CESI
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DIGITALISING PUBLIC SERVICES
Making it work for citizens, business and workers

RESEARCH IN THE FRAMEWORK OF CESI'S PROJECT "DIWORK - DIGITALISING PUBLIC SERVICES: MAKING IT WORK FOR CITIZENS, BUSINESS AND WORKERS"

FINAL REPORT:

ANNEXES

2022

VISIONARY ANALYTICS

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1. Annex I: defence sector

This is an overview of the digitalisation trends and impacts on workers in the defence sector, more particularly on the military personnel that is represented by CESI member organisations. The chapter is an overview of the survey responses of three CESI members that indicated they represent military personnel and responded to the survey questions.

1.1. Digital evolution in the defence sector

Defence systems, organisational models and processes can be complicated, slow and inefficient but they need to be fast and agile. The digitalisation process in the defence sector has begun already in 1960s, as they started using computer technology for military intelligence, i.e., to perform complex mathematic calculations for artillery and ballistics accuracy, then to manage logistics, and supply inventories, wage payments and maintain personnel records.[1] Since 1970s militaries are using computers for command and control, intelligence, surveillance, and reconnaissance. Since 1990s computing power and availability of data are used to improve battlefield communication between units and strategic command and to enhance precision-strike capabilities. As of today, militaries have almost fully computerised and interconnected their communications, sensory capabilities, logistics, maintenance and command and control. The key digitalisation trends identified by the CESI members are the following (see Figure 1):

- **Automation of tasks**. In the defence sector robotic process automation (RPA) has found its roots in the administrative offices, with automation of such tasks as financial management, human resources, contracting and acquisition.[2] Its application in mission space has just begun, with examples of automating creation of flight authorisations, air and ground space planning (e.g., automated navigation in aircrafts, remotely-controlled vehicles that conduct tasks) and maintenance operations (e.g., automated maintenance of vehicles). Other example is the use of drones for military and civil missions (e.g., in the prevention and intervention operations for security uses, for the surveillance of oil pipelines). One out of three CESI members that responded to the question think it is a very important trends, and two think it is fairly or somewhat important.
- **More collaborative work** facilitated by digital technologies and various platforms. For example, soldiers use GPS and radio with encrypted systems for communication. One out of three CESI members think this is a very important trend and two think it is somewhat important.
- **Data-driven processes and decision-making**. Defence sector collects great amounts of data. High-level diagnostic and predictive data analytics can help military commanders make more insightful, forward-looking decisions related to readiness planning, logistics planning, workforce management and military intelligence. [3] For example, in terms of readiness for the mission, analytics connect data about personnel and their training and show how they could work in various combinations under varying conditions. This allows commanders to see what would happen if they made changes to any factors. Analytics can also predict the force structure demand for a particular geographic location over a period of time. An example of predictive analytics in workforce management is how it can help to deal with complex issues such as sexual assaults in units. Advanced analytics allow to understand what factors (e.g., gender, age, diversity, experience of units and their leaders, as well as the nature of the mission) can lead to a higher likelihood of a sexual assault in a unit. This approach can also be used for suicide prevention, discrimination complaints and violence in the workplace. Satellites and modern meteorological and environmental detection equipment is used

[1] Fiott, D., 2020. "Digitalising defence", European Union Institute for Security Studies. https://www.iss.europa.eu/content/digitalising-defence

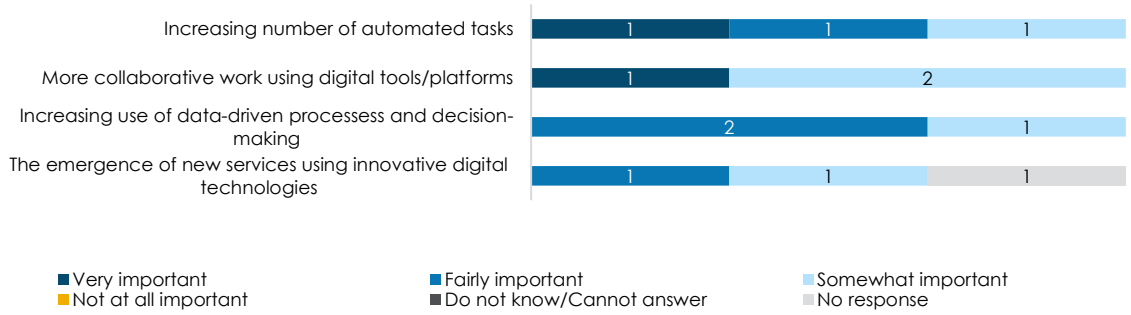
[2] Vincent, B., 2020. "Defense is Embracing Robotic Process Automation But It's Not Yet Scaling It". Nextgov. https://www.nextgov.com/emerging-tech/2020/04/defence-embracing-robotic-process-automation-its-not-yet-scaling-it/164855/

[3] Jachimski, S. 2017. Predictive Analytics Handbook for National Defence. Booz Allen Hamilton Inc.

to acquire precise data and make decisions with more safety, as explained by a CESI member. None of the CESI members think this is a very important development, but two believe it is fairly important and one that is somehow important.

- **The emergence of new services based** on such technologies as artificial intelligence (AI), robotics, blockchain, virtual reality (VR), Internet of Things (IoT). In the defence sector this refers to AI that is embedded in weapons and other warfare systems, military transportation, robotic systems. Two CESI members think it is fairly and somewhat important.
- **The use of anti-drone systems** was mentioned by a respondent as an additional trend. This refers to defensive technology that aims to defend against drones that can conduct surveillance or attacks. This is an important development considering the increasingly more widespread use of precision strikes by using drones.[4] However, no armed force in the EU states has integrated point air defence systems to combat drones up to this day.

Figure 1. Importance of trends in the defence sector as reported by CESI members



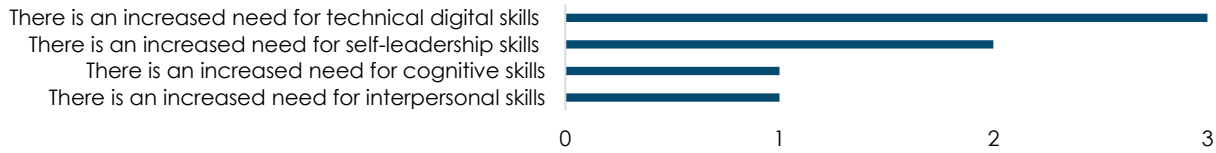
Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

With the advent of the pandemic, employers in the defence sector have authorised the use of technology and remote flexible work, ensuring security procedures. Asked how the COVID-pandemic affected digitalisation of the sector, CESI members explained that it has accelerated the process by enabling smart working, as well as by enabling employees to become more confident and knowledgeable about IT and digital systems.

1.2. Impact on workers' skills in the defence sector

All three CESI members agree that in the past five years there has been an increase in the demand for *technical digital skills* such as programming, data analysis and statistics, computational and algorithmic thinking, data literacy (Figure 2). Two out of three believe that there is more demand for *self-leadership skills*, including self-management and self-awareness, self-directed learning and development, entrepreneurship, ownership, and decisiveness as well as coping with uncertainty. Less need can be observed for *cognitive skills* (e.g., problem-solving, logical reasoning, time management, prioritisation, communication, adaptability, and ability to learn) and *interpersonal skills* (e.g., role modelling, sociability, empathy, collaboration, empowering, resolving conflicts, coaching, and fostering inclusiveness).

Figure 2. The demand for skills in the defence sector as reported by CESI members

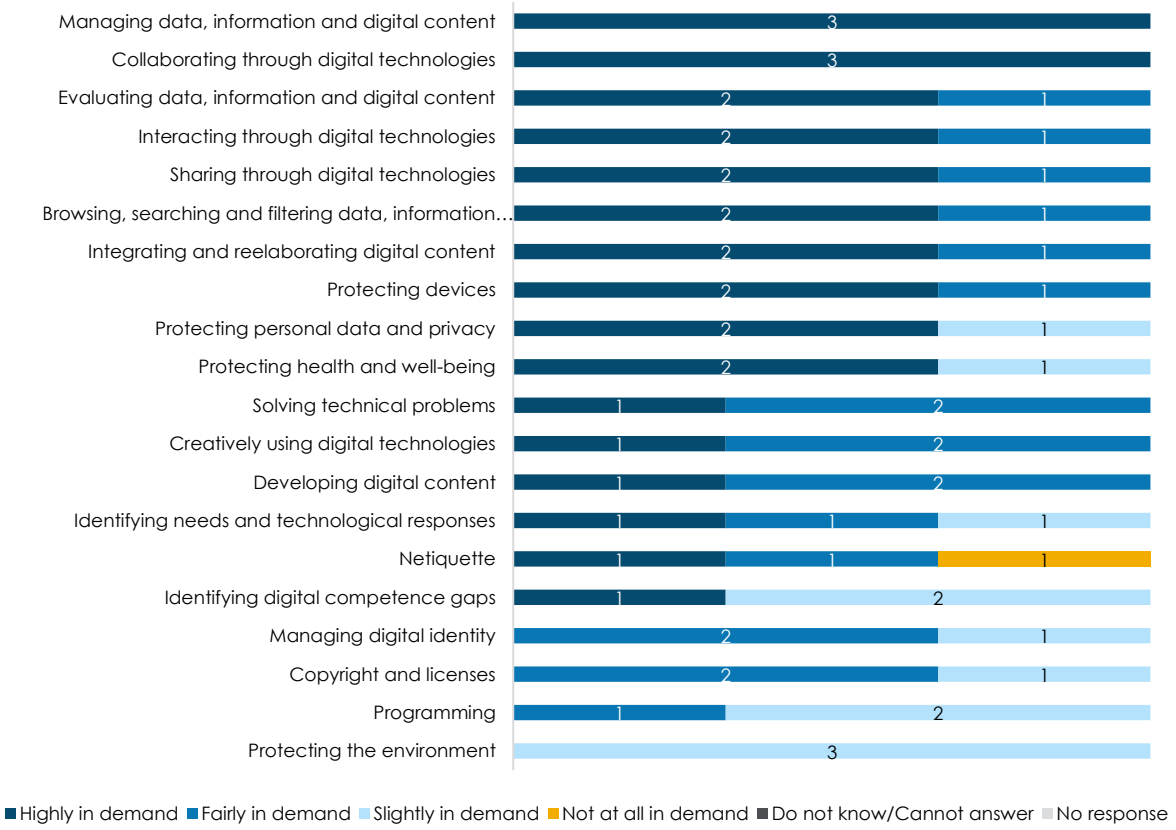


Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

[4] Gosseling-Maalo, E., 2021. "Outsmarted & Unfunded: Europe's Counter-Drone Industry". The Square. http://www.thesquarecentre.org/2021/03/02/outsmarted-unfunded-europes-counter-drone-industry/

Taking a more precise look, CESI members think that skills that *ability to manage data, information, and digital content*, as well as *collaboration through digital technologies* are the most in demand (Figure 3). Only slightly in demand is the *ability to protect the environment* while using digital skills (i.e., to be aware of the environmental impact of digital tools and their use).

Figure 3. Demand of digital competences in defence sector according to CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

CONF.S.A.L. (a CESI member) noted that the current skills of the defence sector personnel are insufficient, and that in addition to adequate technological equipment they should be trained. CISAL (a CESI member) also noted that it is necessary to train management personnel on IT and digital matters. The respondents explained that digitalisation increased the prevalence of e-learning in the defence sector.

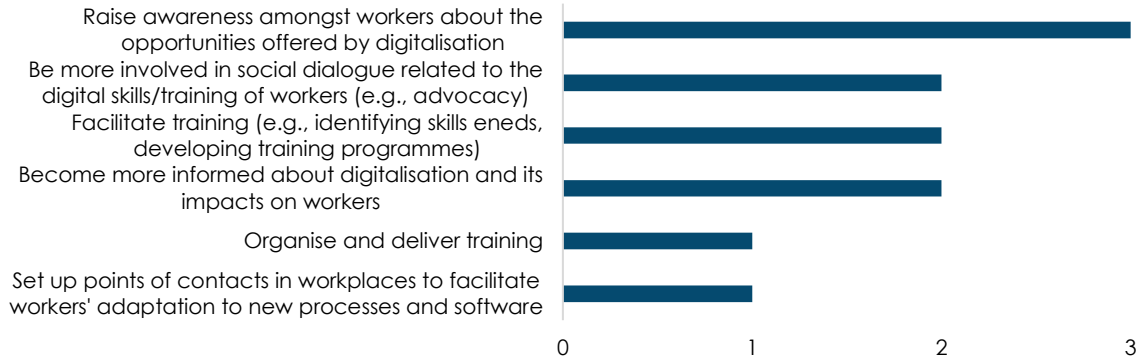
The main barrier related to addressing the changing skills needs in the defence sector is *lack of access to training for workers*, as organisations do not offer sufficient learning opportunities to acquire the necessary skills. CONF.S.A.L. (a CESI member) explained that the courses on digitalisation are sometimes aimed only at a limited number of staff (e.g., middle managers).

