Older Workers in Digitalizing Workplaces: A Systematic Literature Review

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Older Workers in Digitalizing Workplaces

A Systematic Literature Review

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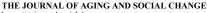
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Older Workers in Digitalizing Workplaces: A Systematic Literature Review

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Abstract: Workplace digitalization created a sea change in work practices and it altered the situation of older workers. Digitalization entails the increased use of digital technologies, such as computers and online services. Older workers often possess limited digital skills, which may put their labor market participation at risk. Previous studies began exploring how older workers fare when their workplaces are digitalizing. However, the research field is still emerging and remains fragmented. This article comprises a systematic literature review that takes inventory of what we currently know about older workers in digitalizing workplaces. It demonstrates that older workers experience the digitalization of their workplaces in various areas, reaching from health monitoring to work arrangements. Interestingly, challenges and opportunities emerge in each area affected. This Janus-faced situation underlines the complexity of consequences, and it raises questions about social inequalities in these consequences. The work environment plays a crucial role in shaping how older workers experience workplace digitalization. It shapes which options for adaptation they have, and to which degree they can act on these options. This circumstance makes workplaces an excellent starting point for interventions. Country-characteristics likewise exert an influence. While characteristics such as retirement regulations are purposefully modified for intervention, other characteristics, such as culture, are not. This circumstance limits governmental options for shaping the situation of older workers in digitalizing workplaces. Future research should further explore the situation of older workers in digitalizing workplaces, paying special attention to the theoretical framework and to developments in the wake of the COVID-19 pandemic.

Keywords: Digitalization, Automation, Computer, Older Workers, Old Age

Introduction

Digitalization has generated a sea change in contemporary societies. Digitalization denotes the increased use of digital technologies, such as computers, smart phones, online services, and artificial intelligence (Elia, Margherita, and Passiante 2020; Denner, Puschel, and Roglinger 2018). It does not just drive economic change and growth; it also deeply affects our everyday lives, including how we work and communicate with others (Beringer and Sixsmith 2013; Gilleard and Higgs 2008). For example, work meetings increasingly take place as video conferences, and some jobs have been entirely replaced by computers and robots (Kodema 2020; Kurer and Gallego 2019). These developments highlight the fact that many workplaces are in the process of digitalizing, and that they are changing markedly during this process. The Organisation for Economic Co-operation and Development (OECD 2019) has even suggested that workplace digitalization has now progressed so far that

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in order to fully participate in the labor market one now needs to have digital skills. The Nordic countries and New Zealand are at the forefront of this development, whereas other countries, in particular those in Latin America and Eastern Europe, lag behind (OECD 2019). To give some impression of the diffusion: within Europe, a continent with huge disparities in digitalization, more than 90 per cent of workplaces already make use of computers and broadband technology (European Commission 2016).

One particularly critical effect of the digitalization of work is its impact on extended working lives. Extended working lives have been at the center of political discussions for the past several decades. They denote a workforce participation that lasts until a later age. Such an extended working life is deemed necessary because of population aging, which is currently occurring around the globe (United Nations 2019). Population aging reduces the size of the workforce and puts financial pressure on pension schemes. Policymakers seek to counter these effects through extended working lives. This can be achieved in several ways: by preventing individuals from leaving the workforce early, by raising the state pension age, and by encouraging retirees to work while receiving pension benefits (Phillipson 2019; Van Yperen and Wörtler 2017). Because of the wide range of strategies, the age groups targeted also range widely from individuals in their 40s and 50s who are still working, via those in their 60s approaching the state pension age, to those in their 70s who have already retired (Phillipson 2019; Harris et al. 2018). Digitalization may affect this goal of extending working lives.

Older workers are often assumed to possess limited digital competence because they grew up without the internet and technological devices such as computers, cellular phones and tablets (OECD 2019). Empirical studies have found that older workers indeed are less likely than younger workers to employ Information and Communication Technologies (ICT) in their jobs (Schleife 2006). According to a Dutch study, older workers also use less complicated applications and encounter more difficulties compared to younger workers (De Koning and Gelderblom 2006). Therefore, many older workers are in need of re-training in digital tasks to avoid unemployment and inadvertent early retirement (Lee, Czaja, and Sarit 2008). This need intensified during the COVID-19 pandemic, when work was further digitalized to enable home offices. Yet, the practice of working in a home office also increased older workers' digital skills (Pit et al. 2021). Thus, older individuals nowadays need to be digitally skilled to adapt to extended working lives (Nagel 2020). Without digital skills, extended working lives may not be viable.

At the same time, digitalization may benefit those older workers who have digital skills. Digital technologies can lighten the workload of older workers, for example, by making their work tasks less physically demanding and by allowing them to work from home instead of travelling (Dropkin et al. 2016). Moreover, digital work technologies can help older workers to monitor and manage their health, for example by reminding them when to take breaks from work (Nagarajan and Sixsmith 2021). These effects may increase the productivity of older workers, making it easier for them to remain in the workforce (Lee, Song, and Kwak 2020). Thus, digitalization may help older workers to extend their working lives.

Previous research has demonstrated that there exist both obstructive and supportive effects of digitalization on older workers. It also showed that these effects may come about through numerous mechanisms, making them complex and diverse (Nagarajan and Sixsmith 2021: Dropkin et al. 2016). The complexity further increases because the effects differ across individuals, workplaces, and countries (Nagarajan and Sixsmith 2021; Lee, Song, and Kwak 2020; Van Dalen, Henkens, and Schippers 2009). Differences across individuals arise along educational levels and generational memberships, among other things (Peng, Anwar, and Kang 2017; Gilleard and Higgs 2008). They align with well-known social inequalities that shape the lives of older workers and influence their life situations and opportunities (Komp-Leukkunen 2019). Differences across workplaces and countries arise because the lives of older workers are shaped by the social contexts in which they are embedded. The social context denotes the institutions, expectations, rules and norms that surround us (Hendricks 2012). It influences how

the digitalization of work takes shape and the various ways in which older workers react to it. Countries form part of the social context in that they provide the framework for our everyday lives. Workplaces are part of the social context because they constitute part of the work environment. While workplaces denote the locations and infrastructures of work, work environments additionally encompass social interactions and relationships (Al-Khawaja and Langston 2018; Stansfeld and Candy 2006). Thus, both work environments and countries are part of the social context surrounding older workers in digitalizing workplaces. Therefore, their characteristics influence how older workers fare when their workplaces are digitalizing. Consequently, we need a detail-oriented assessment to understand these complex and diverse mechanisms of how older workers manage in digitalizing workplaces.

A detail-oriented assessment of older workers in digitalizing workplaces is particularly important because this research field is still emerging. There remains a limited number of studies on the topic, theories and concepts are still being developed, and the empirical landscape is still being drawn. A detail-oriented assessment of our state of knowledge may help us better understand the situation of older workers in the digitalizing workplace, and it may help researchers decide how this research field can best be further developed. The present study provides such an assessment.

This study then assesses how older workers fare in digitalizing workplaces. To do this, it conducts a systematic literature review, meaning a review that explores previous research in a structured and purposeful way. In doing so, it answers three research questions: (1) How do older workers experience the digitalization of their workplaces? (2) How does the work environment matter for older workers in digitalizing workplaces? and (3), How do country characteristics shape the situation of older workers in digitalizing workplaces?

