment conditions vary across different segments of the labour market, and the results show that development also differs in these segments or types of businesses. Previous research demonstrates a number of trends in the labour market; for example, poorer-quality psychosocial work environments have not only been identified in Sweden. Additional identified trends were centralization of power and control in organizations, facilitated in part by new IT systems, while responsibility has been individualized.

A trend of flexibilization has also become clear, but it is related more to employees working at times that suit the organization's needs. The best work environment conditions were in highly technological, knowledge-intensive jobs. While the demands of these jobs may be higher, the employees, primarily men, were given more power and training. The worst work environment conditions were in labour-intensive service production jobs (postal services, transport, hotels, restaurants, cleaning and call centres). Immigrants were overrepresented in this group.

Subcontractors competed for the lowest price, resulting in poor finances, temporary assignments, an increased work pace and worse working hours. The greatest deterioration was among so-called human service professions (schools, healthcare and social services). Women were overrepresented here. Major restructuring processes, cost savings, increased administration and other illegitimate tasks were perceived as the biggest problems. Employees of subcontractors experienced worse work environments than others regarding several work environment factors (Härenstam et al., 2005).

In a survey study, Gallie (2005) demonstrated that perceived job pressure declined between 1996 and 2001 in the EU and Sweden. The analysis indicated that decreased working hours in the EU may have contributed to the trend. But of the 14 countries, Sweden had the highest perceived work pressure. The UK and Finland also ranked high, while Spain and Portugal ranked the lowest. In general, the study showed that increased competence demands, increased job control, increased use of advanced technology, unsafe jobs and longer working hours were associated with increased work pressure (Gallie, 2005).

Working hours

A 12-hour workday has become increasingly common in some jobs, partly because the labour market requires shift work and 24-hour service. Employees often think this is an appealing way to work, and costs can be lower for employers. The disadvantages of such long shifts include increased fatigue, accident risk, sleep disturbances, errors and impaired job performance. The research results are

contradictory in terms of positive or negative findings, due, among other reasons, to which outcome measurements the various studies use. The author points out that long workdays combined with a heavy workload are thought to lead to a particularly strong rise in fatigue and exhaustion, as well as impaired attention. These negative results did not appear in jobs with low demands and opportunities for longer breaks during the shift. Jobs that involve risks, such as chemical substances, heavy loads or other physical work environment factors should not be carried out in 12-hour work shifts, because existing information, norms and regulations are adapted to 8-hour workdays. Knowledge about how these risks change with a 12-hour workday is very limited; nor is there sufficient research on the long-term effects on health and well-being of long workdays (Bendak, 2003).

Safety and regulatory systems

New work environments may have negative effects on safety, but research on these connections is limited. Many studies have shown that new organizational forms such as "downsizing" (staff reductions) and "outsourcing" (moving production to subcontractors) have a negative impact on safety, health and social relationships. Several studies have also shown that these new organizational forms are related to increased physical work demands, job insecurity, reduced participation, increased sickness absence and cardiovascular disease. Piece work often leads to an increased work pace, which is connected to a higher risk of accidents. There are also indications that immigrants have a higher risk of accidents, though studies in this area are somewhat contradictory. Some explanations that have been raised include that immigrants work in high-risk operations to a greater extent; that their language proficiency is insufficient; that communication with them is inadequate; that they do not obtain training and education to the same extent; and that they may tend to take higher risks because they are a vulnerable group that could otherwise risk losing their jobs. Development towards more sustainable work systems could contribute to improved safety. One interesting development for the future is to invest more in promoting safety, where organizations encourage group-based self-organization to build up safety and obtain mutual support for decisions that are taken (Koukoulaki, 2010).

Choudhry et al. (2007) present an overview of definitions, concepts and models used in the field of safety, especially the concept of safety culture, which has been evolving since the late 1980s. While safety culture has several definitions, they all include a requirement for good attitudes towards safety, integrated with a well-functioning safety management system. Reactive initiatives used to be common, such as measuring accident outcomes.

These measures are poor indicators of the effectiveness of a system and only illustrate situations in which the systems fail. They are gradually being replaced by proactive initiatives, in which the safety climate is measured, safe behaviours are rewarded, and safety-improving activities are in focus within the framework of a well-functioning safety management system.

A good safety culture is characterized by active managerial support, employee involvement and effective development strategies. The issue of how to develop and establish a good safety culture in an organization is in urgent need of research. There is also a significant lack of knowledge about the interaction between how individuals' behaviour influences systems and how systems influence individuals' behaviour (Choudhry et al., 2007).

Occupational health and safety regulations have gone from detailed regulations to a systematic, process-based self-control model. In their overview of this model for the management of occupational health and safety, Gallagher and Underhill (2012) point out that the many changes underway in working life render preventive occupational health and safety management more difficult. Examples of these changes include workplaces with multiple employers, heterogeneous groups of

employees with different employment conditions and the difficulty of handling complex psychosocial issues. Other examples of changes include outsourcing, privatization, reduced union membership and the growth of service sector jobs, while industrial jobs are declining in number. Multiple studies show

that unclear management structures and unclear responsibilities, reduced participation from employees, outsourcing and changed employment conditions increase the risk of work environment problems as well as poor occupational health and safety. Well-functioning management systems are characterized by active engagement from top management, actively participating and involved employees, a management system that is well integrated into the organization's decision-making processes, trained and motivated managers and supervisors, and a management system that is relevant and adapted to the organization's needs. With respect to psychosocial health risks, the human consequences (anxiety, depression, burnout and other mental health problems) and the financial costs for society and organizations are enormous. Consequences affecting organizations include an impact on job satisfaction, occupational injuries, cognitive performance, absence, engagement, motivation, productivity and the quality of products and services. The tendency to individualize psychosocial work environment risks entails a focus on the traits of individuals as both problems and solutions. Risks that are increasing in scope include violence, threats and harassment. Studies in this area have identified causes such as increased work demands, decreased support and reduced control of work, as well as role conflicts and role uncertainty. The continued development of regulations is necessary for addressing the new conditions and new kinds of risks that are arising, and new forms of interaction must also be developed. This area contains few high-quality intervention studies focused on the organization, compared to studies focused on individuals. More longitudinal intervention studies are required, for example on how well-functioning processes for developing and maintaining occupational health and safety management systems can be adapted to a changing world. An additional question is how to spotlight the various benefits of a healthy and safe workforce (Gallagher & Underhill, 2012).

According to Leka et al. (2016) views on occupational health and safety have changed, for example with regard to regulations and standards, in part because the world has changed. According to current trends, occupational health and safety is thought to have too many rules relative to the risks, and the issues have low legitimacy. There has been too much focus on safety and too little on issues of health. Poor financial resources reduce the inclination to permit occupational health and safety issues to have an impact. At the same time, views of occupational health and safety management must be renewed and broadened to include issues of productivity, an organization's image and reputation, and sustainability alongside health and safety issues. A long-term approach that is decoupled from political ideologies is needed for the future, along with more education among important stakeholders.

Furthermore, better collaboration among actors within occupational health and safety is needed (Leka et al., 2016).

Demographic changes

One of the most important trends is demographic changes due to a longer life expectancy. The workforce is becoming older in

OECD countries, both because people remain healthy for longer as they age and because the retirement age has risen. It is therefore increasingly important to develop practices that facilitate work for older people and for them to be able to remain in working life for longer. This includes a better work environment through management and organization, as well as support systems comprising established and new technology. It also involves proactively adapting jobs to leverage the knowledge and experience of older people. Regarding technological support

systems, there are many new technological opportunities for supporting older workers, such as collaborative robots, exoskeletons and VR glasses. Research is limited on new technological support systems and older workers. From the literature review, it can be concluded that more research is needed on how production systems can be designed for older workers (Calzavara et al., 2019).

Interventions and work environment improvements

Overall, a country's work environments can be improved or worsened via various mechanisms. One common approach is to endeavour to improve the existing jobs at companies and organizations. Another approach is to endeavour to ensure that the new technology and new organizational forms introduced into existing organizations improve the work environment. A third mechanism comprises the structural changes that take place on the labour market, i.e. that jobs with poor work environments disappear or are moved out of the country, or new jobs are added that do not have the same work environment risks. A study from Denmark shows that work environments improved from 1990 to 2000. However, the improvement is thought to be due not to work environment interventions in existing jobs, but to a different distribution of occupations in the labour force. The number of employees in high-risk professions declined and the number of employees in low-risk professions increased; thus the distribution changed and total risk declined (Burr et al., 2003).

Murphy & Sauter (2004) classified interventions according to four foci: legislative/policy, employer/organizational, job/task and individual. Each focus included primary, secondary or tertiary interventions. The results show that most published research studies are about individual interventions, often stress prevention. Few organizational interventions are published in peer-reviewed journals.

Several reasons may be behind this; one could be that interventions for individuals are less risky for corporate management than organizational interventions. In general, the results are mixed and the outcome variables are often health or well-being. Broader efficiency, productivity and cost measurements should also be used here. The overall experience of a well-functioning intervention is characterized by support from top management, employee participation, a detailed risk analysis and initiatives focused on the work and workplace. The recommendation is for research to focus more on the effects of organizational interventions, including legislation/policies and the work/workplace, as well as on improving intervention methodology. An example of an issue about which knowledge is limited is what conditions serve as motivation for initiating interventions aiming to improve health and safety, and what these decision-making processes look like (Murphy & Sauter, 2004).

Sonntag (2001) describes the development of occupational health and safety research, especially with a focus on occupational psychology. In the 1980s, occupational psychology and safety research focused on individuals and behaviour. It was later expanded to include theories and models of human work, stress at work, resources at work and integrated models for safety and health. Several methods were developed during the investigated time period. A focus on a combination of the individual and situation comprised the most common intervention strategies. For example, new concepts were developed for consultancy and new methods for personal learning before future occupational health and safety interventions. Practical experiences from the research for the future demonstrate the need for better collaboration between researchers and practitioners that also involves individuals with a multidisciplinary focus. Leadership must support occupational health and safety initiatives in the organization, and they must be integrated into the strategic management system (Sonntag, 2001).

Publication trends

One approach to assessing trends in occupational health and safety is to explore trends in

the publication of scientific journals. Publication trends among articles in the Journal of Applied Psychology and Personnel Psychology were studied between 1963 and 2007. Most articles were on the areas of methodology and psychometric issues. Other popular areas were predictors of performance as well as work motivation and attitudes. Articles about laws and regulations seem to be published with some lag. More recently, articles about selection, training, learning, organizational development and change have increased in number. Peaks in publications can also be seen for trends that have come and gone, such as management by objectives in the 1970s and leadership and participation in the 1960s. It should be noted that articles about "human factors" and applied experimental psychology declined sharply throughout the period, areas in which there are now very few publications. The authors are also critical of the often large disconnect between what researchers write about and what practitioners read. For the field to be able to influence corporate leaders, decision-makers and politicians, the research must be more relevant to these groups (Cascio & Aguinis, 2008).

Another study (Chung & Williamson, 2018) looks at publication trends between the years 1960 and 2010 in the top three journals in the field of ergonomics, Ergonomics, Human Factors and Applied Ergonomics. The results show that applied research and collaboration between research and industry grew in the period studied. During this time period, research teams increased in size, and empirical research as well as applied research became more common among researchers. Thus there are indications that the gap between research and practice has reduced somewhat with time. Most articles throughout the time period are on biomechanics, displays, controls and computer interfaces, macroergonomics and work physiology. Articles on biomechanics increased in number, while articles on work physiology decreased over the time period (Chung & Williamson, 2018). In their analysis of publication trends in the field of ergonomics connected to sustainable development, Radjiyev et al. (2015) show that the number of publications on ergonomics is rising, but its share among all scientific publishing is declining. Both the number and share of publications in the field of sustainable development are increasing. The four sub-areas with the most publications are "methods and techniques", "human characteristics", "work design and organization" and "health and safety". Publications are declining in the first two sub-areas, while they are increasing in "health and safety".

Regarding areas of application, publications about agriculture are decreasing in number, but publications about architecture, industrial design, product design and renewable energy and technology are increasing in number. The disciplines overlap in several areas, such as health and safety, and there are also abundant opportunities for integration in product and building design, as well as energy systems (Radjiyev et al., 2015).

Roetting and Luczak (2001) conclude in their article that research on occupational health and safety in Germany from 1980 to 2000 focused primarily on the worker and the workplace, and less on the organizational and societal levels. Furthermore, there were no significant changes in research focus over these years. Expert opinions on which areas future research ought to focus resulted in numerous suggestions. Health-hazardous chemicals and manual materials handling were assessed as continued areas of importance for research in the future. Better databases and measurement methods for establishing factors that demonstrate relationships between stress and stress-related illness were assessed as important. A clear trend was observed from physical work environment to psychosocial factors. Furthermore, the experts pointed out the need to study the psychosocial consequences of new forms of work. Practitioners need more robust information about how to handle issues such as behavioural changes, threats and violence, flexible working hours and group work. Many of the interviewed experts

expected a greater emphasis on research on industrial organization and work organization with links to occupational health and safety. Areas assessed as in need of further research included healthcare; service, where new technology is being introduced; and small and medium-sized companies. Additional areas included research on work environments for older and younger people. Finally, the article pointed out the need for more longitudinal studies and workplace evaluation studies. Occupational health and safety should be better integrated into operations, with a greater focus on prevention and the future, and should provide support for action in different organizations (Roetting and Luczak, 2001).

4. Work environment trends, knowledge gaps and research need – an integrated discussion

One important trend is that technical development is incredibly rapid, resulting in new work situations and environments about which there is little knowledge. There is a comprehensive need for proactive research and new knowledge in this area, so that new technology can be adapted from the beginning to suit users and thus contribute to a better work environment. The alternative – producing knowledge at a later phase, when the new technology has already been disseminated – is worse. One positive development is that pressure from users and customers on manufacturers and service providers paired with stiff competition is leading to improvements in the ergonomics and occupational health and safety of services and products. In this context, it is important to broaden the understanding of work environment issues to avoid only seeing the effects on health, safety and well-being. Several studies show the positive effects of occupational health and safety and ergonomics on outcomes such as productivity, quality, freedom from disruptions, innovations, learning, profitability, image and competitiveness on the labour market. Work environment issues must be elevated from the individual level to include the organizational and societal levels as well.

With this approach, occupational health and safety can become a strategic component that promotes development and business practices among companies and organizations based on the perspective of opportunity. While there is some research in this field, more examples are needed that can be communicated to decision-makers. More research is also needed on the mechanisms that lead to business benefit, and on how and on what grounds decisions are made about work environment improvements.

The demographic changes occurring as people live longer comprise an important and current trend. These changes place economic pressure on the pension system, causing the age of retirement to rise. It is therefore increasingly important to create jobs and solutions that help older people at work, which also benefits other groups in the labour market. Managerial and organizational changes, a better work environment and technical support systems are needed. It is also important to leverage the knowledge and experience of older people through preventive occupational health and safety management. Technical support systems include collaborative robots, exoskeletons and VR glasses. More research on new technological support systems and older people is needed.

One strong trend is the growing importance of psychosocial and organizational work environments, an area that includes symptoms of stress and exhaustion. This area has knowledge gaps regarding causal mechanisms and how they lead to sickness. While knowledge about risk factors exists, the studies are often cross-sectional and use survey methodology that cannot establish causal relationships. Instead, moving forward, research should involve large, longitudinal studies over a long period of time, with better study design to identify processes that cause mental health problems. Perhaps the greatest lack of research-based knowledge is among intervention studies on how to implement measures for psychosocial and organizational work environment issues. It is especially important to conduct studies on interventions at the organizational level, because most studies to date have addressed individual interventions. There is also a significant lack of intervention

studies on the workplace and societal levels. The effects of legislation and regulations on work environments comprise an example of a research need at the societal level.

The literature review has emphasized the need for more research as well as more actions related to the increasing polarization at work. In-demand employee groups work under better conditions, while other groups find it increasingly difficult to obtain jobs and are forced to work in poor work environments, on short-term contracts based on companies' needs. The work environment is also harsher for government agency employees and public employees in education, healthcare and social services as well as among emergency service staff etc.

This is due to reorganization and cost savings as well as more administrative and illegitimate tasks. Work environment issues here include threats, violence and harassment, which have increased over time. This has emerged in part in new contexts with very little knowledge and research, which naturally must be remedied urgently.

Globalization of products, services, production and the labour force affect the work environment in various ways. The competitive climate can be tougher and involve higher-pressure working conditions. Industry trends such as downsizing and outsourcing entail risks for occupational health and safety. One such risk is that risky jobs are moved from Sweden to other countries with lower occupational health and safe requirements. Another risk is that people who work temporarily in Sweden are subjected to worse work environments, and at the same time, they receive inadequate training about the work environment and risk management.

The growth of jobs in the service sector is a clear trend. As a consequence, customers and their demands for high-quality service have closer proximity to employees. These increased customer demands occasionally also apply to availability, which is associated with the flexibilization of working hours, for example. In some jobs, the line between work and free time is increasingly blurred.

Safety initiatives are a trend in several contexts and in many large companies. Societal regulations related to occupational health and safety have gone from detailed regulations to a systematic, process-based self-control model. However, it is important for regulatory systems to be modified and adapted to the surrounding world. This focus on management systems and safety culture has led to improvements. The premise includes engagement from top management, actively participating and involved employees, a management system that is well integrated into the organization's decision-making processes, trained and motivated managers and supervisors, and a management system that is relevant and adapted to the organization's needs.

Based on this literature review about work environment trends, it is evident that most articles are about risks, health risks and a negative impact on well-being as well as factors that create bad work environments. Only a limited share of work environment research is about positive effects, such as stimulating jobs that promote development, health, learning, and good organizations. Factors that produce negative outcomes and risks may differ from factors that produce positive outcomes and development. Naturally, a more even balance between research focused on negative and positive outcomes is desirable. Few studies focus on the opportunities of societal trends and the positive changes that they may produce. One of the included studies mentions that to a greater extent, young people choose employers that provide stimulating jobs at organizations with positive values that are consistent with the individual's values. When there is a lack of expertise in a given area, it often means that the work environment is improved so that the organization can attract more job applicants. Job crafting is another example of an interesting positive trend. Positive work environment trends also include a stronger focus on safety issues in many organizations. These examples illustrate positive trends that promote better work environments. There is a general need for

knowledge and research to better understand and strengthen the positive driving forces and effects of a good work environment.

There are many knowledge gaps regarding research methodology, which comprise a research need. First, there is a need for studies that are methodologically designed to establish causal relationships. It is insufficient to study correlations. Furthermore, studies are needed on work environment interventions, which are lacking at the workplace, organizational and societal levels, while there are many studies at the individual level. There are knowledge gaps with regard to how measures are implemented and the various system effects they produce. Work environment interventions and work environment measures must be investigated based on their financial consequences and other system effects. Societal trends and interventions focused on factors other than the work environment may have consequences for the work environment, which should be investigated. More knowledge is also needed about how organizations take decisions about the work environment and work environment improvements.

Comments on the literature review of work environment trends

Literature reviews are needed for various reasons. This becomes particularly evident when research findings point in different directions, and also when there is an abundance of research in an area that is also mature and established, and when the question is systematic and limited. This literature review includes interview studies, survey studies, systematic and non-systematic literature reviews, register studies and studies of publication traditions. Some studies look back on historical development and then extrapolate suppositions about whether development will continue in the same direction. Other studies use interviews with various groups of respondents who present their thoughts on what they believe the development will be. These thoughts are then compiled into some kind of a common picture. In this literature review on work environment trends, it became clear that the field has no established and mature research tradition with a generally accepted approach to methods and methodology. The articles included in the literature review used different methods and had different research questions and foci, and the studies were carried out in different contexts. One might say that these studies comprise distinct efforts in a large field, and extensive coverage is not reported in this kind of literature. Furthermore, the review includes only a few studies from Sweden and the Nordic countries. This also means that the special conditions of the Swedish model, cooperation between the social partners and the role of trade unions are not captured, which are additional limitations. Thus the literature review does not provide a representative and comprehensive overview of work environment trends. Another consequence is that it was impossible to compare the included studies in order to identify consensus or areas of uncertainty. Rather, this literature review reflects the diversity of the various articles identified.

Due to significant methodological variation and because the field has not established quality criteria, detailed quality criteria could not be used. In research fields with limited research that is of varying degrees of quality, the option remains to compile the best possible synthesis of knowledge from the published studies, i.e. the best possible available knowledge.

All studies have shortcomings, and there are many potential sources of error. No studies in this review would have been judged as high quality based on traditional quality criteria for research articles, such as longitudinal RCT studies (randomized controlled trials). It can be mentioned in this context, however, that none of the authors of the included studies declared conflicts of interest. Evidence-based research about the future is not exactly possible, so other quality criteria must be used for this kind of study. Another way

to put this is that as a field, work environment trends are difficult to research. Meanwhile, this literature review highlights the work environment trends that are discussed in the research literature and points to desirable measures and research needs.

Thus, to compile more comprehensive information about work environment trends and the work environment of the future, it will not suffice to shed light on the research perspective captured by a research literature review. This approach must be supplemented with other information, such as a statistical perspective in which statistical data describe changes in the work environment, health, well-being, occupational injuries, sick leave and other indicators. Furthermore, the issues must be complemented with additional perspectives, for example from the working life perspective, which captures the attitudes and experiences of people in working life; the mass media perspective, which captures descriptions of the work environment from mass media and social media; and a professional perspective, to express the knowledge and experiences of occupational health and safety professionals.

The latter perspective includes so-called grey literature, such as reports, studies, reviews, books and trade publications. This kind of synthesis would provide a more complete picture of a field as complex as work environment trends.

5. Conclusions

A limited number of research studies are published in the scientific literature on the work environment of the future and work environment trends. Moreover, the published studies vary with regard to content, focus, methodology and area of application. The international literature contains few studies from Sweden and the Scandinavian countries. From the 20 studies included in this literature review, the following conclusions have emerged.

The rapid technological development means that technology will increasingly take over certain tasks, but it will also create new jobs and improved work environments. Technology will also change the character of the remaining jobs and thus the work environment as well. While today's employees may not be particularly concerned about new technology taking over their jobs, there are risks that increased awareness of this development may have negative consequences for perceptions of one's job situation. A need exists for more knowledge and research about this technological shift and its consequences for people in working life. The amount of research on psychosocial and organizational work environments has increased over time, especially on matters of stress and exhaustion. Within this area, trends such as globalization, flexibilization and international competition have been assessed potentially leading to worse occupational health and safety, increased demands, worse working hours, lower pay, centralized power and control as well as jobs lost to other countries. Other studies have pointed to the opportunities that global changes may lead to increased collaborations in team-based organizational forms, more organizational collaboration in networks, less hierarchical organizations, less managerial control, and greater control among individuals over their work and workplace. This positive development has primarily been observed in advanced, highly technological and knowledge-intensive jobs, while the negative development has been observed primarily in labour-intensive service jobs, including in schools, healthcare and social services. More research and knowledge is needed about how new organizational forms influence the work environment.

One trend in the field of safety is to enhance the focus on safety management systems, combined with a safety culture. The best results are achieved when these systems are integrated into an organization's decision-making processes. Furthermore, engagement from top management, actively participating and involved employees, trained and motivated managers and supervisors, and a management system that is relevant and adapted to the organization's needs are required. Regulations have been developed towards a systematic, process-based self-control model.

Due to demographic changes, the retirement age is rising. More research is therefore needed to develop organizations and technology in order to support older people in their work duties, and also to leverage their skills and experiences.

This also applies to people with different cultural backgrounds. Furthermore, more research is needed into why violence, threats and harassment have increased.

In general, most studies have involved risks and work environment problems. More research is needed on factors that create a positive, stimulating work environment that promotes development, health and learning.

In addition, outcome measures often comprise effects on safety, health and well-being. Future studies also need to include the effects on organizations' efficiency, innovation, learning and image. Work environment issues must be taken from the individual level to the organizational and societal levels to be able to strategically support operational development. Moving forward, research studies must be designed to establish causal relationships.

Statistical correlations are insufficient. Furthermore, intervention research that can provide insight into the effects of various work environment measures is needed at the workplace, organizational and societal levels. This should include financial consequences and system effects.

6. Appendices

Appendix A: Included articles

Bendak, S. (2003). 12-h workdays: current knowledge and future directions. Work and Stress, 17(4), 321-336.

Bliese, P. D., Edwards, J. R., & Sonnentag, S. (2017). Stress and well-being at work: A century of empirical trends reflecting theoretical and societal influences. Journal of Applied Psychology, 102(3), 389-402.

Brougham, D., & Haar, J. (2018). Smart technology, artificial intelligence, robotics, and algorithms (STARA): employees' perceptions of our future workplace. Journal of Management & Organization, 24(2), 239-257.

Burr, H., Bjorner, J. B., Kristensen, T. S., Tuchsen, F., & Bach, E. (2003). Trends in the Danish work environment in 1990-2000 and their associations with labor-force changes. Scandinavian Journal of Work Environment and Health, 29(4), 270-279.

Calzavara, M., Battini, D., Bogataj, D., Sgarbossa, F., & Zennaro, I. (2019). Ageing workforce management in manufacturing systems: state of the art and future research agenda. International Journal of Production Research, 1-19.

Cascio, W. F., & Aguinis, H. (2008). Research in industrial and organizational psychology from 1963 to 2007: Changes, choices, and trends. Journal of Applied Psychology, 93(5), 1062-1081.

Choudhry, R. M., Fang, D., & Mohamed, S. (2007). The nature of safety culture: A survey of the state-of-the-art. Safety Science, 45(10), 993-1012.

Chung, A. Z., & Williamson, A. (2018). Theory versus practice in the human factors and ergonomics discipline: Trends in journal publications from 1960 to 2010. Applied Ergonomics, 66, 41-51.

De Bruyne, E., & Gerritse, D. (2018). Exploring the future workplace: results of the futures forum study. Journal of Corporate Real Estate, 20(3), 196-213.

Gallagher, C., & Underhill, E. (2012). Managing work health and safety: recent developments and future directions. Asia Pacific Journal of Human Resources, 50(2), 227-244.

Gallie, D. (2005). Work pressure in Europe 1996–2001: Trends and determinants. British Journal of Industrial Relations, 43(3), 351-375.

Härenstam, A., & MOA Research Group. (2005). Different development trends in working life and increasing occupational stress require new work environment strategies. Work, 24(3), 261-277.

Koukoulaki, T. (2010). New trends in work environment–New effects on safety. Safety Science, 48(8), 936-942.

Leka, S., Jain, A., Zwetsloot, G., Andreou, N., & Hollis, D. (2016). Future challenges of occupational safety and health policy-making in the UK. Policy and Practice in Health and Safety, 14(1), 65-80.

Oechsler, W. A. (2000). Workplace and workforce 2000+–the future of our work environment. International Archives of Occupational and Environmental Health, 73(1), S28-S32.