Figure 4. Main barriers to address the changing skills needs in the defence sector as reported by CESI members

Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

All respondents think that Trade Unions should *raise awareness* amongst workers about the opportunities that digitalisation offers (Figure 5). Two out of three TUs agree that professional organisations should be more involved in social dialogue related to the digital skills and training of workers, become more informed about digitalisation and how it impacts workers, and facilitate training (see Box 1). However, organising and delivering training, as well as setting up points of contact in workplaces to help workers to adapt are not see as useful measures.

Figure 5. The role of Trade Unions in addressing the changing skills needs in the defence sector as reported by CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

Box 1. Good practice of CONF.S.AL. on raising awareness about training opportunities in the defence sector

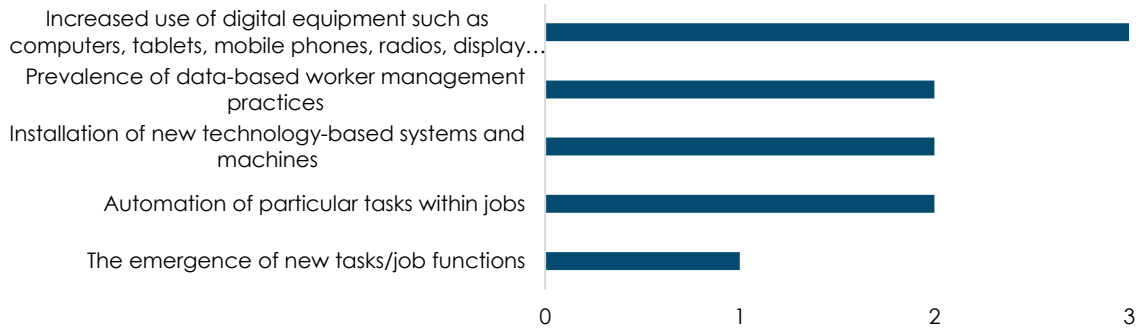
Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector.

Italian Workers' Autonomous Trade Unions Confederation (Confederazione Generale dei Sindacati Autonomi dei Lavoratori (CONF.S.A.L.) has shared its good practice on informing workers about the available training opportunities. CONF.S.A.L. uses it social media channels to advertise training courses on a daily basis. It has also often urged administrations to organise trainings related to digitalisation for the workers. However, despite its efforts some employees do not respond positively to the possibility of acquiring new skills in the IT fields.

1.3. Impact on work organisation in the defence sector

All Trade Unions have observed that in the last five years there has been an *increase in the use of digital equipment for work purposes* (Figure 6). These range from simple technologies such as mobile phones, tablets, and computers, to radios, display units and more advanced technologies. The results of the survey suggest that emergence of new tasks or job functions (e.g., army chief digital officer) are not as common in the sector.

Figure 6. The most prominent changes to work organisation practices in the defence sector as reported by CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

Trade Unions also reported that there has been an increase in agile working. CONF.S.A.L. (a CESI member) noted the need for a specific regulation to for staff and employers on the remote work. Similarly, CISAL (a CESI member) indicated that there is lack of organisational support to properly embrace remote work in defence sector (Box 2).

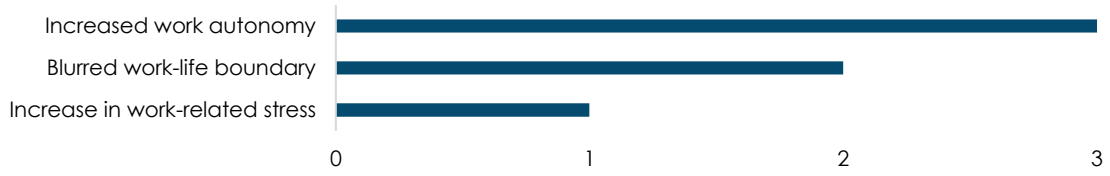
Box 2. CISAL efforts to promote agile working

Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector.

Italian Confederation of Free Workers' Unions (Confederazione Generale dei Sindacati Autonomi dei Lavoratori (CISAL) provides support and information to workers related on the agile working arrangements. It has explained that these efforts of the Trade Union are sometimes met with resistance and mistrust by the top management in the companies. Employers hold little knowledge about the agile work, and they often encounter misinformation. These negative attitudes make it impossible to organise constructive discussions and to develop much-needed regulations on agile work.

In terms of the implications of digitalisation on workers, all CESI members reported that workers have more opportunities to decide where and when to work, *increasing their autonomy* (Figure 7). On the other hand, two TUs indicated that digitalisation leads to blurred work-life boundary due to new working arrangements that allow to work from home and work intensification. One TU also reported increase in work-related stress due to constant use of digital technologies, job insecurity and work intensification.

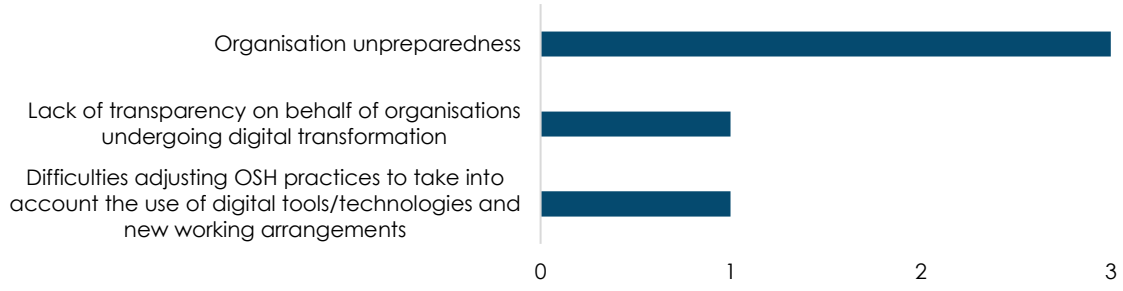
Figure 7. Key occupational safety and health effects of digitalisation in the defence sector as reported by CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

TUs think that the key barrier that makes it difficult to address the changing work organisation practices is *organisation unpreparedness*. Organisations lack expertise and coordination between departments/ managers to successfully support workers in the light of changes due to digitalisation (Figure 8).

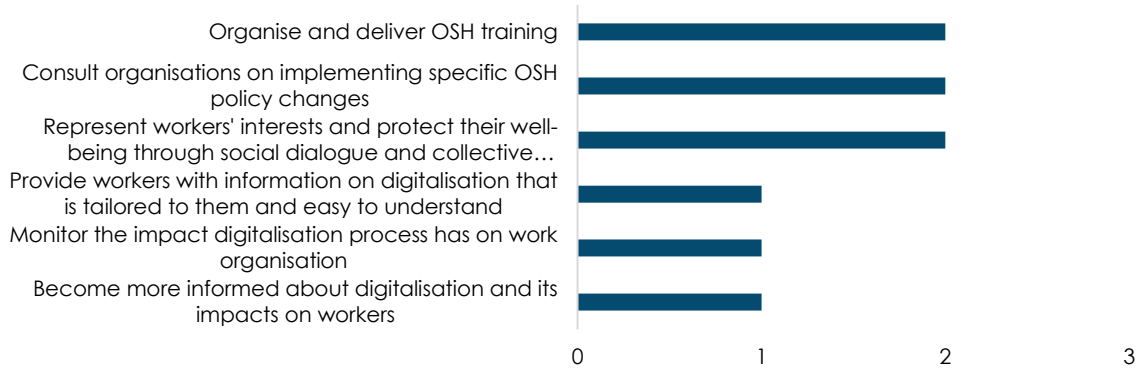
Figure 8. Main barriers to address the changing work organisation practices in the defence sector as reported by CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

To address the changes in work organisation due to digitalisation, CESI members believe they can *organise and deliver OSH training*, *consult organisation on implementing specific OSH policy changes* and advocate workers' needs through *social dialogue and collective bargaining* (Figure 9). Notably, only one CESI member believes that TUs should become more informed about digitalisation and its impacts on workers or monitor what impact digital transformation has on work organisation. Only one TU thinks it is important to provide workers with easy-to-read tailored information on digitalisation.

Figure 9. The role of Trade Unions in addressing the changes in work organisation due to digitalisation as reported by CESI members

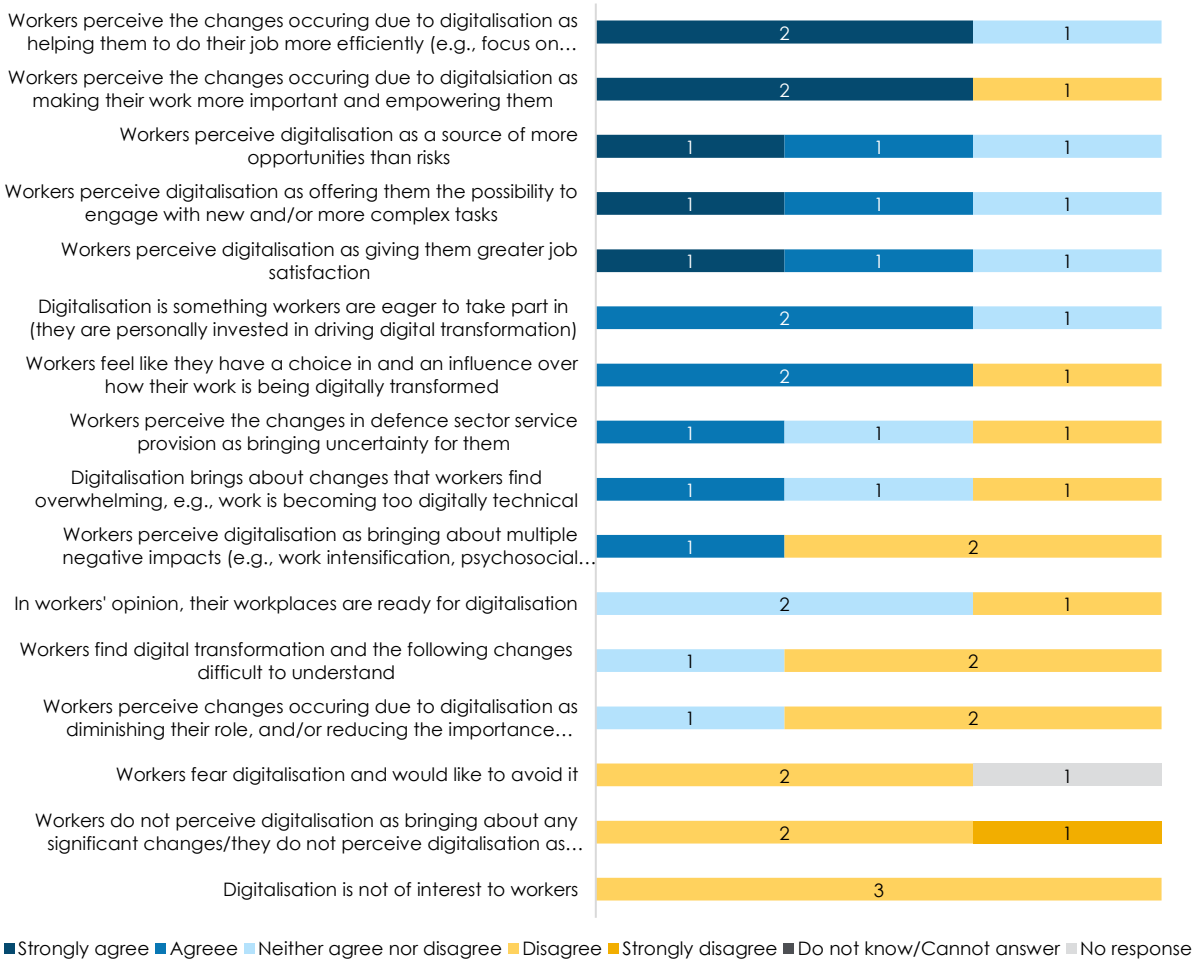


Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

1.4. Attitudes towards digitalisation in defence sector

According to CESI members, military personnel that they represent has highly positive attitudes towards digitalisation (Figure 10).

