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Florin Frant

Use of Technology in the European Union

Technology today plays a central role in European workplaces. It not only enables the direct production of goods and services, but it also facilitates communication and innovation. Given that innovation is one of the main pillars of the knowledge-based economy, and that Europe has committed itself to becoming the most competitive knowledge-based economy in the world as set out in the Lisbon Strategy, the use of technology and uptake of new technologies is becoming increasingly important

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1. Policy context

Technology plays a significant role in workplaces. It not only enables the direct production of goods and services, but it also facilitates communication and innovation processes. Innovation is one of the main pillars of the knowledge-based economy, and Europe has committed to becoming 'the most competitive knowledge-based economy in the world' as set out in the Lisbon Strategy. Thus, the use of technology and uptake of new technologies – such as information and communication technologies (ICT) – is increasingly important. Economies with a skilled labour force are better able to create and make an effective use of new technologies. In its microeconomic and employment policy guidelines, the European Commission encourages investments in human capital through better education and skills in order to increase the adaptability of workers and companies, as well as the flexibility of labour markets.

However, some concerns have emerged that the benefits and costs of technology use are unevenly distributed between different parts of the EU and also among its citizens. Equality concerns relate to whether the complexity and the cost of new technologies will widen the gaps between industrialised and less developed areas, between young and older people, and between those having enough knowledge and skills and those who have not.

2. Concerns about technology use

Since the 1990s at least, concerns about the impact of the uptake of technology have occupied policymakers. The pace at which new technologies are introduced varies between countries, regions, economic sectors, industries and companies (European Commission, 1996). The European Commission has observed that the benefits – in the form of prosperity – and the costs – in the form of burden of change – are unevenly distributed between different parts of the EU and also among its citizens. Equality concerns relate to whether the complexity and the cost of the new technologies will widen the gaps between industrialised and less developed areas, between young and older people, and between those having enough knowledge and skills and those who have not (European Commission, 1996, p. 3).

In general, workplace innovation can have a positive outcome for workers in terms of increased quality of work and well-being. However, evidence of a downside is also emerging, including the potential for increased stress and job insecurity (Totterdill et al, 2002). Furthermore, at a policy level, the relationship between the introduction of new technologies and required skills of the labour force has caused concern. An earlier study on the use of technology commissioned by Eurofound suggested that the introduction of new technologies may lead to a 'polarisation of the workforce into those enjoying relatively stable and skilled work, and a group of low-skilled, temporary workers in atypical forms of employment' (Weiler, 2006, p. 19). In the literature, explanations for the observed upskilling of the labour force are partly sought in the 'skill-biased technological change' hypothesis. This hypothesis assumes that the reason for the upskilling of the labour force is related to the nonneutrality of technological change, which benefits skilled labour more than other production factors (Piva et al, 2005; Chenells and Reenen, 1999). In other words, as highly skilled workers benefit more from technological change, an acceleration in the rate of technological change increases the demand for skilled labour (Piva et al, 2005). According to Chenells and Reenen (1999), evidence exists to support this hypothesis.

Some authors also believe in 'skill-biased organisational change', which implies a greater impact on work organisation. They state that the increasing diffusion of new organisational practices in companies plays a role in the growing demand for skilled workers. Their reasoning is that organisational practices such as teamwork and multitasking require workers to perform a greater variety of tasks and to rotate between different jobs, which in turn requires higher skills (Piva et al, 2005).

Both hypotheses seem, however, complementary: technological and organisational change often occur simultaneously and generate mutually reinforcing effects in terms of productivity (Piva et al, 2005). Therefore, it can be concluded that skills remain an important concern when it comes to benefiting from technological change.

3. Developments in technology use

According to Zijlstra (2007), the developments in technology use can be classified into three phases:

1. mechanisation;
2. automation;
3. computerisation.

In each phase, more human activities are substituted by machines. While in the mechanisation phase human muscle power is substituted by machines in simple and repetitive operations, in the automation phase, machines also take over the gearing of several simple operations to each other.

In the automation process, human operators controlling industrial machinery and processes are replaced by control systems, for example, by computers. Whereas mechanisation provided human operators with machinery to assist them with the physical requirements of work, automation greatly reduces the need for human sensory and mental requirements. When the personal computer (PC) was introduced in the 1970s and 1980s, the automation of office practices began, followed by computerisation in the 1990s. The introduction of algorithms enabled simple decisions to be taken by machines. The development of microchips led to the creation of more high-speed computers that were able to communicate through networks and the microchips, in turn, enabled faster data processing and data transport, resulting in major efficiency improvements.

In light of these changes in technology use, the nature of work is changing and so are the demands that are put on workers. People are no longer at the centre of the production process. Work is becoming more abstract: it requires a mental representation of the production process and an assessment of work processes by means of information (Zijlstra, 2007). Consequently, a computerised information society has become the most important objective of work. This is a major reason for the increasingly cognitive character of work and the increasing cognitive demands that are put on workers.

