High-performance work systems and firm innovation: the moderating role of digital technology and employee participation. Evidence from Europe

Ylenia Curzi and Filippo Ferrarini
Marco Biagi Department of Economics, University of Modena and Reggio Emilia, Modena, Italy

Received 3 November 2022
Revised 10 February 2023
3 August 2023
Accepted 27 October 2023

Abstract

Purpose – In the literature, evidence is to be found of the positive effect of high-performance work systems (HPWSs) on innovation in firms. However, innovation is enabled by not only human resources but also digital technology, and scholars have called for further investigation into the interplay between digital technology and HRM systems. Drawing on signalling theory and HPWSs research, the purpose of this study is to explore the moderating role of digital technologies in the relationship between HPWSs and innovation in the firm and consider employee participation as an additional conditioning factor.

Design/methodology/approach – This study uses data from the European Company Suvery 2019 administered in a sample of more than 20,000 European establishments and applies logistic regression with a three-way interaction.

Findings – HPWSs underpin product and process innovation. Moreover, this study shows that in firms with low levels of employee participation, digital technology enhances the effect of HPWSs on innovation, while in firms with high levels of employee participation, this effect is reduced.

Originality/value – This study enriches the scholarly discussion about the link between HPWSs and innovation in the firm, by investigating in theoretical and empirical terms the moderating effect of digital technology, underlining that either positive or negative synergistic effects are possible. By adding employee participation to the analysis, the authors cast light on an important boundary condition for understanding when the synergic effects become more prominent. This intends to respond to recent calls from scholars and practitioners for more insight into the precise nature of the synergies between HPWSs and digital technology on innovation in the firm, with important implications for management.

Keywords High-performance work systems, Innovation, Digital technology, Employee participation, European company survey, Europe, Human resource management

Paper type Research paper

Data availability statement: The data supporting the findings of this study is available at UK Data Service: http://doi.org/10.5255/UKDA-SN-8691-1.

Both authors contributed equally to this manuscript. The authors are extremely grateful to the Eurofound for making this research possible, by providing the data set. The authors wish to thank William Bromwich for his painstaking attention to the copy-editing of this paper.

Management Research Review
Vol. 47 No. 13, 2024
pp. 51-68
Emerald Publishing Limited
2040-8269
DOI 10.1108/MRR-11-2022-0751

1. Introduction

Innovation is key for firms seeking a sustainable competitive advantage in rapidly changing business environments (Haar *et al.*, 2022). Based on the idea that innovation in firms is ultimately based on employee motivation and the ability to generate and implement creative ideas (Bhatti *et al.*, 2021) and that human resource management (HRM) practices play a key role in this regard (Shin *et al.*, 2018), much research has been conducted in recent decades on the link between HRM practices and innovation in firms. Researchers have focused particularly on high-performance work systems (HPWSs) (Chowhan *et al.*, 2017; Seeck and Diehl, 2017) – defined as systems of interconnected practices designed to enhance employee knowledge and abilities, motivation to perform and the opportunity to contribute to the achievement of organisational goals (Appelbaum *et al.*, 2000; Jiang, *et al.*, 2012). Previous studies have argued that HPWSs relate to innovation through the positive influence on employee attitudes (e.g. job satisfaction, hope and psychological capital more broadly) (Behravesh *et al.*, 2020; Elrehail *et al.*, 2021). Accordingly, it is assumed that HPWSs are indicative of the firm commitment to the development and well-being of its employees, leading them to reciprocate with behaviour (knowledge sharing, creative and innovative work behaviours) that enhances the innovative performance of the firm (Bhatti *et al.*, 2021; Bos-Nehles and Veenendaal, 2019).

In addition to HPWSs, contemporary organisations are increasingly harnessing the potential of digital technology (e.g. social media, mobile devices, robots or analytics) to significantly innovate their processes, products, services and business models (Ayoko, 2021; Minbaeva, 2021). As a result, many scholars agree that the joint consideration of HPWSs and digital technology is crucial for firms seeking to remain competitive in the digital economy (Santoro and Usai, 2018). If both HPWSs and digital technology individually enhance organisational innovation, then examining their joint impact helps organisations to identify novel strategies to maximise their innovative potential. In this respect, it has been argued that the combined use of HPWSs and digital technology gives rise to positive synergies that "make an organisation better able to sense changes in the environment and gain a competitive advantage" (Kaushik and Mukherjee, 2022, p. 1631).

While previous studies argue that HPWSs and digital technology complement each other in promoting innovation, the way the two interact in practice is still unclear. In fact, research on the "dark side" of HPWSs (Behravesh *et al.*, 2020; Kloutsiniotis *et al.*, 2021) suggests that the relationship between HPWSs and organisational innovation may be more complicated than expected, especially in digitally transforming firms (Parker and Grote, 2022).

Accordingly, scholars and practitioners have called for more insights into the precise nature of the potential synergies between HPWSs and digital technology on organisational innovation (Kim *et al.*, 2021; Minbaeva, 2021; Zheng *et al.*, 2020). As has been emphasised, research in this area is important, because it can help to bridge the research-practice divide (Minbaeva, 2021) and provide insights to inform management decisions and promote practices that benefit *all* stakeholders (Bondarouk and Brewster, 2016), thereby ensuring the long-term viability and sustainability for the organisation and its employees.

This paper addresses this issue starting from the primary research question: How do digital technologies moderate the relationship between HPWSs and innovation in the firm?

Drawing on signalling theory (Connelly *et al.*, 2011), we interpret HPWSs in terms of the messages an organisation sends to employees to inform them about the behaviour that is expected, supported, encouraged and rewarded in line with the strategic goals of the firm, as well as to signal the employee-related philosophy of the firm (i.e. employee well-being orientation or employee-exploitation orientation; Wang *et al.*, 2020). In this paper, we apply the same approach to the adoption of digital technology. We, therefore, examine two

competing hypotheses: that digital technologies may either enhance or reduce the positive association between HPWSs and innovation, by strengthening or weakening the message of the organisation's commitment to its employees underlying HPWSs.