Figure 10. Attitudes of workers in the defence sector according to CESI members



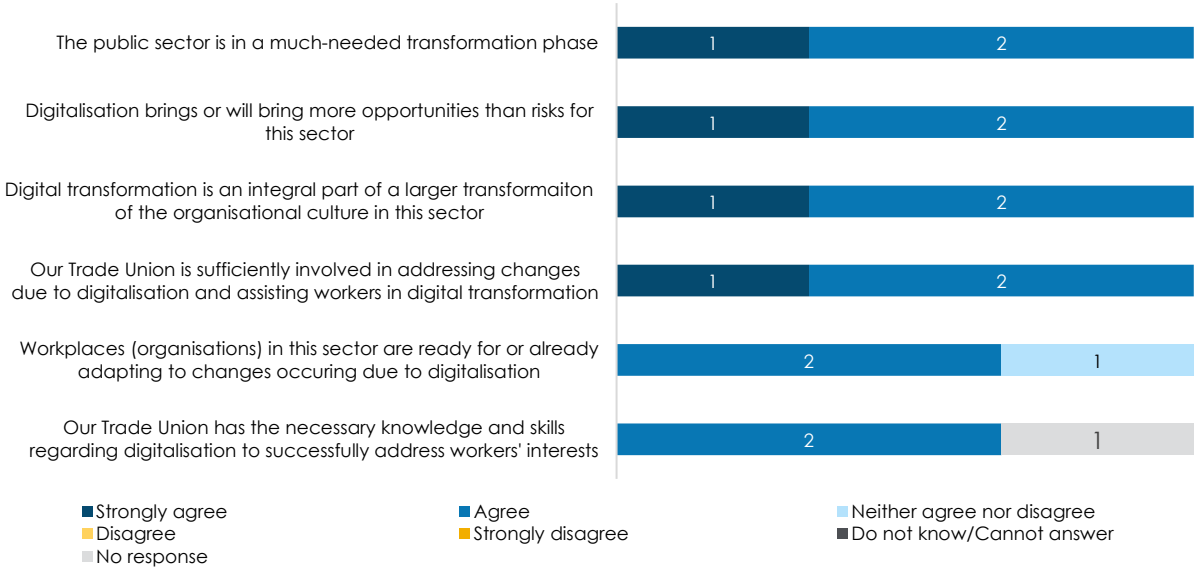
Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

All three respondents at least somehow agree that *workers perceive digitalisation as a source of more opportunities than risks*. Workers believe that digitalisation helps them to do their job

more efficiency, makes their work more important, gives them a chance to engage with new tasks, empowers them and gives them more job satisfaction. Two out of three TUs disagree that workers think of digitalisation as affecting them in a negative way. Workers in the sector appear to be personally involved in the process, do not fear it, find it interesting and are eager to take part in it, understanding that it brings significant changes. Two TUs disagree that changes due to digitalisation are difficult to understand for workers, but at the same time two Tus agree that these changes bring uncertainty for them and are overwhelming.

CESI members also perceive digitalisation in the defence sector as a positive development (Figure 11). They believe that it will bring more opportunities than risks for workers. The respondents understand that digitalisation is much-needed in the public sector and that it is part of the change of organisational culture. One out of three TUs is indecisive whether workplaces in the sector are ready for digitalisation but others believe they are. In terms of TUs' involvement in digitalisation, all three TUs believe that they are sufficiently involved in addressing changes due to digitalisation and two believe they have the necessary knowledge and skills to do that. CONF.S.A.L. (a CESI member) noted that as the organisation it should also invest more resources in digital evolution and embrace it from within.

Figure 11. CESI members' attitudes to digital transformation in the defence sector



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

2. Annex II: security sector

This is an overview of the digitalisation and its impact on workers in the security sector. It presents the results of the survey of four CESI members that represent police staff and firefighters.

2.1. Digital evolution in the security sector

CESI members from the security sector report the following trends of digitalisation (Figure 12):

- **More services provided online**. This refers to online crime reporting, registering a firearm, fire reporting via instant messaging.
- **More collaborative work using digital tools,** i.e., using platforms and electronic devices to take notes on the case.
- **New processes that use digital technologies** such as artificial intelligence (AI), blockchain, augmented/virtual reality, Internet of Things (IoT). Examples of these new practices include AI-drive automatic license plate recognition, social media threat analysis software, facial recognition technologies, use of mobile infrared cameras, and chatbots. An example given by CISAL (a CESI member) illustrates the use of electronic identification document (a card) for operators in the security sector, which allows identification of officers, allows them to access Internet and encrypted documents.
- **Robotic process automation** (RPA), which is used in policing for fixed penalty processing, intelligence reporting, crime reporting, firearms license processing, replacing the need for officers to enter the same information into different systems. [5]
- **Data-driven predictive and behavioural analytics** that are widely used in policing to predict crime (and where officers should patrol) and in fire emergency services to identify and prioritize certain property fire inspections over others. [6] The main associated benefits of predictive analytics is gains in effectiveness and efficiency, which, for example, let police to conduct better tailored interventions, and achieve benefits. [7] For example, AI-based analytics tool helped to cut burglaries by 27% and property theft by 19% in several US cities.[8] On the other hand, analytics can lead to concerns about pervasive policing, leading to concerns about widespread surveillance and privacy issues.[9] AI prediction tools can also reinforce human bias, as research has found that vulnerable communities are more susceptible to big data discrimination.[10]

[5] Warhurst, Chris, Hunt, Will, 2019. The digitalisation of future work and employment: Possible impact and policy response, 24.

[6] Tomar, L., Guicheney, W., Kyarisiima, H., & Zimani, T. 2016. "Big Data in the public sector: Selected applications and lessons learned", Inter-American Development Bank; Barbero, M. Coutuer, J. et al., 2016. Big data analytics for policy making. European Commission; Madaio, M., Chen, S.-T. et al., 2016. Firebrid: Predicting Fire Risk and Prioritizing Fire Inspections in Atlanta. Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining.

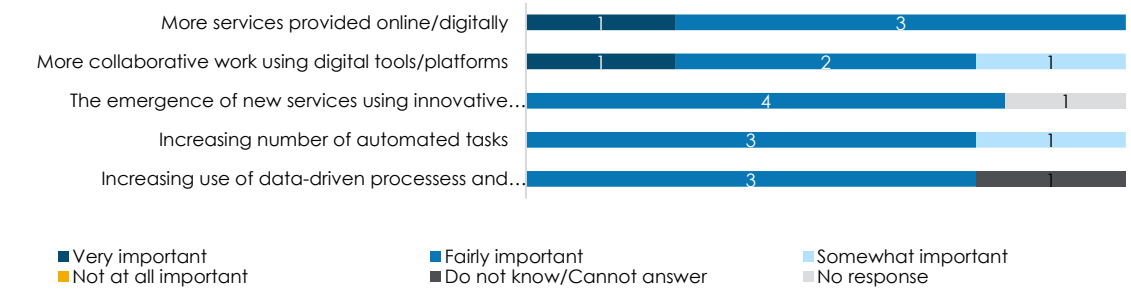
[7] Perry, W. L., McInnis, B. et al., 2013. Predictive Policing: The Role of Crime Forecasting in Law Enforcement Operations. RAND Corporation.

[8] Goldsmith, S., & Crawford, S. 2014. "The responsive city: Engaging communities through data-smart governance". Jossey Bass.

[9] Horvitz, E. 2016. Artificial intelligence and life in 2030. Stanford University. https://cra.org/ccc/wp-content/uploads/sites/2/2016/09/ai_100_report_0916fnl_single.pdf

[10] Gangadharan, S. P., Eubanks, V., & Barocas, S. 2014. Data and discrimination: collected essays. Open Technology Institute & New America; Newman, N. 2014. How Big Data Enables Economic Harm to Consumers, Especially to Low-Income and Other Vulnerable Sectors of the Population. US Federal Trade Commission; Barocas, S., & Selbst, A. 2016. Big Data's Disparate Impact. *California Law Review, 104(1)*, 671-729; Madden, M., Gilman, M. et al. 2017. Privacy, Poverty, and Big Data: A Matrix of Vulnerabilities for Poor Americans. *Washington University Law Review, 95(1)*

Figure 12. Importance of trends in the security sector as reported by CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=4.

The pandemic has resulted in more teleworking in the sector and workers had to learn how to use different software programs for online meetings as explained by one respondent. However, the use of remote work was still marginal because of the barriers to guarantee security of sensitive or confidential data and processes when working outside the office. The pandemic had also had great impact on the mode of delivery of training in the security sector as CESI members explained that the need for training and upskilling courses increased, and all training was done through e-learning. Interestingly, another CESI member reported that rather than accelerating digitalisation the pandemic has slowed it down since the sector had to focus its efforts on the protection of public order and safety.

2.2. Impact on workers' skills in the security sector

Two out of three CESI members that represent security sector workers report that in the past five years they have observed to change in terms of skills that workers need to do their job (Figure 13). One Trade Union reported the increased need for interpersonal, cognitive, and self-leadership skills.

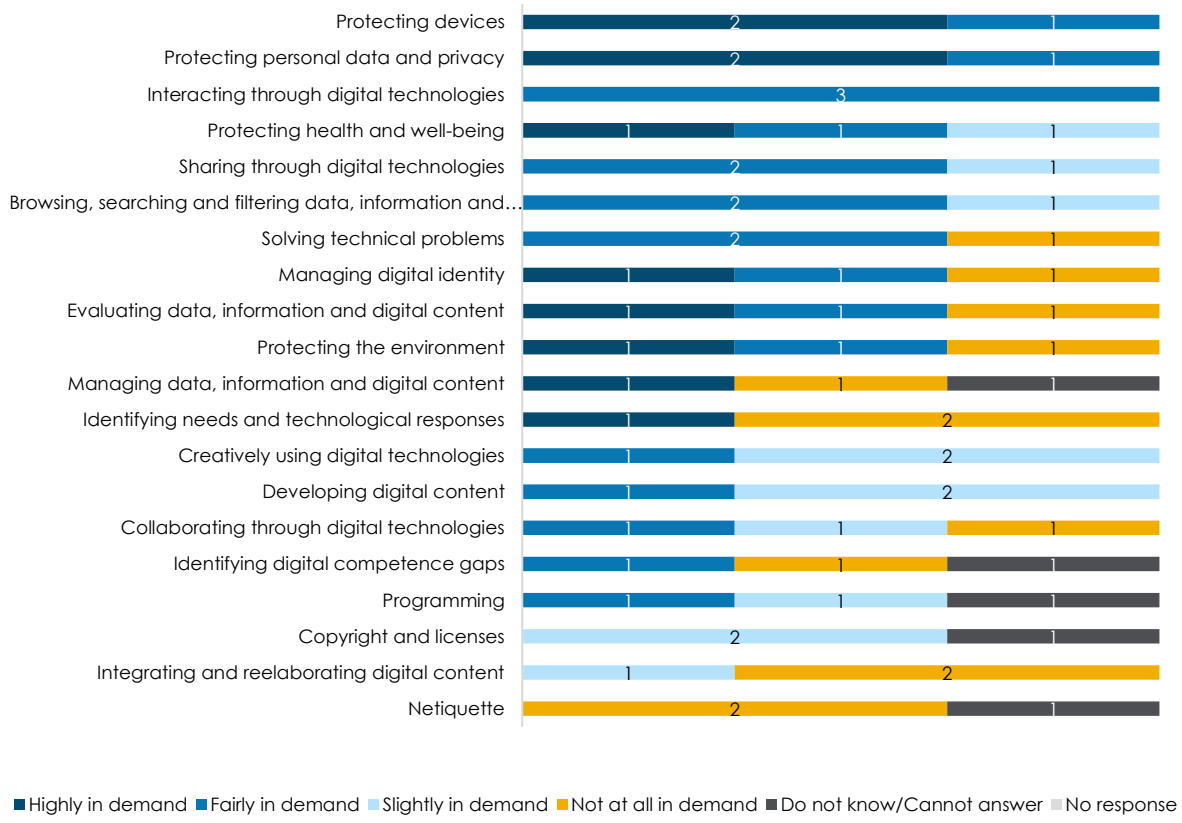
Figure 13. The demand for skills in the security sector as reported by CESI members

Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

All three CESI members representing security sector named two skills as the most highly in demand: 1) the ability to *protect devices and digital content*, to understand risks and threats in digital environment, be aware of the safety and security measures regarding reliability and privacy, 2) and *the ability to understand how to use and share personally identifiable information* while protecting oneself and others from damages, to understand that digital services use a "privacy policy" to inform how personal data is used (Figure 16). All three respondents also believe that *interacting through digital technologies* (e.g., the ability to write emails, participate in video conferences and calls) is a skill that is fairly in demand in the security sector. Skills that are least in demand are netiquette (i.e., the ability to be aware of behavioural

norms and know-how on using digital technologies and in digital environment, being aware of cultural and generational diversity in digital environments and audiences), and integrating and re-elaborating digital content.