Oldham, G. R., & Fried, Y. (2016). Job design research and theory: Past, present and future. Organizational Behavior and Human Decision Processes, 136, 20-35.

Radjiyev, A., Qiu, H., Xiong, S., & Nam, K. (2015). Ergonomics and sustainable development in the past two decades (1992–2011): Research trends and how ergonomics can contribute to sustainable development. Applied Ergonomics, 46, 67-75.

Roetting, M., & Luczak, H. (2001). Ergonomics as Integrating Constituent in Occupational Safety and Health—Past, Present, and Future. International Journal of Occupational Safety and Ergonomics, 7(4), 507-526.

Sauter, S. L., & Murphy, L. R. (2004). Work organization interventions: state of knowledge and future directions. Sozial-und Präventivmedizin, 49(2), 79-86.

Sonntag, K. (2001). Psychological approaches to OSH Research—An evaluation of 20 years of psychological research on industrial safety and health in Germany. International Journal of Occupational Safety and Ergonomics, 7(4), 561-573.

Appendix B: Methods and search strategies

The literature search

The literature search was carried out in collaboration between responsible researchers and information specialists. It began by identifying relevant terms and phrases for the search strategy based on the purpose of the compilation. The design of the strategy was made with the aim of identifying as many as possible of all relevant studies but at the same time making reasonable delimitations for the implementation of the project. In the process of designing the search strategy, initial searches were conducted to ensure that the strategy returned relevant studies.

Searches were initially conducted in two international databases, Scopus and Web of Science, and included studies in English, published from January 2000 to June 25, 2019. To this search, a further search was added to the Ergonomics Abstracts database. Since this database also has controlled subject words, the same keywords were used to search the subject field as well, after which these articles were added. The search in Ergonomics Abstracts was conducted on it October 9, 2019, and related publications from January 2000 through October 9, 2019.

The search process as well as the inclusion and exclusion process are described in Figure 1. They use the search strategies are presented for the respective database. The search strategy was initially built into the Scopus database, by gradually putting together the different parts. The strategy was then adapted to search the Web of Science database, and finally to the search in the Ergonomics Abstracts database. Responsible researchers provided standard articles and suggestions on search terms and decided on the search strategy. All identified studies were imported into reference management. The EndNote X9 system, where duplicate thinning was performed.

Thinning of articles against relevance, inclusion, exclusion, and quality criteria

The examination of identified studies against the inclusion and exclusion criteria (Table 1) was carried out in two steps. In step 1, responsible researcher, supported by the web-based tool Rayyan (rayyan.qcri.org), reviewed the summaries of the identified studies. Here, the relevance criterion was used that the article should address the main question of the overview, ie. working environment trends and changes over time. For inclusion, it was also required that the article meet the inclusion criteria and not meet the exclusion criteria. Here, some studies were considered ”possible” to include, since the evidence in the summaries was not sufficient to make decisions. The studies that were not excluded were ordered in full text.

In step 2, the responsible researcher examined the full texts against the main question of the overview and against the inclusion and exclusion criteria. Studies that did not meet the relevance and inclusion criteria were eliminated. The studies that were considered possible for inclusion were reviewed by two researchers, and after discussion, decisions were made on inclusion or exclusion.

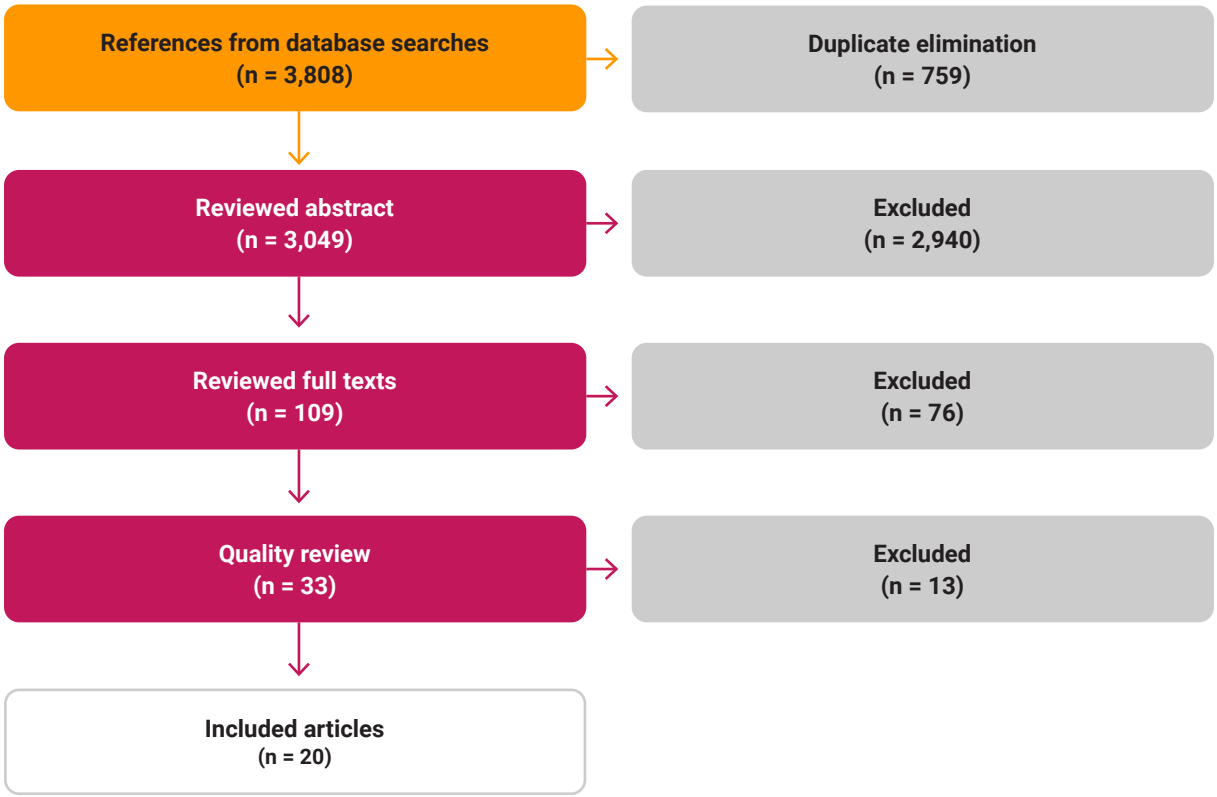
The criteria in step 3 consisted of a quality review of the included studies. The quality criteria meant that the publication would be published in a scientific publication of good quality, with a collegial review procedure. Furthermore, the article would in some way contain a method description or method statement. Items that did not meet these quality criteria were excluded.

Table 1: Inclusion and exclusion criteria

	Inclusion	Exclusion
Population	Working life context and labor market.	Individual professions, individual professions or similar concepts / synonyms. Studies with empirics that do not include Europe. Only one working environment factor.
Exposure	Societal trends - national and international. Organizational-level trends. Trends conveyed in mass media or by stakeholder groups. Research results that lead to demands for changes, legislation etc.	Trends at regional and local level. Studies whose focus is on the health effects of an individual exposure.
Result	The changes, trends or issues that are brought about as an impact on the work environment.	Issues, trends or changes that relate to a limited part of a work environment, a professional group or an industry.

Figure 1 below shows the number of search hits and the search results as well as the number of excluded articles in the different steps.

Figure 1: The number of articles in the various steps during the search process and excluded articles



A list of all excluded studies can be found on mynak.se in connection with this report.

A: Search strategies for each database

Scopus (Elsevier)

Search date: 27 June 2019 umber of hits: 2,836 hits	Limitation, type of publication (article, reveiw, book, book chapters), 2000 onwards and language (English, Danish, undefined): 1,531 hits
1. Working environment	
TITLE("business organization") OR TITLE(company) OR TITLE(corporation) OR TITLE(employment) OR TITLE(ergonomic) OR TITLE(firm) OR TITLE("health and safety") OR TITLE("home office") OR TITLE("human resources") OR TITLE(job) OR TITLE(labor W/1 force OR market OR supply) OR TITLE(occupation) OR TITLE(occupational w/1 group OR health) OR TITLE(organizational) OR TITLE(profession) OR TITLE("safety and health") OR TITLE(staffing) OR TITLE(vocation) OR TITLE(vocational) OR TITLE(work W/1 characteristic OR location OR locus OR organization OR place OR relationship OR site OR conditions OR environment OR life OR arrangements OR study) OR TITLE("worklife") OR TITLE("working life") OR TITLE(workforce) OR TITLE(workplace) OR TITLE(human W/1 factors OR ergonomics)	
2. Trends	
TITLE(future W/1 development OR direction OR of) OR TITLE((forecast AND NOT climate OR weather)) OR TITLE(foresight) OR TITLE(megatrend) OR TITLE(prognos* AND NOT (prognostics)) OR TITLE(scenario) OR TITLE("state of the art") OR TITLE(trend W/1 time OR long-term OR analysis OR temporal OR recent OR statistical OR toward OR future OR utilization OR current OR new OR emerging OR latent) OR TITLE("trends in") OR TITLE(Landmark) OR TITLE(milestone) OR TITLE(manifest OR manifesto) OR TITLE("best practice") OR TITLE(trending)	

Field tag/s: TITLE = Title; AND NOT = Excluding specified terms; W/n = within, the first term is to be found within a given number of other terms (0–255) from the subsequent terms; * = Truncation; " " = Quotation marks, searches for a phrase

Web of Science (Thomson Reuter)

Search Date: June 25, 2019 Number of hits: 3,753 hits	Limitation, type of publication (article, reveiw, book, book chapters), 2000 onwards and language (English): 1,636 hits
1. Working environment	
TI=("business organization") OR TI=(company) OR TI=(corporation) OR TI=(employment) OR TI=(ergonomic) OR TI=(firm) OR TI=("health and safety") OR TI=("home office") OR TI=("human resources") OR TI=(job) OR TI=(labor NEAR/1 (force OR market OR supply)) OR TI=(occupation) OR TI=(occupational NEAR/1 (group OR health)) OR TI=(organizational) OR TI=(profession) OR TI=("safety and health") OR TI=(staffing) OR TI=(vocation) OR TI=(vocational) OR TI=(work NEAR/1 (characteristic OR location OR locus OR organization OR place OR relationship OR site OR conditions OR environment OR life OR arrangements OR study)) OR TI=(worklife) OR TI=("working life") OR TI=(workforce) OR TI=(workplace) OR TI=(human NEAR/1 (factors OR ergonomics))	
2. Trends	
TI=(future NEAR/1 (development OR direction OR of)) OR TI=(forecast NOT (climate OR weather)) OR TI=(foresight) OR TI=(megatrend) OR TI=(prognos* NOT (prognostics)) OR TI=(scenario) OR TI=("state of the art") OR TI=(trend NEAR/1 (time OR long-term OR analysis OR temporal OR recent OR statistical OR toward OR future OR utilization OR current OR new OR emerging OR latent)) OR TI=("trends in") OR TI=(Landmark) OR TI=(milestone) OR TI=(manifest OR manifesto) OR TI=("best practice") OR TI=(trending)	

Field tag/s: TI= = Title; NOT = Excluding specified terms; NEAR/n = the first term is to be found within a given number of other terms from the subsequent terms; * = Truncation; " " = Quotation marks, searches for a phrase

Ergonomics Abstracts

Supplementary search in Ergonomics Abstracts 9 October 2019
Search in titles

No.	Description	Search terms	Number of hits (approx.)
1	**Work environment (Keywords)**	SU (“future development” OR “future direction” OR (forecast NOT (climate OR weather)) OR foresight OR “future of” OR megatrend OR (prognosis* AND NOT prognostics) OR scenario OR “state of the art” OR “time Trend” OR “long-term trend” OR “trend analysis” OR “temporal trend” OR “trends in” OR “recent trend” OR “statistical trend” OR “trend toward” OR “trend of” OR “future trend” OR Landmark OR milestone OR manifest OR manifesto OR “best practice” OR “current trends” OR “new trend” OR “recent trend” OR “latent trend” OR “emerging trend”)	36,527
2	**Work environment (Title)**	TI ("business organization" OR company OR corporation OR employment OR ergonomic OR firm OR "health and safety" OR "home office" OR "human resources" OR job OR "labor force" OR "labor market" OR "labor supply" OR occupation OR "occupational group" OR "occupational health" OR organizational OR profession OR "safety and health" OR staffing OR vocation OR vocational OR "work characteristic" OR "work location" OR "work locus" OR "work organization" OR "work place" OR "work relationship" OR "work site" OR "work conditions" OR "work environment" OR "worklife" OR “working life” OR “work life” OR workforce OR “work arrangements” OR workplace OR “human factors and ergonomics” OR “human factors” OR “work study”)	24,194
3	**Trends (Keywords)**	SU ("future development" OR “future direction” OR (forecast NOT (climate OR weather)) OR foresight OR “future of” OR megatrend OR (prognos* AND NOT prognostics) OR scenario OR "state of the art" OR “time Trend” OR “long-term trend” OR “trend analysis” OR “temporal trend” OR “trends in” OR “recent trend” OR “statistical trend” OR “trend toward” OR “trend of” OR “future trend” OR Landmark OR milestone OR manifest OR manifesto OR “best practice” OR “current trends” OR “new trend” OR “recent trend” OR “latent trend” OR “emerging trend”)	525

Supplementary search in Ergonomics Abstracts 9 October 2019
Search in subject headings

No.	Description	Search terms	Number of hits (approx.)
4	**Trends (Title)**	TI ("future development" OR “future direction” OR (forecast NOT (climate OR weather)) OR foresight OR “future of” OR megatrend OR (prognos* AND NOT prognostics) OR scenario OR "state of the art" OR “time Trend” OR “long-term trend” OR “trend analysis” OR “temporal trend” OR “trends in” OR “recent trend” OR “statistical trend” OR “trend toward” OR “trend of” OR “future trend” OR Landmark OR milestone OR manifest OR manifesto OR “best practice” OR “current trends” OR “new trend” OR “recent trend” OR “latent trend” OR “emerging trend”)	22,646
5	**Combined**	(1 OR 2) AND (3 OR 4)	1,126
6	**Combined**	Limiters - Publication Date: 20000101- Expanders - Apply equivalent subjects	645

Part 2 – Digitalization and the work environment

Summary

The purpose of this literature review is to contribute a systematic and thematic overview of research on the consequences of digitalization for work environments as well as for preventive occupational health and safety management, and to identify future research needs in the field. A broad definition of digital technology has therefore been applied; it includes various kinds of smart machines, robots and tools equipped with digital technology, as well as digital objects such as various software systems, animations, simulations, audio and video.

This literature review was written as a "rapid review", which is a systematic study carried out in a short period of time. This means the analyses are less in-depth and focus instead on categorizing into themes and describing the data. Literature searches were conducted in the international databases Scopus and Web of Science. Additional searches were conducted to obtain Nordic materials via the databases SwePub, Cristin, Forskningsdatabasen.dk and Norart. Of the 3,740 hits reviewed based on the inclusion and exclusion criteria, as well as for quality, the final selection included 73 high-quality articles published from and including the year 2010. The results of the literature search were categorized into themes in several different areas, which also serve as the headings under which the results of the literature review are presented.

The organizational and social work environment comprise one overarching area. This section presents articles on the impact of digitalization on the work environment with regard to demand and workload, opportunities for influence and participation, social relationships at work, relationships between work and the rest of life, as well as opportunities for development and learning at work. It can be seen that together, digital technology and the work environment comprise a complicated tapestry of risks and opportunities. It is even the case that a single form of digital technology can have both a positive and negative impact on the work environment. Digitalization has enabled new forms of communication and new communication pathways, which several articles show can contribute to increased participation in and influence on the design and development of the operation. Meanwhile, other articles show that digitalization can generate expectations for constant availability, with the accompanying risk of interruptions while working, which contributes to a heavier burden on cognitive function. Regarding demand and influence at work, several articles emphasize how the digitalization of workplaces has contributed to more standardized work methods and has reduced the ability to influence how to complete one's tasks. Digital technology may also have significant consequences on social relationships at work, especially on social support. When more and more employees use digital technology to work remotely, away from the physical workplace, there is a risk of social isolation. Meanwhile, several other articles point out positive effects on the social climate from the same technology: digital technology can break down isolation, with new opportunities for digital communication or socializing with groups other than one's immediate colleagues.

The ability to work remotely, supported by digital technology, has had consequences for the relationship between work and the rest of life. On the positive side, authors emphasize increased opportunities for independently determining when and where work will be carried out, along with, in some cases, a perceived improved work–life balance. At the same time, the absence of boundaries may catalyse conflict between work and personal life, or trouble managing the boundary between work and personal life. Regarding the relationship between digital technology and opportunities for learning and development at work, a

number of articles demonstrate differences between the genders: men receive assignments with higher qualification requirements or are granted more power in their work duties by participating more often than women in technological development and implementation. On the other hand, women are assigned tasks with lower qualification requirements and reduced power, because they are not perceived as interested in or knowledgeable about technology and are thus excluded from important development work. Several articles describe new opportunities for skills development through online training initiatives.

The other overarching area comprises the effects of digitalization on the conditions for preventive occupational health and safety management regarding the physical as well as organizational and social work environments. Most of the articles in this category focused on the physical work environment. This indicates that research on preventive occupational health and safety management takes place largely within the physical dimension of occupational health and safety. In addition, the review reveals a significant focus on industry or other traditionally male-dominated sectors, such as construction or mining. Our material has few studies on preventive occupational health and safety management of the physical work environment in female-dominated industries, professions and sectors. One or several work environment problems were identified in the articles with a preventive approach. These problems may be the result of digital technology, for example the safety risks of common workstations for people and smart robots, or the risk of inadequate recovery due to ICT and a lack of boundaries between work and personal life. Preventive efforts focused primarily on organizations and managers, and indicated the importance of, for example, offering employees various flexible work options, developing policies and guidelines to establish boundaries in relation to flexible work, and avoiding increased control. Opportunities to work preventatively to improve work environments were emphasized: for example, potentially lightening the workload by transferring certain duties to technology, or simply using technology to warn individuals when the workload is becoming too heavy. Simulations and VR experiments make it possible to develop, test and evaluate robot–individual interactions without jeopardizing employee safety. Similarly, digital technology enables new forms of employee training: using various visualization technologies, employees can learn how to complete their tasks safely, thus improving their safety awareness – all in a safe environment.

It is worth noting that there are few articles about how to work preventively with digital technology and the organizational and social work environments. In addition, few articles combine the physical with the organizational and social work environments. We therefore encourage more interdisciplinary research that can connect the development of digital technology to work-environment issues, for example, in order to prevent or eliminate risks early at the design and development phase. We have also observed a pattern: technology-heavy articles have a strongly positive view of technology, while articles with an emphasis on social sciences take a more negative view of technology. Uniting these two approaches in a joint research project could be productive for work environment improvements. Moreover, we encourage research that studies and contributes to opportunities to develop the positive aspects of digitalization, such as e-learning at the workplace as well as different uses of digital tools for increased participation in the development of activities.

1. Introduction

Digital technology is developing at a furious pace and contributing to comprehensive changes to society and working life. The digital transformation of work affects both content and design. In this literature review, digital technology refers to different kinds of smart machines, robots and tools that are equipped with digital technology, as well as digital objects such as various software systems, animations, simulations, audio and video. Digital technology can be introduced for different reasons, for example to streamline and eliminate certain tasks, to improve process efficiency, to improve communication and availability, to take advantage of employee skills, or to introduce new business or organizational models. In other words, a positive view of digital technology lies behind its introduction, but its impact on the work environment is not necessarily positive. Regardless of why, the increased rate of digitalization has an impact on the work environment; it can often be both negative and positive, as well as difficult to predict. In addition, it is not only work that is being digitalized, but also life outside of work, which in turn affects work and makes working life even more complex. Thus there are significant reasons to compile existing information in the area, both to make the information available and to identify possible knowledge gaps and research needs.

This part of the literature review therefore highlights research-based information on the effects of digitalization on the work environment, the impact on conditions for preventive occupational health and safety management and what knowledge gaps and research needs exist. The literature review was written as a rapid review and includes the physical, organizational and social work environments. The review is not limited to a particular industry; rather, the focus is on the phenomenon of digitalization and the work environment.

Furthermore, the literature review is intended for practitioners, researchers and decision-makers who are interested in digitalization and the work environment.

The purpose and questions will be presented next, as well as a glossary of key technical terminology in this sub-report. This will be followed by a description of the method that forms the basis of the literature review and how the work was carried out. Information from the included articles will then be presented in thematic sections, each of which concludes with a summary and a list of references. The result section will be followed by a summarizing discussion of the work environment and digitalization in relation to changes to working life in Sweden, the need for continued research, and reflections on methodology choice. The sub-report will conclude with final thoughts and an appendix.

Purpose and questions

The purpose of this literature review is to contribute a systematic and thematic overview of research on the consequences of digitalization for work environments and for preventive occupational health and safety management, and to identify future research needs in the area. The literature review therefore answers the following questions:

- What is the impact of the digitalization of work (and personal life) on the work environment?
- What significance does the digitalization of work (and personal life) have for preventive occupational health and safety management?
- What are the future research needs within the area?

Important terms

To facilitate continued reading, we will define some of the technological terms that are important in this report here. The terms are presented in alphabetical order.

Augmented reality – a live observation of a physical, realistic environment, the elements of which are enhanced by (or supplemented with) computer-generated sensory impressions.

Digital technology – refers here to different kinds of smart machines, robots and tools that are equipped with digital technology, as well as digital objects such as various software systems, animations, simulations, audio and video.

Digitally mediated telework – refers to employees having the opportunity, to varying extents – from a half day per week to all working hours – to work from a location other than the workplace and during hours other than formal working hours.

ICT demands – describes new and changed demands for employees in their work environment, with direct consequences for health and well-being. More specifically, these are demands that cause work interruptions, too many emails and phone calls, and technical issues as well as unclear boundaries between work and personal life.

Robot – a programmed machine that performs physical tasks.

Virtual reality (VR) – an enhanced, computer-simulated reality.

Work space/collaborative work space – a work area in which people and digital technology work together.

2. Method and implementation

Literature search

The purpose of this study is to compile the current state of research-based knowledge on the consequences of digitalization on the work environment and for preventive occupational health and safety management. A systematic literature review was therefore assessed as a suitable method. By collecting, categorizing into themes and compiling scientific studies in a given field (or based on specific questions), a good overview of the current state of knowledge can be obtained in a reasonably timely manner. This process also creates opportunities to identify knowledge gaps and needs for further research. Because time was limited, this review is a so-called rapid review, which differs from a systematic review in several ways, though the two approaches have many similar traits.[1] In both cases, the reviews are based on systematic, transparent and replicable literature search methods.

In both cases, selection is based on inclusion and exclusion criteria. The primary difference between the two review methods is the amount of time required. A rapid review ordinarily takes no more than six months, while a systematic review commonly takes twice as long. Because of the time limit, the review and analysis of the literature result in categorization into themes and data descriptions rather than a deeper analysis and unpacking of the material. That would require a systematic review. Thus the advantage of a rapid review is that it enables a systematic literature review that can be completed relatively quickly. This is advantageous if information is needed about an emerging social phenomenon or a phenomenon considered particularly important to learn about quickly.

The first step in a systematic literature review is to design a comprehensive search strategy, i.e. to develop relevant search terms and decide which databases to use and how to collect and manage the information from them. In this case, the comprehensive search strategy was designed in dialogue between information specialist Malin Almstedt Jansson at the University Library at the University of Gävle, and the experts Professor Ann Bergman at Karlstad University, Associate Professor Kristina Palm at Karolinska Institutet, KTH and Karlstad University, and PhD Calle Rosengren at Lund University. The search strategy was designed with the goal of identifying as many relevant studies as possible while setting reasonable limitations in order to facilitate completion of the project. While designing the search strategy, the information specialist conducted initial searches to ensure that they returned relevant studies. To identify as many relevant studies as possible, searches were conducted in two international databases: Scopus and Web of Science. These databases were chosen for their broad coverage of various disciplines and subjects and because they index high-quality international scientific journals. One limit was to initially only search for and include studies published after and including 2005, even if it could be asserted that some industries have worked with digitalization since earlier than this. At the same time, a rapid review requires certain limits for the material to be manageable in the end in terms of time and resources.

The search process and the inclusion and exclusion process follow the so-called PEO (Population, Exposure, Outcomes) framework

1 Tricco, A. C., Antony, J., Zarin, W. et al (2015). A scoping review of rapid review methods. BMC Medicine, 13(1), No 224.

and are described in Table 1. The final search terms for each database were hammered out in dialogue among the experts and information specialist and are presented in Appendix A. They were built in the Scopus database initially and were then adapted for searches in the Web of Science database. The information specialist conducted the literature searches in consultation with the experts. They provided standard articles and proposals for search terms and took decisions on the search strategy. The searches were conducted in June 2019. Additional searches were conducted to include Nordic materials from the SwePub, Cristin, Forskningsdatabasen.dk and Norart databases. Here, "Nordic materials" means articles written in Danish, Norwegian or Swedish. Articles written by Nordic authors in English were covered by the searches in the international research databases Scopus and Web of Science. SwePub is a Swedish database of scientific publications from Swedish higher education institutions; Cristin is an equivalent Norwegian database of scientific publications from Norwegian higher education institutions and Forskningsdatabasen.dk is a portal for research publications from Danish research institutions and researchers. Lastly, Norart is a database of references to Norwegian and Nordic journal articles. The searches were carried out in each respective language. In addition, manual searches were conducted of the journals Arbetsmarknad & Arbetsliv, Tidsskrift for arbejdsliv and Sökelys på arbeidslivet to ensure that relevant articles were included.

All identified studies were imported into the reference management system EndNote X9, and duplicates were eliminated.

Screening of publications based on inclusion and exclusion criteria

The final search resulted in 3,740 articles which were uploaded to Rayyan (rayyan.qcri.org), the reference management system designed especially for working with systematic literature reviews. The three experts reviewed one third of the articles each for inclusion or exclusion based on the established criteria (see Table 1). After reviewing 300 titles and abstracts, the experts discussed texts marked "maybe" and texts that were "excluded" to ensure consensus for the rest of the process. After reviewing and sorting all 3,740 abstracts and titles, 513 articles remained that were assessed as relevant for the literature review. Due to the large quantity of articles produced by the search relative to the timeframe for the study, the number needed to be reduced further before the full texts of the material could be assessed for relevance; additional reviews were therefore carried out. The aim was to exclude book chapters and reports, and to only include articles published after and including 2010 in journals listed in the so-called Norwegian list and Web of Science, and whose first author is connected to a European university.

A number of articles were included in the process which are referred to in certain technology journals as letters. These were included because they are relatively short, but have the same structure as a scientific article.