Moreover, we argue that the combined effect of HPWSs and digital technology on innovation is contingent on the level of employee participation. Drawing on the industrial relations literature, we consider employee participation in terms of the influence of employees on higher-level management decisions that deal mainly with issues at a tactical (e.g. issues related to work organisation, technology and pay systems) or strategic level (e.g. issues related to investment and disinvestment, company mission and goals) (Knudsen *et al.*, 2011). Consistently, we distinguish between employee participation and employee involvement, that is the influence of employees on decisions that deal mainly with operational matters at the job/task level (Knudsen *et al.*, 2011), which is typically seen in HPWSs as an opportunity-enhancing practice (Sun *et al.*, 2007; Elrehail *et al.*, 2021).

The present study contributes to the literature in several ways. First, while this study supports the dominant assumption of positive synergistic effects between HPWSs and digital technology on innovation, it challenges the notion that the combined use of HPWSs and digital technology is always positive for innovation, by highlighting the fact that the competing perspective (i.e. negative synergistic effects) is also plausible. Second, by providing theoretical and empirical evidence that both positive and negative synergistic effects are supported with different levels of employee participation, we cast light on an important boundary condition for understanding when each perspective becomes more prominent. Third, the paper contributes to the emerging body of research which points to a closer integration between HPWSs and employee participation as a way towards a genuine mutual gains perspective on HPWSs (Guest, 2017), offering a more nuanced understanding of the role of employee participation in firms seeking to benefit from the positive synergistic effects of HPWSs and digital technology on organisational innovation.

2. Theoretical background and hypotheses

2.1 High-performance work systems, digital technology and innovation

HPWSs, as a coherent system of interrelated HRM practices designed to develop employee skills, motivation and opportunities to contribute to organisational performance (Jiang, *et al.*, 2012), is key to enhancing innovation (Bhatti *et al.*, 2021; Chowhan *et al.*, 2017; Haar *et al.*, 2022; Seeck and Diehl, 2017).

According to signalling theory (Connelly *et al.*, 2011), HPWSs function as a communication mechanism by which the firm signals to the employees the type of behaviour that is expected, supported, encouraged and rewarded in line with the strategic goals of the firm, as well as the firm's employee-related philosophy (Wang *et al.*, 2020).

In this sense, HPWSs practices aimed at enhancing the employees' skills and competences (e.g. training), while also motivating them (e.g. rewards, performance appraisal and intrinsic motivation practices) and providing them with the opportunity to take risks, experiment and to share their knowledge (e.g. job autonomy and information sharing) signal that innovative work behaviour, creativity and knowledge sharing are organisationally valued forms of behaviour by which employees can contribute to the innovative capacity of the firm (Bhatti *et al.*, 2021; Bos-Nehles and Veenendaal, 2019).

At the same time, there is evidence that these practices are associated with positive work-related attitudes, such as commitment, job satisfaction (Behravesh *et al.*, 2020) and psychological capital, such as a willingness to persevere (Elrehail *et al.*, 2021). Accordingly, it has been argued that HPWSs act as a signal of the organisation's commitment to the development and well-being of the employees (Behravesh *et al.*, 2020), leading them to

reciprocate through the kind of behaviour required to foster innovation. Proponents of this view (in a mutual gains perspective) argue that HPWSs convey the message that both employers and employees will benefit from the adoption of these systems.

According to signalling theory, the effectiveness of a particular signal can be influenced by the presence of other signals (Connelly *et al.*, 2011). This suggests that HPWSs signalling effectiveness can be influenced by the adoption of digital technology.

Digital technology (e.g. mobile devices, robots, social media and analytics) can facilitate significant innovation in company processes, products, services and business models (Ayoko, 2021; Minbaeva, 2021).

Studies focusing on changes in tasks and work design link the adoption of digital technology (e.g. three-dimensional printing) to enhanced job complexity and skill variety (Ben-Ner *et al.*, 2023). In a similar way, the adoption of robots is intended to eliminate routine tasks, offering employees the opportunity to be involved in more creative work, use their skills more effectively for creativity and exercise greater discretion (Dixon *et al.*, 2021; Parker and Grote, 2022; Santoro and Usai, 2018; Smids *et al.*, 2020; Vrontis *et al.*, 2022; Wilson and Daugherty, 2018).

Moreover, real-time data on work processes provided by data analytics can generate knowledge (Zheng *et al.*, 2020), thus increasing job feedback and expanding the opportunities for employees to be creative.

Further, the use of data analytics and robotics has been linked to an increased ability on the part of the firm to measure individual contributions to productive processes, increasing the perception on the part of employees of performance appraisal fairness and accuracy (Dixon *et al.*, 2021; Sharma and Sharma, 2017). It follows that workers will feel more motivated to reciprocate with a higher level of commitment towards the organisation's desired behaviours (Sharma and Sharma, 2017) (i.e. the generation of new ideas).

Other studies (Tortora *et al.*, 2021) confirm that the use of mobile devices and social media provides more extensive access to information, facilitating knowledge sharing throughout the organisation and stimulating employee growth, learning and skills.

It is widely assumed that these technology-enabled changes reflect the organisation's commitment to a human-centred approach to technology adoption and implementation (Parker and Grote, 2022). The adoption of digital technology, thus, signals the intent of the organisation to not only invest in the development of new products and processes to improve organisational performance but also expand the employees' job resources and opportunities for growth, learning and mastery of their jobs, in line with a mutual gains strategy, leading the employees to reciprocate with greater creativity.

It follows that adoption of digital technology may strengthen the positive message conveyed by the adoption of HPWSs. In this connection, it has been argued that a human-centred approach to technology is more likely in organisations where HPWSs are already present (Arslan *et al.*, 2022; Kim *et al.*, 2021; Parker and Grote, 2022).

This suggests that HPWSs and digital technology may be complementary and mutually supportive in signalling to the employees the company's commitment to a mutual gains strategy.

We, therefore, state the following:

H1a. There is a two-way interaction between high-performance work systems and digital technology with the use of digital technology strengthening the positive relationship between high-performance work systems and innovation.

At the same time, it has been argued that HPWSs have a dark side (Godard, 2004). Proponents of this view (adopting a critical perspective) argue that the implementation of

HPWSs increases job demands (Behravesh *et al.*, 2020; Guest, 2017). For instance, opportunity-enhancing practices (e.g. job autonomy and information sharing) and ability-enhancing practices (e.g. continuous training) can make work more challenging, while practices enhancing motivation (e.g. performance appraisal and pay-for-performance schemes) may put pressure on employees to work more intensively (Kloutsiniotis *et al.*, 2021)

As a result, the message that HPWSs convey to employees is one of expectations of increased performance that primarily benefit the company and only incidentally, as a by-product, the employees (Kroon *et al.*, 2009).