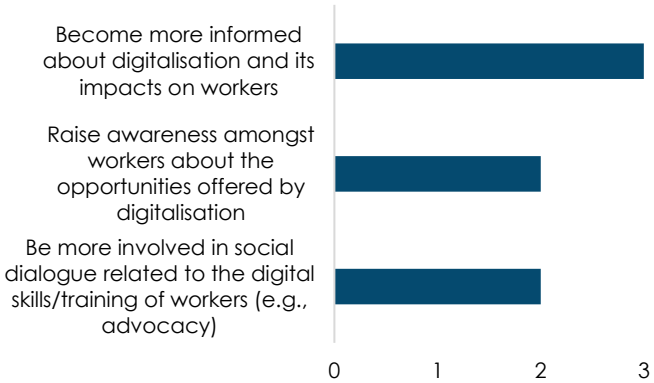
Figure 14. Demand of digital competences in security sector according to CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3

Figure 15. Main barriers to address the changing skills needs in the security sector as reported by CESI members

Figure 16. The role of Trade Unions in addressing the changing skills needs in the security sector as reported by CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

Difficulties to identify the skills needs was chosen as the key barrier that prevents successfully addressing the changing skills needs in the security sector (Figure 15). One TU also thinks that security sector staff lack access to training and that they do not see the need for training. CESI

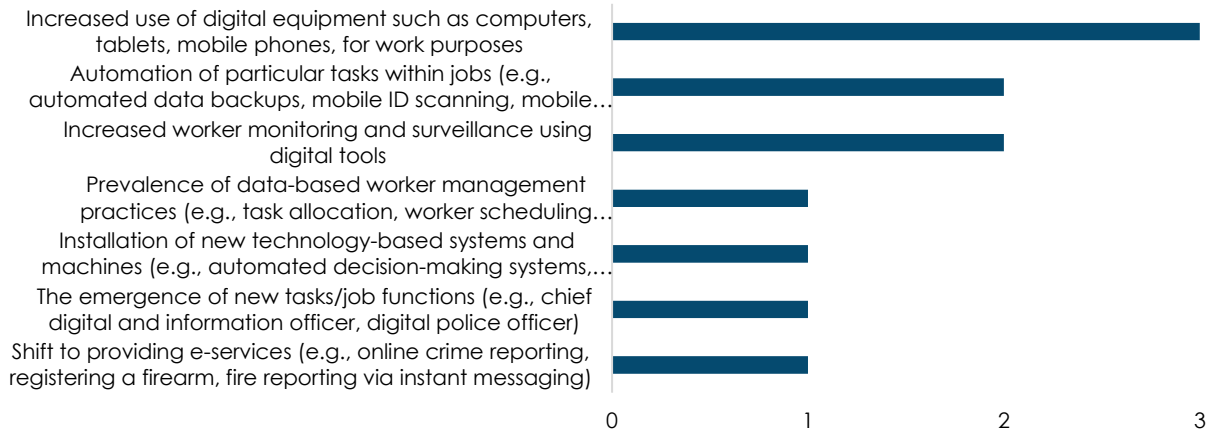
members noted problems with the training that is available for the staff in the sector, it comes with a delay or is not sufficient. On the other hand, CISAL (a CESI member) has noted a good practice of employers using virtual reality (VR) for the training of firefighters.

Becoming more informed about digitalisation and its impacts on workers is seen by all respondents as a main way to support workers with regard to changing skills needs (Figure 16). Other measures that TUs could employ according to CESI members are raising awareness about the opportunities offered by digitalisation for workers and being more involved in social dialogue that is concerned with digital skills or training of workers. CISAL (a CESI member) has noted that as a Trade Union it implements initiatives that aim to raise awareness among workers and administrations about increasing online training.

2.3. Impact on work organisation in the security sector

The most prominent change to work organisation practices due to digitalisation appears to be *increased use of basic digital tools* (Figure 17). They can be used by security sector personnel for creating spreadsheets, communicating with colleagues and citizens, taking notes, running searches. Two out of three respondents indicated that they have observed *increased automation* and *increased worker monitoring and surveillance* using global positioning system (GPS), web cameras, and wearable devices. Other noteworthy changes in work practices of the security staff are data-based worker management, installation of new technology-based machines and systems, creation of new tasks and jobs, as increased number of e-services.

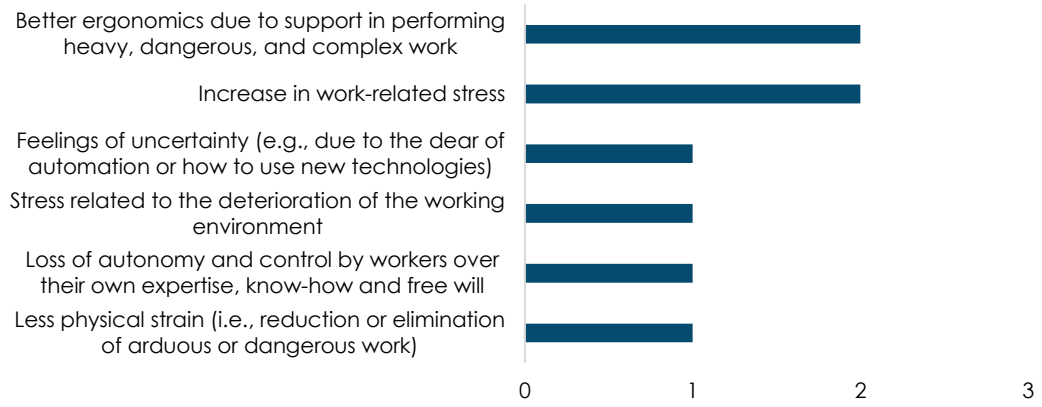
Figure 17. The most prominent changes to work organisation practices in the security sector as reported by CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

Two most pronounced occupational safety and health (OSH) effects of digitalisation in the sector illustrates both the opportunities and risks of digitalisation for workers (see Figure 18). On one hand, digitalisation can lead to better ergonomics due to support that digital tools and machines provide workers for performing heavy, dangerous, and complex work. On the other hand, it can lead to higher levels of work-related stress, which can be rooted in job insecurity, higher demands, work intensification, constant use of digital technologies. Customs Officials Association (Tullivirkamiesliitto- Tulljänstemannaförbundet (TVML) (a CESI member) has highlighted another important risk that digitalisation introduces for workers in the security sector. It has explained that social media functions as a channel where employees can be harassed and bullied for their work. Such experiences can definitely affect workers' mental health as well as satisfaction with their job.

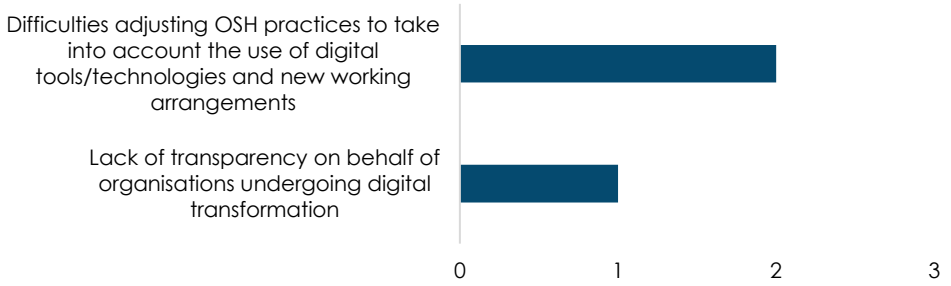
Figure 18. Key occupational safety and health effects of digitalisation in the security sector as reported by CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

The main barrier that hinders smooth changes in work organisation practices is *difficulties to adjust OSH practices* so they would take into account the use of digital tools/technologies and new working arrangements (Figure 19). One TU also indicated that *lack of transparency* on behalf of organisations in terms of what kind of technologies are used in the workplace and what data they might gather about workers is another barrier.

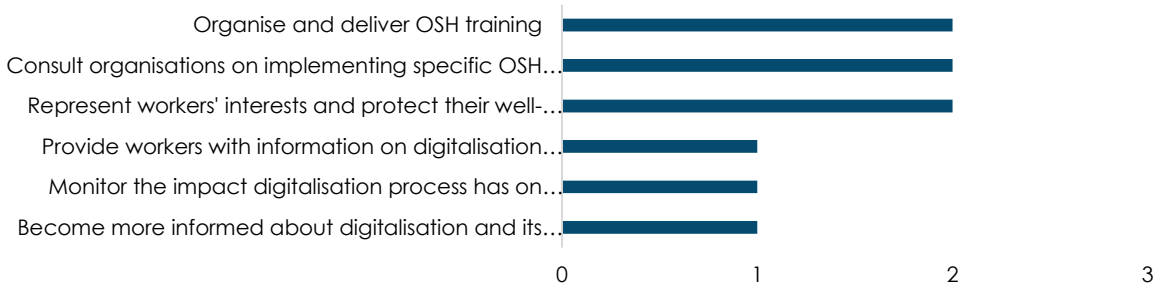
Figure 19. Main barriers to address the changing work organisation practices in the security sector as reported by CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

Trade Unions from the security sector believe that they should *provide workers with information* on digitalisation, *monitor the impact* that digitalisation has on work organisation and *represent workers' interest through social dialogue and collective bargaining* (Figure 20). These measures were selected as the main way to support workers through digitalisation by two out of three CESI members.

Figure 20. The role of Trade Unions in addressing the changes in work organisation due to digitalisation as reported by CESI members

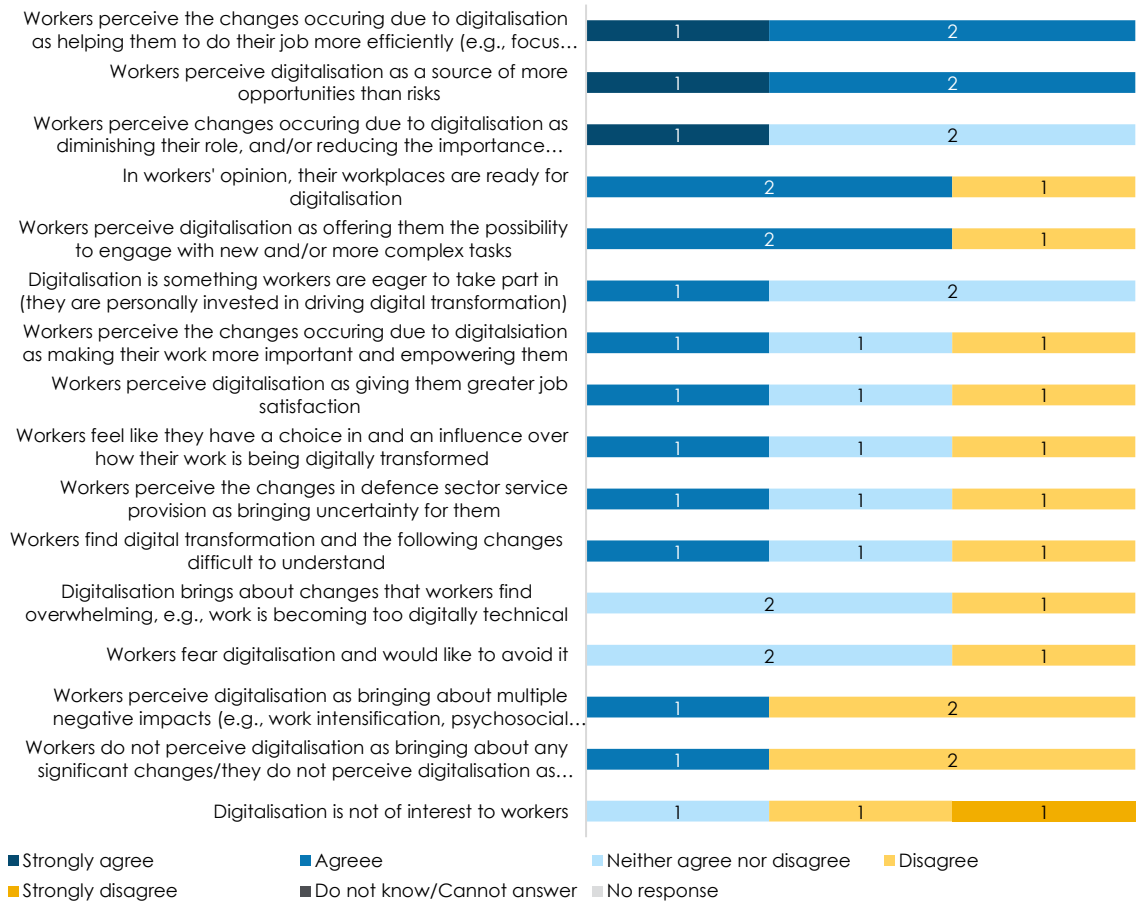


Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

2.4. Attitudes towards digitalisation in the security sector

CESI members agree that workers see digitalisation positively, as a source of more opportunities than risks (Figure 21). CESI members believe that workers in the security sector appreciate digitalisation as a way to make their work more efficient and be able to engage in new tasks. According to CESI members, workers that they represent think that their workplaces are ready for digitalisation. Workers in the sector seem to be interested in digitalisation and understand that has significant impact on their work (although one TU disagrees).