For studies that met the inclusion criteria, the full text was ordered. In the second step, the experts reviewed these texts for relevance based on the inclusion and exclusion criteria. The software Mendeley was used for the assessment; 30 articles were uploaded into a folder for joint assessment as a "control group" and the rest were allocated among the three experts. After the experts reviewed and assessed the 30 articles, their decisions for inclusion, exclusion and those marked as uncertain were compared. Consensus on uncertainty was high while there were minor differences regarding inclusion and exclusion. The majority decision for exclusion or inclusion was upheld, and these articles were discussed for the purpose of strengthening consensus for the next assessments.

Before the experts continued to review their respective articles for relevance, they dedicated additional time to discussing the in-

Table 1: Inclusion and exclusion criteria according to the PEO framework

	Inclusion	Exclusion
Population	Individuals with paid work including self-employed and similar terms/synonyms	Volunteer work and unpaid housework. Individuals without paid work and students.
Exposure	Digitalization, digital technology that changes/affects working conditions negatively and/or positively.	Digitalization in the form of the English term digitization. Computerization. Technology that is not digital.
Outcome	Work environment, changes in the work environment, impact on the work environment and conditions for occupational health and safety management. Work environment includes social factors, organizational factors, physical factors, i.e. factors that affect working conditions.	Individual's health, illness, well-being and diseases that are not connected to the work environment or working conditions. Studies that are not connected to the work environment and working conditions. Studies that were not carried out in the context of the workplace and organization. Studies in which digital technology was used as a research method, for example collection and analysis of medical data, impact of chemical substances on the environment. The organization's productivity, efficiency, corporate management or finances.

clusion and exclusion criteria to further clarify their meaning and strengthen consensus. The researchers agreed to "tag" excluded articles in Mendeley as "excluded" and enter a reason such as: "wrong P" (population or problem), "wrong E" (exposure) and/or "wrong O" (outcome) in relation to the questions. Articles that were included were tagged as "included" and with "orgsoc", "physical" and/or "preventive" in reference to the three relevant themes: organizational and social work environment; physical work environment; or preventive occupational health and safety management. The themes emerged and were selected in dialogue among the experts after reviewing the texts in the control group.

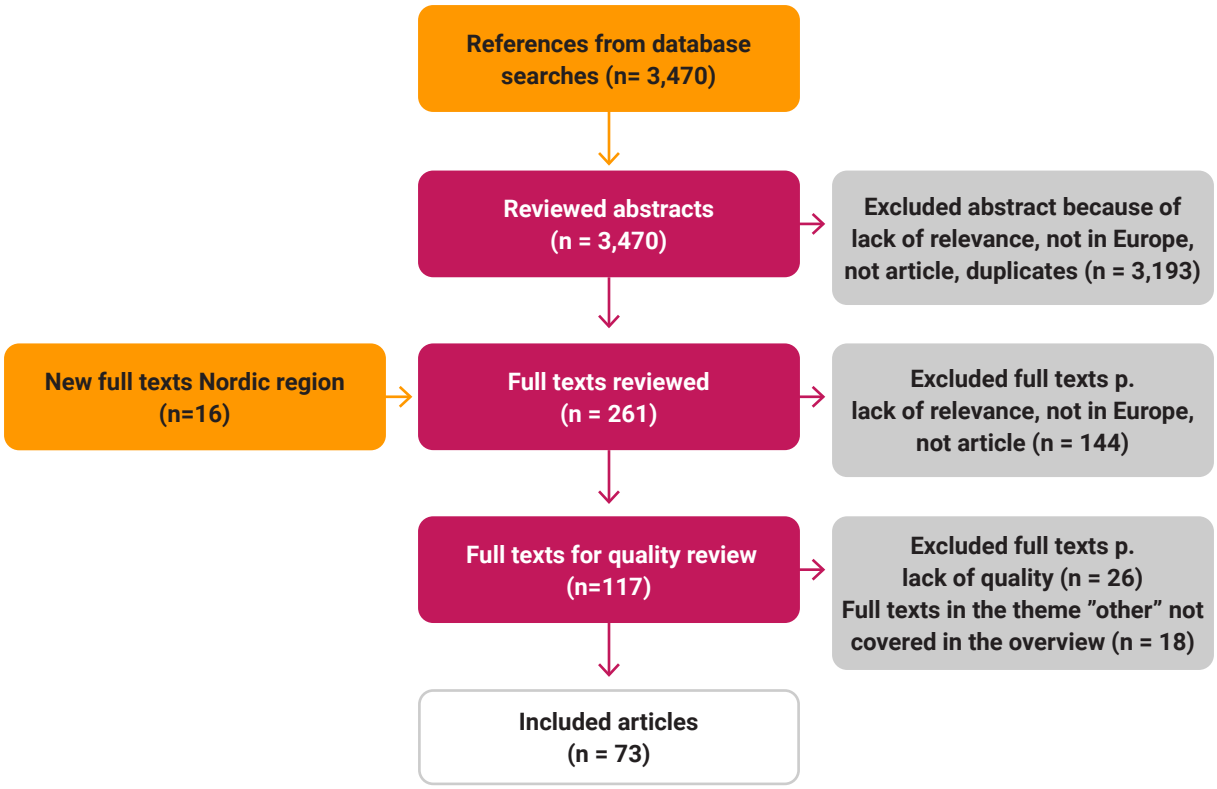
The review was documented in a detailed template. Studies that did not meet the inclusion criteria were eliminated.

Quality assessment of relevant articles

Because the subject area is broad, we have chosen to include different kinds of studies, i.e. we are including qualitative and quantitative studies, as well as articles employing the literature study method. To assess quality, we chose to begin from good scientific practice in several different steps. We checked our procedure with information specialists Berit Hjort and Annelie Ekberg-Andersson at Karlstad University Library.

We opted primarily to only include scientific articles published in journals listed in the Web of Science and/or the so-called Norwegian list. This means that at the foundation, we are supported by the fact that the included articles have undergone the established peer-review process, which is extremely important for assessing scientific integrity and quality. As a second choice, we chose to only include scientific articles; book chapters (including those that have been peer-reviewed) and grey literature have therefore been excluded.

Figure 1: Simplified implementation in numbers



A list of all excluded studies can be found at mynak.se in association with this report.

In the third step, each article was reviewed for quality based on the following criteria, with the assessments “good quality” and “inadequate quality”:

- clarity of purpose and questions
- well executed – study design and method
- the study’s contribution to the research field.

If an article was judged to be of “inadequate quality” according to a given criterion, then it was excluded.

In the fourth step, quality was assessed using the following criteria, once again with the assessments “good quality” and “inadequate quality”. If an article was judged to be of “inadequate quality” according to a given criterion, then it was excluded.

- solid connection to the research field
- solid theoretical support
- data quality
- rigour and relevance of analysis and results.

The remaining articles after these steps were included in the final literature review.

Categorizing the results into themes

As previously mentioned, the articles were categorized into three main themes: organizational and social work environment; physical work environment; and prevention. During the quality assessment, each main theme was further divided into sub-themes. “Physical work environment” did not turn out to be a main theme, because all articles that addressed the physical work environment had a preventive perspective. In addition, there was one theme that we call “other”, containing 18 articles that neither fit into the other main themes nor comprised a common new theme. These articles are not addressed further in this report. The final themes consist of the following two main themes and seven sub-themes; the number of articles is provided in

parentheses. Six articles are included in both main themes.

- Organizational and social work environment (41)
  - Workload, demands and influence on working conditions (12)
  - Social relationships and leadership (9)
  - Knowledge, learning and qualification requirements (6)
  - Flexible work in space and time (14)
- Prevention (38)
  - Prevention – the physical work environment (23)
  - Prevention – the physical work environment with aspects of organizational andsocial work environment (4)
  - Prevention – the organizational and social work environment (11)

Each sub-theme was then split into categories. The main themes, sub-themes and categories are presented below. Each main theme concludes with a bullet point summary and a list of references.

3. Organizational and social work environment

This section presents the main theme Organizational and social work environment, which represents central aspects for understanding and explaining the occurrence of stress and mental health/illness at the workplace. The organizational and social work environment has several different components and is regulated by the Swedish Work Environment Authority's regulations (AFS 2015:4). This area includes: demands at work as well as the resources and responsibilities associated with them; management and control; allocation of tasks; and participation and leeway. The social work environment covers the terms and conditions of the work and includes social interaction, collaboration and social support from managers and colleagues, as well as interactions with managers and colleagues.

The framework of this section includes factors in the work environment such as demands and workload, opportunities for influence and participation, social relationships at the workplace, relationships between work and personal life, as well as opportunities for development and learning at work. All of these themes are important for avoiding stress and illness and promoting health and development among employees.

Workload, demands and influence on working conditions

Demands at work as well as the resources and responsibilities associated with them are considered part of the organizational work environment. Demands at work may include the quantity of work and/or degree of difficulty of a given task. High demands at work could include a large workload (in relation to digitalization, such as amount of email to handle in a day) and degree of difficulty (in relation to digital technology, the challenge of learning a new computer system). For a work environment to be satisfactory in terms of employee health and well-being, previous research clearly demonstrates the importance of demands at work being on a par with the employee's abilities and that employees are given room to influence how work is completed. This area includes 12 articles, divided into two sub-themes: New and changed demands at work due to digitalization; and Changes to influence and spatial and temporal autonomy at work.

New and changed demands at work due to digitalization

Several articles address the new demands of digitalization and its potentially negative effects for employees. Different and sometimes overlapping terms are abundant in this context, such as "technostress" (Bordi et al. 2018) and "ICT demands" (Stadin et al. 2016; Stadin et al. 2019; Stenfors et al. 2013). They all describe the new and changed demands placed on employees and their work environment due to the emergence of information and communications technology (ICT), with direct consequences for health and well-being.

Stenfors et al. (2013) studied ICT demands, which they define as ICT-caused interruptions at work, too many emails and phone calls, technical issues as well as blurred boundaries between work and personal life. In a longitudinal, cross-sectional study using data from the Swedish Longitudinal Occupational Survey (SLOSH) database, the authors demonstrate connections between a high rate of ICT demands and cognitive problems, such as problems with memory,

decision-making ability, concentration and the ability to think clearly.

Stadin et al. (2016; 2019) also use the term ICT demands in two studies (which are also both based on data from the SLOSH database) in relation to work-related stress and self-assessed health. The results of the first study, which was cross-sectional, show that a high rate of ICT demands can lead to work-related stress and worse self-assessed health. An analysis was also conducted of whether ICT demands could be related to socioeconomic factors, such as position, professional group and educational background. It showed that problems with ICT demands are most common among officials, entrepreneurs and managers. Thus, high ICT demands are a a work-environment problem that applies primarily to medium and high earners. The latter, longitudinal study showed that repeated exposure to ICT demands contributes to lower self-assessed health, but only among men. The study also showed that no exposure effects could be determined from a single measuring occasion. According to the authors, this may indicate that for ICT demands to negatively affect health, exposure over a longer time is necessary. The differences between the genders can be explained by gender segregation in the labour market, and by the fact that men work remotely to a greater extent.

Bordi et al. (2018) describe how workload has increased due to increased digital communication. Above all, they emphasize how email quantities are perceived as problematic. Participants in the research study perceived a significant amount of all email as irrelevant. Poorly worded messages with inadequate information were also considered a problem. The expectation to answer email quickly contributed to difficulty concentrating on tasks and an impaired ability to plan and control work. Bordi et al. also point out that technical problems could contribute to an increased workload.

Increased flexibility at work was highlighted as a positive aspect of the emergence of new forms of digital communication. This includes both where and when work could be carried out, as well as the flexibility to decide when to interact with clients, colleagues and managers. This is a consequence of the fact that handling email is "asynchronous" in nature, in that it can be done at certain times and does not necessarily need to be handled immediately, unlike incoming phone calls, a form of "synchronous communication" requiring an immediate response.

The results of Albinsson and Arnesson's (2018) interview study of managers in the public sector also showed that expectations of constant availability to answer emails resulted in difficulty focusing on a given task. Furthermore, brief and ambiguous short email messages result in misunderstandings and conflicts. The managers in the study considered the features of certain digital support systems valuable, but expressed irritation at needing to understand extensive support systems, especially if they only used a special feature occasionally.

Regarding demands at work and workload, one article shows that digital technology occasionally offers opportunities for relief. A study of robots used by surgical assistants during surgeries showed that they can contribute to reducing the overall workload, while actually also increasing perceived independence at work (Wasen 2010).

Changes to influence and spatial and temporal autonomy at work

As mentioned initially, opportunities for control and influence at work are known factors for preventing work-related stress and illness. But what happens to these conditions when working life is digitalized?

Based on a survey study of industrial workers in Spain, Bayo-Moriones et al. (2017) show that the introduction of ICT contributed to employees feeling a greater degree of participation in activities due to improved opportunities for communication. More specifically, they were able to use digital systems to share information with managers and colleagues and to obtain more opportunities

to submit proposals for improving activities. At the same time, the authors cannot point to a simple, straightforward relationship, based on the study results, between the increased opportunities for communication entailed by digital technology and the extent to which employees became involved in the development of activities.

As a possible explanation, they suggest that the relationship is mediated largely by views of employees and how the activities are organized overall.

Based on the results of an ethnographic study of employees of a power grid company in Norway, Andersen (2017) asserts that the design and implementation of new digital technology can have direct consequences on how work is led and allocated, as well as on how tasks are followed up and evaluated. However, the effect is neither straightforward nor one-sided; rather, the impact on working conditions depends on one's position in the organization, technological skills and control over how the technology is implemented. Specifically, the studied case addressed a mapping tool for planning and designing the power grid. The intention was for the tool, Power Data, to guide the work of installers, but it also had features for ordering materials and for communication between installers and planners. The company's goal was to streamline communication and improve efficiency by guiding internal communication to this digital tool.

The result showed that the more technologically skilled employees made the change, which gave them organizational positions of power on a par with management positions, thanks to the fact that they had more control over the design and use of the technological tools.

In a study based on qualitative interviews with medical staff, Andersson et al. (2017) describe how digital tools are perceived as taking the focus from the client meeting, resulting in worse perceptions of the work environment. In this case, the digital tool was a smartphone intended to be used to document the management of medications at an elderly care facility. Introduction of the technology led to perceptions of the work as having become more controlled by external structures, with less perceived influence over working conditions as a consequence. Lotherington and Obstfelder (2015) also studied the consequences of digital technology on the work environment in medical care, primarily with a focus on the implementation of electronic patient records. Based on a survey study of doctors and nurses, they conclude that increased digitalization contributed to a more standardized work process, with less influence over how the work is completed. Digitalization, combined with increased demands for documentation, also led to an increased amount of work being done on screens.

Håkansta and Bergman (2018) show that new, more standardized IT support led to the experience of increased control and standardization of work tasks among occupational health and safety inspectors. This system also entails the transfer of administrative tasks from administrators to inspectors. These administrative tasks were not perceived as part of the heart of professional expertise and the authors assert that these kinds of "perceived illegitimate work tasks", as they call them, lead to reduced well-being and increased stress among employees.

Digital technology can contribute to spatial autonomy and have a positive impact on employees' work environment, because the work can be completed in a focused, undisturbed setting outside of the office. A Finnish study investigated how the health and well-being of knowledge workers was affected by working for one week, supported by digital technology, in a rural setting outside of the city (Vesala and Tuomivaara 2015). A concept used to describe this phenomenon is a "retreat-type telework arrangement". The results showed that during the period of this "work retreat", significantly lower levels of perceived time pressure, interruptions and stress were reported. When the results were followed up after two weeks, many of the positive effects lingered.

Summary: workload, demands and influence on working conditions

- Digital technology can contribute to an increased workload and more interruptions at work – with negative ramifications for cognitive abilities as well as self-assessed health.
- The occurrence of high ICT demands is related to socioeconomic factors and
- gender, to some extent.
- Digital systems can govern work processes with less influence over how work is completed as a result.
- The introduction of digital technology can cause power shifts in organizations, in that technologically skilled workers gain increased control over work processes.
- Robots can help to relieve work demands.
- New opportunities for communication aided by digital technology can contribute to increased participation and influence at the workplace.
- Digital technology enables enhanced spatial and temporal autonomy.
- Choosing to work outside of the office for periods of time can promote job-related health.

References: workload, demands and influence on working conditions

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Social relationships and leadership

The social work environment involves terms and conditions for the parts of work that include social interaction, collaboration and social support from managers and colleagues.

Promoting health requires not only a balance between demands and resources at work; previous studies also demonstrate the importance of social support. This could involve colleagues at the workplace who can help solve a task with their expertise, as well as a supportive hand in moments of perceived setbacks.

Nine articles fall within this area, which is divided into the following sub-themes: Risk of isolation and inadequate social support; Social relationships with managers: surveillance, feedback and trust; Digital groups; and Digital threats and harassment.

Risk of isolation and inadequate social support

Håkansta and Bergman (2018) show that increased opportunities to carry out work outside of the office, aided by digital technology, have contributed to reduced incentive for occupational health and safety inspections of the physical workplace. The authors call attention to the risk of digitally mediated telework contributing to professional and social isolation when fewer employees are at the office, leading to fewer social interactions.

Regarding how telework affects social interactions at work, Maruyama and Tietze (2012) show in their study that employees had excessive expectations of a negative impact, while the outcome was less negative. Meanwhile, the results show that as many as one third of employees experienced a lack of social interaction as a result of telework carried out at home using digital technology. The results of an interview study with French teleworkers point to perceived social isolation as well as a lack of informal relationships with colleagues (Vayre and Pignault 2014). Based on the results of the study, the authors highlight the need for management to arrange physical meetings among employees who largely work outside of the office.

The results from Pettersen (2016) show that relationships and interactions among employees in the physical environment significantly contribute to how they interact online, in the digital environment. Based on the results of an ethnographic field study and a network analysis, people who have not already met or have relationships with other colleagues in the physical world tend to be excluded from digital communication. In relation to the results of the study, the authors emphasize the importance of arranging various social activities to allow employees to meet up in the physical world and get to know one another, in order to facilitate digital collaborations.

As previously mentioned, Hislop et al. (2015) show that digital technology has led to increased spatial autonomy, as employees are not bound to sitting in front of a computer. The authors assert that this fact can contribute to breaking social isolation among teleworkers who work from home. This is because they could choose a work environment outside of the home, where they can interact with other people and still be available for colleagues and clients via mobile phone or email. Employees also appreciated being able to choose pleasant settings (such as a café).

The results of a survey study of employees in the Netherlands show that work outside the office had no negative consequences for collegial behaviour at the workplace, contrary to the hypothesis of the study (ten Brummelhuis 2010). The study defines collegial behaviour as social and communicative behaviour towards colleagues in a workgroup, as well as efforts to contribute to the social atmosphere of the entire workplace.

The results can be explained by the fact that digital technology permits other forms of communication among colleagues and the possibility to work from home makes

work more efficient, and as a result, there is time left over to spend energy on encouraging colleagues and the social atmosphere in the group.

A survey study of Belgian employees in the telecom industry showed no direct links between the amount of telework (number of days which the employee worked from home using digital technology) and job-related health (Vander Elst et al. 2017). However, employees who worked from home more often received less social support, which was related in turn to poorer job-related mental well-being and engagement in work.

The previously mentioned study on robotic assistants in surgery (Wasen 2010) warned that ultimately, surgeons' work may become socially isolated if robots replace the surgical assistants of the past. At the same time, the robots were described as accepted colleagues by surgeons. The authors highlight concepts such as "robot companions" and "robots as team members" and point out that social abilities can be incorporated into the design of technology to a greater extent today, for example with facial expressions, body language, and the ability to read the user's intentions.

Social relationships with managers: surveillance, feedback and trust

In Maruyama and Tietze's (2012) study of teleworkers, it emerged that more often than men, women stated that working from home using digital technology led to their work being rendered invisible, which ultimately had negative effects on their career opportunities. One explanation the authors present is that work is assessed and evaluated based on visibility at the office as a measurement of engagement.

According to Ball (2010), surveillance at the workplace is nothing new, but the emergence of a "culture of measurability" and new digital technology has intensified surveillance of individuals. The article, a historical exposé and mapping of surveillance at work, explains that historically, it has been acceptable for employers (in the context of the paid-work relationship) to monitor work in various ways. The author of the article also emphasizes that surveillance perceived by employees as increasingly extensive or in-depth can have negative consequences for autonomy and influence at work and for trust in the employer.

Digital groups

Bosch-Sijtsema et al. (2011) point out that digital technology has enabled a more distributed work approach in work groups, i.e. groups collaborate on a daily basis even if they are not in the same physical location. This work method may lead to difficulty getting colleagues together in a single location as well as fewer informal discussions and meetings – which the authors assert are important for both the performance of the group and for the work environment.

Digital threats and harassment

An article about sex workers in the UK says that the sex trade today is largely mediated by digital technology (Sanders et al. 2016). Based on a survey study of sex workers, the researchers note that threats and harassment via phone, text message or email comprise the most common crime (about one in three) to which the workers are subjected.

Summary: social relationships and leadership

- How employees communicate and interact digitally and in physical encounters at work cannot be viewed as separate phenomena. When employees regularly work outside of the office and do not have existing, well-established relationships with colleagues, they may easily be excluded from digitally mediated communication.
- Organizations with a large share of employees who work outside of the office need to arrange physical meetings.

- Multiple studies point out the obvious risks of the lack of social support entailed by telework.
- Working outside of the office may contribute to rendering the work invisible, especially for women, which can have negative consequences for career opportunities.

References: social relationships and leadership

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Knowledge, learning and qualification requirements

Because most operations are in constant change, opportunities for skills development and learning at work are increasingly important. Beyond potentially being a precondition for the organization's survival, the opportunity for individual growth is part of a good work environment. High qualification requirements are a positive aspect of a work environment and historically, technological shifts have tended to create concerns about work being deskilled. Six articles are included in this area, which is split into two sub-themes: Knowledge and learning; and Qualification requirements at work.

Knowledge and learning

In a study of hairdressing apprentices' skills development in England, Mullin (2013) showed that the apprentices perceived e-learning as positive overall. E-learning expedited completion of course components, because the participants could choose when and where to complete them. It also contributed to deeper learning, bridge-building between younger and older people at the workplace, increased learning between colleagues, and provided support at work when mentors lacked time. E-learning worked best when the content was practically oriented and when time and resources were allocated at work, while one challenge was that not everyone

had access to their own computer or internet connection. Some of the apprentices felt that colleagues were unaccepting of digital activities being carried out during working hours. Kaasinen et al. (2019) discuss how digital tools can alleviate issues related to learning and skills in industrial manufacturing. By collecting and analysing information about employees' areas of expertise and the company's needs, "big data" could help match people with tasks. Similarly, social media and augmented reality could enhance learning between colleagues and training via virtual reality could prepare operators before a new production system existed in reality.

Qualification requirements at work

The studies addressing the impact of digitalization – such as introducing a robot to a pharmacy setting or ICT into a textile industry – on the degree of qualifications for different tasks all suggest that the qualification requirements for some tasks increase while other tasks are deskilled (Barrett et al. 2012; Giritli Nygren 2012; Findlay et al. 2017; Baccini & Cioni 2010). In addition, in their qualitative study of a hospital pharmacy that introduced a robot for dispensing medications, Barrett et al. (2012) clarify that if all professional groups affected by digitalization had had the opportunity to participate in influencing technological development, implementation and updating, then deskilling probably could have been avoided. In addition, Giritli Nygren (2012) explains that managers at a government agency saw the introduction of ICT as a gender-neutral change, while claiming that women were not as skilled or interested in ICT and were thus also opposed to digitalization. On the other hand, the women felt their work was being deskilled and gave this as a reason for their resistance to ICT.

Summary: knowledge, learning and qualification requirements

- Learning through digital tools can contribute to skills development at the workplace, but some aspects require consideration.
- Advantages: flexible in terms of time; builds relationships between colleagues; in-depth learning; facilitates matching of needs with employee skills.
- Aspects requiring consideration: access to computers and time; content that is practically oriented; in professions that do not ordinarily work with computers, colleagues may disapprove of co-workers using computers at work.
- Digitalization of work can affect the degree of qualification of different tasks: some tasks have elevated qualification requirements while others are deskilled. When a professional group affected by a digital change has the opportunity to participate in technological development, implementation and updating, deskilling can be avoided and upskilling can take place instead.

References: knowledge, learning and qualification requirements

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Flexible work in space and time

As mentioned previously, leeway or autonomy at work and the experience of control are established positive aspects of the organizational work environment. This could mean the opportunity to influence the content of the work and how it is carried out, and today, with digitalized technology, also where and when work is carried out. Digital technology has made it possible to work in spaces other than the physical workplace and at times other than typical working hours, i.e. work is flexible in time and space. The articles in this literature review refer to this phenomenon as "telework" or "new ways of working", and it entails employees having the opportunity to work from home anywhere from half a day a week to all of their working hours, during and/or after regular working hours. In this section of the literature review, we refer to this kind of work as "digitally mediated telework". Even though Sayah had already concluded in 2013 that digital technology was not only bringing work into the private sphere, but private life was entering the work sphere, most studies assert the one-sided perspective that work is entering the private sphere. Based on a quantitative study, Thulin et al. (2019) suggest that the occurrence of digitally mediated telework should be viewed as a coping strategy for handling the challenges of work and daily life, rather than that digital telework causes challenges related to control. The study also shows that more and more jobs involving simple, routine tasks that were once bound to the workplace can now be completed at home through digital telework. This kind of work as well as more complex tasks are done at home largely in order to be able to work undisturbed and uninterrupted. Furthermore, people who carried out complex tasks also often stated that the reason they continued working at home was because the work was fun and challenging.

Fourteen articles are included in this area, which is divided into two sub-themes: Positive flexibility and increased risk of conflict between work and personal life, and Gender roles. The articles in the first area largely share a focus, which has made it possible to conduct an in-depth analysis of the area. Two of the articles were addressed in the section above.

Positive flexibility and increased risk of conflict between work and personal life

Research on work that is flexible in time and space demonstrates both positive and negative effects resulting from this approach. Jostell and Hemlin (2018), Nijp et al. (2016), Gadeyne et al. (2018) and ter Hoeven and van Zoonen (2015) studied the occurrence of certain negative aspects in the work environment but found that these often did not materialize. Jostell and Hemlin (2018) saw no conflicts related to work spilling into the private sphere; they assert that this could be because the participants were so-called professional digital teleworkers, with flexible work hours and perceived control at work. Nijp et al. (2016) studied, using quasi-experimental methodology, a financial company at which the employer implemented digital telework and made sure employees had the necessary technology (including an ergonomic workplace), and also covered their additional electricity costs. No negative outcomes were found here related to demands, control and social support – which are important key factors in the work environment. Gadeyne et al. (2018) determined that employees (with a child) who prefer to integrate work and personal life and who use computers after the end

of the workday did not experience increased time-based or strain-based work-to-home conflict. However, this only applied because the organization had low availability demands and low work demands. Through a national survey study of employees, ter Hoeven and van Zoonen (2015) have shown that flexible work methods can create opportunities for better work–life balance, increased autonomy at work and more effective communication, while the downside is that interruptions can easily occur (compare with chapter 3.1). The researchers assert that the challenge of dealing with interruptions lies in finding a balance between flexibility, connectivity and efficiency, but it is unclear whether the solution is at the individual or organizational level.