This may be the case especially when HPWSs and digital technology are implemented together.

With the introduction of digital technology, variances (e.g. breakdowns and other complex emergent situations) in work and production processes may be less frequent, but no less disruptive (Dixon *et al.*, 2021). The adoption of digital technology, therefore, requires changes in tasks and job designs, with the need for highly skilled employees capable and willing to make any intervention necessary for handling variances locally, at the source, to bring the production system back to normal and not compromise efficiency gains (Parker and Grote, 2022). HPWSs serve precisely this purpose, that is, primarily favouring the adaptation of employees to digital technology requirements and only incidentally, as a by-product, their well-being (Guest, 2017).

Accordingly, it may be that digital technology undermines the positive message conveyed by HPWSs, reducing job satisfaction and employees' commitment towards innovative behaviour. As a result, the combination of HPWSs and digital technology can lead to negative synergistic effects on firm innovation.

In this connection, the adoption of robots in the workplace is often associated with more training practices, as employees need to acquire the necessary skills for their use (Nazareno and Schiff, 2021; Parker and Grote, 2022). However, employees may perceive this training as an additional burden, primarily ensuring the smooth functioning of the robotic systems and the interests of the firm, while only as a by-product promoting their own development, thus reducing their motivation and ability to use their skills for the generation of new ideas. Thus, the use of robots may reduce the effectiveness of training in terms of innovation.

In a similar vein, Strohmeier (2009) notes that the use of computers increases the amount of training delivered to employees (i.e. e-training). However, employees may perceive such training as indicative of additional job demands and expectations, thus reducing the effectiveness of training in improving their skills (Kroon *et al.*, 2009).

In line with the above arguments, we hypothesise the following:

H1b. There is a two-way interaction between high-performance work systems and digital technology such that digital technology weakens the positive relationship between high-performance work systems and innovation.

2.2 The role of employee participation

The critical perspective on HPWSs challenges the notion that employers and employees have shared goals, reflecting a view of employment relations rooted in an inherent conflict of interests between the two parties (Kaushik and Mukherjee, 2022), consistent with the pluralist industrial relations view. According to this perspective, balancing the distinct and conflicting, yet mutually dependent, interests of employers and employees is the key to ensuring that management decisions (e.g. related to HPWSs and digital technology) do not become exploitative but produce benefits for both the firm and the workers (Budd *et al.*, 2004; Guest, 2017). In a situation where competing interests are balanced, employees are

likely to reciprocate with more positive attitudes (e.g. greater commitment and engagement towards the achievement of organisational outcomes) (Guest, 2017).

However, to achieve a balance of this kind, it is of the utmost importance that employees have a say in decisions affecting their work and the functioning of the firm with a view to protecting their interests (Budd *et al.*, 2004; Guest, 2017).

In this respect, it is important to underline that the employment relations literature clearly distinguishes between employee participation (i.e. employees' influence on higher-level management decisions mainly dealing with strategic or tactical issues such as work organisation, technology, pay schemes, company mission and goals, investment and de-investment) and, on the other hand, employee involvement (i.e. employees' influence on lower-level decisions mainly dealing with operational issues at the job/task level) (Knudsen *et al.*, 2011), which is included in HPWSs as an opportunity-enhancing practices (Elrehail *et al.*, 2021; Sun *et al.*, 2007). Industrial relations studies point to employee participation as the key to ensuring that workers have an effective means to protect their interests (Drago and Wooden, 1991). Recently, scholars have consistently called for a closer integration between HPWSs and employee participation as a way towards a genuine mutual gains approach to HPWSs (Guest, 2017).

By combining insights from the industrial relations literature and signalling theory, we view employee participation as a signal that management recognises that employee influence on decisions concerning HPWSs and technology is essential to ensure that the combination of the two does not subordinate employee interests to management goals. In this sense, employee participation is a particularly strong, visible and credible signal of the employer's commitment to pursuing a mutual gains strategy, reducing the information asymmetry between the employer and employees.

We, therefore, expect that in firms in which employees can influence higher-level management decisions, the message of the firm's genuine commitment to its employees, which the employer is trying to convey through the adoption of HPWSs and digital technology, will be stronger and more consistent and, thus, more effective in inducing employees to reciprocate through behaviour that enhances innovation in the firm.

We, thus, hypothesise the following:

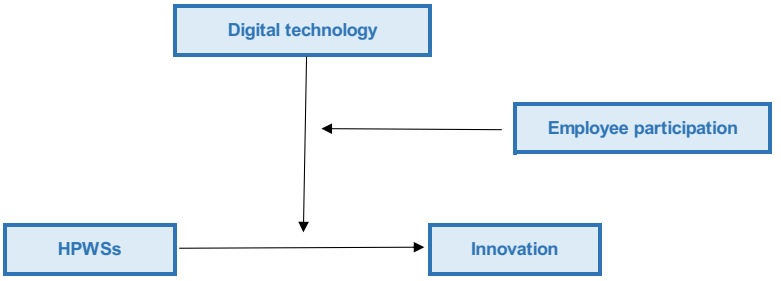
H2. There is a three-way interaction between high-performance work systems, digital technology and employee participation on innovation, such that the positive relationship between high-performance work systems and innovation is stronger with a high level of adoption of digital technology and employee participation.

The conceptual model of the relationship between the dimensions considered is outlined in Figure 1.

3. Material and methods

3.1 Data

The hypotheses were tested using the European Company Survey 2019, a large-scale, cross-national survey carried out in 2019 by Eurofound and Cedefop which comprises data on HRM practices, digital technology, innovation in the firm and employee participation in more than 20,000 establishments in Europe. The unit of inquiry for the survey is the establishment, the local unit or site, and the survey collects data from management and employee representatives at each establishment. In this study, we rely on the data set of management respondents (Eurofound and Cedefop, 2020a).