4. Research in the field

Technology has a great impact on workers' task characteristics and thus on their health and wellbeing. This section will explore the research literature analysing the relationship between technology use, work content, work organisation and health outcomes.

Strategies to divide and simplify work – building on the ideas of Adam Smith (The wealth of nations, 1776), Frederic Taylor (1865–1915) and Henry Ford (1863–1947) – led to simple and monotonous work with a highly repetitive character in both manufacturing industries and office work. Machines increasingly dictated the work pace. A paced task is one in which a time limit has been imposed, while schemes of pacing deal more with the degree of control one has

over the task (Garrett et al, 2000). Work tasks can be machine-paced, self-paced or not paced at all.

A machine-paced task is defined by a fixed time in which a task is to be performed. The same amount of time is allocated to a task, regardless of whether the task is successfully completed or not. Machine-paced work in industry offers certain economic advantages, such as the minimisation of work in progress, maximisation of floor space usage and simplification of the organisation of supplying components to the right place at the right time (Garrett et al, 2000). The concept of pacing is widely used in industry, since it reduces the variability of the production line – that is, work in progress – and limits the number of items stored in a queue or stockpile. Many industries incorporate some form of pacing into their manufacturing lines. However, under this type of paced working condition, operators are required to complete each task within a rigidly fixed time such that certain principles related to the quality of work are lacking. An important principle that is lacking in such a case is job control, which is known to be related to a worker's well-being (Jonge et al, 2007).

Moreover, in the case of machine-paced work such as assembly line work, time pressure and a high work pace lead to high psychological job demands. According to Karasek's 'job demand–job control' model, working situations with high job demands and low job control lead to high levels of strain among workers (Karasek, 1985). Many empirical studies have confirmed this hypothesis (Jonge et al, 2007). Several studies have shown that machine-paced tasks have negative consequences for the mental health of workers. Research in this regard generally reported more depressive feelings, negative self-perception, apathy, reduced self-confidence, alienation and higher levels of dissatisfaction among workers (Zijlstra, 2007).

5. Repetitive work

Repetitive work is characterised by repeating a single work task over and over while performing repetitive movements of the upper limbs (Bonde et al, 2005). This type of work represents an important risk factor for developing musculoskeletal disorders (MSDs) (Melchior et al, 2006; Dhondt et al, 2001). Among manual workers who traditionally use machines, like assemblers and machine operators, the prevalence of MSDs and levels of exposure to physical risk factors in the workplace are particularly high (Melchior et al, 2006).

Furthermore, although repetitive work is defined by physical work characteristics – that is, upper limb movements – it is correlated with psychosocial factors (Bonde et al, 2005). For example, a measure of repetitiveness is cycle time, which may be related to time pressure and perceived job demands. Moreover, repetitive work is most often associated with low job control, skill discretion and decision latitude. Repetitive work may increase the psychosocial load at work and cause psychological strain among workers in the form of stress symptoms. This, in

turn, may lead to musculoskeletal tenderness and pain due to increased muscle tone, modified pain perception and reduced capacity to cope with the biomechanical workload (Bonde et al, 2005; Huang et al, 2002).

Many studies have shown strong relationships between job-related stress symptoms and the reporting of musculoskeletal pain (Andersen et al, 2002; Huang et al, 2002).

6. Work intensity

It is frequently suggested that computerisation – namely, the introduction of new technical systems – has led to an intensification of work and higher psychological job demands (Zijlstra, 2007). A report on the previous wave of the EWCS in 2000 found that a strong link exists between the degree of work intensity and the reporting of health problems (Paoli and Merllié, 2001, p. 13). It has been shown that effects of the introduction of new technical systems on work intensity depend on the occupational level of the workers (Zijlstra, 2007). For instance, workers with a low occupational level may experience an increase in work intensity because their work content grows at a lower rate: they have more monotonous and routine work to accomplish, requiring their attention continuously to perform the work tasks. This leads to increased psychological demands and lower levels of wellbeing. However, such effects are not found among workers at high occupational levels (Zijlstra, 2007).

Explanations for this finding are sought in the fact that workers at high occupational levels were more frequently involved in making decisions regarding the introduction and implementation of new technical systems. In other words, they had more power and influence in the workplace and could ensure that the introduction of new technical systems contributed to making their work both more interesting and varied.

Blatter and Bongers (1999) performed risk analyses of the intensity of computer use and the risk of repetitive strain injuries (RSI). The research found that more than six hours of computer use a day is associated with an increased risk of RSI. A recent systematic review of the effects of extended computer use found moderate evidence of an association between the duration of mouse use and the incidence of hand or arm complaints among office workers (Ijmker et al, 2007). A study by Houtman et al (2006) among over 21,000 European workers showed that working with computers contributes to a high psychological workload; the data for this study came from the 2005 EWCS.

7. Learning opportunities and use of skills

Automation is found to be associated with poorer work content and reduced learning opportunities. Operators of highly automated systems frequently do not feel that they are in control of the system and thus cannot prove their ability to

perform well in their job. They experience low levels of job demands – that is, their work is boring – and of subjective health and job satisfaction (Zijlstra, 2007).