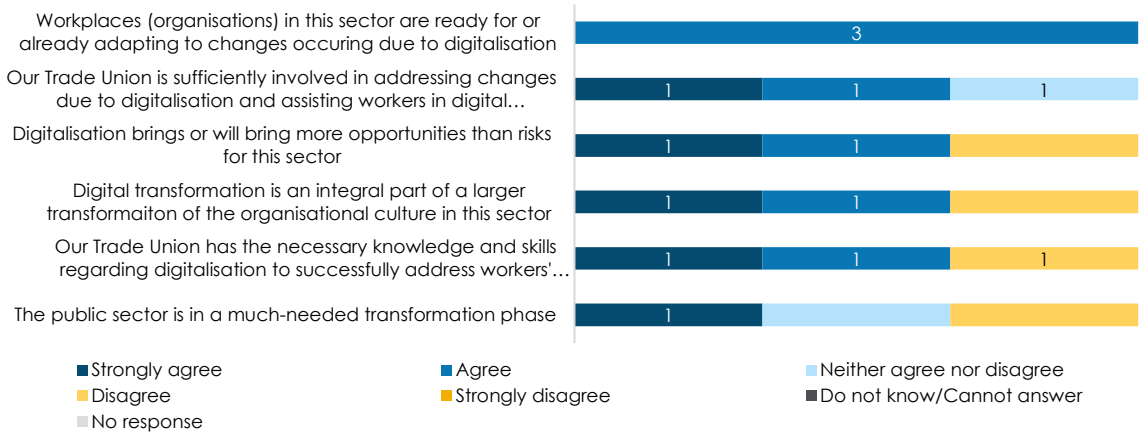
Figure 21. Attitudes of workers in the security sector according to CESI members



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

All CESI members that answered the question believe that organisations in the security sector are ready to adapt to digitalisation (Figure 22). Two out of three CESI members agree that as Trade Unions they are sufficiently involved in supporting workers through digitalisation and that they have the necessary knowledge and skills to do that. Two TUs agree and one disagrees that digitalisation will bring more opportunities than risks for the sector and that is an integral part of a transformation of the organisational culture.

Figure 22. CESI members' attitudes to digital transformation in the security sector



Source: Visionary Analytics, 2021. CESI Members' survey on digitalisation of the public sector, N=3.

3. Annex III: digitalisation in transport and manufacturing

This is a brief overview of the key findings about digitalisation and its impact on workers in the three trade unions representing workers in transport (Autonomous Train Drivers' Unions of Europe (Autonome Lokomotivführer-Gewerkschaften Europas (ALE) and Air Traffic Controllers European Union's Coordination (ATCEUC) and manufacturing (Autonomous Trade Union Organisation of Steelworkers (FISMIC).

ALE represents train drivers specifically from 13 European countries, around half of whom are from private sector. ATCEUC is a professional union representing engineers, as well as air traffic controllers (ATCs) who are responsible for the safe flow of air traffic in the air traffic control system. These workers work from air traffic control centres or control towers, giving clearance for take-off of aircrafts, monitoring the position, speed, altitude of aircraft in the airspace that they are responsible for using the radar and giving direction to the pilots. FISMIC is a trade union affiliated to CESI's member CONF.S.A.L. and it represents steel manufacturing workers from the private sector in Italy. The chapter summarizes key findings from the interviews with the representatives of the three organisations.

3.1. Main digitalisation trends and developments

For train drivers the main signal of digitalisation is the use of digital tools and systems that support them in their work. A key development as explained by ALE is the fact that instead of physical books or paper documents that are necessary for their job, they are using tablets which contain all this information in a digital form. ALE explained that train drivers have a book of rules which they must consult when an unexpected situation occurs or when they forget what is the safe and correct way to act in different situations. To consult this book or keep themselves informed about the current situation of different tracks in the train stations is a few functions for which train drivers rely on tablets now.

There are also many different tools that support drivers in driving the train. For example, traditional signalling systems (i.e., fixed line side equipment that looks like road traffic lights) are replaced by in-cab signalling systems. In practice this means that a digital system monitors the conditions of the tracks, the speed and positions of trains and safe braking distances and advises the driver on how to control the train in a safe way, usually by providing target speed. The train's brakes are applied if the driver does not follow the advice. There are other tools like sensors that collect data on braking or temperature that are essential for train drivers to do their job.

New digital tools are replacing analogue tools and mechanisms in the work of air traffic controllers. The key tools used to carry out the job of air traffic controllers is a radar via which workers receive all the information necessary to guide the aircraft and a radio (push-to-talk radiotelephony system) via which they communicate this information to pilots. The aircraft controller's job has been digitalised in 1970s-1980s when analogue radar systems started being replaced with more sophisticated radars and complemented by the use of computers, who would calculate the position of aircrafts based on the signals and provide controllers with highly accurate calculations allowing them to handle hundreds of thousands of aircrafts. Another related development was emergence of Controller Pilot Data Link Communications (CPDLC) as a means of communication between controller and pilot. It allows ATCs to communicate with pilots via keyboard instead of voice communication. A related development was a replacement of paper flight progress strips which ATCs used to track a flight. It has been supplemented by technology and in some cases replaced by computer displays (i.e., electronic strips displayed on the radar screen).

Digitalisation in the automotive sector, particularly for steel manufacturers represented by FISMIC entails changes in work processes. For the steel manufacturers digitalisation has started a few years ago with the adoption of robots that could help workers with lifting heavy weights and the mechanisms that would rotate the cars that were being manufactured. Manufactures use iPads to control robots. White-collar administrative staff has also experienced changes in terms of using digital systems for car off selling and promotion. Another important development is the new ways workers communicate with each other through digital means.

The pandemic had accelerated the use of digital training for train drivers and air traffic controllers. However, all interviewees noted that there were no significant changes to the work of air traffic controllers, train drivers or manufacturers, as workers in these industries cannot conduct their work tasks remotely. On the other hand, white collar administrative workers in these sectors shifted to teleworking. ATCEUC also noted that there are projects experimenting with virtual centres, i.e., closing a centre in one country and having a controller from another country supervising its flights. It noted the issues of legal nature that arise with such practices, suggesting they might be problematic.

3.2. Impact on workers' skills

In terms of skills, workers in specific industries need specific technical skills for operation of digital tools or systems that are relevant in their work. These skills are developed through trainings. For example, initial training for newly recruited train drivers covers all the skills that drivers might need. These skills include digital competence to use digital tools, such as the tablet. In Spain, every two years each train driver must have three days of training to update their knowledge of rules that apply and consider any new developments. This is especially necessary for drivers that usually drive one kind of trains (e.g., high-speed trains) and might forget specifics of controlling a freight train or a commuter train. ATCEUC also explained that trainings on how to use new systems are implemented in order to ensure their safety.

Trade unions mentioned the decrease in demand for certain skills due to adoption of ICT tools for work. ATCEUC explained that there has been a decrease in demand for mathematical skills of air traffic controllers, as they now rely on digital systems to calculate the time it takes for an aircraft to fly from one point to another. It was something workers had to do themselves before the adoption of digital systems. ATCEUC also mentioned difficulties that workers had encountered when switching to more digital tools. When computers had started to be applied for their work, some workers, especially older ones, did not know how to use a keyboard because they never had a computer before.

Digitalisation is also associated with deskilling. ALE also touched upon the topic of **deskilling** of workers when referring to current European Commission initiative to introduce digital translation devices for cross-border train driving. As of now, train drivers are required to have at least B1 level of proficiency in any language of the countries they are passing through. This is to ensure that in case of any accidents train drivers are capable to communicate and ensure the safety of the train, goods, and passengers. If digital devices would be introduced, workers would likely no longer need to practice their language skills, which is an example of how deskilling can happen in the transport sector. In a similar vein, ATCEUC explained that over reliance on digital tools for essential calculations can lead to situations where if systems malfunction (e.g., GPS offsets the location of aircraft), workers would not be able to respond to the challenges.

As the functions of workers might change, a change in skills requirements can be expected. With a look to the future, ALE mentioned that with the potential of autonomous driverless trains, workers would hold a supervisory role, supervising the systems that operate the train and solving problems that occur in unexpected situations which digital systems cannot address. This points to the importance of train drivers developing problem-solving, supervision skills, as well as attentiveness.

In a similar vein, due to changes in work organisation, FISMIC has noted that workers need soft skills such as leadership, communication, coordination, team working, and autonomy in

decision-making. This is a result of more teamwork that is required in manufacturers' work today.

Digitalisation has an effect on the training of workers. Digitalisation has affected how training is conducted for train drivers as well as air traffic controllers. ALE explained that various digital tools are used to give training to new drivers as well as to retrain workers on different unexpected conditions. It was noted that not all countries have access to more advanced technologies and simply use a computer and a screen for these trainings. Spain, on the other hand, has access to very advanced simulators which allows trainees to train in a very real environment and makes the training more effective. ATCEUC also mentioned that during the pandemic they have developed training courses for newly recruited air traffic controllers that allowed them to practice from their home. This was also useful for current workers as well, as ATCEUC noted it was important to keep workers practicing their skills to not forget how to control normal flows of air traffic which has been reduced by 70% during the pandemic.

In terms of train drivers, these digital trainings have been the main way drivers were trained during the pandemic and therefore made some workplaces think of using it as a long-term measure to provide all the trainings in a digital way. However, ALE explains that while digital training is useful to prepare workers for unexpected situations, it should not become the main way that people who are new to the profession are trained to become train drivers. The initial training of driver-to-be should involve real-life experience where they are taught by experienced professional drivers and not in virtual simulations. Digital tools used for training introduces the risk of trainees missing invaluable lessons that they can only learn from their teachers and not getting the most valuable feedback.

FISMIC emphasises the need of workers to be trained and informed on the digital tools that they are expected to use for their work. To this end the trade union organises the trainings itself (see Box 3). The trade union also highlighted that the training organised by companies is not sufficient as they approach it as a one-off event rather than a continuous professional development, which is necessary to keep up with the speed of digitalisation.

Box 3.Good practices of FISMIC related to developing digital skills and embracing digitalisation

FISMIC organises trainings and courses about digitalisation and the use of digital tools to develop skills of workers in a more systematic way. This is part of the bilateral agreements that FISMIC and its member unions has with companies. These bilateral agreements make sure that the company and the trade unions facilitate and promote the training of workers. Each company that is a signatory of the agreement pays a percentage for each worker that funds their training. Entities accepted by the government conduct the training. The key topic of these trainings is security. FISMIC also conducts courses for its member organisations to raise awareness about digitalisation, i.e., what it means, and courses on the use of simple tools, e.g., Zoom. Member organisations attend these trainings actively. FISMIC conducts these trainings itself from the funds of the various projects, FISMIC also organises workshops and public events with universities of company representatives that focus on more specific use on certain tools.

FISMIC uses an electronic bulletin board to streamline its communications to its member organisations and workers they represent. Electronic bulletin board allows workers to log in and share, request, or discuss information, any documents. The bulletin board was useful during the pandemic to inform manufacturer workers, who had been at home and not working, about any updates on the situation. It was a way for trade unions to make workers feel less isolated and more connected during the pandemic. Trade unions use the forum to post any information related to covid-19 or any relevant documents or information about the agreements that they made with companies and that workers should be aware of, to name a few.

Source: Visionary Analytics, 2021. DiWork study interviews with CESI members on digitalisation of the public sector.

3.3. Impact on work organisation

Respondents have discussed the changes in work organisation practices due to digitalisation. The following are the key benefits and risks related to digitalisation that were observed by ALE, ATCEUC and FISMIC.

OSH benefits. Train drivers used to carry with them the bag full of documents that are necessary for their work which is no longer necessary because of the convenient access to this information via tablets. This reduces the physical strain on workers as they no longer have to carry weight on their backs. Another way digitalisation has improved OSH of workers has been the use of sensors placed outside the train to gather data necessary for the operation of the train. This means that workers do not need to go outside their cabin in difficult weather conditions, for example, increasing their levels of comfort at work, reducing risks of health issues and contributing to more efficiency. However, ALE also brought up the right of workers to retire which can be impacted by digitalisation. As use of ICT makes workers' job easier, it can revoke train drivers' right to early retirement due to assumptions that they are now working in more comfortable workplaces and do not need to retire earlier.

FISMIC explained that digitalisation can reduce the physical strain of work on manufacturers, as robots are helping workers to lift heavy weights. Similarly, the mechanisms that rotate cars prevent workers from staying in discomfort for too long while working.

ATCEUC noted that no changes regarding OSH due to digitalisation can be observed. The very nature of the job dictates it can be stressful as it involves large responsibility while on duty. Nevertheless, ATCEUC noted the levels of stress for workers are not strongly related to digitalisation, unless in times when digital tools malfunction.

More effective work. Train drivers need to navigate through a large amount of information making it difficult to find what they need in a certain situation fast. As they can access this via tablets the navigation becomes much more effective and drivers can find what they need faster, making their work more efficient. For ATCs, digitalisation allows them to control more aircraft than before although the number of workers remains the same, illustrating how digitalisation can increase effectiveness of work.

New roles/functions. When talking about the possibility of automated driverless trains, ALE mentioned that train drivers would still be present in the cabin but supervising instead of driving the train. The human drivers would be necessary to address incidents on the rail or unexpected situations.