Material and Methods

This article maps the field of research on older workers in digitalizing workplaces through a systematic literature review: a structured, analytical means of gaining an overview of a research field (Shaffril, Samsuddin, and Samah 2021). By methodically choosing, analyzing, and documenting relevant literature, this approach answers predefined questions in a way that outlines the extant content and amount of knowledge (Petticrew and Roberts 2008). This quality makes it particularly suitable for emerging research fields like this one that focuses on older workers in digitalizing workplaces.

As a first step, the project team initially assembled the scientific literature they were already aware of on the topic. This step rendered fourteen texts. Then, they collected additional literature through a search on Google Scholar, using all possible combinations of terms for (a) older workers, and (b) the digitalization of workplaces. The terms for older workers used were "older worker*," "older employee*," "senior worker*," "senior employee*," "elderly worker*," "elderly employee*," and "work in old age". The terms for the digitalization of workplaces used were "digital* AND work*," "digitize* AND work*," "automation AND work*," "Industry 4.0 AND work*," "technology AND work*," "computer AND work*," "ICT AND work*." The identified texts were saved, with duplications and improperly identified search results being discarded. This search rendered fifty-nine additional texts. The team subsequently reviewed the texts collected thus far and conducted an additional search for relevant texts that (a) were written by experts they had identified, (b) were referenced in the texts they had found, or (c) mentioned additional search terms they had identified in the texts we had found. The new search terms used were "blended work," "home office AND COVID," and "techno* AND ageism." This final step rendered eighteen more texts, resulting in a total of ninety-one texts. The article collection took place between March and November 2021.

Next, the research team selected which texts to include in the analysis. The primary criterion here was peer-reviewed journal articles published in English in order to capture the

current international scientific debate on the topic. Additionally, the texts were required to have older workers in digitalizing workplaces as their main topics or as one of their main topics to ensure they contained circumspect and in-depth analyses of the topic. The team assessed the texts collected according to these criteria by reading the entire texts. For quality assurance, two researchers carried out an assessment independent of one another. They then compared their results, finding an interrater reliability of 76 percent. Subsequently, they discussed the texts they had disagreed on. The consensus was to select forty-one articles for the analysis. The selection was discussed in the entire research team and one further article was selected, bringing the sample up to forty-two articles. The selected articles are listed in Supplementary Table 1.

In the last step, the texts were analyzed. The analysis started out with the project team reviewing the entire body of literature to gain an overview of the state of knowledge. This review occurred in three groups of three to four persons each, with each group focusing on one research question. The groups identified the main themes discussed. Afterwards the themes were discussed in the entire project team for quality control and to reduce overlaps. Next, the groups coded the relevant texts for each topic, meaning that the central findings were listed and the number of texts mentioning them was counted. Afterwards the coding was discussed in the entire project team and modifications were made where necessary to avoid overlaps and to ensure a coherent level of abstraction and the consideration of all aspects. The following pages outline the findings.

How Older Workers Experience the Digitalization of their Workplaces

Twenty-two of the articles analyzed discuss how older workers experience the digitalization of their workplaces. This number indicates that slightly more than half of the articles focus on this topic. The articles investigated the older workers' experiences across five domains: health, accessibility, and safety; productivity; job resources and interpersonal relations; work-related demands; and work participation. Table 1 provides an overview of which articles focus on each of the domains.

Table 1: How Older Workers Experience the Digitalization of their Workplaces

Experience	References
Health, accessibility, and safety	Hudomiet and Willis 2021; Nagarajan and Sixsmith 2021; Oksa et al. 2021; Pit et al. 2021; Segkouli et al. 2021; Tams et al. 2021; Van Yperen and Wörtler 2017; Damman 2016; Dropkin et al. 2016
Productivity	Hudomiet and Willis 2021; Nagarajan and Sixsmith 2021; Oksa et al. 2021; Mauno et al. 2019; Soja and Soja 2019; Van Yperen and Wörtler 2017; Sharit et al. 2009; Lawhon, Ennis, and Lawhon 1996; Staufer 1992
Job resources and interpersonal relations	Oksa et al. 2021; Segkouli et al. 2021; Greenan and Messe 2018; Van Yperen and Wörtler 2017; Dropkin et al. 2016; Zhan 2016; Sharit et al. 2009
Work-related demands	Oksa et al. 2021; Segkouli et al. 2021; Van Yperen and Wörtler 2017; Damman 2016; Dropkin et al. 2016; Zhan 2016; Sharit et al. 2009
Work participation	Alcover et al. 2021; Hudomiet and Willis 2021; Tams et al. 2021; Mauno et al. 2019; Greenan and Messe 2018; Behaghel, Caroli, and Roger 2014; Brooke 2009; Lee, Czaja, and Sarit 2008; Magnani 2006; Friedberg 2003

Source: Komp-Leukkune et al.

Health, Accessibility, and Safety

Ten articles document how older workers experience the digitalization of work in relation to health, accessibility, and safety. The use of digital technologies has reduced the physical demands of work (e.g., lifting, carrying, pulling) (Hudomiet and Willis 2021) and can thereby enable older workers to participate in the workforce until a later age. Remote work arrangements, which are typically mediated by the use of digital technologies, can support the workforce participation of older workers with mobility problems (Damman 2016) and reduce fatigue and work-related stress (Dropkin et al. 2016). However, remote working can lead to musculoskeletal problems resulting from poor ergonomic design of remote office spaces (Van Yperen and Wörtler 2017; Dropkin et al. 2016), and the use of digital technologies at work is associated with sleep problems and technostress (Oksa et al. 2021; Tams et al. 2021). Moreover, digital solutions can improve workplace safety and accessibility and support older workers' health through personalized ergonomics, personalized workstations, and monitoring (Nagarajan and Sixsmith 2021; Pit et al. 2021; Segkouli et al. 2021). Enhanced ergonomics and workstations can accommodate physical problems and improve the overall accessibility of workplaces. Monitoring through pervasive technologies allows identifying health risks, preventing accidents, detecting work-related stress, measuring fatigue, and improving performance visibility. Despite these benefits, privacy and invasion concerns are raised by Segkouli et al. (2021) who emphasize the need for an ethics framework in smart workplaces in order to define the practices of data monitoring, tracking, and processing.

Productivity

The impact of digital technologies on older workers' productivity is unclear. Eight articles explore this, reaching contradictory conclusions. On the one hand, Van Yperen and Wörtler (2017) report that older workers who use technologies at work need less effort and time to fulfil job tasks. Both Lawhon, Ennis, and Lawhon (1996) and Nagarajan and Sixsmith (2021) suggest that the use of digital technologies can improve productivity among older workers. Similarly, Oksa et al. (2021) describe that the use of professional social media at work can have a positive impact on an individual's sense of competence and autonomy. On the other hand, older workers face challenges with respect to productivity in digitalized workplaces. They report work intensification, high time pressure, increased cognitive demands, and intensified skill- and knowledge-related learning demands (Hudomiet and Willis 2021; Soja and Soja 2020; Mauno et al. 2019; Staufer 1992). Regarding alternative work arrangements, Sharit et al. (2009) illustrate how home-office settings can lead to either experiencing fewer distractions and improved concentration, or the opposite, with possible impacts on productivity.