Source: Authors' own creation

Figure 1.
Conceptual model

3.2 Measurement and variables

3.2.1 High-performance work systems. Following Haar *et al.* (2022), we selected 25 items to cover seven types of practice: training, recruitment, rewards, performance appraisal, intrinsic motivation practices, information sharing and job design. The practices included were measured through different variables and scales assessing the presence of certain practices (i.e. yes/no questions) or their intensity (i.e. percentage of usage among employees), as well as the extent to which those practices are used [i.e. from 1 (not used) to 3 (on a regular basis), or from 1 (never used) to 4 (very often used)]. Then, following prior studies (Chowhan *et al.*, 2017), items were standardised into z-scores to obtain equal weights in the creation of the index. Finally, the final construct was created by combining the standardised variables into a single index by a process of addition in line with prior studies (Shin *et al.*, 2018); Cronbach's alpha 0.793.

3.2.2 Technology. Digital technology was measured through an index (TECH) capturing the level of digital technology adoption in the workplace, in line with previous studies (Cirillo *et al.*, 2021). Specifically, it was computed by adding together four dummy variables regarding the adoption of robotic systems in the establishment, the use of data analytics to monitor employee performance, the adoption of data analytics to improve the production process or service delivery and the use of mobile devices and personal computers (previously transformed). The final index ranged from 0 (no technology in the workplace) to 4 (all types of technology were present). The final index was then mean-centred to test the moderating effect.

3.2.3 Employee participation. Employee participation (EMPL_PAR) measured the extent to which employees influenced higher-level management decisions in five areas, corresponding to the dimensions considered by Zhou *et al.* (2019). The variable consisted of five items measuring the extent to which employees had directly influenced management decisions on such tactical or strategic issues as the organisation and efficiency of work processes, training and skills development, pay schemes, working time arrangements and dismissals according to a scale ranging from 1 (not at all) to 4 (to a great extent). The items were summed together, and the final variable ranging from 1 (no influence in any areas) to 20 (great influence in all areas) was then standardised into z-scores to test the moderation effect: Cronbach's alpha 0.759.

3.2.4 Firm innovation. In line with other studies using the European Company Survey questionnaire (Della Torre *et al.*, 2021), innovation was measured with a dichotomous variable consisting of two items, which took the value of 1 in cases in which the firm reported that it had introduced at least one innovative or significantly changed product/

service or process since 2016 which was new for the company or both for the company and the market, 0 otherwise.

3.2.5 Control variables. Several control variables were used. We included establishment characteristics like establishment years (log years) in line with Chang *et al.* (2013). Following Meuer (2017), we included establishment size (0 = large companies with more than 249 employees vs 1 = SMEs with up to 249 employees); industrial sector (0 = manufacturing vs 1 = service and construction), strategic orientation of the firm (1 = innovation strategy and 0 = otherwise) and market competitiveness (1 = very competitive and 0 = otherwise). Moreover, we controlled for country diversity, as, according to the European Innovation Scoreboard 2019, there are great differences in the innovation performance across EU member states. We took Sweden for reference purposes (European Union, 2019).

Questions and items for each variable are shown in Appendix.

3.3 Analysis

Because we use cross-sectional, self-reported data collected from a single sampling unit through a single questionnaire, common method bias could be an issue. Noteworthy, Eurofound implements procedural remedies (Podsakoff *et al.*, 2003) to ensure the high quality of the data collected. For instance, advanced translation techniques, cognitive testing techniques and different scale formats and clear labelling for each point on the response scales were used to reduce the complexity and/or ambiguity of the items and to minimise biased responding (for further information, see the Eurofound quality control report – Cedefop and Eurofound, 2019). Also, we checked for common method bias using Harman's test (Podsakoff *et al.*, 2003), consistent with previous studies (Bos-Nehles and Veenendaal, 2019). The results indicated that significant common method bias is not present in our data, as the variance extracted by a single component was below the threshold of 50%.

As innovation was measured through a dichotomous variable, binary logistic regression was used to test the hypotheses. First, we performed the regression to test the influence of HPWSs on innovation. Then, we introduced the TECH variable (mean centred) and the interaction term between HPWSs and the adoption of digital technology to test the first two alternative hypotheses. Subsequently, we tested the three-way interaction by including employee participation (EMPL_EMP) (standardised) as the third moderating variable. A simple slope test was then carried out. To ensure the results were representative in terms of the distribution of establishments in terms of sector, size and country, we applied the weighting scheme of the survey (pweight option in STATA) (Eurofound and Cedefop, 2020b).

4. Results

Table 1 presents the descriptive statistics of the main variables of the model. All variables are positively and significantly correlated, and the descriptive statistics exclude the multicollinearity issue.

Table 2 shows the direct relationship between HPWSs and innovation (Model 1), the interaction between HPWSs and digital technology (TECH) (Model 2) and the three-way interaction between HPWSs, digital technology and employee participation (EMPL_PAR) (Model 3).

In Model 1, the effect of HPWSs on innovation is positive and significant ($\beta = 0.041$ and $p \leq 0.01$). The effect of the control variables is in line with the literature and expectations regarding size, sector, strategy orientation and differences in the innovation capacity of European countries (European Union, 2019; Meuer, 2017).

Model 2 presents the interaction between HPWSs and the adoption of digital technology (TECH) on innovation. The interaction is positive and slightly significant ($\beta = 0.005$ and $p \leq 0.10$). However, we opted for a more conservative approach using the ($p \leq 0.05$) threshold. Hence, neither *H1a* nor the *H1b* was supported.

Model 3 shows a negative significant effect of the moderated moderation ($\beta = -0.007$ and $p \leq 0.01$), which disconfirms *H2*. However, the results are relevant and worthy of attention.