Gombert et al. (2018) show in their qualitative diary study in the service sector that employees who used their smartphones often for job-related tasks in the evening, but who also experienced high-quality sleep, had higher chances of effectively managing self-control demands the next workday. On the other hand, if sleep quality was poor, these chances decreased. Adisa et al. (2017) showed in a qualitative interview study in the banking and financial sector that smartphones gave employees the necessary flexibility to balance demands at work and in their personal lives, while also catalysing work–life conflict. Despite the advantages of flexibility, the researchers point out that there are challenges; for example, the number of work hours often increases, which can make it difficult to disconnect from work, thus causing tension in relation to family and other private activities. Ojala et al. (2014) show in their industry-wide survey study that individuals who did informal overtime work at home felt guilty about neglecting issues at home, and that working from home during a portion of formal working hours led to conflict at home related to time use. Grunau et al. (2017) show in a quantitative survey study that white-collar workers and managers in private companies use ICT more at work, and work more hours per week, than blue-collar workers. Furthermore, they observed a link between ICT and hours worked, which means that work is therefore carried out in the private sphere to a greater extent (compare ICT demands, chapter 3.1). This can lead in turn to difficulty managing the boundaries between work and personal life, which Grunau et al. assert can be considered a work environment issue. Grunau et al. also note that access to ICT can mean that more private matters are handled at work/during working time and work is actually carried out less efficiently. Charalampous et al. (2019) show in a literature review that flexible work creates opportunities and potential problems. The autonomy to make one's own decisions is positive and serves as an opportunity. In contrast, the risk of isolation is problematic; it is also problematic that managers are more likely to micromanage and control employees more and more frequently, which can lead to emotional exhaustion and reduced job satisfaction (compare chapter 3.2).

Gender roles

Rafnsdóttir and Júlíusdóttir (2018) show in a qualitative interview study that the introduction of virtual work and digitally mediated telework did not change gender roles. Rather, the study shows that it makes women's lives even more hurried, leading to an increased balancing act between work and personal life. Compared with men, women worked harder and more efficiently to manage to both work as managers and take care of the family. Male managers seemed to have more control over their time and were also able to establish clearer boundaries, and they continued to engage less in child and family care. In a quantitative survey study, Hubers et al. (2011) studied the coping strategies used by professionals to create work–life balance. No significant differences were found between women and men; for example, both genders worked after working hours and both were available for their family during working

hours, which can be explained by the fact that most study participants were highly educated, something the authors assert could mean increased demands for equal conditions within the family. In a qualitative study, Gálvez et al. (2018) show

that digital teleworking can challenge traditional gender labour models, if not traditional gender roles. According to the authors, Spanish working life, which includes long siestas, has been adapted to traditional gender norms, where men work and women take care of the home and family.

Due to these long siestas, employees are at work for approximately two more hours per day than employees elsewhere in Europe. This becomes problematic when women want to enter the labour market, but still have responsibility for the home and family. When women were given the opportunity to work from home for part of the working week (digital telework), they could still spend as many hours working, but the time

that would have gone to a siesta otherwise could be used for housework. In addition, the women had clearer agency related to work and could more clearly criticize the customary masculine Spanish work model, with its long siestas.

Summary: flexible work in space and time

- More and more tasks, including routine tasks, are carried out through digital telework, but private matters are also handled digitally at the workplace.
- Digital telework can be a strategy for improving work–life balance.
- Digital telework can have both positive and negative effects for individuals.
- Positive: better work–life balance; increased autonomy at work; more efficient communication.
- Negative: tasks are easily interrupted; can catalyse conflicts between work and personal life; difficulty managing boundaries between work and personal life; digital telework combined with poor sleep can lead to worsened self-control the next workday.
- While research shows that digital telework can have both positive and negative effects, it also shows that some expected negative aspects may not materialize: conflicts between work and personal life; reduced perceived control; deskilling and reduced social support.
- Digital telework can both maintain traditional gender roles and help break them down.
- Digital telework can facilitate the questioning of highly masculine labour models.

3.4.4 References: flexible work in space and time

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4. Prevention

This section presents the main theme of Prevention, which includes articles about the use of digital technology with the intention of improving the physical, organizational and social work environments in some respect. The organizational and social work environment (AFS 2015:4) were already defined in Chapter 3. The physical work environment typically refers to external material factors. The Swedish Work Environment Act (SFS 1977:1160) includes several occupational regulations pertaining to the physical work environment, such as air and ventilation, sound and noise, light and lighting, ergonomics, temperature and climate, computers and screen work, loads and heavy lifting, chemicals, machines and personal protective equipment.

Our interpretation of the main theme of Prevention is relatively broad, and the conclusions and discussions of the articles we have included have forward-looking ambitions for change and prevention in occupational health and safety. This main theme includes articles on three different combined areas: prevention and the physical work environment; prevention and the physical work environment with aspects of organizational and social work environments; and prevention and the organizational and social work environments. Most of the articles focus on the physical work environment. However, a frequent sub-theme is the interaction between people and different kinds of digital technology. Here, digital technology refers to different kinds of smart machines, robots and tools that are equipped with digital technology, as well as digital objects such as various software systems, animations, simulations, audio and video.

The results of the main theme Prevention are presented differently compared to the previous main theme. This is because most of the articles in this main theme were written by researchers in the field of technology and they are largely based on different kinds of experiments and interventions. The purpose of the studies described below is to prevent various problems in the work environment and thus also to improve it. For example, digital technology has been developed and used to teach inexperienced electricians how to carry out risky procedures using simulations, rather than practicing them in real-world situations with an electric current. Unlike the articles on organizational and social work environments, this kind of article is usually based on one or several clear hypotheses that are then developed and tested. Thus, the purpose and results of the study frequently coincide. For example, this may appear as follows: "The purpose of this study is to develop and test X because we believe it may be beneficial for Y". The result could then be, for example: "Yes, X works and should be used", or "No, X does not work and should be modified". In most cases, the articles on prevention do not have the same discussion and problem-based character as the articles in the previous main theme. Because many of them are based on technological and mathematical theory development and methodology, our knowledge is limited when it comes to discussing the applied theoretical and methodological models on a deeper level. Our review in the following section is therefore more descriptive in nature than the previous section.

Prevention – the physical work environment

The articles on the physical work environment discuss the conditions for and consequences of both direct and indirect interactions relative to various aspects of the physical work environment, such as safety and ergonomics. Ergonomics refers to the physical load to which an individual is exposed when completing a task. Ergonomics ordinarily

encompasses the physical load on muscles, joints, hearing and vision, for example. References may also be made to cognitive ergonomics, which is the cognitive load required to interpret information and signs from people and technology.

Digital technology can be used for preventive purposes by identifying, helping to remedy and thus preventing safety risks and ergonomic risks. Technology can also serve as an assistive aid to train employees or function as a warning system. Twenty-three articles are included in this area, which is divided into two sub-themes: Digital technology and safety; and Digital technology and ergonomics. Because the sub-themes both contain quite a lot of articles covering a wide variety of areas, different sub-categories have been identified.

Digital technology and safety

The sub-theme Digital technology and safety is divided into Collaborative work spaces and safety; Digital technology and education for improved safety; and Assistive aids for improved safety.

Collaborative work spaces and safety

Five of the articles are about the direct interaction between people and digital technology in relation to safety. The physical location, i.e. the interactive area, where people and one or more smart robots work closely together and interact with one another, for example in industrial environments, is often called a "work space" or "collaborative work space". This area is associated with physical risks for people, which is why some of the preventive development and occupational health and safety management involves making smart robots even smarter.

Oyekan et al. (2019) aim to prevent the risk of collisions by creating virtual environments in which employees' reactions to both predictable and unpredictable robot motions are studied. The human reactions comprise the data, which are used to improve smart robots' interactions with people in order to prevent collisions. López-Martínez et al. (2015) also want to help improve safety for individuals who work closely with robots. Using simulations, they are developing and testing safety modifications (automatic) for a robot arm, which is intended to reduce the risk of human injury in the event of a collision between a robot arm and a human head. Nikolakis et al. (2019) are aiming to prevent collisions between industrial robots and people by using optical sensors to study the time required for the robot to "detect" a human presence and trigger a response. Tarallo et al. (2019) are aiming to develop a virtual interactive method that contributes to preventing accidents and reducing ergonomic risks in conjunction with manual industrial work involving people and robots interacting and working side by side. Through case studies and simulations, various risks and exposures are studied and evaluated, which in turn lays the foundation for a risk-free, ergonomically designed collaborative work space. Grabowski (2011) uses an intelligent neural system for recognizing high-risk situations in spaces where people and robots collaborate. Information is derived from the results about how to create a safe work space.

Education for improved safety

Four of the articles show how digital technology can be used to train individuals in how to carry out work safely. Rwamamara et al. (2010) use 3D and 4D visualization technologies to demonstrate that safety can be improved and high-risk ergonomic tasks can be reduced at a construction workplace. Through visualizations, they identify the different types of safety risks and ergonomic risk factors, which in turn lay the foundation for how to physically design the workplace. Bosché et al. (2016) have also developed a system that merges reality and virtual reality, in the form of a construction site, to provide construction workers with realistic training working in hazardous environments, for example at heights, by using VR goggles. The need for such training, especially in the construction industry, was demonstrated in a literature review

by Zhao and Lucas (2015) who point out the need for VR simulations to train construction workers to work safely with electricity. Because the risks associated with this kind of task are significant, VR simulations allow them to practice dangerous tasks safely. Grabowski and Jankowski (2015) use VR simulations to improve safety awareness among miners by training them to identify and avoid risks in mining tasks in a safe environment.

Assistive aids for improved safety

From three articles, it emerges that digital technology can have a preventive effect by functioning as an assistive aid to avoid high-risk situations in real-world work. In an article about firefighters and the safety risks to which they are exposed, such as smoke inhalation, Sebastião et al. (2019) conduct an experiment with a so-called Vital-Jacket.

The jacket measures different kinds of vital signs in firefighters, such as heart rate, breathing and body temperature. The authors show that the jacket can prevent accidents by helping firefighters identify dangerous situations. Kurien et al. (2018) intend to create a safer construction site in terms of the risk of falls and of workers being struck by objects. Through experiments and simulations, a remote-controlled robot is being developed and tested that construction workers can use in high-risk situations. Tatić and Tešić (2017) aim to create a safer industrial workplace using mobile augmented reality. Industrial workers can take this assistive aid with them to various high-risk environments and receive help and instructions for safely carrying out different real-world procedures.

Digital technology and ergonomics

This section describes the possibilities of digital technology to restrict the ergonomic load, i.e. the physical load to which an individual is exposed when carrying out a task. This section includes articles in which ergonomics relate primarily to physical load.

Ergonomic design of the workplace

This section covers the nine articles that show how digital technology can be used as a tool to create an ergonomically designed workplace with a reasonable physical load. Most of the articles are specifically about industrial labour. Tarallo et al. (2019) are developing a virtual interactive method that contributes to preventing accidents and reducing ergonomic risks in conjunction with manual industrial work involving people and robots interacting and working side by side. Through case studies and simulations, various risks and exposures are studied and evaluated, which in turn lays the foundation for a risk-free, ergonomically designed collaborative work space. Sanchez-Lite et al. (2013) aim to use a new method (NERPA) for 3D visualization to study, evaluate and improve the ergonomic design of industrial production sites involving assembly lines. Caputo et al. (2019) aim to use Digital Human Models (DHM) to develop a method that helps assembly line designers in the automotive industry to evaluate and design ergonomically sustainable workplaces. The study presents both a simulation of the workplace and a test case of different ergonomic risk factors at a real workplace. To prevent carpal tunnel syndrome among employees with one-sided hand movements, especially in industry, Molnár et al. (2018) conduct experiments using a datalogger in the form of a glove. The glove registers muscular load and movements.

The project results provide important information for designing work and work tasks. To identify and measure muscular exposure to risks related to manual industrial labour, Plantard et al. (2017) are developing a virtual method using a Microsoft Kinect skeleton. By conducting both pure simulations and measurements of professional workers in their actual work environments, data are obtained that are valuable for making ergonomic improvements to the work environment.

Daria et al. (2018) are aiming to use a VR-Ergo Log system to create a virtual version of an industrial workplace that can

simultaneously register an individual's movements and heart rate while performing certain procedures. The system makes it possible to identify and thus prevent ergonomic risks when designing a workspace, and also creates opportunities for employees to practice tasks.

One of the articles that does not focus on industrial work is that by Rwamamara et al. (2010), who use 3D and 4D visualization technology to demonstrate that safety can be improved and high-risk ergonomic tasks can be reduced at a construction workplace. Through visualizations, they identify the different types of safety risks and ergonomic risk factors, which in turn lay the foundation for how to physically design the workplace. Colombo et al. (2013) are using so-called Digital Human Models (DHM) to develop a simulation method to design the refrigerated units used in supermarkets. The method will be used to make it possible to design the units in such a way that prevents ergonomic risks when handling the refrigerated goods inside. Pata and Moura (2018) aim to use metaheuristic algorithms to develop a decision-making system for the organization of work. This decision-making system takes into consideration the different characteristics of individuals, as well as the ergonomic load and technology involved in different tasks. By optimizing scheduling, allocation of work, and human resources and characteristics, the decision-making system prevents the risk of different kinds of work-related musculoskeletal disorders.

Assistive aids for decreasing load

In three articles, digital technology was used as an assistive aid in the actual work for the purpose of reducing ergonomic load. Dalager et al. (2010) carry out a literature review to map and compare surgeons' physical exertion in conjunction with robotic-assisted and conventional laparoscopic surgery. The review shows that robotic-assisted laparoscopic surgery involves less physical exertion, but further research in the area is required in order to best design the ergonomic conditions for robotic-assisted laparoscopic surgery. Kim et al. (2018) are developing a smart robot that, by collaborating with the individual, both assists with real-world manual work and registers joint torque when performing the work. If a given joint is overloaded, the robot provides guidance on how to modify manual handling to reduce the load. Castillo-Martinez et al. (2018) are developing a smartphone-based application that helps individuals evaluate the lighting in various work environments and set it based on the guidelines for the work environment in the area. This gives the individual information about the correct lighting.

Herzog et al. (2018) take a preventive approach by focusing on the optical risks of smart glasses, when used while working in a warehouse. The experiment shows that preventive action should be taken, as an elevated localized defect (scotomas) can be identified as a direct consequence of using smart glasses.

Summary: prevention – physical work environment

- Collaborative work spaces for people and robots in industry comprise a high-risk work environment. Traditionally, people have had to adapt to machines and robots. Today's digital technology has developed robots and machines that adapt to human movements and avoid injuring people.
- Through digital technology, robots have become smart machines that can detect, recognize and handle unpredictable and quick movements by an individual.
- Simulations and VR experiments, which allow the development and evaluation of safe environments without risking life and limb, are an essential part of preventive physical occupational health and safety management.
- Using different kinds of visualization technology, workers can practice and learn how to carry out their work safely and thus improve their safety awareness. They can also safely practice dangerous steps, such as electrical installations.

- Different kinds of digital technology are used as assistive aids to enhance the safety of the real-world work situation. This could involve warning systems built into clothing or mobile devices that workers can take with them to high-risk work situations for help and instructions on site.
- Through the development of remote-controlled robots, workers can carry out high-risk work from a distance in a safe environment, for example in the construction industry, where robots can work at heights while workers are on the ground.
- Digital technology contributes not only to enhancing safety, but also to preventing ergonomic injuries, especially in industry. Data simulations and measurements of individuals in the actual work environment make it possible to study different kinds of physical loads and their ergonomic consequences. This information forms the basis of the ergonomic design of the workplace and provides instructions on how to best complete tasks.
- Algorithms are being used to develop decision-making systems that will promote the organization of ergonomically sustainable work. When work tasks are allocated, consideration is given to the different employees' characteristics and to the physical demands and load of the various work steps, which contributes to optimal matching.
- Digital technology is used as an assistive aid for real-world work to help employees complete tasks in such a way that ensures they do not overburden muscles or joints, and to ensure the lighting is not too dim during a given work step, for example. Smart digital technology identifies an ergonomic problem and informs the employee about which option can reduce the load.

References: prevention – physical work environment

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Prevention – the physical work environment with aspects of organizational and social work environments

Four articles address preventive occupational health and safety management more comprehensively. They provide information about how to design work spaces in different industrial environments using digital technology to promote a good physical, social and organizational work environment.

The articles all cover the design of work spaces and tasks, and have therefore been combined under one sub-theme. Unlike the articles in section 4.1, in addition to preventive physical occupational health and safety management, these also discuss how to adapt the workplace and tasks to employees' qualification level, age and need for further training.

Design of the workplace and tasks

Faber et al. (2017) carry out a study based on simulations aiming to create a shared industrial work space for people and robots, in which the robots adapt to the people and their positions and movement patterns. The study focuses not only on safety and the physical load, but also on the mental burden for the individual. In their article, Peruzzini and Pelliccari (2017) present an experiment in which advanced digital technology in industry 4.0 is used to reshape existing machines ("adaptive manufacturing systems") to ensure that common work spaces are characterized by a good physical work environment and that they are adapted to the qualifications and abilities of individual employees. Older workers comprise a special target group for this mechanical adaptation. In a later article, Peruzzini et al. (2019) assert that a multi-modal human-centred approach is crucial for developing, shaping and evaluating shared and interactive workstations for people and machines in smart industry

4.0. Through a mixture of methods based among other things on simulations, VR and subjective survey data, guidelines are created for how to design shared workstations to create physical, cognitive and emotional sustainability among employees. Braccini and Margherita (2018) aim to use mixed methods to study the extent to which a digitalized smart industry 4.0 in dish manufacturing is characterized by financial, environmental and social sustainability. Regarding social sustainability, which refers to individuals and their conditions, the study shows that industry 4.0 did not lead to the disappearance of work, as had been feared. Instead, the technological development entailed improvements and additional opportunities for improvements to the physical working conditions. In addition, there were increased opportunities for employees to improve their skills and qualifications in a more knowledge-intensive direction. In both cases, the authors assert that this contributes to good conditions for preventing an unsustainable physical, organizational and social work environment.

Summary: prevention – the physical work environment with aspects of organizational and social work environments

- Technological development in industry 4.0 has contributed in some respects to improving work safety and to changing the content of the work, which is why the qualification level has increased among employees. This development promotes a sustainable work environment in general.
- Using digital technology, different kinds of experiments were carried out, including data simulations and experiments in the actual work, to identify physical, organizational and social risk factors. The information lays the foundation for how to design workplaces to ensure physical, cognitive, mental and emotional sustainability for individuals. Individual characteristics are factored in here as well, such as age.

References: prevention – the physical work environment with aspects of organizational and social work environments

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Prevention – the organizational and social work environment

In the articles that focus on preventive occupational health and safety management in the area of organizational and social work environments, three sub-themes have been identified: Digital technology as an assistive aid for work; Design of inclusive work; and Design of flexible work.

Digital technology as an assistive aid for work

Three of the articles show how digital technology can function as a tool for managing work tasks and demands. Zubrycki and Granosik (2016) study therapists' needs for and attitudes towards the use of social robots when working with autistic children. Using mixed methods (questionnaire and experiments), first the authors studied the therapists' attitudes towards social robots and what functions they want the social robot to serve to facilitate their real-world work. Then they studied the extent to which the therapists actually perceived the robot as helpful in their work. The study shows that the therapists want to improve the robot so that it can reduce their workload, for example by completing different administrative tasks and providing decision-making support.

Pejoska et al. (2016) have developed a new method for informal learning in the construction industry by improving the conditions for social interaction among employees via augmented (enhanced) synchronous communication (real-time communication between a number of people). With this approach, whether they can see one another or not, the construction workers can communicate and gesture to discuss, evaluate and manage different dimensions of the work. Simply put, social support and information exchange are facilitated. Landi (2018) aims to use robots to impact human–robot interactions in industrial scenarios to prevent mental workload and stress among workers.

In experiments in which individuals complete different work steps with a so-called affective robot, the robot registers the individual's heart rate to measure stress levels. If the robot registers increased stress, it can adapt the work pace to a healthy level for the individual.

In addition, if needed, the robot can offer feedback to the worker to prevent excessively high stress levels.

Design of inclusive work

Two of the articles demonstrate how digital technology can be used preventively by creating conditions for an inclusive work environment for older workers and for people with disabilities. Nikayin et al. (2014) carried out a study aiming to investigate the health-promoting effects of the use of ICT among older workers. Based on different kinds of qualitative data, the authors show that employees given the opportunity to use ICT to monitor their health and store information about it improve their

health and can thus work longer. This assistive ICT aid is expected to prevent illness among older workers by providing motivation and instructions both at work and outside of work. Gastaldi et al. (2015) show in their article that a good and inclusive work environment for employees with different kinds of disabilities can be created through increased ICT access, because ICT enables a flexible work approach that can be adapted to the individual, which helps people with disabilities.

Design of flexible work

Six articles are about how employers can take a preventive approach to flexible work in terms of time and space. Based on their studies, Ojala et al. (2014) propose policies, and Vayre and Pignault (2014) propose a training programme that can guide workers through work without boundaries. Vayre and Pignault also show that different kinds of digital telework have different effects and must be handled differently – however, they do not say how. Gombert et al. (2018) show that employers should be cautious about asking employees to answer work-related questions outside of working hours and that managers should be attentive to the fact that they are role models. In a quantitative survey study, Hubers et al. (2011) assert that employers should offer the option for digital telework. They also emphasize the importance of giving consideration to aspects such as childcare options and that different groups have different needs and possibilities. Charalampous et al. (2019) indicate that when work that is flexible in time and space is offered, managers should avoid micromanaging and should instead trust that employees will do their work regardless of where or when. In addition, organizations should actively prevent isolation by creating social networks among colleagues and between employees and managers who work freely in time and space. Finally, Bosch-Sijtsema et al. (2011) emphasize the importance of designing office settings that facilitate informal meetings and that give groups the opportunity to sit near one another.

Summary: prevention – the organizational and social work environment

- Digital technology can serve a preventive purpose for the organizational and social work environments by helping employees manage work demands in various ways. One way to handle demands is through social support. One article shows how technology enables visually synchronous communication, where employees are given the chance to help one another handle work demands and tasks, even if they are in different locations.
- Different kinds of smart robots have been and are expected to be developed to help employees handle work demands by carrying out administrative tasks, providing decision-making support, or warning and guiding employees who are approaching excessively high stress levels.
- Studies show how digital technology can be used to create inclusive conditions for older workers and workers with disabilities. In the example with older workers, the idea is to inform, motivate and guide them towards a healthy lifestyle – both at work and outside of work. Regarding people with disabilities, the assertion is that ICT contributes to creating flexibility when it comes to where work is carried out.
- Studies show that digital technology allows work to be disconnected from time and space. This may have both positive and negative effects on the work environment. The articles primarily illustrate the risks of work without boundaries and how employers and managers should approach this lack of boundaries and proactively prevent work from leaking into personal time too much.
- Some initiatives directly target employees, for example training programmes in how to handle the risks of work without boundaries and how to develop social networks to prevent isolation.
- Other initiatives target employers and managers instead. This involves taking a

preventive approach by offering various opportunities for flexible work, developing policies and guidelines to establish boundaries in relation to flexible work, avoiding increased control of employees and being aware that they should serve as good examples themselves.

References: prevention – the organizational and social work environment

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5. Summarizing reflections on the consequences of digitalization for the work environment in a Swedish context

The purpose of this sub-study is to create an in-depth, easily accessible literature review, based on national and international research, about how digitalization may affect the work environment and conditions for preventive occupational health and safety management in the future. Another purpose is to identify knowledge gaps. In this section, we discuss how to understand the findings of the literature review in a Swedish context and, given what we have seen in this review, what to consider with respect to the digitalized work environment of the future.

The conditions for and opinions about what comprises a good work environment may differ from country to country. In Sweden, unions and employers share responsibility for developing and agreeing on the applicable regulations of working life. The Swedish model is based on agreements and terms which are regulated in collective agreements adapted to industries and workplaces. In addition, employers in Sweden have statutory responsibility for the work environment, and for how occupational health and safety issues will be handled, as well as for employee rehabilitation and for adapting work based on their abilities. Sweden differs in several respects when it comes to views on the work environment. For example, in Sweden, equality and participation are considered important conditions for a good work environment. The Swedish model and its emphasis on participation, paired with research in the field, provides excellent conditions for working preventively with the negative effects of digital technology on the work environment. However, further research is needed on how the influence of unions on the work environment has changed over time, and what consequences any changed power relationships at workplaces may have for the development of work environments of the future. In addition to preventive occupational health and safety management, another step towards a sustainable digital working life is to place significant emphasis on researching the positive aspects of digitalization.

Potential impact of digitalization on the work environment of the future

The first question of the study is: What is the impact of the digitalization of work (and personal life) on the work environment of the future? The review shows that together, digital technology and the work environment comprise a complicated tapestry of risks and opportunities in the work environment. In fact, the same form of digital technology can have both positive and negative effects on the work environment. The classic notion that all things have drawbacks is also true here. Figure 2 illustrates the possible organizational and social effects of digitalization that we found in the 41 articles addressing these areas. Thereafter, we discuss the paradoxical effects of digital technology on the work environment.

When introducing a new digital assistive aid, this figure can be used to help identify possible positive and negative effects. For example, if a workplace wants to introduce part-time telework as an option, the negative effects can be reviewed and consideration can be given to which effects may be relevant and should thus be factored in when implementing the option.