Job Resources and Interpersonal Relations

Eight articles address the domain "job resources and interpersonal relations." Most of these studies focus on the use of digital technologies for remote work arrangements and their impact on job resources and interpersonal relations. On the one hand, digital-based communications can support a sense of community irrespective of the physical location of the worker and increase a feeling of competence and autonomy (Oksa et al. 2021). Also, they can reduce age discrimination and stigmatization due to the physical separation from the workplace (Dropkin et al. 2016). On the other hand, they can stimulate the creation of in-groups, marginalization of remote workers, workplace cyberbullying, and organizational detachment (Oksa et al. 2021; Dropkin et al. 2016). Furthermore, they can lessen the access to job resources, like incidental learning (Sharit et al. 2008), and the opportunities for training and mentoring other employees (Greenan and Messe 2018). Finally, they can lead to loneliness and frustration due to physical

separation from the workplace and from other employees (Segkouli et al. 2021; Van Yperen and Wörtler 2017; Dropkin et al. 2016; Zhan 2016).

Work-related Demands

Seven articles deal with changes in work-related demands due to the digitalization of work, mainly in the context of remote work arrangements. Remote work arrangements such as home office and blended work create the possibility of doing work both on-site and off-site, making work independent of time and location. Several studies report that home-office or blended work can reduce work-related demands, such as commuting, travel, and work speed, among older workers (Van Yperen and Wörtler 2017; Damman 2016; Dropkin et al. 2016; Zhan, 2016; Sharit et al. 2009), and lessen the exposure to stressors such as working from unfavorite places, noisy or overcrowded spaces (Van Yperen and Wörtler 2017; Zhan 2016). Zhan (2016) uses the job demands-resources model for explaining the expected positive outcomes of blended work among older workers. Such positive outcomes would result from a reduction in job demands and an increase in job resources. Being able to perform tasks from a distance can also support a better work-life balance, for example, by having more time to spend with family and friends, to volunteer, and to provide informal care (Van Yperen and Wörtler 2017; Damman 2016; Dropkin et al. 2016; Zhan 2016; Sharit et al. 2009). The latter advantage is particularly important for women, who are the main care providers within families (Damman 2016). However, older workers who work from home can experience unclear boundaries between their private and professional lives (Oksa et al. 2021; Segkouli et al. 2021; Dropkin et al. 2016). Moreover, such work arrangements can cause additional expenses for equipment, faster internet connection, or adequate office furniture, which may not be provided by the employer (Dropkin et al. 2016).

Work Participation

Based on a study of US workplaces in the 1984–2017 period, Hudomiet and Willis (2021) conclude that older age groups were slower to start using computers and their skills more often became obsolete in a computerized environment. For these reasons, computerization of the workplaces had clear negative effects on the wages of older workers compared to younger workers. Women were particularly affected because of the lack of on-the-job training, and office workers were particularly affected because their jobs could be replaced by computers. Furthermore, Behaghel, Caroli, and Roger (2014) find that the adoption of technological and organizational innovations decreased firms' demand for older workers, whereas Greenan and Messe (2018) argue that companies' introduction of new ICT and management tools reduced the use of workers above the age of 45 as internal mentors, thereby weakening their role as knowledge and experience transmitters in the workplace. Previous research also points toward older workers being more susceptible to negative consequences of work intensification and job demands due to technological advances (Tams et al. 2021; Mauno et al. 2019). Those older workers with lower educational levels were particularly affected (Alcover et al. 2021; Hudomiet and Willis 2021; Lee, Czaja, and Sarit 2008; Friedberg 2003). Alcover et al. (2021) introduce the Aging-and-Tech Job Vulnerability framework to describe the combined effect of age and digitalization of work on older workers' work participation and job quality. However, Brooke (2009) and Magnani (2006) document differences across labor market sectors, thereby reminding us to use caution in statements about the situation of older workers. For example, the IT sector seems particularly incompatible with extended careers because of the speed of change and the constant need for new skills in the sector (Brooke 2009).

How the Work Environment Matters for Older Workers in Digitalizing Workplaces

Half of the articles discussed in this review address how the work environment may matter for older workers in workplaces undergoing digitalization. Four issues appear as particularly important: employers' attitudes toward older workers' digital competences; possibilities for teleworking or blended working; the implementation of new ICT in the workplace; and the training opportunities for older workers to increase their digital skills. Table 2 shows which articles touched upon these topics.

Table 2: How the Work Environment Matters for Older Workers in Digitalizing Workplaces

Work Environment	References
Attitudes toward older workers' digital skills	Van Selm and Van den Heijkant 2021; Harris et al. 2018; Solem 2016; Sharit et al. 2009; Van Dalen, Henkens, and Schippers 2009
Teleworking/blended work	Van Yperen and Wörtler 2017; Damman 2016; Dropkin et al. 2016; Zhan 2016; Sharit et al. 2009
Implementation of new technologies	Segkouli et al. 2021; Soja and Soja 2020; Mantzana, Themistocleous and Morabito 2010; Morris and Venkatesh 2000; Staufer 1992
Training opportunities	Greenan and Messe 2018; Van Dalen, Henkens, Wang 2015; Behaghel, Caroli and Roger 2014; Lee, Czaja, and Sarit 2008; De Koning and Gelderblom 2006; Magnani 2006; Morris and Venkatesh 2000; Bartel and Sicherman 1993; Staufer 1992

Source: Komp-Leukkunen et al.

Attitudes toward Older Workers' Digital Skills

Five studies focus on attitudes among employers and managers that are related to older workers' digital competences. One is a scoping review (Harris et al. 2018); one is a cross-national comparison (including Greece, Spain, the Netherlands and the United Kingdom) (Van Dalen, Henkens, and Schippers 2009); and three are country-specific studies (United States (Sharit et al. 2009), the Netherlands (Van Selm and Van den Heijkant 2021), and Norway (Solem 2016)). A consistent finding across these publications is the general assumption of a decreased capacity to use new (digital) technology with increasing age.

Among the studies included in the scoping review on ageism by Harris et al. (2018), eight identified a perception of older workers' lack of technological proficiency. Such an attitude is quite evident in the cross-national study of employers in four European countries conducted by Van Dalen, Henkens and Schippers (2009). They find that almost half of the respondents expected a decrease in the enthusiasm for new technology to take place with an aging personnel structure in their company. In line with this finding is a perception of older workers' limited technological competence. When asked about employees' capacity to deal with new technology, the employers clearly favored younger workers (under 35 years of age) over older workers (aged 50 and above) (Van Dalen, Henkens, and Schippers 2009). A similar pattern is reported by Sharit et al. (2009), who find that only three per cent of the managers in their survey believed that older workers fare better than younger in technological skill, whereas 71 percent thought the contrary. Furthermore, Van Selm and Van den Heijkant (2021) conducted expert interviews with HR professionals and recruiters in the Netherlands, which revealed a picture of older workers being less technologically savvy compared to younger age groups. Finally, in the study based on Norwegian survey data, managers expressed rather positive conceptions of older workers' work performance in general, but when it came to their digital capacities, only three out of ten disagreed with the statement that employees above 50 years of age are less able than

younger employees to cope with data and PC. Furthermore, 62 percent reported on experiences of younger workers being preferred over older workers when new technology or new working methods were introduced (Solem 2016).