The analysis of the three-way interaction is highlighted in Figure 2 and Table 3. When employee participation is low, the adoption of digital technology enhances the effect of

Variables	N.	Weighted N.	Mean	SD	1	2	3	4
HPWS	18,278	1,976,183	0.0045	10.161	1			
TECH	18,278	1,976,183	−0.0420	1.0231	0.323**	1		
EMPL_PAR	18,278	1,976,183	0.0005	0.9900	0.386**	0.202**	1	
INNOVATION	18,278	1,976,183	0.4149	0.4927	0.179**	0.288**	0.168**	1

Notes: HPWSs and EMPL_PAR are a composite scale (z-score standardized values), while TECH is a mean centred index. INNOVATION is a dummy. We did not include controls because of limited space. **$p \leq 0.01$; and *$p \leq 0.05$

Source: Authors' own creation

Table 1. Descriptive statistics and correlations of the main variables of the model

	Model 1 Innovation		Model 2 Innovation		Model 3 Innovation	
Variables	β	SE	β	SE	β	SE
Control variables						
Countries	Yes		Yes		Yes	
SmallComp	−0.465***	0.116	−0.230(.)	0.127	−0.239(.)	0.127
MediumComp	−0.187	0.122	−0.044	0.133	−0.054	0.134
Constr_sect	−1.423***	0.106	−1.207***	0.109	−1.220***	0.109
Service_sect	−0.696***	0.070	−0.762***	0.072	−0.761***	0.072
Logyears	−0.029	0.089	−0.049	0.091	−0.023	0.091
Inn_strat	0.516***	0.066	0.498***	0.068	0.487***	0.067
MarketComp	0.445***	0.089	0.421***	0.090	0.404***	0.088
Independent variables						
HPWSs	0.041***	0.0033	0.026***	0.003	0.021***	0.004
TECH			0.486***	0.031	0.499***	0.032
HPWSxTECH			0.005.	0.003	0.006(.)	0.003
EMPL_PAR					0.202***	0.034
HPWSxEMP_PAR					−0.004	0.003
TECHxEMP_PAR					0.021	0.032
HPWSxTECHxEMP_PAR					−0.007**	0.003
Pseudo R^2	0.082		0.114		0.120	
Observations	18,278		18,278		18,278	
Chi-square (df)	703.87*** (35)		901.43*** (37)		939.84*** (41)	

Notes: Robust standard errors; Significant codes: ***0.001; **0.01; *0.05; and . 0.10; Odds ratios are not reported because of limited space

Source: Authors' own creation

Table 2. Results of the logit model testing the direct effect of high-performance work systems on innovation and the two-way and three-way interaction

HPWSs on innovation, so the greater the combination between HPWSs and digital technology, the greater the probability of innovation (Figure 2). In fact, the effect of HPWSs shifts from $\beta = 0.0106$ and $p \leq 0.05$ with low levels of digital technology to $\beta = 0.0378$ and $p \leq 0.01$ with high levels of digital technology (Table 3). On the other hand, in firms with high levels of employee participation, the greater the level of adoption of digital technology, the lower the effect of HPWSs on innovation. The effect of HPWSs is $\beta = 0.0194$ and $p \leq 0.01$ with low levels of digital technology, while it decreases to $\beta = 0.0146$ and $p \leq 0.01$ with high levels of digital technology (Table 3). The most significant effect occurs in the case of low levels of employee participation and high levels of adoption of digital technology.

5. Discussion and conclusions

Our analysis offers three main clusters of findings, relating to the direct effect of HPWSs on innovation in the firm and to the contribution that this study was intended to provide.

With regard to the first issue, although not hypothesised, the results show that HPWSs have a positive and significant effect on product and process innovation, implying that European companies adopting practices aimed at giving employees the right skills and abilities, motivating them and providing opportunities to contribute with their talent have a greater potential for innovation. Hence, the results confirm the findings of previous studies

Table 3.
Effects of high-performance work systems on product/process innovation at different levels of TECH and EMPL_PAR

		Innovation		
Empl_par	Tech	HPWS	SE (robust)	p-value
Low	Low	0.0106	0.0055	0.0348
Low	High	0.0378	0.0068	0.0000
High	Low	0.0194	0.0065	0.0016
High	High	0.0146	0.0064	0.0114

Source: Authors' own creation

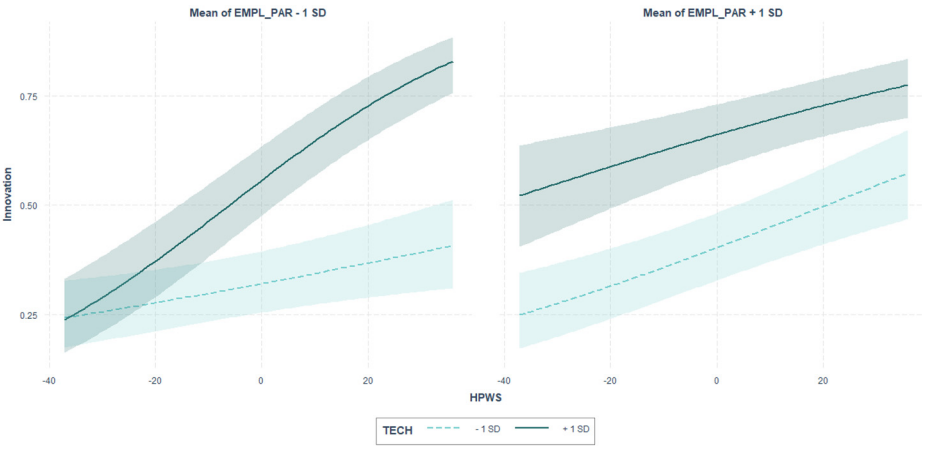


Figure 2.
Three-way interaction among high-performance work systems, digital technology and employee participation on innovation (± 1SD)

Source: Authors' own creation

which highlight the positive effect of HPWSs on innovation in the firm (Bhatti *et al.*, 2021; Haar *et al.*, 2022).

The main contribution of this study is to highlight the need to study the combined effects of HPWSs and digital technology on innovation in greater depth. Drawing on signalling theory, we hypothesised that digital technologies can either enhance or hamper the positive influence of HPWSs on innovation in the firm.

The second cluster of findings supports neither of the two hypotheses. On the contrary, they seem to suggest that HPWSs and digital technology contribute positively to innovation in an independent way.

However, the third cluster of findings provides a more nuanced understanding of the role of digital technology, showing that the interactive effect with HPWSs on innovation depends on the level of employee participation in higher-level management decisions. Specifically, we show that in firms with low levels of employee participation, digital technology enhances the positive effect of HPWSs on product and process innovation, whereas in firms with high levels of employee participation, such an effect is reduced. These results do not confirm our initial hypothesis, illuminating a more complex interplay between employee participation, HPWSs and digital technology.

Signalling theory may help to explain these findings. Specifically, Connelly *et al.* (2011) underline that signalling effectiveness is determined in part by receiver interpretation (i.e. the process of translating signals into perceived meaning) and suggest that receiver interpretation of signals in the present may be affected by their past experience and by their expectations about the future.