Digitalization has enabled new communication pathways, which can result in increa-

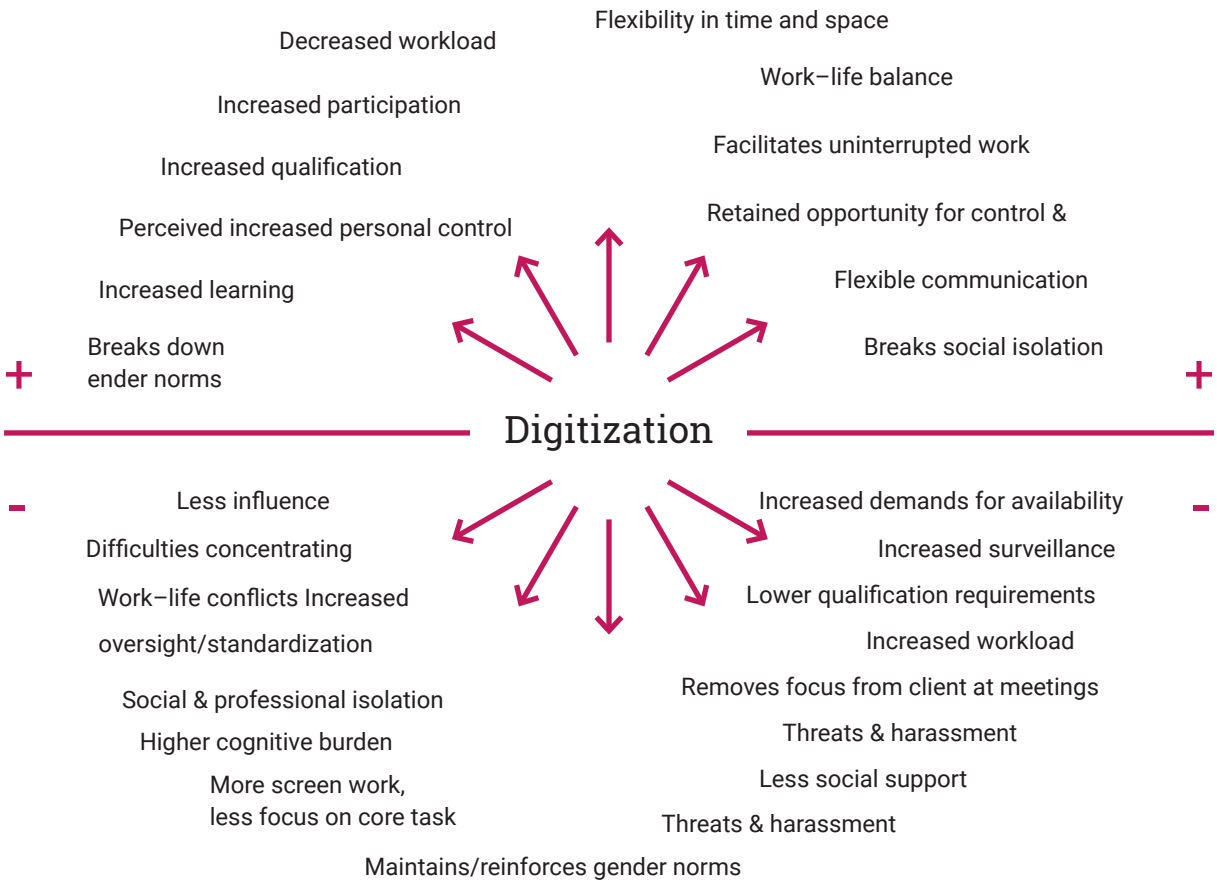


Figure 2. Positive and negative consequences of digitalization on the organizational and social work environments
When introducing a new digital assistive aid, the figure can be used to identify possible positive and negative effects. For example, if a workplace wants to introduce the option of part-time telework for employees, the negative effects can be reviewed and consideration can be given to which effects could be relevant and should thus be factored in when implementing the option.

sed participation in designing the work and developing the operation, but digitalization can also standardize work methods and reduce employee influence over how work is carried out. New digital communication methods also create many opportunities for interruptions at work, which increases the burden on cognitive functions. But because digital technology provides the individual with opportunities for flexibility in space and time, they may also be able to find places and times to work undisturbed and with sustained concentration. Flexibility in time and space is often a positive effect of digitalization. This may be due, in addition to the opportunity to work uninterrupted, to the experience of an improved work–life balance. Paradoxically enough, this same flexibility can also produce conflicts in the private sphere when work and personal life are integrated, for example due to increased demands for availability. When more and more people – including people who carry out complex knowledge work as well as people whose work is more routine – can work from locations other than the physical workplace, the risks of social and professional isolation increase.

At the same time, other research demonstrates the exact opposite: new opportunities offered by digital technology for digital communication or socializing with groups other than one's closest colleagues can break

isolation. However, the risk of social isolation is not necessarily due to flexible work in time and space; it could also be due to the replacement of human colleagues with robots. On the other hand, robots can reduce workload. When work is carried out in locations other than the office, there is also increased risk of less support from managers and more surveillance. Digitalization may therefore affect how work is followed up and evaluated, and can even lead to work being rendered invisible. Excessive or inadequate communication about surveillance of employees' digital footsteps can have consequences for trust between managers and employees.

Digitalization can help break down gender norms at work through increased spatial and temporal flexibility, but the possibilities of digital technology can also maintain or reinforce existing gender norms. Existing gender norms related to technology may also have consequences for qualification requirements when new technology is introduced. While getting to participate in technological development and implementation may lead to increased qualification requirements or more power among men, women may experience deskilling and reduced power because they are not perceived as interested in or knowledgeable about technology and are thus excluded from important development processes.

In addition to the paradoxical effects on the work environment described above, some effects are more unequivocally positive or negative. One positive aspect is that digitalization can lead to increased learning through smart e-solutions. Negative aspects include the fact that digitalization can lead to more screen work and less time for core tasks, and digital activities remove the focus from clients at physical meetings.

Digitalization can also lead to an increased risk of threats and harassment.

There are several risks in the physical work environment related primarily to safety. However, the articles that address these risks take a preventive approach and we will therefore return to this subject under question 2.

In conclusion, when introducing or upgrading digital technology, employers must safeguard the fundamental core values of the Swedish work environment: participation and a high level of personal control at work. Digital technology can strengthen these positive aspects, but there is also a risk of the exact opposite effect: creating organizations that control and monitor their employees. Employers probably also need to view the private sphere as part of the work environment, given the flexible work permitted by digitalization.

Impact of digitalization on the conditions for preventive occupational health and safety management

The second question of the sub-study is:

What significance does the digitalization of work (and personal life) have for preventive occupational health and safety management?

When reviewing the articles, one of the sorting mechanisms was to separate the articles that took a preventive approach to the conditions and consequences of digitalization for a sustainable work environment. The review shows that this was the focus of a relatively large share of the total articles that were ultimately included: 36 out of 73 articles. Of the articles in the category of prevention, 23 focused on the physical work environment; 4 focused on the physical work environment with aspects of organizational and social environments; and 11 focused solely on the organizational and social environments. This suggests that research on preventive occupational health and safety management takes place largely within the physical dimension of occupational health and safety. The review has also demonstrated that, to a significant extent, preventive efforts are focused primarily on industry or other traditionally male-dominated sectors, such as construction or mining. Studies on preventive

occupational health and safety management in the physical work environment in female-dominated industries, professions and sectors are lacking in our material. This may seem somewhat striking in a Swedish context, as overload injuries in retail, healthcare and social services are an urgent matter.

The articles with a preventive focus identified one or more problems in the work environment. These problems may be the result of digital technology, such as the safety risks posed by work spaces shared by people and smart robots, or the risk of inadequate recovery due to ICT and a lack of boundaries between work and personal life. The problems may also stem from aspects that are unrelated to digital technology, such as heavy lifting, one-sided movements, work at heights or an ageing labour force. Sometimes digital technology is the problem and sometimes it is the solution; in some cases, it is both a problem and a potential solution – though in different forms.

All articles under the theme of prevention include positive and negative dimensions in some form, as illustrated in Figure 2. This is not especially surprising, because preventive occupational health and safety management involves identifying a factor perceived as negative, i.e. a problem in the work environment (-) and then attempting to manage that problem by guiding development in a positive direction (+). This is an oversimplification, of course, because the new and apparently positive solution (+) may involve unexpected and undesired consequences in the future (-). On the other hand, this is precisely the dynamic that serves as a constant challenge both in research and in preventive occupational health and safety management. Thus, preventive occupational health and safety management is about identifying problems in the work environment and then reformulating them as relevant research questions. However, these two steps are insufficient for fostering the multifaceted research on the work environment that is necessary for capturing a working life and society in the midst of enormous changes. As this review indicates, we must be observant of the problems and kinds of problems that are being identified and studied, as well as which ones are absent and are therefore not being studied. When it comes to these absent problems, this is not only about uncharted territory with regard to the areas being studied, but also what kind of research in the form of theory formation and perspectives is being applied. A number of understudied areas have been identified in the review; these are presented in section 5.3.

The physical work environment

In many respects, digitalization creates good conditions for preventive occupational health and safety management of the physical work environment. The articles demonstrate how digital technology is used to change work and how it is performed in order to prevent different kinds of risks and problems in the work environment. The preventive initiatives have different target groups: the individual, the workgroup and/or the organization.

One important aspect of preventive occupational health and safety management in the physical work environment involves the changing relationship between individuals and smart robots and the new ways in which they interact. A large share of research is dedicated to ensuring the safety of shared work spaces by developing robots that adapt to people, rather than the other way around.

Simulations and VR experiments enable the development, testing and evaluation of robot–individual interactions without jeopardizing the safety of the individual. Another aspect of preventive safety is that digital technology facilitates new forms of employee training. Using different visualization technologies, employees can learn to carry out work safely, which simultaneously enhances their safety awareness – all in a safe environment. Digital technology can also serve as an assistive aid in the real-world work situation, for example as a warning system built into clothing,

or mobile devices that employees can take to high-risk situations in order to receive help and instructions on site.

Another example of safety risk prevention is the development of remote-controlled robots that carry out dangerous tasks while the worker remains at a distance and in a safe environment.

In addition to the importance of digitalization for knowledge about how to develop safe workplaces, information about the design of ergonomic workplaces is prominent in the review. Digital technology facilitates new ways to measure physical load, both in the actual work situation and using simulations. This information can form the foundation of the ergonomic design of the workplace and provide guidance for how to best carry out the steps of the task. There is also an example of research involving the development of an algorithm-based decision-making system that fosters the organization of ergonomically sustainable work by taking the characteristics of different employees and the physical demands and workload of various steps into consideration when allocating tasks. When it comes to the ergonomic risks of work, technology has also been developed to use warnings and instructions to help employees carry out work in an ergonomically sustainable way.

The physical work environment with aspects of organizational and social work environments

Research that combines issues pertaining to the physical work environment with aspects of the organizational and social work environments shows that digitalization has a positive impact on preventive occupational health and safety management and can inform the design of the workplace, work spaces and work content. It is evident that technological development in industry 4.0 fosters safety at work and can also contribute to elevating the qualification level of employees. Digital technology is also used to identify ergonomic risk factors and work demands that produce an emotionally, mentally and cognitively unsustainable work environment for the individual.

This collective information forms the basis of how the workplace should be designed. Consideration can also be given to individual characteristics such as age and ageing.

The organizational and social work environments

Digital technology has a preventive effect for the organizational and social work environments by serving as an assistive aid for employees to handle demands at work in various ways. For example, this could involve digital technology facilitating both audio and visual communication between employees and allowing them to help one another in real time, even if they are in different locations. Othe ways in which digital technology can serve as an assistive aid for handling demands include smart robots, which can help employees carry out administrative tasks, provide decision-making support, or warn and guide employees who are approaching excessively high stress levels.

Some of the studies show how digital technology can be used to create inclusive conditions for older workers and workers with disabilities. Digital technology is used to inform, motivate and guide older workers towards a healthy lifestyle both at work and outside of it. Regarding people with disabilities, research shows that ICT can prevent segregation by contributing to increased flexibility in how work is carried out, thus facilitating diversity.

A final dimension of digitalization and preventive occupational health and safety management involves the design of flexible work. Digital technology has led to the decoupling of work from time and space, which, in addition to having positive effects, has also led to risks in the work environment. These risks form the basis of the preventive initiatives in these articles. Some of them identified measures for employees, such as

training in how to handle the risks of limited boundaries between work and personal life, as well as developing social networks for preventing isolation. Preventive efforts, which are primarily the responsibility of organizations and managers, include the importance of offering employees different opportunities for flexible work, developing policies and guidelines to establish boundaries in relation to flexible work, avoiding increased control and remaining aware that managers should serve as good examples themselves.

Identified needs for continued research

The third question of the sub-study is: What are the future research needs within the area? We answer this question by first discussing the effects of digitalization on the organizational and social work environments, then in relation to preventive occupational health and safety management with regard to digital technology, and finally by stepping back and considering more general points.

Organizational and social work environment

Demand and workload are two important issues when creating a good work environment. Digitalization produces new ICT-related demands and because digitalization is constantly evolving, more research is needed on the relationship between exposure to ICT demands and work-related illness. It is essential for future research to take gender into consideration. Research could also benefit from the application of a salutogenic perspective, i.e. looking at what can generate positive effects, and here, we believe research on work in rural environments serves as a good example. It would therefore be interesting to study how employers can enable work with digital technology to be carried out in relaxing environments for people, without compromising on other important aspects, such as efficiency and quality, or how such work could be combined with personal life.

Historically, machines have been able to replace the human labour force in various ways and with the digital technology of today, and of the future, this development is likely to become faster and faster. Already now, research shows that robots can reduce workload and be perceived as colleagues while also making work more isolated. Thus, more research is needed on the ramifications for social support when robots replace human colleagues. For example, technological developers and occupational health and safety experts could collaborate to study whether robots can be developed in such a way that they not only contribute to work capacity, but also provide social support and collegial collaboration. More and more communication is taking place via digital channels, which has both advantages and disadvantages. More studies are therefore needed about the relationship between on-line and off-line communication to understand how to best design work environments that foster social interaction. The Work Environment Authority's Organizational and Social Work Environment Provisions (2015:4) address issues such as discriminatory treatment and bullying; threats and harassment are also part of this area and therefore comprise an important aspect of the work environment.

In this literature review, this issue is addressed in only one article and in a marginalized industry: sex work. However, it is reasonable to assume that threats and harassment via digital technology occur in other industries as well, and the issue should therefore be studied further.

Continuous learning and so-called lifelong learning are highly relevant matters in Sweden. Universities are receiving expanded assignments to pursue the issue, and it would be interesting to study how digitalization could provide support in this area. The research in this literature review demonstrates the advantages of e-learning and other digital tools, but this research is still in its infancy and needs to be broadened and deepened.

The review shows that there are differences in the matter of qualification requirements at work for professional groups who get to be involved in the development, implementation and renewal of new technology

compared to those who do not get to participate. Here, there is a significant need for research and development of models that can guide organizations in developing, introducing and updating digital technology without deskilling tasks or professions. This research must also give consideration to gender.

The research presented in this literature review has a one-sided focus on the way in which work spills into the private sphere, while ignoring private activities using digital technology that take place in the work sphere. Research is therefore needed on the effects on the work environment of private digital activities at work. For example, it would be relevant to investigate the impact on collaboration, conflicts, trust and opportunities to concentrate at work. The research presented here focuses on the home as the alternative workplace, but digital technology enables work to be done elsewhere as well (as briefly mentioned on page 16: "retreat-type telework arrangement"). Research could delve more specifically into whether different places, such as trains, libraries and cafés,

and different times, such as evening or morning, have significance for the digital telework environment. Another aspect of flexible work is that employees often work sporadically while on holiday, and further research could investigate the opportunity to recover as well as how this affects employees' private relationships, and their relationships with colleagues and managers.

Prevention

Research on preventive occupational health and safety management for the physical work environment is important because it has a clear focus on how digital technology can help to prevent safety risks and ergonomic risks in different work environments (occasionally also caused by digital technology). One important contribution from this research is that it discusses and provides guidelines for the design of the work space/place, and shows how digital technology can help employees to minimize risks when carrying out their work. This research often has a limited focus, for example on a specific safety risk or physical load, and our review demonstrates the need for studies that incorporate all of the specific information about different aspects of the physical work environment into a larger organizational and social context. Together, the physical and the organizational and social work environment comprise the actual work environment in which employees spend their working hours. Based on what we know today about mind–body interactions, it is important to study the ways in which physical, social and organizational work environments interact. We also need studies about the impact of digital technology on professions in service-based operations, such as office work, human service professions in healthcare and social services, as well as schools, retail, hotels and restaurants. In addition, we need research on the physical work environment that gives consideration to gender and diversity.

The articles that focus on preventive occupational health and safety in the organizational and social work environment show that research tends to focus on how digital technology can help employees handle work demands in various ways. This includes creating good conditions for social support between colleagues, alleviating the workload by transferring certain tasks to technology, or the technology simply warning individuals when a workload is becoming too heavy. Several articles, based on the limited boundaries of digital working life, identify preventive measures for both employees and managers to help employees navigate this lack of boundaries. It is notable that very little research covers how to work preventively with regard to digital technology and the organizational and social work environment. In addition,

the research appears to view the individual as a passive recipient of technological change, and not as an actor who actively participates in shaping technology. The review shows that, as with the physical work environment, further research is needed on how to adapt technology to individuals' needs and conditions, and not the other way around.

Research on preventive initiatives related to shared physical work spaces seems to be broader and thus more clearly standardized than research on preventive initiatives regarding the digital organizational and social work environment. This area also lacks research that takes gender and diversity perspectives into consideration.

Based on the fact that only a few articles simultaneously consider the physical, organizational and social work environments, we can conclude that this area requires more research. Admittedly, we are aware that it can be difficult to combine all of these dimensions in article form, as space is limited, but this does not preclude us from addressing the need.

We view this particular interface as extremely important for attention moving forward, because we suspect that the simplified division of the physical workload on the one hand and mental and social on the other is in many cases already obsolete. In some industries, such as grocery, healthcare and social services, work is characterized by physical challenges, the challenges of contact with customers and clients, and challenges associated with the organizational context. These studies are conspicuously absent. If we look at the Swedish context, female-dominated professions in general and female-dominated human service professions in particular are the most problematic from a work environment perspective. Preventive occupational health and safety management in these professions must take physical, organizational and social factors into consideration. In this area too, research focusing on gender and diversity is conspicuously absent.

In conclusion, we have identified healthcare and social services as an industry in which large investments are made in digital technology, but in which studies on the impact of digitalization on the work environment are few. Studies addressing the digitalization of healthcare and social services often have a one-sided perspective on quality of care, but this must be supplemented with a work environment perspective, especially because these two elements interact. Furthermore, many of the articles that were excluded from this study focused on developing new digital technology for different types of work, but they lacked attention to the impact on the work environment. We believe that one way to bridge this gap in the issue is to conduct interdisciplinary research that connects the development of digital technology to matters related to the work environment. In addition, we have seen a pattern: technology-heavy articles have a strongly positive view of technology, while articles with an emphasis on social sciences take a more negative view of technology. Uniting these two approaches in a joint research project could be productive for work environment improvements.

6. Methodological considerations

Even though the literature review was carried out with a systematic approach as a rapid review, some limitations are worth explaining. The searches of the international databases used the word "NOT" to exclude specific terms; this may be problematic because it risks removing words that could be relevant. Another strategy would have been to only focus on including relevant words and concepts to the study.

We would like to note here that the results described and the research needs we point out are based entirely on the articles included in this literature review. We may therefore propose research that does in fact exist, but in articles that our literature search did not produce. The choice to only include articles in scientific journals, in an effort to strive for high scientific quality, could be called into question, as so-called grey literature (non-peer-reviewed reports, publications from government agencies, reference books, etc.) may also be of high scientific quality.

When taking such a broad approach, as is the case in this literature review, one challenge is that studies of vastly differing natures are included and the quality assessment cannot be standardized, but must be adapted to each research field and tradition. When we designed the study and chose to include the physical work environment, we did not expect it to be such a technologically heavy and experimental area. Therefore, the presentation of the two main themes differs. We took a more descriptive approach to the preventive studies, especially those pertaining to the physical work environment.

The broad approach could be considered a problem, but instead we have viewed it specifically as an opportunity to be able to complete a broad literature review that shows how digitalization can affect all areas of the work environment.

Finally, it has primarily been an advantage to work as a team of three experts on this literature review. We were able to discuss uncertainties and ensure a high-quality process to a much greater extent. The disadvantage is that it was harder to reach consensus. However, the advantages outweigh the disadvantages.

1. Appendix

A: Search strategies for each database

Scopus (Elsevier)

Search date: 27 June 2019 **Number of hits: 11,107 hits**	**Limitations, type of publication (article), from 2005 on and language (English): 3,049 hits**
1. Digitalization	
TITLE-ABS-KEY (”Artificial intelligence”) OR TITLE-ABS-KEY (”Augmented reality”) OR TITLE-ABS-KEY (digital W/0 work OR workplace OR technology OR era OR age) OR TITLE-ABS-KEY (digitalisation) OR TITLE-ABS-KEY (”ICT”) OR TITLE-ABS-KEY (”Industry 4.0”) OR TITLE-ABS-KEY (”Job polarization”) OR TITLE-ABS-KEY (monitoring W/0 internet) OR TITLE-ABS-KEY (robotics) OR TITLE-ABS-KEY (robotisation) OR TITLE-ABS-KEY (”Information and communication technology”) OR TITLE-ABS-KEY (telecommuting) OR TITLE-ABS-KEY (telework) OR TITLE-ABS-KEY (”tele work”) OR TITLE-ABS-KEY (”Virtual reality”) OR TITLE-ABS-KEY (”Smart production”) AND NOT (TITLE-ABS-KEY (”Mechanics” OR ”Kinematics” OR ”Robotic cells” OR ”Educational” OR ”Students” OR ”School” OR ”Universities” OR ”Electr* engineering” OR ”Computer-aided design software” OR ”City planning” OR ”Urban planning” OR ”Carbon” OR ”Seismic”))	
2. Work environment	
TITLE-ABS-KEY((work OR worksite OR job OR office) PRE/0 Environment) OR TITLE-ABS-KEY(”Working environment”) OR TITLE-ABS-KEY((labor OR working OR work OR job) PRE/0 Conditions) OR TITLE-ABS-KEY(Conditions PRE/1 (labor OR work OR job)) OR TITLE-ABS-KEY(Work PRE/0 place OR site OR locations OR life) OR TITLE-ABS-KEY(Work W/1 boundaries) OR TITLE-ABS-KEY(Workplace OR Worksite OR Workspace)	
2. Health	
TITLE-ABS-KEY ("Well being" OR Wellbeing) OR TITLE-ABS-KEY (Health W/0 (work* OR employ* OR occupational OR effects)) OR TITLE-ABS-KEY (healthy PRE/0 (employee* OR work*))	

Field tag/s: TITLE-ASB-KEY = Title, abstract or keyword; AND NOT = Excluding specified terms: PRE/n = Preceded by, the first term is to be followed by the subsequent term(s) within a given number of other terms (0–255); W/n = within, the first term is to be found within a given number of other terms (0–255) from the subsequent terms; * = Truncation; “ ” = Quotation marks, searches for a phrase

Web of Science (Thomson Reuter)

Search date: 27 June 2019 Number of hits: 4,797 hits	Limitations, type of publication (article), from 2005 on and language (English): 2,069 hits

1. Digitalization

(TS= ("Artificial intelligence") OR TS= ("Augmented reality") OR TS= (digital NEAR/0 (work OR workplace OR technology OR era OR age)) OR TS= (digitalisation) OR TS= ("ICT") OR TS= ("Industry 4.0") OR TS= ("Job polarization") OR TS= (monitoring W/0 internet) OR TS= (robotics) OR TS= (robotisation) OR TS= ("Information and communication technology") OR TS= (telecommuting) OR TS= (telework) OR TS= ("tele work") OR TS= ("Virtual reality") OR TS= ("Smart production")) NOT (TS= ("Mechanics" OR "Kinematics" OR "Robotic cells" OR "Educational" OR "Students" OR "School" OR "Universities" OR "Electr* engineering" OR "Computer-aided design software" OR "City planning" OR "Urban planning" OR "Carbon" OR "Seismic"))

2. Work environment

TS=("Work environment"OR "Worksite environment" OR "Job environment" OR "Office environment") OR TS=("Working environment") OR TS=("Labor conditions" OR "Working conditions" OR "Work conditions" OR "Job conditions") OR TS=("Conditions of labor" OR "Conditions of work" OR "Conditions of jobs") OR TS=(" Work place" OR "Work site" OR "Work locations" OR "Work life") OR TS=(Work NEAR/1 (boundaries)) OR TS=(Workplace OR Worksite OR Workspace OR Worklife)

2. Health

TS= ("Well being" OR Wellbeing) OR TS= (Health NEAR/0 (work* OR employ* OR occupational OR subordinate)) OR TS= ("Healthy employee*") OR TS= ("Healthy work*")

Field tag/s: TS= = Title, abstract or keyword; NOT = Excluding specified terms; NEAR/n = the first term is to be found within a given number of other terms from the subsequent terms; * = Truncation; " " = Quotation marks, searches for a phrase

Nordic databases: SwePub, Cristin, Forskningsdatabasen.dk and Norart

SwePub

Swedish: Arbet* AND (digit* OR informationsteknologi* OR IKT OR robot*) AND häls*

Cristin

Norwegian: Arbeid* AND (digit* OR informasjonsteknologi* OR IKT OR robot*) AND hels*

Forskningsdatabasen.dk

Danish: Arbejd* AND (digit* OR informationsteknologi* OR IKT OR robot*) AND sund*

Norart

Norwegian: Arbeid* AND (digit* OR informasjonsteknologi* OR IKT OR robot*) AND hels*

Part 3 – Employment type, health, job satisfaction, occupational injuries and mortality – a review of reviews

Summary

The importance of employment types for health and safety has gained increased attention in recent decades in research as well as in official bodies and international organizations. One reason may be that both in Sweden and internationally, there is a long-lasting trend towards an increase in employment types that deviate from what is referred to as standard employment, which refers to permanent, full-time employment and work carried out at the employer's premises. Non-standard employment is a collective term for employment arrangements characterized primarily by ties that are temporary, part-time, and deviate with respect to where work is carried out, which has significance for employer responsibility. Various studies have found this kind of employment to be associated with negative consequences for occupational health and safety. It is difficult to research employment types and ill health as a field, because many different types of employment exist in Sweden and internationally. Conditions vary, as do frameworks and agreements with regard to labour law.

The reasons for temporary employment vary, but the basic reason is to facilitate adaptation between demand for a company's products and services, and the company's human resources to handle the demand. Other reasons may be that a company lacks in-house expertise for a task, or its employees may be on parental, study or sick leave and must be replaced by temporary substitute workers.

The main purpose of this review of reviews has been to summarize the scientific evidence in a number of systematic reviews of original studies on the health consequences of non-standard employment, with a focus on the dimension of temporary employment contracts. Another purpose has been to describe quantitative and qualitative trends for temporary employment contracts in Sweden and internationally, and to identify new emerging employment types. Searches were conducted in the Scopus and Web of Science databases. The relevance of titles and abstracts was evaluated using the tool Rayyan, and scientific quality was evaluated with the AMSTAR instrument. After excluding works based on relevance and quality, four reviews remained. A supplementary manual search resulted in the addition of three more reviews. The search period was 2005–2019 and the search was limited to European conditions. The articles in the reviews included approximately 200 original studies. In addition to the scientific review studies, a search was conducted for grey literature in the field, i.e. distinguished literature on the subject from large international organizations. After excluding works based on relevance and quality, seven reports remained.

A supplementary manual search produced seven more reports. Texts were reviewed by two individuals before being chosen for inclusion or exclusion.

The reviews show that the research area of employment types and health has numerous methodological problems, rendering it difficult to aggregate the findings of different studies and producing inconsistent results, i.e. the results do not agree with one another. The research is highly heterogeneous with regard to how employment types, outcome measurements, follow-up times and contexts are categorized, making it difficult to draw conclusions. With this in mind, it is still possible to establish the following about associations between employment types and health in a broad sense.