Positive descriptions of older workers typically include characteristics such as high reliability and trustworthiness, and a strong commitment to the job. On these attributes, older workers score considerably higher than younger age groups (Sharit et al. 2009; Van Dalen, Henkens, and Schippers 2009). According to Sharit et al. (2009), older workers are also viewed as having a strong ability to work independently. Consequently, they are assumed to be well suited for telework, a type of job arrangement that some organizations offer to their employees (Sharit et al. 2009).

Telework/Blended Work

The increasing use of ICT in workplaces enables telework or blended work. Four of the articles discuss how blended work arrangements are likely to impact on older workers, largely deeming the greater flexibility to be particularly suitable for older workers and therefore increasing their opportunity to remain employed for longer (Van Yperen and Wörtler 2017; Damman 2016; Dropkin et al. 2016; Zhan 2016). This point is also an important takeaway from the article by Sharit et al. (2009) on the employability of older workers as teleworkers.

In their conceptual review article, Dropkin et al. (2016) list several potential benefits of blended work for older workers, among them increased autonomy, decreased psychosocial stress, lower exposure to travel and improved work-life balance. Van Yperen and Wörtler (2017) refer to research where older workers are found to have more need for autonomy and less for structure compared to younger workers, and to more often experience health and mobility limitations or have a partner with such challenges, all of which could make the option of working from home attractive. Blended work practices can also more easily facilitate a gradual retirement process and represent a bridge from traditional employment to retirement (Van Yperen and Wörtler 2017; Damman 2016; Zhan 2016).

On the other hand, there are risks associated with blended work that may be more pronounced for older workers, for example, psychological distress due to higher demands for multitasking and issues with work-family boundaries and role conflict (Dropkin et al. 2016). Finally, older workers may face barriers to blended work. Dropkin et al. (2016), Van Yperen and Wörtler (2017) and Sharit et al. (2009) all emphasize how older workers may be at a disadvantage due to a lack of skills and experience with ICT, and less interest from employers in investing in appropriate equipment or ICT training activities directed at their age group.

Implementation of New Technologies

How new technologies are introduced or implemented in the workplace is addressed in five of the reviewed studies. Two publications emphasize older workers' autonomy in the implementation process as particularly important (Segkouli et al. 2021; Staufer 1992). Similarly, Morris and Venkatesh (2000) underline the importance of perceived behavioral control for older workers. Autonomy may support workers' involvement in the implementation process and help the individual worker regulate the progression according to their needs and potential. This is exemplified by Staufer (1992). Based on in-depth interviews with employees, supervisors, and managers in Germany, he stresses the importance of giving older employees the opportunity to identify their own needs and suggest improvements when new technology is implemented, in order to feel a sense of control in the process and to avoid the perception of technological changes as threatening. Segkouli et al. (2021) elaborates on the need for workers' autonomy and privacy, and for the employers to secure transparency, trustworthiness,

accountability, as well as for ethical decision-making and human-centered data management in the implementation of digital workplace technologies.

A further recommendation is provided by Soja and Soja (2020). Drawing on data from Poland, they suggest the value of age-balanced team building, and age-adjusted change management in implementation processes. In addition, they emphasize the advantage of utilizing the competencies of older workers in processes of ICT changes. Finally, Mantzana, Themistocleous, and Morabito (2010) point to the importance of well-managed training processes when new ICT systems are implemented, which brings us to the fourth work environment issue: the training opportunities of older workers.

Training Opportunities

The opportunities for older workers to participate in training have been found to be rather restricted in general (Van Dalen, Henkens, and Wang 2015). This also seems to hold for training aimed at increasing digital skills, an issue addressed in eight publications in the present review.

Although technological changes should imply a greater need for training, Magnani (2006) reveal that in Australian workplaces, the training opportunities of workers aged 55 and older were significantly reduced in industries undergoing technological change. Such a practice may be considered unfortunate as older workers may gain significant benefits from job training. For example, according to Bartel and Sicherman (1993), workers in US industries with high rates of technological change retire later if the changes are accompanied with high rates of on-the-job training. Another example is the French study by Greenan and Messe (2018), who show that the probability of being an internal mentor after age 45 was higher for employees who had participated in training concerning the use of new ICT tools compared to non-participants. Behaghel, Caroli, and Roger (2014), also based on data from France, conclude that training tends to offset the negative effects of introducing new ICT work practices on older workers. However, it offers only limited prospects to enhance older workers' employability. Hence, the authors suggest that increasing the employability cannot rely entirely on training. One option is to allow older workers more time to adjust to new technology and working methods. In fact, Morris and Venkatesh (2000) argue that training programs should be tailored for different age groups because their needs differ. For older workers, they suggest starting the learning process with what they call "technology familiarization" in order to help the workers to become more comfortable with the process, and to reduce any possible anxiety about the new technology. De Koning and Gelderblom (2006) suggest that learning by doing might be quite effective for older workers, and perhaps more effective than formal training courses. This is in line with the work of Staufer (1992), who argues that the best way for older employees is to engage in learning at their workplace, a familiar space in which they are less likely to feel anxious, and more likely to obtain knowledge and competence. Finally, findings from a qualitative study by Lee, Czaja, and Sarit (2008) among older unemployed persons who wish to return to work suggest that technology training programs for older individuals with low ICT skills should allow for a group format where learning experiences can be shared, where there is access to ample feedback, and where it is possible to engage in hands-on learning activities.

How Country Characteristics Shape the Situation of Older Workers in Digitalizing Workplaces

Twelve of the articles analyzed document and explain how country-differences shape the situation of older workers in digitalizing workplaces. Table 3 provides an overview of the main arguments used. It shows that the arguments center on the country-wide use of digital technologies, training programs, labor market structures, culture, welfare policies, and governmental responses to the COVID-19 pandemic.

Table 3: How Country Characteristics Shape the Situation of
Older Workers in Digitalizing Workplaces

Country Differences	References
Country-wide use of ICT	Battisti and Gravina, 2021; Grigoli, Koczan and Topalova 2022; Lee, Song, and Kwak 2020; Peng, Anwar, and Kang 2017; Dropkin et al. 2016
Governmental policies and programs for computer training in old age	Nagarajan and Sixsmith 2021; Peng, Anwar, and Kang 2017; Dropkin et al. 2016
Labor market structure	Grigoli, Koczan and Topalova 2022; Peng, Anwar, and Kang 2017; Van Dalen, Henkens, and Wang, 2015; Marshall 2011; Van Dalen, Henkens, and Schippers 2009; Malul 2009
Country-specific culture	Fischer et al. 2021; Dropkin et al. 2016; Van Dalen, Henkens, and Wang 2015; Van Dalen, Henkens, and Schippers 2009
Welfare policies	Fischer et al. 2021; Grigoli, Koczan and Topalova 2022; Dropkin et al. 2016; Van Dalen, Henkens, and Wang, 2015; Malul 2009; Van Dalen, Henkens, and Schippers, 2009
Governmental policies for the COVID-19 pandemic	Pit et al. 2021

Source: Komp-Leukkunen et al.