Echoing this insight, Wilkinson *et al.* (2013) suggest that employees with limited experience of employee participation are likely to welcome any initiative that gives them the opportunity – albeit limited – to become involved in decision-making (e.g. influence on lower-level management decisions), whereas the positive effect of employee influence on higher-level management decisions on their attitudes and commitment tend to diminish as the employee experience of participation increases. In line with these arguments, our analysis suggests that the combined use of HPWSs and digital technology is seemingly more effective in signalling the company's goodwill and, thus, in inducing positive employee reactions, when decisions about strategic or tactical issues are unilaterally made by management. In contrast, enabling employees to influence higher-level management decisions can generate a desire for more participation at that level – some power creates a "taste for power" on the part of employees (Drago and Wooden, 1991, p. 178). It is worth noting that our measure of employee participation captures employee influence over decisions on a wide range of tactical and strategic issues, but it does not include influence on the company's mission and goals. As a result, employees may feel that the participation scheme offers them less power than they are aspiring to, leading them to interpret their influence on the combined adoption of HPWSs and digital technology as a means that may improve their well-being as a by-product, but which is primarily aimed at pursuing goals that remain the prerogative of management, thus having little to do with a "mutual gains" strategy.

5.1 Theoretical implications

Drawing on signalling theory (Connelly *et al.*, 2011), this paper explores in theoretical and empirical terms the combined effect of HPWSs and digital technology on innovation in the firm. The prevailing assumption in existing studies is that of positive synergistic effects between HPWSs and digital technology on innovation in the firm (Kaushik and Mukherjee, 2022; Santoro and Usai, 2018). The adoption of digital technology in organisations where

HPWSs are already present is likely to signal to employees that technology is consistently implemented and developed with a human-centred approach (Arslan *et al.*, 2022; Kim *et al.*, 2021; Parker and Grote, 2022), reinforcing the message of the organisation's commitment to a mutual gains strategy implicit in HPWSs and, thus, the effectiveness of HPWSs in generating more positive employee reactions (Behravesh *et al.*, 2020; Elrehail *et al.*, 2021) and eventually a positive relationship between HPWSs and innovation (Bhatti *et al.*, 2021). While this study supports this view, it also challenges the notion that the combined use of HPWSs and digital technology is always positive for innovation, by highlighting the fact that the competing hypothesis of negative synergistic effects is supported. In this sense, digital technology may weaken the positive influence of HPWSs on innovation, by signalling that HPWSs primarily favour the adaptation of employees to the demands of digital technology for the primary benefit of the organisation and only incidentally, as a by-product, their well-being, thus reducing positive individual attitudes and commitment to the behaviour required for innovation in the firm.

These findings contribute to the scholarly discussion about the risks of digital technologies (Arslan *et al.*, 2022; Bondarouk and Brewster, 2016). Previous studies in this strand of research have mainly focused on the analysis of technology-enabled changes in tasks and work designs (Kim *et al.*, 2021; Parker and Grote, 2022). Our paper enriches the debate, redirecting attention to the exploration of the interplay of HPWSs and digital technology on innovation as a fruitful analytical approach by which to study the dark side of digital technology. Moreover, previous studies in this strand of research have mainly concentrated on the negative consequences in terms of the replacement of labour by artificial intelligence, the neo-Taylorism of algorithms, increasing digital surveillance and performance monitoring (Nazareno and Schiff, 2021). Our results complement the existing research, suggesting that increased job autonomy, job feedback, skill variety and use can equally be perceived negatively by employees in highly digitalised firms.

Furthermore, drawing on the industrial relations literature (Budd *et al.*, 2004; Knudsen *et al.*, 2011), we add employee participation to the analysis of the interplay between HPWSs and digital technology. By providing theoretical and empirical evidence that both positive and negative synergistic effects are supported at different levels of employee participation, we cast light on an important boundary condition for understanding when each perspective becomes more prominent, thus responding to calls for more insights into the precise nature of the synergies between HPWSs and digital technology on innovation in the firm (Kim *et al.*, 2021; Minbaeva, 2021; Zheng *et al.*, 2020).

Finally, this paper contributes to the emerging body of research which calls for a closer integration between HPWSs and employee participation as a way towards a mutual gains approach (Guest, 2017), offering a more nuanced understanding of the role of employee participation in firms aiming to take advantage of the positive synergistic effects of HPWSs and digital technology on innovation. By establishing a link between signalling theory and the industrial relations literature, we argue that the signalling effect of employee influence on higher-level management decisions may diminish over time as employees increase their experience of participation, with negative effects on the HRM and digital technology signalling process. This issue deserves further investigation, opening the door for further innovative research and theoretical development.

5.2 Managerial implications

The results of this study also have managerial implications. To promote innovation, managers should implement HPWSs aimed at providing workers with abilities, motivation and opportunities to develop product and process innovation. Managers could also rely on

digital technology to enhance innovation in their organisations. Moreover, this study suggests that companies should take employee participation into consideration when combining HPWSs and digital technology.

Employee participation is key to ensuring that the combined use of HPWSs and digital technology does not subordinate employees' interests to management objectives. This combined use can undermine innovation if employees perceive that the offer of participation does not respond to their aspirations for participation. This may happen as employee experience of participation increases to cover a wide range of tactical or strategic issues, with the exception of the company's mission and goals, leading employees to misinterpret the message of the company's commitment to a mutual gains approach with the implementation of HPWSs and digital technology. As a result, companies that intend to avoid this apparent contradiction need to not only promote employee participation but also extend it to the definition of the company's mission and goals.

Such a configuration of participation is possible if it is underpinned by a genuine commitment on the part of both management and employees to a partnership aimed at ensuring the long-term viability and sustainability of the firm and its employees (Knudsen *et al.*, 2011).

5.3 Limitations and future research directions

This study relies on a large-scale cross-sectional data set, which limits the ability to unambiguously determine the direction of causality. As a result, future studies adopting longitudinal research designs will need to address this issue. Moreover, the survey imposes constraints on the construction of the variables, as it does not provide extensive question batteries for the measurement of specific concepts. Similarly, it was not possible to measure the level of employee skills, though some studies suggest that this is an important dimension when studying the influence of employee participation (Zhou *et al.*, 2019). Therefore, it would be useful for future research to analyse the interactive effect on innovation of employee skills, employee participation, digital technology and HRM practices. Moreover, our model did not consider any mediating variable in the HPWS–innovation link, though the literature underlines the need to further explore the HPWS–innovation relationship by considering different mediators (Seeck and Diehl, 2017). Hence, future research will need to test variables such as employee creativity, employee innovative work behaviour and knowledge-sharing behaviour as potential mediators of the HPWS–innovation relationship. Finally, significant differences in the relation patterns of the model may be identified when considering specific countries in Europe.