Mental illness is a common outcome measurement in the reviews and is included in four of them. There are indications of associations between temporary employment and mental illness. The area is characterized by original studies that include many different indicators and measures of mental illness, rendering aggregation of the findings difficult. Few studies investigate occupational injuries, but one large,

high-quality original study demonstrates elevated risk. There are many original studies of job satisfaction, but the results are inconsistent. For physical and global health and for mortality, the material was too limited to serve as a basis for any kind of conclusion about associations.

As previously stated, methodological weaknesses are a strongly contributing factor to the rather vague picture. The report therefore includes an extensive review of methodological problems in studies of the effects of employment types. In many areas, the studies were heterogeneous. Consequently, the term "temporary employment" covers many different sub-types and the concept of "well-being" includes many different and disparate terms related to illness. To rectify these issues and develop knowledge of the area, we do not need more of the same; rather, we need thoroughly considered study designs and theoretically motivated studies that relate to the research front.

Research needs and knowledge gaps are presented based on the review studies.

Several specific proposals are presented regarding both methodological aspects and practical questions. One overarching conclusion is that the research may need to take a broader approach and place temporary employment in the larger perspective of working life and welfare. Implementing this kind of broader approach will require interdisciplinary collaboration that includes research questions at the individual, company and societal levels.

The second part of the study is based on grey literature, which in this case primarily comprised texts from the large international organizations: the EU, ILO and OECD. With a few exceptions, the running statistics show minor changes to the distribution between permanent and temporary employment in the EU countries in the 2000s. It cannot be determined whether a shift has taken place between different kinds of temporary employment, because the available statistics are not classified in this way.

A trend report which could comprise an extrapolation of statistical series is necessary for preventive measures. However, it is difficult for this kind of study to capture weak trends or to detect new phenomena or their effects, because, naturally, it takes time before the effects are noticed, and even longer before a scientific, quantitative empirical analysis can be carried out. Many years pass before the results of high-quality longitudinal studies can be determined.

This is deeply problematic from a practitioner's perspective, and more space must be given to alternative models for knowledge acquisition.

This kind of model exists in the "New Forms of Employment" project, which identified nine new forms of employment, which experts assessed in 14 aspects of occupational health and safety including social safety net, stress, work intensity, flexibility, work–life balance, career and skills development, work content, integration into the work organization, representation at the workplace and income.

In the model, expert analyses and assessments of the new employment types are based on empirical and theoretical arguments. The method may have potential for the accumulation of knowledge for early and preventive initiatives in the matters of both individual work and the design of the work content of positions.

1. Introduction

The significance of types of employment for health and safety has received increased attention in recent decades, both in research and among official bodies and international organizations. This is likely primarily because in Sweden and internationally, there is a lasting trend towards an increase in employment types that deviate from what is known as standard employment, and these kinds of positions are associated with increased risks of illness, lack of work–life balance and a weak social safety net (Quinlan, 2015).

The area is difficult to research because there are many different types of employment in Sweden and internationally, with a wide variety of terms, conditions and labour law frameworks and contracts. The area contains a multitude of concepts and descriptions that vary by country and region. The common overarching division is between standard employment (SE) and non-standard employment (NSE) – or typical and non-typical work, which generally has the same meaning. The latter phrasing seems to be on the decline, and SE and NSE are commonly used in research and among international organizations like the EU, ILO and OECD. Standard employment refers to permanent, full-time positions, in which the work is carried out at the employer's premises (ILO, 2016). Some definitions also include what is known as "social protection" (Hünefeld & Köper, 2016), which varies from country to country. Non-standard employment is a collective term for the remaining ties, the main characteristics of which are that the tie is temporary, part-time and also deviates with regard to where work is carried out, which subsequently has significance for the responsibility of the employer. The quality of being temporary is thus one of several dimensions of NSE and there are different kinds of time limits. Swedish usage and labour law typically employ the terms tillsvidareanställningar (permanent employment) and tidsbegränsade anställningar (temporary employment), which are the terms used in this report unless there is cause to use other terms.

Reasons for temporary employment

The reasons for temporary employment types vary, but the basic reason is to facilitate adaptation between demand for a company's products and services, and the company's human resources to handle the demand. This includes financial grounds, such as lower salary costs. Companies that are active on a market, but also public organizations to some extent, face volatile demand, leading to varied and flexible needs for labour. Temporary employment allows companies to adapt their labour force, which is referred to as numerical flexibility. Another reason for temporary employment could be that a company has a job that needs to be done, but lacks in-house expertise for the task – it is beyond the core business, but is too temporary to serve as grounds for a permanent hire. A considerable share of short-term positions are also generated by a company's employees taking parental, study or sick leave, necessitating replacement by a temporary substitute worker.

Temporary employment contracts can cover work lasting from several hours to several years. Examples of short-term contracts include work as a retail cashier during a sale (on-call or as-needed employment), or an hourly position as a substitute at a school to replace someone on short-term sick leave. One longer-term example is seasonal work, a form of employment used primarily in tourism and green industries. An example of longer-term temporary employment is a project that leads to project-based or object employment. Naturally, project-based

work can also be used in the framework of permanent employment, for example if an organization lacks the necessary expertise for a particular project, and this expertise is assessed as no longer necessary after completion of the project.

Two- and three-party employment

Non-standard employment can be between two or three parties. Two-party employment is direct employment by an employer. A three-party employment relationship arises when a company leases an employee from another company. In recent decades, the staffing industry and work via temporary agencies has become increasingly prevalent.

Put simply, temporary agencies place workers with a client company for pay.

An alternative to consulting a temporary agency is to hire an external company to complete the work on contract. In terms of the work environment, the key difference is that with leasing, the company that has leased the employee is responsible, while with contracting, the contracting company is responsible.

With three-party employment, the worker is paid by the organization to which the worker belongs (the legal employer).

A three-party employment relationship does not necessarily mean the position is temporary. The limit applies to the time the employee spends working at a given company.

Research on employment types – names and forms

Internationally comparative research on SE and NSE has been complicated by the lack of common terminology and definitions (Wilkin, 2013). Time limits comprise the most notable and researched dimension of NSE. The most common terms in European research are "temporary", "fixed-term" or "non-permanent employment" (De Cuyper et al., 2008). In the US and Canada, the term "contingent work" is common and in Australia and New Zealand, the term "casual employment" is used.

Furthermore, countries are dissimilar with regard to contracts and legislation. Temporary employment in Europe has better-regulated protections with respect to work environments, labour law and social justice law than in the US, Canada and Australia. A prevalent discussion in the research is about whether casual work is a particularly divergent employment type compared to the European form of casual work, which has more legal protections and comprises its own category. However, casual work does have similarities with so-called on-call work and with the newer form, gig work – two employment types that are on the rise in Sweden and Europe. This is why casual work has been included in the literature search and in the literature review.

Yet another dissimilarity is that in American research, self-employment is included in the category of temporary employment, while in European research, this employment type is not usually classified this way because it is covered by entirely different labour law and occupational health and safety laws and regulations. Self-employment is one part of a three-party relationship. The construction includes a contract of employment between the self-employment company and the elf-employed worker, and a contractor agreement between the self-employment company and the end customer (SOU, 2017). This study includes three-party relationships via staffing. This category also has different definitions and legislation, which limits international comparisons. However, there is an EU regulation that provides a common framework for the labour market in the EU. When evaluating the included reviews, individual studies were excluded because they did not apply to European conditions.

In this literature review, we adopted the European division based on legal areas and did not include self-employment, a group that also includes a number of variations such as self-employment with family assistants,

freelancers and more, which are not included in the framework of this assignment. The situation for self-employed workers was also recently addressed in the national report A changing working life – how is the responsibility for the working environment affected? (SOU, 2017). In addition, reports on the development of self-employment are plentiful.

Adjacent research areas

Job (in)security

the extensive research on job insecurity focuses on the time limits of a position, but in general the research is on perceived insecurity in a position and grounds for insecurity, such as a risk of unemployment. A brief presentation of some divisions and overlaps in the research on job insecurity and the research on NSE may therefore be warranted. Research on insecurity shows that expectations about the duration of employment play an important role in the experience of insecurity. Permanent employees do not expect unusually high security, and this difference in expectations can be considered an important reason why permanent employees and temporary employees do not have vastly different experiences of job insecurity (De Cuyper et al., 2008).

One meta-analysis (Keim, Landis, Pierce & Earnest, 2014) showed that temporary employees experienced greater job insecurity than permanent employees, but the negative effects of job insecurity seemed to be greater among permanent employees. Due to their higher expectations of security and stability, permanent employees perceived the consequences of a job loss as greater than temporary employees did. Accordingly, Klandermans, Hesselin & Van Vuuren (2010) found that people with an objectively insecure position assessed the risk of job loss as higher, but the consequences as smaller, while people with an objectively secure position made the reverse assessment, i.e. the risk of job loss was perceived as lower, but the consequences were perceived as greater.

For temporary employees, the research indicates that right from the first day of the job, they have noted that the position will almost certainly end. The effects of psychological breaches of contract therefore differ

between the two groups (De Cuyper & De Vitte, 2007; De Cuyper et al. 2008; De Cuyper, Notelaers & De Witte, 2009).

Rather, among temporary employees, expectations are tied to the temporary position becoming a permanent position. Temporary positions can be seen as a "long job interview" which affects the behaviour and reactions of the employee during the period of employment (Virtanen et al., 2005).

Precarious work

The discussion of time limits and insecurity also includes the term "precarious work" (Standing, 2016), which is not an employment type, but a collective name, a kind of second-rank job in terms of status with regard to security and financial compensation.

According to ILO (2012), precarious work is characterized by uncertainty about the length of a position, multiple employers or a disguised employment relationship, a lack of benefits and protections associated with employment, low pay, and obstacles to joining a trade union and collective bargaining. Time limits are a criterion of precarious work, which may be right for some temporary positions, but is not a general criterion. Project-based positions for assignments requiring expertise need not be considered "bad" jobs, and time limits alone are insufficient grounds for classifying these assignments as precarious work. Time limits are the focus of this study, i.e. we do not address other dimensions related to precarious work. The studies by Koranyi, Jonsson, Rönnblad, Stockfeldt & Bodin (2018) and Rönnblad et al. (2019) are broader, but we are limiting ourselves to the dimension of time limits in the review of those studies.

Summary

The area of NSE is difficult to investigate regarding both individual studies and review

studies, due to the prevalence of heterogeneity in many different aspects. There are actual differences between countries and a large quantity of terms, which are not always used consistently. Depending on the purpose of a review, limits and categorizations must be adapted. There may be significant differences in the length of exposure between positions in the same category. We will return to these methodological issues in the discussion of the results in the review study. Before presenting the review study, we will introduce the state of temporary employment types in Sweden, as well as statistics on the development of the various types.

Trends in different types of temporary employment in Sweden

By way of introduction, brief descriptions were provided of several different types of temporary employment. Here, we will present more in-depth information and trends. Statistics Sweden's labour market statistics and periodically published summaries provide a good overview of trends and changes in the composition of temporary employment in Sweden. In a longer-term perspective, since 1987, the share of temporary employment has increased from around 11 per cent in the early 1990s to about 17 per cent in 2015. However, some changes have been made and the statistics from the 1990s are therefore not entirely comparable. The increase took place primarily in conjunction with the crisis in the 1990s (Statistics Sweden, 2015).

Statistics Sweden's statistics (Labour Force Surveys) are divided into different types of temporary positions. One Statistics Sweden report (2015) includes definitions of the various types and their development from 2000 to 2015.

General fixed-term employment: The employer does not need to provide a particular reason for why the position is temporary. After a total of two years in a five-year period with the same employer, the position becomes a permanent. This employment type was added in 2008 and is included with another group, rather than presented separately in the 2015 report.

Temporary substitute: A temporary substitute is always a replacement for a specific individual. A person can work at the same employer through one temporary substitute position following another. In 2005, temporary substitutes were the most common type of temporary employment and comprised 27 per cent of temporary positions. That share has continually declined since then and in 2014, temporary substitutes comprised 18 per cent of temporary positions.

Throughout the entire period, work as a temporary substitute was more common among women.

Object/project-based employment: With project-based employment, an individual is hired for a determined time to carry out a specific project. The position is for the completion of a specific task. Object employment takes place in the construction industry and in medical care. Employment as a doctoral student, which can last up to five years in total, is classified as object/project-based employment. The share of object/project-based employment fell between 2005 and 2014 from 15.4 to 9.5 per cent. This employment type is more common among men than women, but the difference was halved during the period, from 8.6 to 4.3 per cent.

Probationary employment: In the Labour Force Surveys (LFS), a person counts as being employed on probation until permanent employment has formally entered into force. According to Statistics Sweden, probationary employment often leads to a permanent position. As a group, probationary employees largely follow the development for temporary employees. The share of probationary employees increased until the financial crisis of 2008 by almost 2 percentage

points, from 8 per cent in 2005 to 9.6 percent in 2008, and then declined slightly, as with as-needed positions, followed by a

recovery to around 10 per cent. The share of women with probationary employment was lower, averaging at about 7 per cent during the period. Variation was greater among men; between 12 and 17 per cent of men with temporary employment had probationary positions. On average, the difference between the genders was about 7 percentage points.

Seasonal work: These temporary positions recur every year at the same time or season. They only last for the season, regardless of whether the individual has been promised a position for the next season.

On-call: This employment type is applicable both if the agreement for work was made well in advance, or on the day the work will be carried out. "On-call" can be either a type of substitute, but then only for the work shift, or it can involve stepping in to work during work peaks because the employer needs reinforcement for reasons other than temporarily replacing a regular staff member. No agreements are made for regular work of a given scope.

On average, 18 per cent had on-call employment during the period of 2005–2014. The percentage declined somewhat during the period. There had been a slight increase until the financial crisis of 2008, but the long-term trend has subsequently been a decline in the share of on-call employment. When the total share of temporary employment begins to grow again, the share of on-call workers declines. On-call employment is more common among women than among men. The difference between the genders averaged at 3.5 percentage points.

Employed by the hour with an agreed schedule for a certain period of time: This employment type involves work on an hourly basis according to some kind of work schedule. Hourly employment was the most common type of temporary employment in 2014 and the share increased by almost 75 per cent from 13 percent of temporary employees in 2005 to 23 per cent in 2014. The increase occurred among both women and men. Hourly employment without a schedule falls under the "on-call" category.

Statistics Sweden also reports statistics on several other less common types of employment in terms of numbers: traineeships, vacation work, employment as an elected representative, and employment during the school term and academic year. These are not addressed in this report.

Purpose

Starting from the project assignment and considerations described in the foreword and introduction of the report, the primary purpose is to summarize the scientific evidence in systematic research reviews of original studies that investigated the consequences of non-standard employment (NSE) for occupational health and safety. The focus is on the dimension of temporary employment contracts.

Another purpose is to describe quantitative and qualitative trends for temporary employment contracts in Sweden and internationally, and to identify new emerging employment types. This is based on research publications and the perspectives of several major international organizations, as presented in their own publications. Comparisons of trends and developments as conveyed by the research and the organizations are also included.

A third purpose is to identify knowledge gaps based on the reviewed literature and to present research needs in the area of non-standard employment, with an emphasis on temporary contracts.

The assignment was formulated as a "rapid umbrella review", which entails a review of reviews (Spruce & Booth, 2009). In this case, a search of grey literature was also included. Grey literature refers to reports, dissertations, manuscripts, guidelines, etc. produced by government agencies, universities and other organizations and companies (Godin, Stapleton, Kirkpatrick, et al., 2015).

Review studies of employment types and health outcomes

Review articles summarize the evidence and results of original studies. When multiple reviews exist, it is possible to conduct systematic reviews of their findings. Review articles may take the form of systematic meta-analyses, literature reviews and narrative presentations, for example. Smith, Devane, Begley & Clarke (2011) have developed several recommendations for conducting reviews of reviews in order to obtain high-quality scientific evidence. Provided that the reviews are based on original studies of high scientific quality and with a specific purpose, and that reviews such as meta-analyses are based on validated methods, reviews of review articles make it possible to draw conclusions based on a much larger quantity of empirical research than would be possible with individual studies or reviews, by taking advantage of scientific reviews that have already been carried out.

Reviews of reviews can establish fundamental trends in the results that could not be established in reviews based on more limited material.

A systematic review of earlier systematic reviews follows the same principle as a review of original studies, requiring relevant content, precision and objectivity. Special tools have been developed for this process. A frequently used instrument is AMSTAR (Shea et al., 2007; 2009), which establishes several requirements for reviews, including explicit inclusion and exclusion criteria; specification of the research question; searches in more than one relevant database; evaluations of data by at least two independent experts; homogeneity of results; any publication bias and a summary of included and excluded studies, their content and scientific quality (see Table 3).

Systematic meta-analyses can indeed be powerful tools, but the conditions for carrying out meta-analyses may be difficult to achieve in a research field characterized by heterogeneity and a dearth of common theories and terminology, as is the case for employment types. The original studies are therefore interpreted based on several theoretical approaches. For example, Hünefeld & Köper (2016) discuss the completed meta-study based on theories for segmented labour markets, stress, fairness and social comparisons. The researchers found significant heterogeneity in review studies with the tag temporary employment. This tag included different kinds of employment conditions, different follow-up times (see, for example, Virtanen et al., 2005), and the original studies contained a wide variety of covariates for which the researchers controlled. Due to heterogeneity, there are too few studies to carry out systematic meta-analyses and calculations of effect sizes, etc. (Hünefeld et al., 2019). These limitations are an argument for complementary kinds of studies in which it is easier to factor in heterogeneity, such as narrative analyses.

For the reviews, SAWEE recommends an analysis model called the PEO framework: Population, Exposure, Outcomes. This model originates in epidemiological and medical research. Corresponding with the model's terminology, a specific population is studied, such as professionals; different kinds of employment types serve as the exposure (SE and NSE); and symptoms of various medical and psychological illnesses are the outcomes.

As this study focuses on employment types and trends, the empirical material in the scientific literature will unavoidably be limited and in some cases lacking entirely, as these new employment types are insufficiently prevalent for original empirical studies and thus for reviews. The PEO framework can therefore only serve as a loose model for the structure and presentation of the study. Any conclusions about consequences for the work environment or outcomes

may therefore require support from previous research on employment terms and from known connections between psychological conditions, aspects of occupational health and safety, and illness.

Method

The literature review began with a dialogue between the information specialist and the experts for the purpose of identifying relevant terminology and phrases for the search strategy. The search strategy was designed in order to identify as many relevant studies as possible, while including reasonable limitations for the completion of the project. While designing the search strategy, the information specialist conducted initial searches to ensure the strategy led to relevant studies.

Searches were conducted in the Scopus and Web of Science databases. The time range was limited to studies published in 2005 and later. Because the first searches for titles, abstracts and keywords generated far too many studies for inclusion within the framework of this literature review, the search was limited to titles only.

The search process as well as the inclusion and exclusion process are described in Table 1. The final search strategies for each database are presented in Appendix 1. The search strategy was initially built in the Scopus database by gradually compiling the different components. The strategy was adapted for searching the Web of Science database. An information specialist carried out the literature searches in consultation with the experts in the project. The experts provided standard articles and suggested search terms, and made decisions about the search strategy. The searches were conducted in June 2019 and supplemented with manual searches up until 15 October 2019.

All studies that were identified via bibliographic databases were imported into the reference management system EndNote X9, where duplicates were eliminated as per Bramer, Giustini, de Jonge, Holland & Bekhuis (2016).

In an initial step, 28 reports from government agencies, organizations and companies were also identified for a review of relevance. Grey literature was identified in conjunction with searches for equivalent literature for two other projects on work environment trends and digitalization (15 May 2019).

Screening of publications based on inclusion, exclusion and quality criteria

The identified studies were reviewed based on the inclusion and exclusion criteria in two steps (Figure 1). In step one, the project expert reviewed the abstracts of the identified studies for relevance using the web-based tool Rayyan (rayyan.qcri.org). Full texts were ordered for the studies that met the inclusion criteria In step two, the experts reviewed the full texts for relevance based on the inclusion and exclusion criteria. Studies that did not meet the inclusion criteria were eliminated. Materials found via manual search were reviewed using the same process and criteria for inclusion and exclusion. The selection process

Table 1: Inclusion and exclusion criteria

	Inclusion	Exclusion
Population	Individuals with paid work and similar concepts/synonyms.	Individuals without paid work, volunteer work, unpaid housework and students. Standard employment types.
Exposure	Driving forces/trends in society that lead to the development of new types of employment. Non-standard employment, based on existing reports on new types of employment.	
Outcome	The effects of employment types on health and well-being, working conditions and the work environment.	Studies that are not connected to the work environment and working conditions. Studies on the individual's health, illness, well-being and diseases that are not connected to the work environment and working conditions.

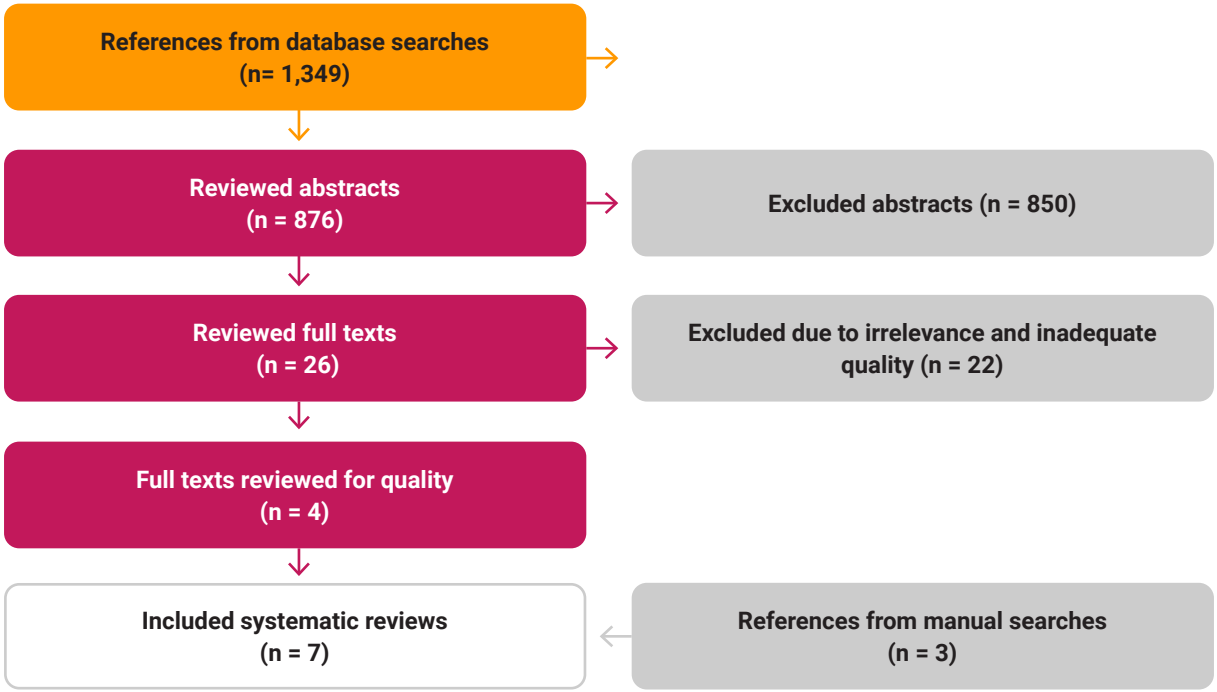
is illustrated in the flow diagram in Figure 1.

The search profile can be found in Appendix 1. In the first round, 1,349 articles were identified. After reviewing the abstracts, the number of potentially relevant reviews was reduced to 26, the full texts of which were reviewed by two independent researchers. An additional 22 articles were eliminated due to irrelevance. The final number of systematic reviews was thus seven, after the addition of three articles found via manual search, two of which were published after the search in May 2019 (Hünefeld & Köper, 2016; Hünefeld, Gerstenberg & Hüffmeier, 2019; Rönnblad et al., 2019). One of the review articles (Imhof & Andresen, 2018) consisted of a systematic mapping of research on temporary employment and well-being, followed by a presentation of research needs and knowledge gaps. The review is thus not an empirical study of connections between health and employment types, but it is of high quality and its focus on knowledge gaps is highly relevant to this review.

AMSTAR was used to assess the methodological quality of the review studies (Shea et al. 2007; 2009) (see Table 3).

As stated previously, 28 reports from government agencies, organizations and companies were also identified for a review of relevance. Of these, seven were included for the final analysis (listed in Appendix 2). The basis for exclusion of the other 21 reports is that they only contained overlapping information or had no relevant original information compared to the included reports. It turned out that the search had not captured reports from the European Foundation for the Improvement of Working and Living Conditions (Eurofound). A manual search produced seven relevant Eurofound reports which were included after independent reviews by two experts. The report titles are listed in Appendix 2.

Figure 1: Flow diagram based on the principles of Preferred Reporting Items for Systematic Reviews (PRISMA) (Moher et al., 2009).



A list of all excluded studies can be found at mynak.se in association with this report.

2. Results part 1 – the review studies

The results are divided into two parts. The first part contains an examination and summary of the review studies. First the characteristics of the identified review studies are described; then the studies are presented individually and grouped by outcome. This is followed by a review of the methodological challenges of the research, important practical research questions, and knowledge gaps.

The second part presents an examination of the grey literature from major international organizations – the EU, ILO and OECD. The section begins with overarching statistics on the evolution of NSE focused on different kinds of temporary employment. After this is a section about new employment types.

Characteristics of the review studies

The database searches and manual searches led to six review articles published between 2005 and 2019. One additional review article, "Unhappy with well-being research in the temporary work context: mapping review and research agenda" (Imhof & Andresen, 2018), was not an empirical study of connections between employment types and health, but rather a review of the research that has been conducted in the area, followed by an agenda for future research. We return to this study in the section on research needs and knowledge gaps.

Table 2 is a highly condensed presentation of the six review studies and Table 3 is a condensed quality review of the studies based on the AMSTAR methodological quality criteria. Before describing the individual studies, we will present several observations and comments of relevance for interpreting the results of the review studies, which follow in the next section.

An initial observation applies to the significant differences in scientific quality requirements for inclusion in the various review studies. This is shown in part in Table 2. The most evident expression of this is the requirement for longitudinal or prospective studies in which causality can be analysed. Only one of the reviews includes this requirement (Rönnblad et al., 2019). As a result of strict scientific requirements, very few original studies meet the requirements for inclusion in the review studies. The vast majority of original studies in the reviews are cross-sectional analyses, the results of which do not meet the scientific requirements to serve as a basis for conclusions about causal relationships. There are significant practical challenges to carrying out prospective studies of a phenomenon characterized specifically by its short-term nature, which is likely reflected in the lack of such studies. The cost of a larger quantity of studies is presumably lower scientific quality of the analysed studies, which is offset in some cases by the inclusion of many more studies, for example to allow for meta-analyses. Two studies (Koranyi et al., 2018 and Rönnblad et al., 2019) explicitly state that they followed the recommendations for systematic reviews of observational studies and for examining the evidence of the results.