Country-wide Use of ICT

A first argument ties country differences in the situation of older workers in digitalizing workplaces to country differences in digital technology use (Battisti and Gravina 2021; Peng, Anwar, and Kang 2017). Grigoli, Koczan and Topalova (2022) studied twenty-three advanced economies from around the world, concluding that automation displaces older workers, particularly men, in routine-task occupations. The higher the degree of automation in a country, the higher the displacement. Peng, Anwar, and Kang (2017) counter that digital technologies can increase the productivity of older workers, especially for those who have low education. Such a development maintains the employability of older workers. Lee, Song, and Kwak (2020) consider this suggestion, arguing that it allows older workers to remain in the workforce until a later age. They find such an effect holds true for low-educated older workers in Japan and Korea, but for higher-educated older individuals in Japan only. This finding underlines that the effect of digital technologies interacts with country-specific educational structures. Dropkin et al. (2016) point out that in the United States some governmental subsidies can be used to build up a digital infrastructure if this benefits older workers. This insight suggests that the effects of digitalization unfold in connection with country-specific governmental support programs.

Governmental Policies and Programs for Computer Training in Old Age

The positive effects of automation on workforce participation in old age hinge on older workers knowing how to use digital technologies. The second argument focuses on this circumstance. Nagarajan and Sixsmith (2021) argue that digital training programs for older individuals, as they are offered by the government agencies "Employment and Social Development Canada" and the "Australian Human Rights Commission," can create such knowledge. Peng, Anwar, and Kang (2017) underline that governments, especially, can create such training programs through public sector investments. Consequently, country differences would emerge along the public

sector investment profiles. Dropkin et al. (2016) add that in the United States, not only government entities, but also nonprofit organizations play a role in providing such services.

Labor Market Structures

A third argument discusses labor market characteristics, which are mentioned by half of the studies exploring country differences. Marshall (2011) argues that according to life-course theory, the labor market should be considered influential. Life-course theory explores how human lives progress over time. According to the theory, the social context gives lives a structure that is specific to their place. When social contexts differ, then so do the structures of the life-courses. Malul (2009) specifies that the labor market situation is influential because older workers consider this situation when deciding whether or not to receive digital training and whether or not to remain in the workforce. Van Dalen, Henkens, and Schippers (2009) add that the influence of labor market structures also unfolds because policymakers and employers consider these structures when deciding on how to handle older workers. Countries with high unemployment rates, such as Greece and Spain, facilitate older workers' exit from the workforce. In contrast, countries with low unemployment rates or labor shortages facilitate older workers' training and retention. Examples of such countries are the United Kingdom and the Netherlands. Van Dalen, Henkens, and Wang (2015) reaffirm this observation.

Various other characteristics of the labor market likewise exert an influence. Grigoli, Koczan, and Topalova (2022) and Van Dalen, Henkens, and Schippers (2009) underline that the predominant industries play a role, with a strong service sector keeping older workers in the workforce. In contrast, strong labor unions, strong collective agreements, seniority-based wages, and high employer contributions to social insurance may lead older workers to leave the workforce. Peng, Anwar, and Kang (2017) report the general trend of labor markets in Nordic and Continental Europe as being more regulated than those in the Mediterranean and Anglo-Saxon countries. The higher the level of regulation, the higher the older workers' earnings. In addition, all these country characteristics enter the considerations of older workers, employers, and governments when deciding on how to handle digital training in old age and the importance of keeping older workers in digitalizing workplaces.

Country-specific Culture

However, labor market structures do not shape the situation of older workers in digitalizing workplaces all by themselves. Instead, they are embedded in country-specific cultures, as the fourth argument underlines. Culture shapes the perceptions of old age and of older workers' skills (Fischer et al., 2021; Van Dalen, Henkens, and Wang, 2015; Van Dalen, Henkens, and Schippers, 2009). Van Dalen, Henkens and Schippers (2009) reveal country differences in employers' assessments of older workers' technology skills, with Dutch employers having the most pessimistic, British employers the most positive, and Greek and Spanish employers having an intermediate assessment of these skills. Van Dalen, Henkens, and Wang (2015) explain that the assessments may be partly influenced by previous country-specific policies and practices that still linger in the back of the employers' minds. To solve this problem, Dropkin et al. (2016) suggest that governments inform employers and other stakeholders about new insights from research, practices and success stories. Such information may correct misconceptions and shift assessments, thereby increasing the possibilities for older workers to remain in digitalizing workplaces.

Welfare Policies

A fifth argument sets the focus on welfare policies. Two studies used the concept of welfare regimes to capture the differences in labor markets and cultures. Welfare regimes are ideal types of welfare states, a concept which Van Dalen, Henkens, and Schippers (2009) find useful

because it captures culture as well as welfare provision. Fischer et al. (2021) add that it is also associated with how care services are provided. However, despite the suggested usefulness for understanding how older workers fare in digitalizing workplaces, this has not yet been studied. Future research still needs to explore the extent to which welfare regimes can explain country differences in the situation of older workers in digitalizing workplaces. Previous research took the alternative approach of focusing on individual governmental policies.

Retirement regulations are the welfare policies most often discussed in the articles we analyzed. Four out of the twelve articles exploring country difference mentioned them. Grigoli, Koczan, and Topalova (2022) even consider them to be one of the main influences on the situation of older workers. The logic is simple: the easier these regulations make an exit from the workforce, the easier can older workers avoid dealing with the challenges of digitalizing workplaces (Dropkin et al., 2016). An exit from the workforce is easy if the state retirement age is low and pension benefits are high (Grigoli, Koczan, and Topalova 2022). Yet, Van Dalen, Henkens, and Wang (2009) and Van Dalen, Henkens, and Schippers (2015) point out that, across Europe, early retirement options have been tightened and state pension ages have been increased in recent years. As a result, older workers have fewer and fewer options for avoiding the challenges of digitalization. Dropkin et al. (2016) even go so far as to suggest that in the United States, retirement regulations should be further tightened to keep even more older workers in the workforce. Such a strategy would force older workers and their employers to find a solution to the challenges of digitalizing workplaces. In such a situation, the American "Age Discrimination in Employment Act" and the "Americans with Disabilities Act" may necessitate work in old age to become more digitalized. The digitalization could allow for older workers with medical conditions or disabilities to continue to carry out their work tasks, for example by working from home using digital technologies.