It has been debated whether ICT leads to a poorer work content and fewer learning opportunities or, on the contrary, whether it leads to an upgrading of qualifications and more learning opportunities. A study by Kraan et al (2000) including more than 11,000 Dutch workers shows that, in most cases, the introduction of new ICT is associated with greater learning opportunities. Nonetheless, whether the impact of ICT on learning opportunities is positive or negative depends on the occupation. For example, in the case of administrative and logistic professions, the introduction of specialised software is associated with poorer work content and fewer learning opportunities. Kraan et al show that this effect could be offset by certain organisational practices, such as decentralised decisionmaking processes or autonomous work teams.

A study by Green et al (2003), investigating the impact of computer usage at work and other job features on changing skills requirements of workers, reveals that the spread of computer use is strongly associated with the process of upskilling. A Canadian survey on working with technology, which has mapped the continuous rise in computer-based technologies since 1985, also finds that computer use is linked to upskilling. The study concludes that, due to computer-based technologies, a widespread process of job upskilling is taking place, through both an occupational shift to higher skill jobs and an increase in skills requirements across most occupations (McMullen, 1996).

Recent research by Zijlstra (2007) highlights that insufficient mastery of computer applications may lead to feelings of incompetence and subsequently to lower well-being among workers. If technology is introduced without paying enough attention to the workers concerned, in terms of participation, training and instruction, workers may feel threatened in their jobs.

8. Autonomy

High-skilled computer work is characterised by increased levels of autonomy, decentralisation of decision-making processes and worker participation (Hempell et al, 2005; Kraan et al, 2000). In their study among a large sample of Dutch workers, Kraan et al show that computer work is associated with greater work autonomy than work which does not involve computer usage. It is well known that high levels of autonomy at work have positive effects on workers' well-being (Bakker and Demerouti, 2007). Worker autonomy is therefore considered an important characteristic of quality of work (Kyzlinková et al, 2007).

The introduction of autonomous teams in organisations can be considered in conjunction with job improvement measures. A study on teamwork and high performance organisations by Eurofound in 2007 did not, however, reveal a clear-cut correlation between the presence of teamwork and increased autonomy (Kyzlinková et al, 2007). The study reveals that the degree of worker autonomy is

influenced by the worker's occupation. The study's findings suggest that team workers are more autonomous workers due to their higher concentration in occupations such as legislators, senior officials, managers and professionals. Other professions, namely craft and related trades workers, plant and machine operators and assemblers, report low autonomy at work despite a high incidence of teamwork.

9. Conclusions

As highlighted in the previous sections based on existing research, it appears that changes in technology use and work organisation influence the psychosocial and physical aspects of working conditions. Working conditions, in turn, directly impact on workers' satisfaction, performance, productivity, health and well-being (Houtman et al, 2001).

Working conditions determine to a certain extent the requirements that work imposes on the worker (Dhondt et al, 2002). These requirements are influenced by the technology used and work organisational practices. Abundant scientific evidence confirms that the psychosocial work environment impacts greatly on the health and well-being of workers, as shown in higher levels of work-related stress and musculoskeletal complaints, and lower reported job satisfaction and work engagement. The influence of the psychosocial work environment on workers' health and well-being can be either positive or negative. Combining the predominant theoretical models of work characteristics and health outcomes1, the most important determinants of psychosocial health and well-being can be listed. Based on these models, the following work characteristics are considered to significantly contribute to a good quality of work and positive health outcomes:

sufficient skill variety;
moderate job demands;
sufficient control over one's own task performance;
some degree of social support;
feedback about results and performance;
sufficient task identity – the job forming a significant entity of activities;
a work task that is, to a certain extent, significant to others;
sufficient job security;
sufficient rewards, for example, pay.

Several principles form the basis of these theoretical models which link work characteristics to workers' health outcomes. First, it is their multidimensional aspect: job demands, job resources and work-related health outcomes consist of physical, cognitive and emotional dimensions. Secondly, most theories start from a balance principle, considering that job strain is the result of an imbalance between the demands workers are exposed to and the resources they have at their disposal. On the other hand, personal growth, creativity and learning develop when job demands and job resources are balanced. Some models have extended

this 'balance principle', which can be considered as a compensatory relation between job demands and job resources in causing work-related health outcomes.

Such theories assume that the job demand–job resources relation is rather specific: for instance, an emotional demanding task is best regulated or compensated for by an emotional resource – such as social support – while non-specific resources – such as physical strength – are thought to be less effective in compensating emotional demands.

Apart from these psychosocial working conditions, the physical working conditions also influence the health and well-being of workers and will thus equally be considered in this study. Physical work factors – such as local mechanical stresses, work postures and musculoskeletal loads – are related to the use of computer and machine technology by workers. Such work characteristics strongly influence the risks of developing musculoskeletal problems, such as back pain and upper extremity disorders (Karwowski and Marras, 1999).

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