A second observation notes the differences in how the reviews presented the criteria for quality and relevance applied to the original studies for inclusion in the reviews. The overview of the review studies (Table 2) shows a frequent lack of information about whether or not the AMSTAR criteria were met. This does not mean the criteria were not met, however, but rather that this information was not presented in the review study.

In summary, the review studies had vastly different quality requirements, and the quality of the six review studies also varied with regard to application of the AMSTAR quality criteria (Table 3), which should be taken into consideration when drawing conclusions

about connections between employment types and health.

Description of the six review studies

The oldest study – Virtanen et al., published in 2005 – is based on 27 original studies, of which 14 were prospective, 2 were retrospective and 11 were cross-sectional. The search period concluded in October 2003 and went all the way back to the 1960s, with slightly varying starting years for different databases, but almost all analyses pertain to conditions preceding the year 2000. The analyses of self-reported mental health included nearly 50,000 people; the analyses of physical and global health included approximately 40,000 people, excluding musculoskeletal disorders (approximately 18,000 people), which were analysed separately, occupational injuries (nearly 300,000, excluding the US, 250,000 of which were from an Italian study) and mortality (two Finnish prospective studies with around 80,000 people). In total, 40 analyses were conducted, of which 26 pertained to conditions in EU countries. Four of the analyses were of conditions in the US and were large prospective register studies of sickness absence, which is not an outcome of our review study. Many analyses pertained to conditions in Finland. Many different professional groups were represented. Because there were few studies for most of the outcomes, meta-analyses were only conducted of mental health and the macro variable of unemployment. In summary, the study is of high quality and meets most of the AMSTAR requirements, which did not yet exist when the study was published in 2005. However, the researchers worked in accordance with general quality requirements of empirical studies.

The second oldest study is Wilkin's study from 2013. The 72 studies included in the meta-analysis covered a broad range of professions, such as teachers, engineers, clerical workers and call centre employees, with a total of 237,856 employees. Most of the studies were cross-sectional. The study outcome was job satisfaction. Both direct connections between employment type and mental health and moderators via job security were studied. Most of the studies were from the 2000s; some were from the 1990s and the oldest was from 1974.

The third study (Hünefeld et al., 2016) includes two analyses/questions. One is about the direct path between employment type and mental health, while the other is about mediation via job insecurity

and other external factors. The search period was from January 2000 to January 2015. Forty-two studies were analysed (of which three were longitudinal) with reference to the connection between temporary employment and mental health. Some publications contained more than one analysis, leading to the presentation of 84 analyses. The analyses were standardized for correlation calculations and significance tests. The number of people included in the various original studies was not presented. The review study had low quality requirements for inclusion and several methodological problems, but offers a relatively detailed report of the scientific shortcomings of the original studies and material, which elevates the quality of the study.

The fourth study by Koranyi et al. was published in 2018 and is a systematic review of the relationship between precarious employment and occupational accidents and injuries. The study is characterized by thorough compliance with and reporting on the inclusion criteria, as well as high requirements for inclusion, but did not require a prospective study design. As the title suggests (Precarious employment and occupational accidents and injuries – a systematic review), this study has a broader approach than temporary employment; it is about precarious employment, in which time limits are one of several criteria in the definition (other criteria include part-time, low wages and inopportune working hours). The selection process resulted in 17 studies, four of which included the

dimension of time limits and were carried out in EU countries.

The fifth review study (Rönnblad et al., 2019) was by some of the same authors as study 4 and focused on precarious employment and different dimensions of mental (ill) health, such as depression and stress. Like study 4, this study is characterized by thorough compliance with and reporting on the inclusion criteria, and had high requirements for inclusion, including in this case that the study should be longitudinal. The selection process resulted in 14 studies, three of which were European and applied to the dimension of time limits (two Finnish, one Swedish).

The sixth review study (Hünefeld et al., 2019) is similar to Wilkin's study (2013) in that it is about job satisfaction, but it also includes mental health. It focused on temporary agency workers (TAW), i.e. three-party employment, with European conditions. Twenty-eight studies were identified for the period of 2000 to 2016 about the relationship between TAW and job satisfaction and mental health. Because some of the studies included more than one analysis, 45 effect sizes were calculated. The study emphasized comparisons to permanent employees. Studies with other comparison groups were omitted. All studies of mental health were cross-sectional. For job satisfaction, two studies had a longitudinal design. The study was carried out by the same research team as the third study (Hünefeld et al., 2016). Like the 2016 study, this study also thoroughly reviews and discusses the scientific shortcomings and merits of the material, which enhances its scientific quality. (Compare point 8 in AMSTAR, Table 3.)

Results grouped by outcome

The results of the review studies are presented below, organized by outcome. As far as possible, we have investigated whether the six different review studies refer to the same original studies or populations, which could result in the overestimation of support for a particular tendency. Because the review studies do not all report the included original studies, the review cannot be absolute and some degree of overlap cannot be discounted. The image that emerges is that overlapping is limited and cannot affect the overarching

Table 2: Summary of method, design and outcomes of the six review studies

Study	Virtanen et al. 2005	Wilkin et al. 2013	Hünefeld et al. 2016	Koranyi et al. 2018	Rönnblad et al. 2019	Hünefeld et al. 2019
Type of study/ period	Literature 1967–2003	Meta-analysis, 1970–2009	Systematic review 2000–2016	Meta-analysis 1990–2017	Systematic review 2000–2017	Systematic review, 2000–2016
Comparisons	Permanent – Temporary (employment context)	Permanent and different kinds of temporary	Permanent and temporary	Permanent and temporary	Permanent and temporary	Staffing versus permanent employees
Type, number of studies	14 prospective, 2 retrospective, 11 cross-sectional	72 studies, no specific details	39 cross-sectional and 3 longitudinal. 84 analyses	4 European cross-sectional on temporary employment	3 European longitudinal studies	24 studies on job satisfaction, 21 on mental health
Outcomes/follow-up time	Mental, physical, global health, illness	Job satisfaction	Different mental health measurements	Occupational injuries	Several dimensions of mental health	Job satisfaction, mental health

Table 3: Assessment of the six review studies based on AMSTAR's quality criteria (Shea et al., 2009; 2011).

Methodological quality criteria based on AMSTAR	Virtanen et al. 2005	Wilkin et al. 2013	Hünefeld et al. 2016	Koranyi et al. 2018	Rönnblad et al. 2019	Hünefeld et al. 2019
1. Were explicit inclusion criteria established prior to conducting the study?	No information	No information	No information	Yes, protocol	Yes, protocol	No information
2. Were there at least two independent reviewers and procedures for disagreement?	No information	No information	No information	Yes, blinding and procedure	Yes, blinding and procedure	No information
3. Were comprehensive literature searches conducted in at least two databases?	Pubmed, PsychINFO, CSA Sociol. abstracts	Yes, multiple and manual searches	Psyndex, PsychINFO, Pub Med, WISO, Econlitt	Pub Med, PsychINFO, Web of Science	Pub Med, PsychINFO, Web of Science	Psyndex, PsychINFO, Pub Med, Web of Science
4. Was publication status used as an inclusion criterion?	Yes, peer-reviewed	Both peer-reviewed and grey literature	Both peer-reviewed and grey literature	Yes, peer-reviewed	Yes, peer-reviewed	Both peer-reviewed and other literature
5. Was a list provided of excluded and included studies?	Only included	Only included	No	Yes	Yes	Only included
6. Were characteristics of the original studies available/presented?	Yes	No	No	Yes	Yes	Yes
7. Scientific quality of different studies assessed and documented	Yes	No reporting	No	Yes	Yes	Yes.
8. Did the conclusions take into account the scientific quality of the studies?	Yes	Yes	Yes	Yes, when evaluating the evidence	Yes, when evaluating the evidence	Yes
9. Were the methods for combining the studies suitable?	Yes	Yes	Yes	Yes	Yes	Yes
10. Was publication bias assessed?	Yes	Yes	No	Yes	Yes	No
11. Were conflicts of interest reported?	No information	No information	No information	Yes, no conflicts	Yes, no conflicts	No information

results and conclusions.

Mental health

Mental health and illness are common outcome measurements in the reviews, occurring in four of the six reviews. The original studies include many different measurements of mental health and illness.

The review study by Virtanen et al. (2005) indicates higher rates of mental illness among temporary employees than among permanent employees. The analyses of self-reported mental health included nearly 50,000 people. The researchers found significant heterogeneity in the material, for example with regard to type of temporary employment,

different measurements for mental (ill) health and more. In deeper analyses of contextual conditions, Virtanen et al. also find that unemployment levels play a role and modify the connection: illness was higher with lower rates of unemployment and lower percentages of temporary employees in the labour force. The researchers interpret the former connection as an expression of the fact that in periods of low unemployment, groups of people with poorer health are mobilized in the labour market to a greater extent, and primarily in temporary positions. The latter connection may reflect the fact that when the number of temporary jobs is low, the group is composed to a greater extent of so-called "bad jobs". When the group grows, heterogeneity also increases and a larger share of "good jobs" is included.

Hünefeld & Köper (2016) asked whether temporary positions increase the risk of mental illness, but found no consistent connections. Sixty per cent of the included studies showed no significant connection and half of the significant connections showed a lower risk of worsening mental health among temporary employees than among permanent employees. Nevertheless, the study demonstrates the importance of moderating factors.

Negative health effects are accordingly moderated by employees' attitudes, such as voluntary-involuntary, unemployment level, life circumstances and the need for security.

As previously stated, Rönnblad et al. (2019) have high requirements for scientific quality, leading to the inclusion of only two European populations (Finland and Sweden). The results are inconsistent, which the researchers attribute to the fact that the category of temporary employment is too broad (ranging from day-long to multi-year positions).

Hünefeld et al. (2019) analyse the connections between temporary agency work and mental health in several different aspects based on 28 articles. Their conclusion is that the connections are inconsistent in relation to the 11 different types of mental illness found in the included studies. Modifying factors were analysed with the same method used by the same researchers in their 2016 study. When comparing permanent employees and temporary agency workers with regard to specific aspects of mental health (fatigue and depression), temporary agency workers have higher levels, but there are not enough studies to be able to draw any certain conclusions about connections.

Job satisfaction

The results of Wilkin's 2013 study are difficult to interpret due to significant heterogeneity of the group of temporary employees, but suggest that temporary employees have slightly lower job satisfaction than permanent employees.

Hünefeld et al. (2019) analysed studies of job satisfaction among temporary agency workers. The results are inconsistent. Seven studies showed that temporary agency workers reported less job satisfaction than permanent employees. Two studies demonstrated the reverse, and seven studies had no statistically significant connection. There were also differences in how the different studies adjusted for covariates.

Like Wilkin (2013), Hünefeld et al. (2019) conclude that there is a high degree of heterogeneity with regard to national context, study design, study group, controlling for covariates and definitions of outcomes, which all limit opportunities to generalize and draw conclusions.

Physical health, including global health and musculoskeletal disorders

Virtanen et al. (2005) analysed physical health, global health and musculoskeletal disorders.

Relatively few studies were considered to be of sufficiently high quality for inclusion. Outcome measurements for the first two factors varied significantly. Four European studies covered musculoskeletal disorders. The meta-analyses did not demonstrate elevated odds ratios for any type of disease. These physical outcome variables were not included in any other studies.

Occupational injuries

The review study by Virtanen et al. (2005) suggests that occupational injuries are more common among temporary employees than among permanent employees. Of the 11 European studies, most demonstrate a positive connection, including in particular the best qualitative studies with prospective study designs. Some studies showed no connection and one study, based on a random sample, showed a negative connection. There were too few studies to conduct a meta-analysis.

This was also the case for the other review (Koranyi et al., 2018), which analysed occupational injuries. Of the six studies it included on temporary contracts, five were European. One of the studies was about workers building a railway for a high-speed train in Italy, which was a four-year project. It showed elevated risk for subcontractors compared to direct employees, which comprised the reference group. Risk was highest for workers in jobs with the lowest qualification requirements and shortest contracts. Fully 122 subcontracting companies took part in the project and risk was significantly higher in the largest companies. However, two original studies in the review, one of which was based on a representative sample in Spain and was assessed as high quality, did not show a connection. The other two studies, one of which was based on a so-called convenience sample, i.e. a non-random sample, also showed no connections. The two review studies (Virtanen et al. 2005 and Koranyi et al., 2018) complement one another in that the Koranyi study covers the time from 2004, when Virtanen's study concluded. The assessment of overlap identified one North American study of nurses, which was not factored in to the conclusions as we are limiting our review to European studies. Both of the review studies fulfil requirements for high scientific quality and the best (prospective) original studies indicate an elevated risk of occupational injury among temporary employees. Overall, however, the research basis in the area is small and the material is heterogeneous, which justifies continued research that ideally should be more particular to specific professions and sectors in order to reduce heterogeneity. It should focus on professional fields in which occupational injuries occur frequently.

Mortality

Only one review study investigated mortality and the material is limited, consisting of one original study. However, it is a high-quality prospective register study (Kivimäki et al., 2003). In this study of municipal employees in Finland, a connection between employment type and mortality emerged. Mobility from temporary to permanent employment was associated with reduced risk (Virtanen et al., 2003).

Outcome summary

For mental illness, the most common outcome of the studies included in the review, there were indications of connections between employment type and illness. For occupational injuries, one large, high-quality study demonstrates elevated risk. For job satisfaction, there are many original studies, but the results are inconsistent. For physical and global health and for mortality, the material is too limited to serve as a foundation for pronouncing connections.

Methodological problems and weaknesses are a strong contributing factor to the rather vague picture. In many cases the material is too limited and heterogeneous to be able to draw conclusions or obtain scientific evidence of the investigated connections.

The review studies that applied relatively stringent requirements for inclusion include very few studies. For example, only two European studies were included in the review study by Rönnblad et al. (2018), even though the review study covered over 17 years (2000–2017). In this report, we have given consideration to methodological quality when drawing conclusions about connections between employment type and health. In addition,

essentially all international and widespread instruments for assessing quality are designed to review scientific studies in which variables can be controlled or manipulated. This research structure is rarely possible in studies of working life conditions.

Knowledge gaps and important research areas

The identified review studies all dedicate significant space to problems found when analysing the original studies and some space to future research needs and knowledge gaps. By way of introduction, the wide variety of terminology as well as NSE types was pointed out. All of the reviews address and discuss this heterogeneity, which is seen as a reason behind the frequently inconsistent results.

Heterogeneity characterizes almost all classification terminology – the category of temporary employment can refer to time periods ranging from one day to several years, highly skilled work is mixed with very simple work, etc. Representative samples are mixed with industry- and company-specific samples. Full- and part-time workers are mixed together, as are contextual conditions such as local unemployment and other labour market conditions. Regarding outcomes, many different outcomes are used and some may be operationalized differently in different studies, which is problematic.

By definition, it is difficult to collect information about experiences with new employment types or temporary employment, because the number of people in these employment types may be very limited in a random sample of normal size. Participants may be difficult to reach, which causes a high attrition rate. As a rule, the review studies do not include information about attrition rates in the original studies, or whether this served as a criterion for exclusion. Given the short-term nature of the employment (exposure) and that people move between different positions, any connection between a given exposure and a simultaneous or subsequent outcome is uncertain.

Research on temporary contracts is a relatively new field and the picture that emerges through the review studies depicts

an immature research field in the sense that it lacks common theories and terminology that can be systematically tested in empirical studies. It is consequently difficult to accumulate information and to compile different studies and enhance collective understanding. The additional contribution of information from more studies of limited scientific quality is likely to be limited.

Need for theories and theoretical links

With regard to the review analyses, research needs and knowledge gaps have been formulated almost solely in terms of the theoretical and methodological shortcomings of the reviewed research.

As an example of the varying theoretical perspectives, Hünefeld et al. (2019) name four theories which they found in the reviewed original studies of temporary agency workers, which served as interpretive frameworks and bases for predicting mental health and attitudes towards work.

First, there are so-called segmentation theories which consider the labour market from a centre–periphery perspective, with an insider group (standard employment) and an outsider group (non-standard employment), groups which, in addition to the aspect of time, also differ in several other respects, such as working conditions and opportunities for growth. In turn, this leads to dissimilarities in mental health and attitudes towards work.

Second, there are stress theories such as the demand–control model, the effort–reward model, and the demand–resource model. They see a causal connection to illness from working conditions such as little leeway, little reward for effort, and insecurity.

A third theory focuses on organizational justice, which involves the extent to which

employees perceive the organization and management as fair in matters of pay, procedures and information. Many studies show a connection between the experience of fairness and job satisfaction and health.

Social exchange theories comprise a fourth explanatory model, which are special theories about psychological contracts. In exchange for loyalty, engagement and performance, employees expect job security and opportunities for training and development. Experiencing a breach of contract leads to stress and can ultimately increase the risk of illness.

Hünefeld et al. (2019) primarily apply the theories to work for temporary agencies, but these theories, especially stress theories, are also used in studies of other kinds of temporary employment and health.

Methodological aspects

With regard to methodological aspects, the issue of control of the underlying factors is a theme in all reviews. Some studies report the factors for which adjustments were made, while others made no adjustments at all. Taken together, this leads to extreme heterogeneity and one conclusion that can be drawn is that unadjusted values are also used for the studies that adjusted, for example, professional groups to achieve better comparability in the meta-analyses. The recommendation given is that studies must include information that enables stratification in order to discover group-specific effects or study specific professional groups (Hünefeld et al., 2019).

As we have seen, only a few studies had a prospective or longitudinal design, which is necessary for drawing conclusions about causal connections. In this case, the issue is whether illness drives individuals to non-standard employment or if non-standard employment can lead to illness. It is difficult in practice to conduct longitudinal studies on a group that is mobile, as temporary employees

can be, and naturally it is also difficult to draw conclusions about exposure and illness if the study participants changed jobs several times during the follow-up period. However, such longitudinal studies do exist, including one Swedish study (Virtanen, Janlert & Hammarström, 2011). Thorough attrition rate analyses must be conducted in longitudinal studies. Did participants leave the study because they found a better job or due to illness, or because they left the labour market? Designing longitudinal studies also involves determining appropriate follow-up times, which are a cause of heterogeneity and an obstacle for drawing comparisons.

Contextual conditions

This study did not include studying the significance of contextual factors as a purpose, but these should be discussed based on the evaluation of the review studies. In some of the original studies, certain contextual factors are controlled – in others, context is an object of study. A few of the review studies group the original studies in such a way that allows for empirical tests of the significance of contextual factors. Virtanen et al. (2005) thus found indications that illness in temporary employment is modified by the national unemployment level and the national proportion of temporary employees. Morbidity among temporary employees was higher when unemployment was low and also when the proportion of temporary employees was low. Hünefeld et al. (2019) also address contextual factors at the individual level, for example whether temporary employment was voluntary or involuntary and the phase of life of the individual.

The significance of the national or social safety net surrounding the individual, which is assumed to modify the effects of job insecurity (European Commission, 2018), is emphasized in the research literature, but even more so in the publications of international organizations.

The most extensive conclusion for continued research was made by Rönnblad et al.

(2018). They advise against studies of the individual factor of time limitations and argue for broad studies of precarious work, which includes multiple aspects of non-standard employment. According to Rönnblad et al. (2018), this employment type should be placed in a broader welfare perspective.

In summary, contextual conditions are considered important, but there is a lack of systematic research on the significance of contextual conditions for health more broadly.

Mapping of research and a research agenda

As previously mentioned, one of the systematic review studies was: "Unhappy with well-being research in the temporary work context: mapping review and research agenda" (Imhof & Andresen, 2018), an extensive mapping review and analysis of contexts, concepts and study designs of existing research on temporary employment. The purpose of the review was to serve as a foundation for formulating a research agenda in the area of temporary employment types and well-being. The study is based on searches of five scientific databases and the criteria for inclusion were, among others, that only empirical analyses would be included, and the studies were required to be published in peer-reviewed scholarly journals. The final analysis included 54 publications of the original 804 identified. This study can be assessed as high quality.

The study demonstrates significant heterogeneity with regard to what the identified research sorted into the category of temporary employment. The concept of well-being includes a variety of disparate indicators, which the researchers consider a reason for the inconsistent findings in the area. This heterogeneity is applicable regardless of the comparisons made and the work environment variables taken into consideration. The problems detected by the review are largely the same ones that emerged in the six individual reviews, but the basis is much larger and the study was explicitly focused on finding the causes of the inconsistent results.

While theoretical and methodological aspects were the primary focus of the research agendas of the six review studies, Imhof & Andresen (2018) use the results of the review to formulate a research agenda that also includes substantial research questions. The agenda is extensive and only a few main points can be presented here with the research needs that emerged in other studies and conclusions from the overall review.

At the individual level, the following knowledge gaps are in urgent need of research.

- Knowledge about the significance of individual background factors other than demographics is limited. Temporary employment also has an impact on domains of life other than work, such as family and social status. More global health indicators, such as subjective evaluations of overall life situation and domains of life other than work, are therefore needed.
- Knowledge of how personality and personality factors interact with different temporary employment types is essentially non-existent.
- A shortcoming in much of the research is how infrequently the matter of whether temporary employment was voluntary or involuntary was addressed, a factor which can also be assumed to interact with an individual's phase of life. There is a lack of research on how a transition from temporary to permanent employment impacts well-being and health.
- The existing research largely neglects aspects of the work environment that are beneficial to health. For example, this applies to the experience of being in one's desired professional field, use of knowledge and expertise, clear work demands, feedback, social contact and more.

At the organizational level, the following knowledge gaps are in urgent need of research.

- Temporary employment is an overarching-term that covers numerous sub-groups with different employment conditions. Separate analyses of different sub-groups are needed for the purposes of scientific quality and for practical conclusions.
- There is a lack of research on how the use of temporary employees affects permanent employees as a group.
- There is a lack of research on temporary agency work and its particular conditions. Research questions include the impact on temporary employees of being tied to different companies, and how temporary agency workers are affected by the length of a position and changing between different workplaces. These questions require longitudinal studies, which are hugely lacking in the research area.

For framework factors and country-specific contexts, the following knowledge gaps are in urgent need of research.

- The research needs to give consideration to more country-specific aspects, such as legal frameworks, the role of institutional players and the country's labour market. For example, the legal system for temporary agencies differs from country to country, which may have an impact on employees' work situations and health.
- The importance of the national or social safety net, which is assumed to modify the effects of job insecurity, is emphasized in the research literature, but even more so in the publications of international organizations. There is a need for more research and information in this area.

In summary, Imhof & Andresen (2018) identify a large number of substantial research questions and knowledge gaps. Both the study and the six reviews point to a large quantity of methodological challenges that must be managed in order to overcome the prevalence of inconsistent research results. This is also a necessity for carrying out high-quality studies and applicable research.

3. Results part 2 – trends and new employment types

The study questions included investigating the similarities and differences between future trends with regard to driving forces and consequences depicted in the research and depicted by international organizations, as presented in their research reports and policy documents. However, the findings of the analysis of the six review studies of temporary employment types lacked information that could serve as a basis for such a

comparison, and the question and comparison must therefore be disregarded. Another question involved quantitative and qualitative changes in employment types. Here, too, no information could be derived from the six review studies. As partial compensation for this shortcoming, a decision was taken to investigate grey literature for descriptions of new employment types.

Method and procedure

Grey literature from major players such as the EU and global players such as the ILO and OECD from 2005 and later served as the material for identifying new employment types. Twenty-eight publications were identified and consisted, among other things, of future-oriented reviews, research reports and so-called discussion and position papers.

The review of relevance of the identified literature from these organizations revealed a significant amount of overlapping information from the same sources and cross references. Two reviewers carried out separate evaluations of relevance to find the most relevant documents from each organization. The compiled results included four texts published by the ILO, one from the OECD, one from the European Commission and one Swedish state public report (SOU). For an unknown reason, the literature search did not produce Eurofound publications, resulting in an additional manual search of the European Foundation for the Improvement of Working and Living Conditions (Eurofound). The review of Eurofound publications on employment types resulted in seven additional texts, published from 2015 to 2019. Eurofound involves multiple parties, with board representatives for employers, unions, member country governments and more. The foundation studies work environments in the EU to document their status and map where there are special problems. The reviewed organization publications do not reflect any shared, official positions in each respective organization with regard to the matters addressed. Rather, they can be viewed as expert contributions for policy development in each organization.

The review demonstrates consensus among the international organizations in their understanding of the need for high levels of adaptability in working life. In this matter, the balance between companies' needs for flexibility and employees' needs for financial and social security as well as psychological and health protections are central (European Commission, 2018). Temporary employment is an important part of this balance (Eurofound, 2015; 2018a; OECD, 2013). Publications from the ILO include Quinlan (2015), ILO (2016), Fenwick et al. (2016), Stefano (2016) and Behrendt & Nguyen (2018).

The Eurofound studies are primarily surveys of working conditions and occupational health and safety conditions, and are not oriented towards studying or reporting on connections between employment type and health. In this respect, they differ from the research analysed in the review studies. One Eurofound study (2018b) comparing six aspects of quality at work in relation to employment

status found that temporary employees were in significantly worse situations with regard to opportunities for the future and getting to use their expertise and make decisions at work, but they reported better social support. This was especially applicable to short-term employees, but also to employees with longer contracts to some extent.

Without scientific evidence, one impression is that the two approaches – studies of connections and surveys of working conditions – point in different directions. The surveys present a more negative image of the conditions of temporary employment than the studies of connections. This is not necessarily an inconsistent result, if many temporary employees get away from poor working conditions relatively quickly, before their health has been impacted.

The rest of the report is based on the literature of the previously mentioned players, with a focus on new employment types. Before going into greater detail, we will present a statistical description of the development of employment types in Europe. Development in Sweden was described in the section "Trends in different types of temporary employment in Sweden".

Quantitative and qualitative development of employment types in Europe

The surveys carried out by Eurofound every five years, starting in the year 2000 (Eurofound 2017a), are a good source of information about the development of and distribution between permanent and temporary employment in Europe.

Stability comprises an overarching tendency in most EU countries (2017b). There has been some decline in the share of permanent contracts, but only in very few countries was this decline more than marginal (Poland, Croatia and the Netherlands). In one case, Spain, a noteworthy increase in permanent employment has taken place. As for Sweden, the second measurement in 2005 demonstrated some growth, but since then the share has largely been unchanged, which is consistent with Statistics Sweden's Labour Force Surveys. Sweden, with 17 per cent temporary employment, is a few percentage points higher than the EU average.

Of interest in this context is whether a shift has occurred among the different forms of temporary employment. Statistics Sweden's statistics indicate an internal redistribution towards a larger share of the most precarious forms. However, the Eurofound statistics have no categorization that can provide a basis for such an assessment. The overarching trend mentioned in several sources is an increase in temporary agency work. There are also examples of new employment types that are quantitatively small, but that could potentially grow and alter the proportions among the different types. The following section presents an overview of these new types.