Other welfare policies receive less attention. Grigoli, Koczan, and Topalova (2022) underline the importance of unemployment policies. They boil down country differences to the question of whether governments favor generous unemployment schemes or Active Labor Market Policies, which strive to reintegrate the unemployed into the labor market. Generous unemployment schemes incentivize older workers to forgo training programs and wait out any workplace challenges. In contrast, Active Labor Market Policies encourage older workers to upskill and remain integrated within the labor market. Going a step further, some studies suggested that governments should intervene directly in digitalizing workplaces to improve the situation of older workers. Malul (2009) analyzed data from Israel, arriving at the conclusion that an employer subsidy would be beneficial. Such a subsidy would compensate employers of older workers with lower productivity due to lacking technological skills. It would also even out the costs of lost productivity, thereby keeping the older workers attractive to their employers. Dropkin et al. (2016) agree with this suggestion. Moreover, they added that employers who train their older workers in digital tasks should receive tax credits.

Governmental Policies for the COVID-19 Pandemic

The sixth argument considers policies dealing with the COVID-19 pandemic that started in 2019. This pandemic was triggered by the spread of the coronavirus across the globe. Many workers had to switch to home office as a safety measure, which was decreed by governments or suggested by their employers. Home office means that individuals carry out their work tasks within their own homes, usually by means of digital technologies. The rapid digitalization of work tasks in the wake of the COVID-19 pandemic raised concerns about the situation of older individuals. How would they carry out their work tasks when digitalization suddenly became necessary and mandatory? While it is still too early to answer this question, we already now know that governments reacted differently to this challenge, thereby creating additional country differences at this historical point in time. Some governments, such as the Australian and the

Thai, promoted online businesses. Thus, the starting point of their solution strategy was to focus on the companies and, thereby, on the workplaces. The same governments, as well as the Austrian, Israeli, South Korean, and the US, supported education and training. Thus, they tried to enhance the skill levels of older workers, making it easier for them to navigate digitalization at work (Pit et al. 2021). These country differences in the governmental reaction to the COVID-19 pandemic will translate into new country differences in how older workers fare in digitalizing workplaces.

Discussion and Conclusion

The digitalization of work is progressing, and it progressed dramatically in the wake of the COVID-19 pandemic. The situation of older workers in digitalizing workplaces is of particular concern because digitalization and the push for extended working lives may interact. Digitalization may force older workers into retirement, thereby counteracting the goal of extending working lives. However, if digital skills are successfully acquired, digitalization may then assist older workers in their tasks, thereby allowing them to prolong their working lives. This study outlines the different effects of digitalization on older workers, paying attention to the influences of workplaces and countries.

The first research question asked how older workers experience the digitalization of their workplaces. Previous research documented myriad experiences, ranging from those concerning health and safety, productivity, via job resources and interpersonal relations, to work-related demands, work arrangements and work participation (Hudomiet and Willis 2021; Segkouli et al. 2021; Van Yperen and Wörtler 2017; Dropkin et al. 2016). Interestingly, in each of these areas the older workers experience challenges as well as opportunities. This Janus-faced situation shows that the impact of workplace digitalization on older workers is not clear cut. Instead, it may generate both, opportunities and challenges, for older workers at the same time. In some cases, older workers simultaneously experience opportunities and challenges. However, in other cases, social inequalities emerge, with some groups of older workers benefiting from the opportunities while other groups primarily encounter the challenges. Only a handful of previous studies touched upon this topic (e.g., Peng, Anwar, and Kang 2017; Damman 2016; Dropkin et al. 2016; Brooke 2009). Considering the extant heterogeneity among older workers, it would be beneficial if future research determined exactly how social inequalities play out in this development. Gender-differences in particular should be further explored, considering how important they are for questions of work and retirement (Komp-Leukkunen 2019; Phillipson 2019).

The second research question asked how the work environment matters for older workers in digitalizing workplaces. Previous studies showed that the work environment exerts influences especially through the implementation of ICT technologies, the option for teleworking, the training offered, and the employers' and managers' attitudes (Van Dalen, Henkens, and Wang 2015; Van Dalen, Henkens, and Schippers 2009; Morris and Venkatesh 2000; Staufer 1992). These aspects shape older workers' exposure to technologies, their options for learning and utilizing the technologies, and their chances for taking up the options for technology learning and utilization. In this way, work environments take on a crucial function in shaping whether workplace digitalization acts as a challenge or an opportunity for older workers. They become prime starting points for interventions into the experiences of older workers in digitalizing workplaces (Dropkin et al. 2016). Moreover, they generate inequalities in how older workers fare when their workplaces digitalize (Van Dalen, Henkens, and Schippers, 2009; Morris and Venkatesh 2000). Further research is needed to explore such between-workplaces inequalities in greater detail.

The third research question asked how country characteristics shape the situation of older workers in digitalizing workplaces. Previous research showed that the country-wide use of ICT, governmental programs for older workers' computer training, labor market structures, culture,

welfare policies, and governmental responses to the COVID-19 pandemic are influential (Fischer et al. 2021; Grigoli, Koczan, and Topalova 2022; Pit et al. 2021; Lee, Song, and Kwak 2020; Peng, Anwar, and Kang 2017). Interestingly, some of these influences are intended to shape the situation of older workers in digitalizing workplaces, such as the computer training programs and retirement regulations. However, others were not specifically manipulated for this purpose, for example the country-specific culture and the labor market structures (Grigoli, Koczan, and Topalova 2022; Van Dalen, Henkens, and Wang 2015). This combination of intended and unintended influences puts a practical limit on how far governments can shape the situation of older workers in digitalizing workplaces. A recent change is that governmental policies tackling the effects of the COVID-19 pandemic also need to be considered (Pit et al. 2021). Such policies have just now been implemented, which means that their effects will still unfold over the next years and decades. Nevertheless, their concern with the viability of digital workplaces in particular may make them an important cornerstone in how older workers fare. Therefore, the effects of these policies should be monitored as they unfold.

The findings have theoretical and practical implications. Theoretical implications arise because this study enhances our understanding of the situation of older workers in digitalizing workplaces. It documents the range of knowledge on the older workers' experiences, and scattered evidence on the influences of workplaces and country characteristics on the situation of these workers. Interestingly, the focal points of analysis differ across these levels. While the individuals' experiences are mainly explored regarding their work-life balance and challenges as work, workplaces and country characteristics are mainly explored regarding questions of workplace training, productivity, and retirement (Grigoli, Koczan, and Topalova 2022; Van Yperen and Wörtler 2017; Dropkin et al. 2016). This split in focus leads to two different narratives of the effects of workplace digitalization on older workers existing side by side. Only one factor transcends the analysis levels: the extent of technologies used, which shapes the experiences of the older workers, how their work environment reacts, and how their country of residence supports them (Peng, Anwar, and Kang 2017; Mantzana, Themistocleous, and Morabito 2010; Staufer 1992). Therefore, it seems advisable that this factor would be further explored in multi-level studies. Additionally, the literature review revealed a dearth of theories used and the under-studied question of social inequalities. Future research on older workers in digitalizing workplaces should consider exploring these areas especially.

Practical implications arise because this study considers older workers in digitalizing workplaces also from the perspective of employers. It documents that digitalization brings not only challenges, but also a wide range of opportunities that can be harnessed for greater productivity. Employers may use this insight to reconsider their attitudes toward older employees, and how to approach them when workplaces are digitalized (Dropkin et al. 2016). As a result, they may be able to retain their older employees until a later age, thereby realizing the goal of extended working lives. Thus, policymakers and trade unions may be interested in organizing events that show employers how older workers can thrive in digitalizing workplaces, for example, by presenting scientific evidence and models of good practice.