References

Appelbaum, E., Bailey, T., Berg, P. and Kalleberg, A.L. (2000), *Manufacturing Advantage: Why High-Performance Work Systems Pay off*, Cornell University Press, Ithaca, New York, NY.

Arslan, A., Cary, C., Khan, Z., Golgeci, I. and Ali, I. (2022), "Artificial intelligence and human workers interaction at team level: a conceptual assessment of the challenges and potential HRM strategies", *International Journal of Manpower*, Vol. 43 No. 1, pp. 75-88.

Ayoko, O.B. (2021), "Digital transformation, robotics, artificial intelligence, and innovation", *Journal of Management and Organization*, Vol. 27 No. 5, pp. 831-835.

Behravesh, E., Tanova, C. and Abubakar, A.M. (2020), "Do high-performance work systems always help to retain employees or is there a dark side?", *The Service Industries Journal*, Vol. 40 Nos 11/12, pp. 825-845.

Ben-Ner, A., Urtasun, A. and Taska, B. (2023), "Effects of new technologies on work: the case of additive manufacturing", *ILR Review*, Vol. 76 No. 2, pp. 255-289.

Bhatti, S.H., Zakariya, R., Vrontis, D., Santoro, G. and Christofi, M. (2021), "High-performance work systems, innovation and knowledge sharing: an empirical analysis in the context of project-based organizations", *Employee Relations: The International Journal*, Vol. 43 No. 2, pp. 438-458.

Bondarouk, T. and Brewster, C. (2016), "Conceptualising the future of HRM and technology research", *The International Journal of Human Resource Management*, Vol. 27 No. 21, pp. 2652-2671.

Bos-Nehles, A.C. and Veenendaal, A.A. (2019), "Perceptions of HR practices and innovative work behavior: the moderating effect of an innovative climate", *The International Journal of Human Resource Management*, Vol. 30 No. 18, pp. 2661-2683.

Budd, J.W., Gomez, R. and Meltz, N.M. (2004), "Why a balance is best: the pluralist industrial relations paradigm of balancing competing interests", in Kaufman, B.E. (Ed.), *Theoretical Perspectives on Work and the Employment Relationship*, Industrial Relations Research Association, Champaign, IL, pp. 195-227.

Cedefop and Eurofound (2019), *European Company Survey 2019: Quality Control Report, Working Paper WPEF20015*, Publications Office of the European Union, Luxembourg.

Chang, S., Gong, Y., Way, S. and Jia, L. (2013), "Flexibility-Oriented HRM systems, absorptive capacity, and market responsiveness and firm innovativeness", *Journal of Management*, Vol. 39 No. 7, pp. 1924-1951.

Chowhan, J., Pries, F. and Mann, S. (2017), "Persistent innovation and the role of human resource management practices, work organization, and strategy", *Journal of Management and Organization*, Vol. 23 No. 3, pp. 456-471.

Cirillo, V., Evangelista, R., Guarascio, D. and Sostero, M. (2021), "Digitalization, routineness and employment: an exploration on Italian task-based data", *Research Policy*, Vol. 50 No. 7, p. 104079.

Connelly, B.L., Certo, S.T., Ireland, R.D. and Reutzel, C.R. (2011), "Signaling theory: a review and assessment", *Journal of Management*, Vol. 37 No. 1, pp. 39-67.

Della Torre, E., Gritti, E. and Salimi, M. (2021), "Direct and indirect employee voice and firm innovation in small and medium firms", *British Journal of Management*, Vol. 32 No. 3, pp. 760-778.

Dixon, J., Hong, B. and Wud, L. (2021), "The robot revolution: managerial and employment consequences for firms", *Management Science*, Vol. 67 No. 9, pp. 5586-5605.

Drago, R. and Wooden, M. (1991), "The determinants of participatory management", *British Journal of Industrial Relations*, Vol. 29 No. 2, pp. 177-204.

Elrehail, H., Behravesh, E., Abubakar, A.M., Obeidat, S.M., Alsaad, A., Cizreliogullari, M.N. and Alatailat, M. (2021), "High-performance work systems, psychological capital and future time perspective: a cross-nations study", *European Journal of International Management*, Vol. 1 No. 1, doi: 10.1504/EJIM.2021.10038441.

Eurofound and Cedefop (2020a), "European company survey 2019: Workplace practices unlocking employee potential", European Company Survey 2019 series, Publications Office of the European Union, Luxembourg, doi: 10.2806/030551.

Eurofound and Cedefop (2020b), "European company survey 2019: Sampling and weighting report", working paper, available at: www.eurofound.europa.eu/sites/default/files/wpef20014.pdf

European Union (2019), *European Innovation Scoreboard 2019*, Publication office of the European Union, Luxembourg, doi: 10.2873/877069.

Godard, J. (2004), "A critical assessment of the high-performance paradigm", *British Journal of Industrial Relations*, Vol. 42 No. 2, pp. 349-378.

Guest, D.E. (2017), "Human resource management and employee well-being: towards a new analytic framework", *Human Resource Management Journal*, Vol. 27 No. 1, pp. 22-38.

Haar, J., O'Kane, C. and Daellenbach, U. (2022), "High performance work systems and innovation in New Zealand SMEs: testing firm size and competitive environment effects", *The International Journal of Human Resource Management*, Vol. 33 No. 16, pp. 3324-3352.

Jiang, K., Lepak, D.P., Han, K., Hong, Y., Kim, A. and Winkler, A.-L. (2012), "Clarifying the construct of human resource systems: relating human resource management to employee performance", *Human Resource Management Review*, Vol. 22 No. 2, pp. 73-85.

Kaushik, D. and Mukherjee, U. (2022), "High-performance work system: a systematic review of literature", *International Journal of Organizational Analysis*, Vol. 30 No. 6, pp. 1624-1643.

Kim, S., Wang, Y. and Boon, C. (2021), "Sixty years of research on technology and human resource management: looking back and looking forward", *Human Resource Management*, Vol. 60 No. 1, pp. 229-247.