Job loss. Digitalisation can potentially lead to the disappearance of the occupation, considering that technological advancements already place driverless metros and light rail on the market. However, workers in the sector are not ready for technology to take over their roles as concerns over the safety of passengers remain. In this same vein, ATCEUC referred to their works changing because of the potential of pilotless planes. The trade union expressed concerns over such potential developments, but it noted that job loss that has occurred in the past was not a result of technological advancements.

Miscommunication. The example of using digital translation tools for cross-border trains to communicate with infrastructural managers in case of accidents also illustrates how digitalisation can be dangerous. ALE explained that there is a need to consider difficulties that workers would encounter with using this tool, including the risk of miscommunication if the tool malfunctions or is not able to translate the message accurately. This can lead to serious safety issues.

Safety issues. Another risk of digitalisation comes from automation. ALE reported that as train driving becomes increasingly more automated, drivers can feel less engaged, bored, reducing their levels of attention, which could lead to safety accidents. ATCEUC noted the grave safety and health risks that would be a result of replacing air traffic controllers with automated systems which would render their role unnecessary. ATCEUC has referred to the potential problems when using artificial intelligence for work. The work of air traffic controllers is strictly regulated, they have letters of agreements with each aircraft which contain such rules as at what height the aircraft should be at a certain point since take off. ATCEUC explained that due to their expertise and skills, sometimes controllers make an autonomous decision to deter from these agreements if they see that they can guide the aircraft in a different, safer way. Computer would not do this as it is steered by parameters.

Efficiency losses. ATCEUC explained that implementation of any new systems can hinder air traffic controllers' work at first, as it takes time to get used to any new systems. This means they cannot work as effectively as they used to for a time being. Lack of user-friendliness and lack of involvement of the end-users (controllers) when developing new digital systems was mentioned as a barrier to the efficient work of air traffic controllers. ATCEUC have an example of a system which failed its pilot because it simply was designed to alert air traffic controllers using a multitude of colours, which would distract and confuse them.

Invasion of privacy. ALE has explained that in some European countries, drivers are monitored via cameras that are installed inside the cabins. While this can be beneficial in case of accidents or incidents, it risks invading workers' privacy.

Cybersecurity. ATCEUC has explained that their main concerns with digitalisation of work is cybersecurity. Today their system is a closed system and there are no connections from the outside except the radio transmissions and in the case of CPDLC where people have access. But all other data (flight plans, messages related to emergencies) are transferred in the closed ATC system which prevent everyone form breaking in. ATCEUC questions how safe can the newly developed systems be.

3.4. Attitudes towards digitalisation

In general, **trade unions acknowledge the benefits that digitalisation can bring for workers, but also remain conscious about the negative implications**.

ALE believes that workplaces are ready for digitalisation. The trade union itself has expressed positive attitudes towards digitalisation, acknowledging its benefits for train drivers, namely how it can make their day-to-day work easier, more comfortable, and safer. But it remains realistic about the negative effects digitalisation can have for train drivers, specifically referring to the possibility of technical advancements rendering the occupation of train drivers unnecessary. Resistance to being replaced by a machine can be observed in the discourse of ALE as well. However, ALE explained that creation of automated trains and especially infrastructure required for them is an expensive and difficult process, which is more likely to yield results in the far future than today. ALE is also concerned about the losses of relying too much on digital training when preparing new train drivers. Finally, it stresses the concerns related to digitalisation that can affect the safety of work.

ATCEUC has also noted that rather than being a hazard, digitalisation can assist workers, specifically referring to digital systems increasing workers' capability to control more aircraft because of automation. The trade union approaches digitalisation with a positive attitude as well. However, it also notes that there are concept-related difficulties regarding digitalisation, as there is no unified understanding on what it entails and what it means. Importantly, ATCEUC had also expressed its concerns that digitalisation is about replacing air traffic controllers who would no longer be necessary. The trade union explained that workers do not support such approach.

Importantly, ATCEUC stressed the importance of workers being involved in the development stages of digital systems that they will be the end-users of. This is essential to ensure that these systems are designed to meet the needs of the workers rather than developers or other stakeholders. For example, a highly user-unfriendly ATC system was implemented in Poland, where a controller had to work with multiple screens displayed around the central screen, and use two keyboards and multiple computer mice.

FISMIC acknowledges that digitalisation makes the working life for workers easier, however it noted that the process of digitalisation has not been easy for companies, especially small manufacturing companies that had to adapt to the rush of creating digital products. The trade union believes that digitalisation is a positive development if managed well, i.e., if workers are trained and informed each step of the way. One of the key concerns of FISMIC is poor infrastructure in the sector that is necessary for companies to digitalise.

Trade unions are involved in various advocacy activities that related to digitalisation. Workers' representatives making effort through social dialogue to advocate for better and fairer rules that would apply to workers is imperative, especially in times of digitalisation, as explained by ALE (see Box 4).

Box 4. Good practices of trade unions representing workers' interest through advocacy

In its attempt to highlight that smart working should be voluntary and not imposed on workers, FISMIC is engaged in social dialogue with the government as well as concluding company agreements on the topic. The aim of these actions is to ensure that workers have freedom to choose when to telework and are not forced to do it. FISMIC noted that the regulation of smart working is difficult to do at the national level and needs to be tailored for specific companies, meaning that company agreements might be more effective in safeguarding workers' interest. The agreements also focus on the right to disconnect of workers.

ALE is present in different work groups of the European Union Agency for Railways (ERA) which develops the rules for the industry to be applied at the European level. ALE acknowledges that it is important for trade unions as the main representatives of workers to provide feedback of workers to such policy-making bodies. For example, it is now working with the specific working group within the ERA which is concerned with European Rail Traffic Management System (ERTMS), which helps drivers to drive high-speed trains. The working group is developing the system in Europe and digitalisation is present in the discussion. ALE is also now working on the revision of the Train Driver Directive with the EC and different stakeholders.

On its behalf, ATCEUC is engaged in discussions with the European Commission and the Parliament regarding the changes in the licensing and training of controllers. ATCEUC is trying to prevent regulation that would reduce the training time of air traffic controllers.

Source: Visionary Analytics, 2021. DiWork interviews with the CESI members on the digitalisation of the public sector.

ALE notes that it can get difficult for trade union organisations that represent multiple trade unions to fairly represent everyone's' interest at negotiations at EU level, given the diversity of interests and concerns of different trade union members and their workers.

4. Annex IV: digital technologies used in the education and training sector

Table 1. Key digitalisation developments in education and training sector

Digital practice	Definition and examples
Use of basic digital tools (e.g., computers)	The practice of using computers during lessons to look up ideas and information has spread quickly over the past decade in education. Students are using computers to practice their skills and procedures, writing stories and texts. The access to computers in schools is very high, with 80% of students having access to computers in secondary school, and increasing number of students having access to laptops (a possible substitute to desktop computers).[11] The use of computers by students had spread in science, reading and especially mathematics, where the share of students using computers during lessons in maths increased from 3% to 31% in primary education, and from 5% to 23% in secondary education.[12]
Mobile learning	Use of mobile devices like smartphones and tablets for learning and teaching has been on the rise. It is further encouraged by Bring Your Own Device (BYOD) policies in schools.[13]
Online learning resources and courses	Teachers can access learning resources (e.g., single pieces of content or full online courses) that can be used in formal and in-formal settings for learning. Educators can find, copy, use and adapt and share open educational resources (OER) and open courseware (OCW) to support education.[14] Massive Open Online Courses (MOOCs) that emerged in 2012 and opened up education for students that face entry barriers, and facilitate a richer remote learning environment are at the centre of online learning tools.[15] Increasingly common are informal and self-learning opportunities offered and promoted by social networking sites (e.g., LinkedIn, Twitter, Microblog, Facebook).[16]
Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR)	AR/VR/MR innovations can be used to innovate teaching and learning and increase learners' motivation and retention. [17] Technologies that can simulate reality are increasingly popular in the sector, especially in VET schools and such courses as tourism, healthcare, engineering, architectural design (e.g., in machine and heavy equipment simulators).[18] Three-dimensional (3D) models (e.g., of equipment, machines, solar systems, human body) are used to deepen the understanding of students, as well as to simulate real workspaces where students can develop their skills in a controlled environment.[19]

[11] Vincent-Lancrin, S., Urgel, J., Kar, S. and Jacotin, G. 2019. Measuring Innovation in Education 2019: What Has Changed in the Classroom?, Educational Research and Innovation, Paris: OECD Publishing, 28.

[12] Vincent-Lancrin, S., et al. 2019, 28.

[13] ET 2020 Working Group on Vocational Education and Training (VET), 2020. A report of the ET 2020 Working Group on Vocational Education and Training (VET). Eight insights for pioneering new approaches. Luxembourg: Publications Office of the European Union, 58

[14] ET 2020 Working Group on Vocational Education and Training (VET), 2020, 51-52; Braun, A., März, A., Mertens, F., Nisser, A., 2020. Rethinking education in the digital age. European Parliament. Brussels: Publications Office of the European Union.

[15] ET 2020 Working Group on Vocational Education and Training (VET), 2020, 53; McGill Association of University Teachers, N/A. "A Brief History of MOOCs". https://www.mcgill.ca/maut/news-current-affairs/moocs/history#:~:text=The%20term%20MOOC%20was%20coined,and%20Connectivity%20Knowledge%20in%202008. ; Kumaari, P., Naaz, I., 2020. Digital learning through MOOCs: Advantages, Outcomes & Challenges. *UGC Care Journal* (42)4. https://www.researchgate.net/publication/348187317_Digital_learning_through_MOOCs_Advantages_Outcomes_Challenges

[16] ET 2020 Working Group on Vocational Education and Training (VET), 2020, 54.

[17] Ascione, L. 2018. "Virtual reality could help students remember better, new research says". ESchool News. https://www.eschoolnews.com/2018/07/17/virtual-reality-research-remember/

[18] ET 2020 Working Group on Vocational Education and Training (VET), 2020, 60; Braun, A., et al., 2020.

[19] ET 2020 Working Group on Vocational Education and Training (VET), 2020, 64.

Digital practice	Definition and examples
Artificial Intelligence (AI) and learning analytics	AI and (predictive and behavioural) learning analytics are significant part of digitalisation which allows to collect and analyse learner-related data and personalise learning experience, as well as to direct student attrition. [20] AI technology can be used for: [21] • learning analytics, i.e., evaluating students' performance by collecting and analysing data about learners; • personalisation of learning content, i.e., giving students tasks based on their personal level of performance and learning behaviour • monitoring of learners' behaviour, i.e., via facial recognition technology that monitors students' attention. For example, AI technology Lexplore combines eye tracking and AI to determine a student's reading level, allowing teaching to access data for intervention.[22] Currently, AI is most used in the form of video-connected AI systems in classrooms, whereas collected data is complemented with data from social media and Internet of Things (IoT) platforms. [23]
Digitalisation of examinations and digital assessment processes	Internet access can be allowed in examinations and Smart Exam Portals and remote proctoring platforms are increasingly more popular to ensure the fair examination of students. There is a growing to use of ePortfolios for formative and summative assessments, as students can gather transcripts, recordings or any documents proving their achievements.[24] The processes of validation and certification is digitalised as well with the dawn of digital credentials (e.g., open badges). For example, the new Europass entails free tools and services that enable education and training institutions to issue digital credentials proving that the person has been awarded a qualification, making the process of verification faster and easier. **Blockchain** (a decentralised database for transactions between parties that records every change and is accessible from everywhere) plays an important role in the digital certification process, and its application is at the infancy but quickly picking up steam in education. [25] Blockchain can be used not only for certification, issuance and recognition of degrees, but also for tracking of academic content and work, management of payments and cash flows such as tuition fees.[26]

[20] Bright, J., Ganesh, B., Seidelin, C. & Vogl, T., 2019. Data Science for Local Government. Oxford Internet Institute, University of Oxford. Available at: https://smartcities.oii.ox.ac.uk/wp-content/uploads/sites/64/2019/04/Data-Science-for-Local-Government.pdf

[21] Braun, A., et al., 2020, 22-23.

[22] Lexplore Sweden, (n/a). "How it works". *Lexplore*. www.lexplore.com/how-it-works/technology/

[23] Tuomi, I., The Impact of Artificial Intelligence on Learning, Teaching, and Education, Cabrera Giraldez, M., Vuorikari, R. and Punie, Y. editor(s). Luxembourg: Publications office of the European Union. https://publications.jrc.ec.europa.eu/repository/handle/JRC113226

[24] ET 2020 Working Group on Vocational Education and Training (VET), 2020, 65

[25] Grech, A. and Camilleri, A. F. 2017. Blockchain in Education. Inamorato dos Santos, A. (ed.). Luxembourg: Publications office of the European Union. Available at: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC108255/jrc108255_blockchain_in_education%281%29.pdf

[26] Grech, A. and Camilleri, A. F. 2017.