Besides its merits, this study also has some limitations. First, it reviewed studies written in English only. Considering that the aging workforce is a global concern, subsequent work might take into consideration articles published in languages other than English. Second, this study considered all forms of digitalization jointly. This approach is serviceable because the amount of research on the study topic is still low, and the definitions of the forms of digitalization studied are not always clear. However, it is possible that the effects on older workers differ across forms of digitalization. Therefore, it would be worthwhile to carry out research on the relationships of older workers to specific technologies (e.g., social media platforms, desktop client-server work practices, mobile device apps) and how these particular engagements affect their views on technology (or work) more broadly. Third, this study exclusively reported on results in developed countries because previous research has focused so far on these countries.

However, the concerns of workplace digitalization exist also in many developing and less developed countries. Thus, looking at the experiences, attitudes, and policy implementations in middle- and low-income countries would be key to obtaining a broad overview of global differences in how older workers work and how they work with technology. Fourth, this study considers all older workers together, while only sporadically hinting at differences among them. This approach is due to the lack of attention to social inequalities in previous research on this topic. Considering the social inequalities we would expect to exist, it seems advisable that future research would explore them in detail.

All in all, this study shows that workplace digitalization affects older workers in various ways. Older workers may encounter challenges or opportunities, depending on their own context, their workplaces, and the situation in their country of residence. Thus, older workers are not, per se, on the back foot when their workplaces are digitalized. They themselves and the institutions and persons around them can help or hinder in adapting to change. Therefore, the attitudes and actions of both employers and policymakers are crucial when it comes to ensuring the workforce participation in old age while digitalization progresses. With a considerate approach, digitalizing workplaces can further the goal of extended working lives. In particular, theory-driven research and research on social inequalities can further bolster our knowledge on these developments and opportunities.

Acknowledgement

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Supplementary Table 1: The Literature Analyzed

Number	Reference	Contains information on …		
		Older workers	Workplace influences	Country influences
1	Alcover, Carlos-Maria, Guglielmi, Dina, Depolo, Marco, and Mazzetti, Greta. 2021. "'Aging-and-Tech Job Vulnerability': A Proposed Framework on the Dual Impact of Aging and AI, Robotics, and Automation among Older Workers." *Organizational Psychology Review* 11 (2): 175–201. https://doi.org/10.1177/2041386621992105.	X		
2	Bartel, Ann P., and Sicherman, Nichum. 1993. "Technological Change and Retirement Decisions of Older Workers." *Journal of Labor Economics* 11 (1): 162–183.		X	
3	Battisti, Michele, and Gravina, Antonio Francesco. 2021. "Do Robots Complement or Substitute Older Workers?" Economics Letters 208: 110064. https://doi.org/10.1016/j.econlet.2021.110064.			X
4	Behaghel, Luc, Caroli, Eve, and Roger, Muriel. 2014. "Age-biased Technical and Organizational Change, Training and Employment Prospects of Older Workers." *Economica* 81 (322): 368–389. https://doi.org/10.1111/ecca.12078.	X	X	
5	Brooke, Libby. 2009. "Prolonging the Careers of Older Information Technology Workers: Continuity, Exit or Retirement Transitions." *Ageing & Society* 29 (2): 237–256. https://doi.org/10.1017/S0144686X0800768X.	X		
6	Damman, Marleen. 2016. "Blended Work and Employment Participation of Older Workers: A Further Discussion." *Work, Aging and Retirement* 2 (4): 384–389. https://doi.org/10.1093/workar/waw022.	X	X	
7	De Koning, Jaap, and Gelderblom, Arie. 2006. "ICT and Older Workers: No Unwrinkled Relationship." *International Journal of Manpower* 27 (5): 467–490. https://doi.org/10.1108/01437720610683967.		X	
8	Dropkin, Jonathan, Moline, Jacqieline, Kim, Hyun, and Gold, Judith E. 2016. "Blended Work as a Bridge between Traditional Workplace Employment and Retirement: A Conceptual Review." Work, Aging and Retirement 2 (4): 373-383. https://doi.org/10.1093/workar	X	X	X
9	Elias, Steven M., Smith, William L., and Barney, Chet E. 2012. "Age as a Moderator of Attitude toward Technology in the Workplace: Work Motivation and Overall Job Satisfaction." *Behaviour & Information Technology* 31 (5): 453–467. https://doi.org/10.1080/0144929X.2010.513419.			
10	Fischer, Bjorn, Ostlund, Britt, Dalmer, Nicole K., Rosales, Andrea, Peine, Alexander, Loos, Eugene, Neven, Louis, and Marshall, Barbara. 2021. "Co-design as Learning: The Differences of Learning when Involving Older People in Digitalization in Four Countries." *Societies* 11: 66. https://doi.org/10.3390/soc11020066.			X
11	Friedberg, Leora. 2003. "The Impact of Technological Change on Older Workers: Evidence from Data on Computer Use." *Industrial and Labour Relation Review* 56 (3): 511–529. https://doi.org/10.2307/3590922.	X		

12	Greenan, Nathalie, and Messe, Pierre-Jean. 2018. "Transmission of Vocational Skills in the Second Part of Careers: The Effect of ICT and Management Changes." *Journal for Labour Market Research* 52. https://doi.org/10.1186/s12651-018-0240-1.	X	X	
13	Grigoli, Francesco, Koczan, Zsoka, and Topalova, Petia. 2021. "Calling Older Workers back to Work." *Applied Economics Letters* Published online ahead of print. https://doi.org/10.1080/13504851.2021.1876205.			X
14	Harris, Kelly, Krygsman, Sarah, Waschenko, Jessica, and Rudman, Debbie Laliberte. 2018. "Ageism and the Older Worker: A Scoping Review." *The Gerontologist* 58 (2): e1–e14. https://doi.org/10.1093/geront/gnw194.		X	
15	Hudomiet, Peter, and Willis, Robert J. 2021. "Computerization, Obsolence and the Length of Working Life." *Labour Economics* Published online ahead of print. https://doi.org/10.1016/j.labeco.2021.102005.	X		
16	Kurer, Thomas, and Gallego, Aina. 2019. "Distributional Consequences of Technological Change: Worker-level Evidence." *Research and Politics* 6 (1): 1–9. https://doi.org/10.1177/2053168018822142.			
17	Lawhon, Tommie, Ennis, Demetria, and Lawhon, David C. 1996. "Senior Adults and Computers in the 1990s." *Educational Gerontology* 22 (2): 193–201. https://doi.org/10.1080/0360127960220205.	X		
18	Lee, Chin Chin, Czaja, Sara J., and Sharit, Joseph. 2008. "Training Older Workers for Technology-based Employment." *Educational Gerontology* 35 (1): 15–31. https://doi.org/10.1080/03601270802300091.	X	X	
19	Lee, Jong-Wha, Song, Eunbi, and Kwak, Do Won. 2020. "Aging Labor, ICT Capital, and Productivity in Japan and Korea." *Journal of the Japanese and International Economies* 58: 101095. https://doi.org/10.1016/j.jjie.2020.101095.			X
20	Magnani, Elisabetta. 2006. "Technological Change and Older Workers' Training." *The International Journal of Economic Policy Studies* 1: 45–69. https://doi.org/10.1007/BF03405690.	X	X	
21	Malul, Miki. 2009. "Older Workers' Employment in Dynamic Technological Changes." *The Journal of Socio-Economics* 38: 809–813. https://doi.org/10.1016/j.socec.2009.05.005.			X
22	Mantzana, Vasiliki, Themistocleous, Marinos, & Morabito, Vincenzo. 2010. "Healthcare Information Systems and Older Employees' Training." *Journal of Enterprise Information Management* 23 (6): 680–693. https://doi.org/10.1108/17410391011088592.		X	
23	Marshall, Victor. (2011). "A Life Course Perspective on Information Technology Work." *Journals of Applied Gerontology* 30 (2): 185–198. https://doi.org/10.1177/0733464810367791.			X
24	Mauno, Saija, Minkkinen, Jaana, Tsupari, Heidi, Huhtala, Mari, and Feldt, Taru. 2019. "Do Older Employees Suffer more from Work Intensification and other Intensified Job	X		