The best known and most researched new form is gig work or platform work. Other forms are: employee and job sharing, interim management, casual work, voucher-based and portfolio work, crowd employment and collaborative employment. Some of these are not established in Sweden and lack Swedish terminology. According to Eurofound (2015; 2018a), these new types are very broad and include work at an advanced professional level in which professionals are hired for a limited period of time for a specific project on the one hand, and on the other, on-demand work in which the position is only for the period during which the employer needs staff.

For obvious reasons, research is limited on the work environment and health consequences of these new employment types. As mentioned, one exception is gig work, which has received significant media attention and has become the subject of a growing number of scientific articles. Gig work was analysed in a recently published review study initiated by the research council FORTE (Palm, 2019). In the following section, we will present the findings of the review study with a focus on

working conditions, followed by a brief description of the other new employment types mentioned above.

Working conditions and environment in gig work and the gig economy

Not unlike the research area in general, gig work and the gig economy have definition-related issues, with no relatively clear, common definition (Palm, 2019). In this commentary, we will focus on working conditions and aspects of occupational health and safety in the gig economy.

The study also addresses several other structural aspects and aspects related to labour law (see also Eurofound 2018c and 2018d).

First, however, a few things must be said about concepts and terminology. Overall, the terms platform economy and sharing economy are used in parallel with the term gig economy. The completed review (Palm, 2019) is about job platforms and is accordingly limited to paid work. In the study, gig work refers to task-based work arranged via digital platform. Thus the relationship consists of three parties: a worker, a client and a platform provider. Workers are typically viewed and treated as entrepreneurs and there is no employer.

The FORTE review concludes that many studies have been carried out, but most are from the US and pertain to very few platforms, which limits opportunities to draw general conclusions and conclusions about the conditions in Sweden. Overall, the FORTE review is based on 119 identified articles, about 60 of which applied to North American conditions. Working conditions were addressed in 48 articles. Quantitatively, labour law and regulations comprised the largest topic and were addressed in 51 articles. Other topics included industry impact, collective organizing, the scope and demographics of the gig economy, as well as control and recruitment. Articles that only focused on countries outside of the western world were omitted.

The rest of the overview is primarily limited to the findings of the FORTE review on working conditions and environments. The author detects numerous weaknesses in the structure of the identified studies, but the material still permits several conclusions to be made about the working conditions of gig work. Naturally, there is no research on long-term consequences.

The overarching conclusion of the FORTE study is that research on the working conditions of the gig economy is still in its infancy. Some aspects have been researched more than others, but in general, there is little systematic information about the working conditions and working life for those doing gig work. Nevertheless, some tendencies, trends and categories can be discerned. The identified original studies were divided into three basic categories related to qualification requirements and type of work: online skilled work, online unskilled work, and offline manual labour. These categories are highly relevant to the work environment, working conditions and necessary educational background. Knowledge gaps exist in almost all areas of the work environment with relevance to physical and mental well-being.

The gig economy is quantitatively small in Sweden and the data are uncertain. The report "A changing working life" (SOU, 2017) found in one survey with data from 2016 that 2.5 per cent of a random population sample of people aged 16–24 years reported that they had carried out work for a platform. Only 0.45 percent reported platform work as their primary source of income (SOU, 2017).

Work organization aspects: flexibility and control

Work in the gig economy is broadly perceived as extremely flexible. Gig workers are said to be able to personally control when and how much they want to work and the nature of their commitments. But numerous studies indicate that in practice, flexibility is relatively limited and differs depending on the type of

gig work and between different platforms. First, flexibility is limited through organizational factors. Via algorithms, platforms control when and how much gig workers will work and what assignments they will be offered. Dynamic pricing, reviews, acceptance rates and other instruments determine the most financially advantageous times to work and which assignments gig workers are able to accept. It is also possible to continue working on some platforms. Another limit to flexibility is the challenge of finding enough work, which takes up an individual's time.

Second, socioeconomic factors play a role in the opportunity to take advantage of flexibility. Closely associated with the challenge of finding enough work is dependence on income from gig economy work. The degree of dependence is impacted by access to alternative means of livelihood, the possibility of finding another job, and by the size of individual investments made to be able to carry out the work, such as a car purchase.

The level of hierarchical control and opportunities to use gig work for personal flexibility vary between the different categories of gig work. People who do manual labour offline, and who carry out unskilled work online, typically have little control over their choice of assignments. Skilled gig workers who work online have significantly more opportunities to choose assignments and influence their income.

Gig work risk factors

The FORTE review concludes that "in general, there is a lack of systematic information about the prevalence of health risks such as stress, threats, violence and occupational injuries" (op. cit., p. 31) among gig workers. Nor is there any "systematic information about the prevalence of risk factors such as isolation, insecurity and lack of control" (op. cit., p. 31). However, research has been able to demonstrate that different categories of gig workers are vulnerable to somewhat different risks. One such risk in particular is that gig work leads to isolation and thus to inadequate support in the work, which is a health risk. This is based on the fact that isolation is inherent to the organizational structure, which means there are no forms of (equal) communication or meetings between different parties. Workers cannot ordinarily directly communicate with anyone employed on the platform.

Insecurity is another risk factor and the identified research is fairly unanimous on the fact that gig workers face relatively high levels of insecurity on the labour market. However, little research systematically studies the degree of insecurity among various gig work categories (op. cit., p. 33). The insecurity stems primarily from the fact that most gig workers are viewed and treated as self-employed workers. This usually means they lack the rights associated with employment status, such as access to unemployment insurance, sick pay, holiday pay, parental benefit and more. As a consequence of not being employed, gig workers are largely responsible for their own continued education and work equipment.

The overall picture derived from the research is that the effects vary depending on employment rate and qualification level. Vulnerability is highest among gig workers for whom the gig economy is their primary form of employment, and among those who do unskilled work.

The research has also identified occupational health and safety risks connected to insecure and uncertain incomes. The tendency is for high levels of dependence on income from gig work to lead to more hours and longer sessions than permissible and thus, gig workers do not get the necessary rest to work safely.

Other occupational health and safety aspects that are addressed include being locked into uncertain employment conditions and to a certain platform, motivation and engagement, being rendered invisible, de-professionalization, gig work as a springboard to a more secure job on the regular labour market and more.

An overarching conclusion in the review is that there are overlapping risks among different categories of non-standard employment types in the regular economy and gig economy

work. These include isolation, lack of support, uncertain income, etc. These risks tend to be even more tangible for unemployed gig workers. Risks are thus transferred from the employer to the individual gig worker.

Studies on Swedish conditions were largely non-existent and one conclusion in the study initiated by FORTE is that "above all, more research is needed on how working conditions and terms look among gig workers in Sweden" and that "there is a lack of research on how the particular conditions of the Swedish labour market impact employment relationships and the design of work in the gig economy in Sweden" (op. cit., p. 42).

The review study raises several questions about the work environment and research needs related to the emergence of the gig economy and gig work. We will return to these. In general, the research still cannot answer questions about any long-term positive or negative consequences.

New employment types

Eurofound's sixth survey study on working conditions in Europe noted an increase in heterogeneity characterizing the concept of self-employment.

An increasing number and different kinds of self-employment are emerging, and the line between "self-employed" with only one employer is unclear – a so-called "dependent worker" (Eurofound 2017a, p. 24). This has led to different initiatives for clarifying the status of these employment types with regard to labour law and social security law. The comprehensive research project "New Forms of Employment" carried out by Eurofound mapped these new employment types, including their implications for the work environment (Eurofound 2015; 2018c).

The project identified nine new employment types. In addition, 66 qualitative case studies were carried out to investigate how the employment types were represented in the member countries and their effects on working conditions and the labour market. The case studies are available on Eurofound's website http://eurofound. europa.eu/emcc/labourmarket/newforms

The characterizations of the new types were based on a combination of literature reviews, data analyses and case studies. The majority of the new employment types were not yet sufficiently established on the labour market to have broadly used names, which led to Eurofound naming them in accordance with what follows below. The mapping process demonstrated uneven representation of these employment types in the different EU countries. The researchers also analysed the consequences for occupational health and safety of the nine employment types (Eurofound 2015, 2018a). The scenario that emerges reveals significant differences between the nine employment types regarding the 14 analysed aspects of occupational health and safety. Some are primarily relevant to ordinary employment contracts, others more so to self-employed workers and freelancers, while some are relevant to both categories. In summary, the following scenario emerges.

Employee sharing involves an employee being hired by a group of employers to meet their collective needs, resulting in standard employment. Stress, work intensity and inadequate representation are considered the largest occupational health and safety problems.

Job sharing involves an employer hiring two people (or more) on a part-time basis to fill a full-time position. Stress and high work intensity are considered the largest occupational health and safety problems.

Interim management involves temporarily hiring a highly skilled expert/manager to solve a specific problem or lead a specific project. In this way, external management capacity is integrated into the work organization and operation. On the downside, career development and skills development are negatively impacted.

Casual work involves an employer calling in people as needed, with no obligation to regularly offer work. This is by far the most problematic type of employment, with a detrimental situation in many respects: income, a poor social safety net, stress, work intensity, lack of flexibility, lack of work–life balance, problematic for career and skills development, work content, integration into the workplace organization and representation at the workplace.

ICT is a form of mobile work in which an employee can work from anywhere supported by modern communication technology and without being governed by ordinary working hours. This is also a problematic employment type from a health standpoint, with long work hours, stress, high work intensity and problems regarding integration into the workplace organization as well as representation at the workplace.

Voucher-based work involves an employment relationship based on vouchers bought from an authorized organization that covers both pay and social security fees.

Portfolio work is when self-employed workers carry out work for a large number of clients doing small-scale assignments. This is also problematic from an occupational health and safety perspective, with an inadequate social safety net, long working hours, stress, high work intensity, career and skills development, work content, integration and representation.

Crowd employment involves an employer and employee being matched by an online platform. This often involves a larger work task being split up and allocated in a virtual cloud of workers. It has problems related to the social safety net, income, stress, work intensity, integration and representation.

Collaborative employment involves freelancers, self-employees and small companies collaborating to overcome size limitations and professional isolation. Problems related to occupational health and safety include a social safety net, income and representation.

Researchers also identified positive aspects of the new employment types. The most positive aspects emerged for collaborative employment, which was assessed as beneficial in seven of the fourteen aspects: flexibility, work–life balance, stress and work intensity, skills development, work content, autonomy and integration. In contrast, casual work was not assessed as beneficial in any aspect.

Many of the nine employment types overlap with so-called gig work, which is addressed above in a commentary on a FORTE-initiated review (Palm, 2019). The FORTE study's overarching conclusion is that research on working conditions in the gig economy is still in its infancy. Some aspects have been researched more than others, even though there is a lack of systematic information about gig working conditions.

4. Conclusions and overall comments

The significance of employment types for health and safety has gained increased attention in recent decades, both in research and among official bodies and international organizations. The primary reason is likely that both in Sweden and internationally, there is a lasting trend towards an increase in employment types that deviate from traditional, standard employment and these new kinds of employment are associated with an increased risk of illness, lack of work–life balance and a weak social safety net.

The area is difficult to research because there are many different employment types in Sweden and internationally, with an assortment of conditions and various labour law frameworks and contracts. Even though there are numerous studies in the area, few remain after undergoing a quality review. This is part of the reason behind the lack of clarity in the results, in addition to the fact that the material is far too heterogeneous in many aspects, which is problematic for reviews, as these benefit from a large quantity of studies. There is also significant heterogeneity regarding what is categorized as temporary employment in various studies. The concept of well-being also includes many disparate indicators and health measurements. Which comparisons are made and which occupational health and safety variables are taken into consideration, as well as which variables are controlled in the original studies, are also characterized by heterogeneity. There are additional challenges associated with following people in short-term positions, as relatively frequent job changes are inherent to the nature of the work, and analysing connections between exposure and illness is problematic if study participants have changed jobs multiple times during the follow-up period. These disparities are all likely reasons behind the inconsistent results in the area.

Bearing this in mind, the following can be said about connections between employment types and health in a broad sense. Mental illness was the most common outcome of the reviews and the original studies, and there were indications of a connection between employment type and illness. There are round ten different outcome measurements, which poses an obstacle to combining studies for statistical calculations.

A large, high-quality study demonstrates an elevated risk of occupational injuries. For job satisfaction, there were many original studies but the results are inconsistent.

For physical and global health and for mortality, the material is too limited to serve as a foundation for pronouncing connections. This arena also has problems with a wide variety of different outcome measurements, which prevent statistical aggregation.

To contribute to building up the area, continued research must be related to the current state of knowledge and the knowledge front more clearly than has been achieved to date. We do not need more of the same; we need thoroughly considered and focused studies that will help to develop the area.

Based on the research needs specified in the individual review studies and the conclusions in this review, a number of knowledge gaps and urgent research needs have been pointed out. They apply to the individual, organizational and societal levels and are described in the section Mapping of research and a research agenda.

Essentially all international, widespread instruments for assessing scientific quality are designed for reviewing medical and scientific studies. In health-oriented studies of the work environment, the outcome is often a medical variable which is a similarity, but otherwise, possibilities to control and manipulate influential variables are entirely different. Scientific research design is essentially impossible

to use in studies of working life conditions, where research relies on observational studies, which by definition in a scientific frame of reference cannot offer high scientific quality. More suitable quality assessment instruments need to be developed, along with standardized instruments for differentiating the quality of cross-sectional studies. An in-depth discussion of research methodology for studies involving frequently changing work and life situations, as with temporary employment, would be a desirable development in the research area. Naturally, it is difficult to embrace the traditional recommendation for higher quality through longitudinal studies when the "research subject" changes from one short-term position and environment to another. However, longitudinal studies are the best path to understanding which mechanisms behind temporary employment may be associated with mental illness. In summary, the review demonstrates that overall, the research area needs better studies with regard to methodology, which will provide more substance for practical conclusions, to the benefit of individuals and society.

A trend report involving an extrapolation of statistical series as well as early detection of phenomena that may indicate future trends is necessary for preventive measures. The surveys of working life, including employment types, in the EU that are conducted every five years do not demonstrate any robust changes in relevant trends other than a fairly general and weak upswing in temporary employment contracts, and a likely increase in self-employment. However, it is difficult for this kind of study to capture weak trends or to detect new employment types or their effects, because, naturally, it takes time before the effects are noticed, and even longer before a scientific, quantitative empirical analysis can be carried out. Many years may pass before the results of high-quality longitudinal studies can be determined.

Developing future-oriented knowledge of occupational health and safety regarding new employment types therefore requires supplementary initiatives. One such initiative could be to supplement existing research-based information within the area with case studies and expert reviews of the hypothetical consequences of the new types for occupational health and safety. Research projects such as "New Forms of Employment" are an example of this.

One might say this method involves identifying new working life phenomena, employment types in this case, and conducting expert assessments of them in different aspects of occupational health and safety. The project mentioned identified and assessed 14 aspects of occupational health and safety, including social safety net, stress, work intensity, flexibility, work–life balance, career and skills development, integration into the workplace organization and representation at the workplace. The analysis revealed major potential differences in occupational health and safety among the new employment types. The method can be assessed as having significant potential for developing knowledge for early and preventive initiatives in the matter of both individual jobs and the design of the work content of positions.

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Appendix 1. Search strategies for each database

Search date: 25 June 2019, Scopus (Elsevier) Number of hits: 1,507 hits	Limitations, type of publication (article, review, book, book chapters), from 2005 on and language (English): 711 hits
2. Employment forms	
TITLE(Alternative W/1 Work* OR Employ* OR Job) OR TITLE(Atypical W/1 Work* OR Employ* OR Job) OR TITLE(Casual W/1 Work* OR Employ* OR Job) OR TITLE(Contingent W/1 Work* OR Employ* OR Job OR Labour) OR TITLE(Crowd W/1 Work* OR Employ* OR Job) OR TITLE("Digital labour") OR TITLE("Employee sharing") OR TITLE("Flexible work") OR TITLE("Gig economy") OR TITLE("ICT-based mobile work") OR TITLE("Informalizing work") OR TITLE("Job sharing") OR TITLE(Non-permanent W/1 Work* OR Employ* OR Job OR Contracts) OR TITLE(Non-standard W/1 Work* OR Employ* OR Job) OR TITLE (Nonstandard W/1 Work* OR Employ* OR Job) OR TITLE(On-call W/1 Work* OR Employ* OR Job OR Contracts) OR TITLE(Outsourcing) OR TITLE(Platform W/1 Work* OR Econom*) OR TITLE("Portfolio work") OR TITLE(Precarious W/1 Work* OR Employ* OR Job) OR TITLE (Probation) OR TITLE(Seasonal W/1 Work* OR Employ* OR Job) OR TITLE(Temporary W/1 Work* OR Employ* OR Job OR Contracts OR "Agency work") OR TITLE(Temps) OR TITLE("Work organization")	

Field tag/s: TITLE = Title; W/n = within, the first term is to be found within a given number of other terms (0–255) from the subsequent terms; * = Truncation; " " = Quotation marks, searches for a phrase

Search date: 25 June 2019, Web of Science (Thomson Reuter). Number of hits: 1,213 hits	Limitations, type of publication (article, review, book, book chapters), from 2005 on and language (English): 638 hits
2. Employment forms	
TI=(Well-being) OR TI=(Wellbeing) OR TI=(Health*) OR TI=(Safety) OR TI=("Quality of life") OR TI=(Stress) OR TI=("Work ability") OR TI=("Return to work") OR TI=(Behaviour) OR TI=(Engagement) OR TI=(Burnout) OR TI=(Injuries) OR TI=(Satisfaction) OR TI=(Motivation) OR TI=(Livelihoods) OR TI=(Commitment) OR TI=(Engagement) OR TI=(Concepts) OR TI=(Classifying) OR TI=(Insecurity NEAR/1 Work OR Job) OR TI=(Security NEAR/1 Work OR Job) OR TI=("Work environment") OR TI=(psychosocial) OR TI=(ergonomics) OR TI=(workload) OR TI=("work load") OR TI=(turnover) OR TI=(Justice) OR TI=(Strain NEAR/1 Work OR Job) OR TI=(Demand NEAR/1 Work OR Job)	

Field tag/s: TI= = Title; NEAR/n = the first term is to be found within a given number of other terms from the subsequent terms; * = Truncation; " " = Quotation marks, searching for a phrase

Appendix 2. Employment forms Delivery 1 190521

*Included. Excluded titles can be found on the Swedish Agency for Work Environment Expertise's website www.mynak.se

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Part 4 – Concluding comments

Literature reviews and the future

It is almost impossible to write a scientifically based literature review about the working life of the future. The future cannot be researched with traditional approaches because the future has not left any impressions in the form of empirical data. However, it is possible to identify trends and potential directions of development, and thus to improve preparedness for the future. It is also possible to learn how decision-makers, stakeholders, opinion-shapers, experts and researchers view the future, as well as how they are acting and thus influencing the future.

Research reviews are a way to build a knowledge basis for action and for learning about future trends – to compile research in order to discern which conditions have sufficient support in high-quality research, and which do not. The results of such a review can be surprising. "Accepted and significant associations" sometimes do not turn out to be significant and well-founded at all. There may be several reasons. One example could be a still-immature research field without a shared, theoretically supported basis of knowledge to which new research and new information can be related. Consequently, it is difficult to compile findings. In other cases, the research basis might simply be inadequate. In the literature reviews about trends in the work environment and employment forms, both issues were noted, while the literature review about digitalization demonstrated a large quantity of research that could be categorized and compiled to describe the current state of knowledge in a relevant way.

Knowledge regarding what makes a good or bad work environment is well-established. But there is less knowledge about how to create good work environments, or how to implement changes for improvements. What is certain is that moving forward, society, working life and work environments will change, and accordingly, new problems and above all new opportunities will arise. This means that occupational health and safety management as well as research must continuously be carried out and improved, with regard to both practical initiatives and research. By understanding and considering the consequences of changes in a work environment early on, such as industry transformation, new technology and new organizational forms, there are many opportunities to create a better work environment. Developmental directions are being chosen constantly, and all choices have consequences for the work environment, whether positive or negative. Factors for success, especially in a Swedish context, have been identified in research on changes in relation to good work environments. These factors include leadership, participation, decision latitude, delegated responsibility, autonomy and security.

Most articles in the literature reviews on trends in the work environment, digitalization and employment forms are about risks, health effects and negative impacts on well-being, as well as factors that create deficient work environments. A smaller share concerns positive effects and what factors create good work environments. Articles with an improvement-oriented, i.e. forward-looking, preventive perspective comprise a third category. This was more common in the literature review on digitalization, and the focus was on physical factors. The three perspectives – negative, positive and preventive – complement one another, because the underlying factors or mechanisms that create opportunities may differ from those that create risks.

Society and working life

Digitalization is likely one of the trends which, for several years now, has had the most significant impact on working life and society. The global digital infrastructure that has been created in just over a decade creates conditions for and empowers several other trends, such as globalization, specialization and business networks. These trends fundamentally change organizations and governance of operations, and lay the foundation for brand-new work methods and operations. Other trends include issues such as the climate and energy supply, as well as demands for gender equality and demographic challenges. What these megatrends have in common is that they are making an impact on the economic structure and labour market, and will thus ultimately also influence work environments and tasks.

The structural transformation of society and business emerges as an important and potential driving force for improvements in work environments and for better occupational health and safety in the country overall. Structural changes in which one industry reduces the number of employees as another industry grows are changing the exposure panorama. So far, the effects on the work environment of this transformation have predominantly been positive. New technology has been able to eliminate physical risks in the work environment and risks of accidents. Now, fewer people are in physically dangerous environments. If we consider digitalization specifically, it poses a risk of leading to more fragmented and geographically widespread assignments. One trend could be that work is split up and distributed worldwide according to criteria related more to wage costs than to good working conditions and meaningful work. Digitalization creates possibilities for on-demand employment, an employment type that is vastly different from traditional, standard employment, i.e. permanent, full-time employment at the premises of the employer. When used well, digitalization can provide more options for employees and enhance control over one's work, which also makes it possible to achieve better work–life balance and facilitate equality.

Another societal trend is an ageing labour force, due in part to the fact that people are healthier, live longer, and have a higher retirement age. Accordingly, workplaces and technology must be adapted ("design for all", "universal design" and "inclusive working life"), along with how work is organized. For professional groups with heavy and demanding tasks, a variety of proactive adaptations and improvements to the work environment must be implemented in order for these people to be able to work as they grow older without harming their health. Such adaptations will help not only older workers, but also other groups at the workplace. Businesses will also benefit from older workers being able to contribute their experience to younger and less experienced workers. In the literature study on digitalization, it emerged that digital technology can support older workers, and help to foster relationships between younger and older workers.

Meanwhile, there are physical ergonomic problems associated with computer work, as well as rapid technological changes and visual ergonomic problems, primarily for older workers, and these must be addressed via research and product solutions with better design. These examples demonstrate how societal trends create opportunities for positive changes in people's daily lives at work and can help improve the work environment.

Healthcare is a social function that is concretely affected by an ageing population. Used properly, digital technology should be able to create opportunities to give the healthcare system greater capacity and improved working conditions. Unfortunately, research on the impact of digitalization on the healthcare work environment is conspicuously absent.

Occupational health services and other actors that primarily work preventively have experienced that willingness to pay for prevention is low. Considering the new challenges that work environments face, occupational

health services and other actors need more resources for knowledge support to preventive initiatives.

Almost none of the studies included in the literature review addressed the interaction between social partners and the roles of trade unions in the development of jobs and work environments. What does this entail for the ongoing trend towards more individual contracts and individual solutions to problems in the work environment? These questions are of central importance for the future development of Sweden's work environments, even if they were not addressed in this literature review.

If the literature reviews function as they should, they can give different actors the opportunity to understand the implications of the prevalent trends and thus improve opportunities to proactively work to integrate issues related to the work environment into ongoing or future conversion or development projects.

Research on work environments in the future

An overarching experience from working with the literature reviews is that research cannot provide thoroughly scientifically supported answers to every question. Some areas pertaining to the work environment are also difficult to study. For research to be useful, well-proven methods, measurement instruments and theories that can accumulate new findings and results and build long-term expertise are necessary. The research fields are also undergoing processes of maturation, creating a larger, evidence-based body of knowledge to which new research findings can be related. The lack of a clearly accepted body of knowledge that researchers can build upon together is one indication that a research field is not yet mature. In the review of employment forms, the lack of a body of knowledge such as this is clear. Thus it becomes impossible to take full advantage of the large quantity of studies in the reviews, because the existing studies are far too heterogeneous. For example, the category of temporary employment includes many kinds of temporary positions, and the concept of well-being refers to many different measurements of health.

Because too few studies are of sufficiently high quality, it is naturally also difficult to summarize the state of research. This may also be the consequence of a rapidly changing research field, which means that existing knowledge loses its relevance for change management. However, a field being difficult to research is no reason to refrain from doing so. If a field is important, it may even be the case that more robust funding and focus are needed.

Many of today's work situations are inherently complex as well as dependent on many contextual factors. Many of the studies that have been carried out have a limited number of outcome variables and context is disregarded; as a result, these studies often only contribute one perspective on a complex reality. Not only do many of the studies of employment forms have methodological problems scientifically; matters are also complicated by the instability of the real-world situation.

Following people in short-term positions over time is difficult, as the work is characterized by relatively frequent job changes, and even if the researcher succeeds with this task, it is difficult to analyse relationships between exposure and health effects if study participants have changed jobs several times in a relatively short period. The common recommendation for achieving higher quality through longitudinal studies has limited value when the context and exposure undergo uncontrollable changes.

There is a need for broad studies carried out in their actual work contexts that capture the overall picture, as well as multidisciplinary research that can capture both physical and organizational challenges while also investigating the quality of the work. Additional relevant outcome measures are necessary with a focus not only on individuals, but also on

organizations and society. It is far too common for studies of new technology to have only one outcome, which means they only illustrate a part of the whole picture. Research should therefore include the physical, psychological, social and cognitive work environments, as well as outcomes of relevance to organizations' targets, such as efficiency, quality and profitability. Moreover, it is relevant in the Swedish context to emphasize the enormous need for research that follows how the influence of unions and employers on the work environment has changed over time, and the potential consequences of any changed power relationships at workplaces with regard to the development of future work environments.

All three literature reviews, i.e. trends in the work environment, digitalization and employment forms, indicate the necessity of a research structure that can provide answers in terms of causal relationships, and studies that can identify active mechanisms. Furthermore, most articles suggest the need for more research on interventions, which should take place at the organizational level as well as at the workplace and societal levels. For example, technology developers and engineers should conduct research in cooperation with behavioural scientists, health experts and work science experts to a greater extent. This would improve relevance for the work environment and the value of research for designing work environments of the future. Cooperation between different scientific disciplines can better capture and reflect the multifaceted reality in which work is carried out.

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