5. Annex V: digital technologies used in the health services sector

Table 2. Examples of digital solutions used in healthcare sector

Digital solution	Definition and examples
Electronic Health Records (EHR)/ Electronic Patient Files/ Electronic Medical Records/Electronic Patient Records	Electronic Health Record refers to recording, collecting, and storing patient and population health information digitally. It is a medical record or similar documentation of the past and present physical and mental state of health of an individual in electronic form. [27]Examples of EHR systems include Kanta Services in Finland (launched in 2010), which acts as a national health infrastructure and centralised data archive, and includes EHR, ePrescriptions, imaging and other test data, electronic social care documents, personal health and well-being records; National Health Information System in Estonia established in 2008, as well as the national patient portal Digiulugu.ee, which allows citizens to see their health records. EHRs are at the core of healthcare digital transformation, and are the most frequently used digital health technologies. The adoption of EHRs increased in all EU MS since early 2010s, and it is now fully available across EU MS with some countries having adopted it in full. For example, In 2020, eHR was used by 81% of surveyed clinicians in seven European countries. The score for EHR adoption in the EU in 2018 was 3.196, an increase from 2.989 in 2013. Currently the EHRs across Europe offers a wide variety of capabilities, and EHR often include systems allowing ePrescribing and eAppointment. The landscape of EHR is fragmented, considering that just a few countries ensure the system is interoperable and coordinated. Some EHR systems exist within a certain facility, others can be used across different healthcare facilities, some can only be accessed by patients, while other by one healthcare professional or across all healthcare professionals involved in a patient's care. Estonia and Finland are the most cited examples of successful EHR systems nationwide, while countries like Denmark or Belgium use different EHR systems in different regions highlighting the problem of lack of interoperability. Indeed, many countries have issues with linking their national health datasets, meaning that patients have to repeat information about their care through the health system and workers do not have readily available information at the right time.
E-prescribing/ online prescription	Centralised paperless systems for issuing and handling medical prescriptions. Examples include ePrescription systems in countries like Estonia, Finland, Slovenia, and Portugal. **E-prescriptions** were used by 62% of surveyed European clinicians in 2020. Shares of prescriptions that are prescribed digitally are overall high across EU MS. For example, in 2018 92% of all prescriptions in Slovenia were digital, and 98% of those in Estonia). [28]
Online appointment booking	Online appointment booking is the use of digital technologies/patient portals to digitally register and manage, schedule, pay, reschedule and cancel ambulatory appointments and order SMs or e-mail reminders. Examples include Samedi German booking platform, Doctolib software used in European countries, eRegistration service in Estonian hospitals, e-sveikata in Lithuania. Online appointment booking was used by more than a half (54%) of surveyed clinicians. eAppointment or eRegistration systems across EU MS allow patients to see available date for an appointment, waiting times and other relevant information about service providers, and register.
Mhealth including apps for clinicians	mHealth or mobile health refers to the use of smartphones, tablet computers, wearables (e.g., smart watches) where health apps and sensors can be used. It also refers to the use of mobile devices that are used specifically by healthcare providers to provide services and collect data (e.g., portable monitoring systems). Apps for clinicians were rather popular among clinicians in Europe in 2020 (51% of respondents used them). These applications allow clinicians to access patient information across multiple systems. Apps for clinicians: This category of digital health solutions include such mobile apps as Luscii, originally launched in Netherlands but extending its services to other European and African countries. The app can be used for patients to input their vital signs data, which is then processed by AI

[27] European Commission, 2008. Commission Recommendation of 2 July 2008 on cross-border interoperability of electronic health record systems (notified under document number C(2008) 3282). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008H0594

[28] ESPON 2019. eHealth- Future Digital Health in the EU https://www.espon.eu/eHealth, 48.

Digital solution	Definition and examples
	algorithms to inform clinicians when patients need medical attention. Patients can access information on how to cope with their condition and communicate 24/7 with their care professionals via the app. The app is prescribed by doctors and nurses.
Telehealth or telemedicine	Telehealth refers to the provision of remote access to clinical healthcare support, professional and public health education and health administration, using electronic information and telecommunication tools. Services that can be adapted to telehealth include tele-ICUs (intensive care units), tele triage (i.e., screening patients remotely (via web or apps, phone calls, video interfaces) to determine the patient's condition and the care needed). Fully virtual care facilities exist, where medical advice and provision is given remotely through telecommunication technologies (e.g., Mercy's Virtual Care Centre).[29] A good practice of Denmark tele-medical ulcer assessment programme: the nurses see ulcer patients in their homes and take photos of ulcers which they upload to a journal accessible from a cell phone or tablet. In that way they communicate with the hospital and the hospital can assess the ulcer without seeing the patient. Nurses' experiences were positive as they believed digitalisation would lead to "job enrichment and employee satisfaction".[30] Telehealth refers to digital solutions that allow monitoring, prevention, treatment of patients at a distance, allowing to relocate services from physicians' offices and hospitals to patient's homes (it often includes mHealth). The availability of telehealth facilities is high in Europe but they are mostly used for administrative purposes (e.g., meetings, training, and staff education) and its use for clinical purposes is increasing from a low base. For example, in 2018 48% of surveyed European GPs used telehealth for training/education, 19% used it for consultations with other healthcare practitioners, whereas only 9% used telehealth for consultations with patients, and only 4% used it to monitor patients remotely. Denmark and Estonia demonstrate the highest level of telehealth adoption with the former providing advanced telehealth services (e.g., tele monitoring for COPD patients, home monitoring for women with pregnancy complications). Most of the GPs reported being aware of these functionalities but having no access to it. Recent OECD study reinstated that the use of telehealth (as well as mHealth) solutions is limited to exceptional circumstances (e.g., small-scale, local or pilot projects, targeting only certain groups of people). It also includes 'virtual health assistants', certified online chatbots providing basic health check-ups to patients at any time based on their answers about symptoms.
Rostering	Digital systems can be used to manage staff rotas and patient flow.[31]
Automation of pharmacies/drug dispensing	Robotics and pill counters are the most common forms of automation of pharmacies, allowing pharmacies to streamline workflows and reduce the risk of errors. It boosts prescription volume and efficiency.[32]
Point of care (POC) diagnostics	Digitalisation of laboratory and POC platforms, including lateral flow rapid diagnostic test results can improve access to diagnostic services and overall patient management.[33]
Self-tracking (or body tracking) via patients apps/ health apps/	Wearables, implantable devices, mobile applications, any monitoring equipment including portable devices that can be used to track and maintain one's health. Digital technologies are used to measure fitness and health improvement goals (e.g., exercise, diet, weight, sleep), monitor health issues(e.g., blood sugar, blood pressure, breathing functions, mood), receive alerts or reminders to take

[29] Mercy Virtual, N/A. "Delivering Care Wherever Its' Needed", https://www.mercyvirtual.net/about/
[30] Lethbridge, J. 2015. Digitalisation of local authority services in Europe. A briefing paper commissioned by EPSU/ CEMR.
[31] Nursing Times Innovations, 2019. "Using digital tools to improve staff rostering and patient flow". https://www.nursingtimes.net/clinical-archive/healthcare-it/using-digital-tools-to-improve-staff-rostering-and-patient-flow-10-06-2019/
[32] Infowerks, 2020. "The Role of Pharmacy Automation in the Healthcare Ecosystem". https://infowerks.com/pharmacy-automation/
[33] Gous, N, Boeras, DI, Cheng, B, Takle, J, Cunningham, B, Peeling, RW, 2018. The impact of digital technologies on point-of-care diagnostics in resource-limited settings. *Expert Rev Mol Diagn.* 18(4):385-397. doi: 10.1080/14737159.2018.1460205.

Digital solution	Definition and examples
wearables also called Quantified-Self movement	medicine, measure, records, or send data about medication they are taking, order a repeat prescription.[34] Examples of apps for patients include Google Fit, Mi Fit, Noom, the ECG App.
Remote vital sign monitoring	Wearable devices can be used to monitor patients' vital signs. Such devices include patches, clothing based monitors, chest straps, upper arm bands, wristbands and others. The most common application of these tools is for heart rate monitoring and the least common for blood pressure and oxygen saturation monitoring. [35]
Automation of other clinical tasks	Automation of usual hospital care activities such as blood sugar metering, medical examinations, automation of history taking and medical diagnosis. This includes solutions that assist personnel in hospitals. An example is eTriage system in Slovenia, which assist medical personnel in cases of large numbers of incoming patients by identifying those who cannot wait safely and need urgent treatment.
Robotics	Care robots and medical robots are already in use. Robotics and automation are used in health for coding, diagnostics, discharge processing, outpatient clinic outcomes, payment tracking.[36] For example, in Germany robotically assisted surgery is used in laparoscopic surgery, where the surgeon controls tools electronically improving the accuracy of the operation and the speed of patient recovery. Robots are also already used in nursing care (and are planned to use for such functions as bathing and toilet assistance).[37]
Genomics data (storing or using)	Genomics provides information on what kind of health conditions the person is prone to develop. Demand and supply for genetic profiles is increasing and genomics data can improve data-driven, personalised care. Genetic information is integrated only in rare disease diagnosis and cancer screening but is not integrated into routine medical care.[38] Genomics accelerated through AI can help to track pathogens and viruses and identify factors that increase individual's susceptibility or resistance to them.
Radio Frequency Identification tags (RFID)	Healthcare providers use RFIDs that are attached to people or objects and provide identification, tracking, security, and other functions that fall under the general heading of automatic identification and data capture (AIDC).[39] RFID technology automatically identifies and tracks people and object and is therefore useful in solving such healthcare system problems as lack of information and access, patient tracking, long waits at hospitals, inventory management, medication errors, and management of parking.[40]
AI technologies	According to DESI, human health sector is one of the leaders in adoption of AI technology.[41] AI can use the large amounts of health data to improve diagnosis, select treatments and predict clinical outcomes, offering customised decision support for clinicians. AI technologies are used for medical diagnosis and treatment. .AI has the potential to improve the efficiency of health-based detection tasks, diagnosis, select treatments and predict clinical outcomes. It can identify unknown patterns in data, helping to improve the accuracy of administrative or clinical decision making, better allocate resources, anticipate risks, enhance biomedical research and drug discovery, predict the spread of communicable diseases. AI can be used for image analysis (e.g., help examine X-rays, retina

[34] Betts, D., Korenda, L., 2019. A consumer-centered future of health. Deloitte.

[35] Soon S, Svavarsdottir H, Downey C, Jayne, D.G., 2020. Wearable devices for remote vital signs monitoring in the outpatient setting: an overview of the field. *BMJ Innovations(*6), https://innovations.bmj.com/content/6/2/55

[36] Barcevičius, E., Cibaitė, G., Codagnone, C., Gineikytė, V., Klimavičiūtė, L., Liva, G., Matulevič, L., Misuraca, G., Vanini, I., Editor: Misuraca, G., 2019. Exploring Digital Government transformation in the EU - Analysis of the state of the art and review of literature. Luxembourg: Publications Office of the European Union, 24.

[37] The Ministry of Economy, Trade and Industry (METI), 2017. Revision of the Priority Areas to Which Robot Technology is to be introduced in Nursing Care. Available at: https://www.meti.go.jp/english/press/2017/1012_002.html

[38] Muse ED, Torkamani A, and Topol EJ, 2018. When genomics goes digital. *Lancet (*16)391; Rehm HL, 2017. Evolving health care through personal genomics. *Nat Rev Genet* (18)4.

[39] N.A, 2005. Radio-frequency identification: its potential in healthcare. *Health Devices* 34(5).