	Demands? Evidence from Upper White-collar Workers." *Scandinavian Journal of Work and Organizational Psychology* 4 (1): 1–13. https://doi.org/10.16993/sjwop.60.			
25	Morris, Michael G., and Venkatesh, Viswanath. 2000. "Age Differences in Technology Adoption Decisions: Implications for a Changing Workforce." *Personnel Psychology* 53 (2): 375–403. https://doi.org/10.1111/j.1744-6570.2000.tb00206.x.		X	
26	Nagarajan, N. Renuga, and Sixsmith, Andrew. 2021. "Policy Initiatives to Address the Challenges of an Older Population in the Workforce." *Ageing International* Published online ahead of print. https://doi.org/10.1007/s12126-021-09442-w.	X		X
27	Oksa, Reetta, Saari, Tiina, Kaakinen, Markus, and Oksanen, Atte. 2021. "The Motivations for and Well-being Implications of Social Media Use at Work among Millennials and Members of Former Generations." *International Journal of Environmental Research and Health* 18: 803. https://doi.org/10.3390/ijerph18020803.	X		
28	Peng, Fei, Anwar, Sajid, and Kang, Lili. 2017. "New Technology and Old Institution: An Empirical Analysis of the Skills-biased Demand for Older Workers in Europe." *Economic Modelling* 64: 1–19. https://doi.org/10.1016/j.econmod.2017.03.004.			X
29	Pit, Sabrina, Fisk, Malcolm, Freihaut, Winona, Akintunde, Fashola, Aloko, Bamidele, Berge, Britta, Burmeister, Anne, Ciacâru, Adriana, Deller, Jurgen, Dulmage, Rae, Han, Tae Hwa, Hao, Qiang, Honeyman, Peter, Huber, Peter C., Linner, Thomas, Lundberg, Stefan, Nwamara, Mofoluwaso, Punpuing, Kamolpun, Schramm, Jennifer, Yamada, Hajime, and Yap, Jason C.H. 2021. "COVID-19 and the Ageing Workforce: Global Perspectives on Needs and Solutions across 15 Countries." *International Journal for Equity in Health* 20: 221. https://doi.org/10.1186/s12939-021-01552-w.	X		X
30	Schleife, Katrin. 2006. "Computer Use and Employment Status of Older Workers — An Analysis based on Individual Data." *Labour* 20 (2): 325–348. https://doi.org/10.1111/j.1467-9914.2006.00341.x.			
31	Segkouli, Sofia, Giakoumis, Dimitrios, Votis, Konstantinos, Triantafyllidis, Andreas, Paliokas, Ioannis, and Tzovaras, Dimitrios. 2021. "Smart Workplaces for Older Adults: Coping 'Ethically' with Technology Pervasiveness." *Universal Access in the Information Society*, 1–13. https://doi.org/10.1007/s10209-021-00829-9.	X	X	
32	Sharit, Joseph, Czaja, Sara J., Hernandez, Mario A., and Nair, Sankaran N. 2009. "The Employability of Older Workers as Teleworkers: An Appraisal of Issues and an Empirical Study." *Human Factors and Ergonomics in Manufacturing* 19 (5): 457–477. https://doi.org/10.1002/hfm.20138.	X	X	
33	Soja, Ewa, and Soja, Piotr. 2020. "Fostering ICT Use by Older Workers. Lessons from Perceptions of Barriers to Enterprise System Adoption." *Journal of Enterprise*	X	X	

	Information Management 33 (2): 407–434. https://doi.org/10.1108/JEIM-12-2018-0282.			
34	Solem, Per Erik. 2016. "Ageism and Age Discrimination in Working Life." *Nordic Psychology* 68 (3): 160–175. https://doi.org/10.1080/19012276.2015.1095650.		X	
35	Staufer, Michael. 1992. "Technological Change and the Older Employee: Implications for Introduction and Training." *Behaviour & Information Technology* 11 (1): 46–52. https://doi.org/10.1080/01449299208924318.	X	X	
36	Tams, Stefan, Grover, Varun, Thatcher, Jason, and Ahuja, Manju. 2021. "Grappling with Modern Technology: Interruptions Mediated by Mobile Devices Impact Older Workers Disproportionately." *Information Systems and e-Business Management* Published online ahead of print. https://doi.org/10.1007/s10257-021-00526-3.	X		
37	Van Dalen, Hendrik P., Henkens, Kene, and Schippers, Joop. 2009. "Dealing with Older Workers in Europe: A Comparative Survey of Employers' Attitudes and Actions." *Journal of European Social Policy* 19 (1): 47–60. https://doi.org/10.1177/0958928708098523.		X	X
38	Van Dalen, Hendrik P., Henkens, Kene, and Wang, Mo. 2015. "Recharging or Retiring Older Workers? Uncovering the Age-based Strategies of European Employers." *The Gerontologist* 55 (5): 814–824. https://doi.org/10.1093/geront/gnu048.		X	X
39	Van Selm, Martine, and Van den Heijkant, Linda. 2021. "In Search of the Older Worker: Framing Job Requirements in Recruitment Advertisements." *Work, Aging and Retirement* 7 (4): 288–302. https://doi.org/10.1093/workar/waaa026.		X	
40	Van Yperen, Nico W., and Wörtler, Burkhard. 2017. "Blended Working and the Employability of Older Workers, Retirement Timing, and Bridge Employment." *Work, Aging and Retirement* 3 (1): 102–108. https://doi.org/10.1093/workar/waw036.	X	X	
41	Wagner, Nicole, Hassanein, Khaled, and Head, Milena. 2010. "Computer Use by Older Adults: A Multi-disciplinary Review." *Computers in Human Behavior* 26 (5): 870–882. https://doi.org/10.1016/j.chb.2010.03.029.			
42	Zhan, Yujie. 2016. "Blended Work: Further Connecting to the Broader Bridge Employment Literature." *Work, Aging and Retirement* 2 (4): 390–395. https://doi.org/10.1093/workar/waw025b.	X	X	

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