[40] GlobalData Healthcare, 2017. "Radio-frequency identification technology in healthcare". Medical Device Network. Available at: https://www.medicaldevice-network.com/comment/commentradio-frequency-identification-technology-in-healthcare-5848545/

[41] European Commission, 2021. Digital Economy and Society Index (DESI) 2021. Thematic chapters. Luxembourg: Publications Office of the European Union

Digital solution	Definition and examples
	scans), genetic analysis (e.g., AI can draw insights from genome scans), pathology (e.g., AI had been proven to be able to analyse biopsy samples, but its clinical use is not approved yet), clinical decision-support (e.g., AI tools that can predict risks of unplanned hospitalisation). Despite this potential of AI, its use remains low among practitioners in Europe, and most applications are still in the development stage.
Predictive and behavioural analytics	Predictive and behavioural analytics are used in healthcare to predict the spread of disease, tailor interventions (e.g., personalised medicine). In eHealth Big Data refers to health datasets made up of large volumes of data generated at high speed from electronic medical records, mobile phones, social media text and pictures, videos.[42]
Blochchain	Blockchain is used in healthcare to safe and secure healthcare data management[43]
Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR)	The functionalities of AR/VR/MR- based applications for health range from surgery (e.g., for preoperative planning where 3D viewing can help specialist to assess the patient's condition before the operation), analysis and diagnosis (e.g., for the detection of diseases and disorders such as congenital heart disease, addictive disorders), learning in healthcare (i.e., allowing students to have a realistic artificial experience in a 3D operating room, practice true-life clinical procedures), to pain management (i.e., altering pain perception by distraction, focus shifting and skill-building), assistance for people with physical disabilities (e.g., aid for visually impaired or blind people by navigation support and obstacles avoidance), treatments & therapies for patients with mental health issues (e.g., using VR –based head-mounted displays for patients with psychiatric disorders, using VR for treating anxiety disorders).
Digital information sharing	Digital solutions that allow information sharing between patients and professionals and between professionals. Examples include eConsultation portal in Estonia (launched in 2013) which allows communication between family physicians and specialists, eReferral (launched in 2009) in Estonia used by family doctors to link their patients to the next level of care, ePatient system in Portugal, which allows communication between clinicians among other functions.
Drones	Used for medicine and blood deliveries.
Data analysis and new innovative uses of health data	Enabled by the availability of large pools of data related to patients as well as by technological advancements, allows service providers in the sector to adapt their services to users' needs and preferences, to improve patient involvement, to advance the communication between health professionals.
Participative/ participatory (crowd-sourced) medical research	Personal health data is a vital resource for medical research, which can help healthcare system to save and improve lives, reduce health inequalities and benefit society.[44] Data from Eurobarometer 2017 shows that only 21% of Europeans would be willing to share their health data for research purposes.[45]A more recent survey of public perceptions on health data sharing also found that willingness to donate the data is relatively low.[46]
Prevention solution(s)	An example is Telestroke solution in Slovenia, launched in 2015, it works via an audio-visual conference system and contributed to the successful treatment of stroke. As of 2018 the system covered the whole Slovenia and more than 2500 patients were treated.

[42] ESPON, 2019. eHealth-Future Digital Health in the EU. https://www.espon.eu/sites/default/files/attachments/Final%20report.%202019%2003%2025_final%20version_0.pdf, 5

[43] Abujamra, R., & Randall, D. 2019. Blockchain applications in healthcare and the opportunities and the advancements due to the new information technology framework, *Advances in Computers 115;* Siyal, A., Junejo, A., Zawish, M., Ahmed, K., Khalil, A., & Soursou, G. 2019. Applications of Blockchain Technology in Medicine and Healthcare: Challenges and Future Perspectives. *Cryptography,* 3(1), 3

[44] ALLEA, EASAC and FEAM, 2021. International Sharing of Personal Health Data for Research. Available at: https://easac.eu/fileadmin/PDF_s/reports_statements/Health_Data/International_Health_Data_Transfer_2021_web.pdf

[45] Eurobarometer, 2017. Attitudes towards the impact of digitisation and automation on daily life https://europa.eu/eurobarometer/surveys/detail/2160

[46] Middleton, A, Milne, R, Almarri, MA, et al., 2020. "Global public perceptions of genomic data sharing: what shapes the willingness to donate DNA and health data?" American *Journal of Human Genetics 107*.

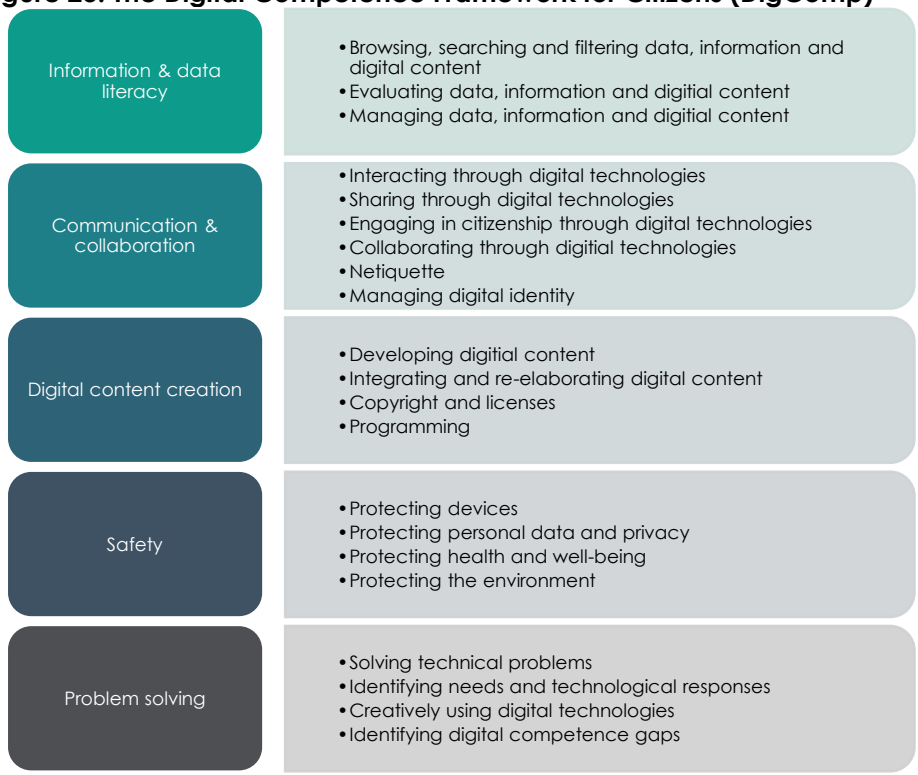
Digital solution	Definition and examples
Health information exchange (HIE)	Adoption of ICT for transferring, sharing, enabling or accessing patient data electronically (hereinafter Health information exchange (HIE) has increased as well. The most common use of HIE among European GPs in 2018 was for receiving laboratory reports (76% of surveyed GPS used it at least occasionally) and certifying sick leaves (66%). However, way more functionalities are not used routinely by a large share of GPs: digital technologies were used less often for such functions as certifying disabilities, receiving and sending laboratory reports and sharing them with other healthcare professionals, exchanging medical patient data/patient medication lists/radiology reports/administrative patient data with other health professionals, interacting with patients by email, making appointments on patient's behalf or exchanging medical patient data with healthcare providers outside the country. Majority of surveyed GPS were either not aware or did not have access to these functionalities.
Assisted-living technologies	Assisted-living technologies refers to combination of digital tools and solutions (e.g., health apps, software, sensors, mobile devices, robots) that can help in long-term residential and home-based care. These technologies include alarm systems that allow patients to contact personnel in emergency situations, fall sensors, GPS tracking of the movement, mobile devices with health apps allowing health workers to check on elderly, track their appointments and prescriptions, enter their home virtually, medication robots that can ensure correct dosage of pills and notify the care workers if the medication was forgotten, rehabilitation robots that ensure the exercise are done correctly and measure the progress . The adoption of these technologies is most common in private nursing homes and home care services, and more advanced technologies such as companionship robots or self-sufficient smart home are gradually deployed in pilot projects in a few EU countries (e.g., assistive social robots collecting and guiding patients to their appointments and other daily activities are piloted in Belgium and England).

6. Annex VI: methodological approach

In this study the concept of digital skills is approached using two complementary digital competence frameworks discussed below.

One of the most known, widely-accepted and used operationalisations of digital competence is **DigComp**, Digital Competence Framework for Citizens published in 2013 by the European Commission.[47] According to DigComp, digital skills are defined as competencies that allow people to use and engage with digital technologies for learning, at work, and for participation in society in a confident, critical and responsible way.[48] The framework divides competences into five competence areas, namely information and data literacy, communication and collaboration, digital content creation, safety, and problem solving (see Figure 23). The competences identified in DigComp include both technical skills (e.g., browsing, searching, and filtering data, programming, solving technical problems) and soft skills (e.g., netiquette, creatively using digital technologies).

Figure 23. The Digital Competence Framework for Citizens (DigComp)



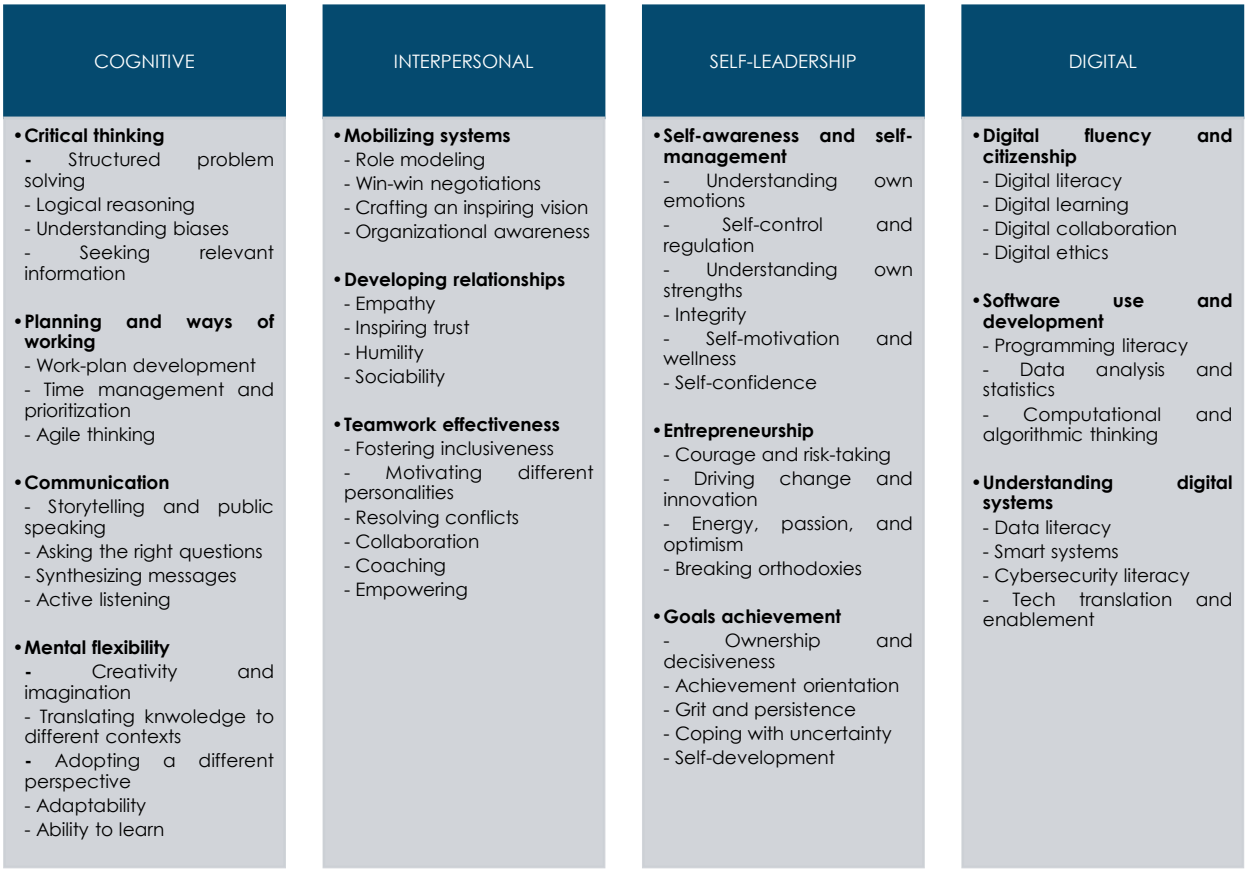
Source: adapted from Carretero Gomez, S., Vuorikari, R. and Punie, Y., 2017. DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use. Luxembourg: Publications Office of the European Union.

[47] The Framework was updated in 2016 (DigComp 2.0) and in 2017 (DigComp 2.1) to include proficiency levels and examples of use. The third update of the framework will be available in early 2022. Source: https://ec.europa.eu/jrc/en/digcomp

[48] Vuorikari, R., Punie, Y., Carretero, S., Van den Brande, I., 2016. DigComp 2.0: The Digital Competence Framework for Citizens, Update Phase 1: The Conceptual Reference Model. Luxembourg Publication Office of the European Union.

A framework developed by McKinsey lends even more precision to the above framework. McKinsey identified 56 distinct elements of talent they call DELTAs and grouped them into 13 skills groups and four categories, namely cognitive, interpersonal, self-leadership and digital (see Figure below). Contrary to DigComp, McKinsey does not refer to all of the fundamental skills for the future of work as 'digital competences' but rather treat digital skills as one of the four categories of skills. Besides the technical skills (e.g., data analysis and statistics, programming), McKinsey provides a very detailed description of multiple skills and attitudes that could quality as soft skills (e.g., creativity and imagination, adaptability, courage and risk-taking).

Figure 24. Foundational skills for the future of work



Source: Dondi, M., Klier, J., Panier, F., and Schubert, J., 2021. Defining the skills citizens will need in the future world of work. McKinsey & Company.

The two frameworks complement each other, with DigComp listing the abilities that citizens must have to be digitally literate, and McKinsey's framework being very elaborate on precise attitudes and abilities necessary for the digital age, giving special attention to soft skills.

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