Kloutsiniotis, P.V., Katou, A.A. and Mihail, D.M. (2021), "Examining the 'dark-side' of high performance work systems in the Greek manufacturing sector", *Employee Relations: The International Journal*, Vol. 43 No. 5, pp. 1104-1129.

Knudsen, H., Busck, O. and Lind, J. (2011), "Work environment quality: the role of workplace participation and democracy", *Work, Employment and Society*, Vol. 25 No. 3, pp. 379-396.

Kroon, B., van de Voorde, K. and van Veldhoven, M.J.P.M. (2009), "Cross-level effects of high-performance work practices on burnout: two counteracting mediating mechanisms compared", *Personnel Review*, Vol. 38 No. 5, pp. 509-525.

Meuer, J. (2017), "Exploring the complementarities within high-performance work system: a set-theoretic analysis of UK firms", *Human Resource Management*, Vol. 56 No. 4, pp. 651-672.

Minbaeva, D. (2021), "Disrupted HR?", *Human Resource Management Review*, Vol. 31 No. 4, p. 100820, doi: 10.1016/j.hrmr.2020.100820.

Nazareno, L. and Schiff, D.S. (2021), "The impact of automation and artificial intelligence on worker well-being", *Technology in Society*, Vol. 67, p. 101679, doi: 10.1016/j.techsoc.2021.101679.

Parker, S.K. and Grote, G. (2022), "Automation, algorithms, and beyond: why work design matters more than ever in a digital world", *Applied Psychology*, Vol. 71 No. 4, pp. 1171-1204.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y. and Podsakoff, N.P. (2003), "Common method biases in behavioral research: a critical review of the literature and recommended remedies", *Journal of Applied Psychology*, Vol. 88 No. 5, pp. 879-903.

Santoro, G. and Usai, A. (2018), "Knowledge exploration and ICT knowledge exploitation through human resource management: a study of Italian firms", *Management Research Review*, Vol. 41 No. 6, pp. 701-715.

Seeck, H. and Diehl, M.-R. (2017), "A literature review on HRM and innovation - taking stock and future directions", *The International Journal of Human Resource Management*, Vol. 28 No. 6, pp. 913-944.

Sharma, A. and Sharma, T. (2017), "HR analytics and performance appraisal system: a conceptual framework for employee performance improvement", *Management Research Review*, Vol. 40 No. 6, pp. 684-697.

Shin, S.J., Jeong, I. and Bae, J. (2018), "Do high-involvement HRM practices matter for worker creativity? A cross-level approach", *The International Journal of Human Resource Management*, Vol. 29 No. 2, pp. 260-285.

Smids, J., Nyholm, S. and Berkers, H. (2020), "Robots in the workplace: a threat to—or opportunity for—meaningful work?", *Philosophy and Technology*, Vol. 33 No. 3, pp. 503-522.

Strohmeier, S. (2009), "Concepts of e-HRM consequences: a categorisation, review and suggestion", *The International Journal of Human Resource Management*, Vol. 20 No. 3, pp. 528-543.

Sun, L.Y., Aryee, S. and Law, K.S. (2007), "High-performance human resource practices, citizenship behavior, and organizational performance: a relational perspective", *Academy of Management Journal*, Vol. 50 No. 3, pp. 558-577.

Tortora, D., Chierici, R., Farina Briamonte, M. and Tiscini, R. (2021), "I digitize so I exist': searching for critical capabilities affecting firms' digital innovation", *Journal of Business Research*, Vol. 129, pp. 193-204, doi: 10.1016/j.jbusres.2021.02.048.

Vrontis, D., Christofi, M., Pereira, V., Tarba, S., Makrides, A. and Trichina, E. (2022), "Artificial intelligence, robotics, advanced technologies and human resource management: a systematic review", *The International Journal of Human Resource Management*, Vol. 33 No. 6, pp. 1237-1266.

Wang, Y., Kim, S., Rafferty, A. and Sanders, K. (2020), "Employee perceptions of HR practices: a critical review and future directions", *The International Journal of Human Resource Management*, Vol. 31 No. 1, pp. 128-173.

Wilkinson, A., Dundon, T. and Marchington, M. (2013), "Employee involvement and voice", in Bach, S. and Edwards, M.R. (Eds), *Managing Human Resources: Human Resource Management in Transition*, Wiley, Chichester, pp. 268-288.

Wilson, J.H. and Daugherty, P.R. (2018), "Collaborative intelligence: Humans and AI are joining forces", *Harvard Business Review*, Vol. 96 No. 4, pp. 114-123.

Zheng, J., Liu, H. and Zhou, J. (2020), "High-performance work systems and open innovation: moderating role of IT capability", *Industrial Management and Data Systems*, Vol. 120 No. 8, pp. 1441-1457.

Zhou, Y., Fan, X. and Son, J. (2019), "How and when matter: exploring the interaction effects of high-performance work systems, employee participation, and human capital on organizational innovation", *Human Resource Management*, Vol. 58 No. 3, pp. 253-268.

Further reading

European Foundation for the Improvement of Living and Working Conditions (2020), "European company survey, 2019", [data collection], UK Data Service. SN: 8691, doi: 10.5255/UKDA-SN-8691-1.

Corresponding author

Ylenia Curzi can be contacted at: ylenia.curzi@unimore.it

Appendix

HPWS		
Description	Item scale	Variable
Training and learning		
How many employees have participated in training sessions at other locations? (% of employees)	1–7	Formal and informal training
How many employees have received on-the-job training? (% of employees)	1–7	
How important are the following reasons for providing training to employees?		
Allowing employees to acquire skills they need to do job rotation	1–4	Training purpose
Increasing the capacity of employees to articulate ideas	1–4	
How many employees are in jobs that require continuous training? (% of employees)	1–7	Skill-enhancing job diffusion
Recruitment		
When recruiting new employees, how important is that the candidate has the skills required to do the job?	0–1	Skilled employee recruitment
When recruiting new employees, how important is that the candidate has the educational qualification that are required?	0–1	
Rewards		
How many employees at this establishment received the following types of variable pay? (% of employees)		
Payment by results	1–7	Variable pay schemes
Individual performance	1–7	intensity
Team performance	1–7	
Establishment performance	1–7	
How often are the following practices used to motivate employees: offering monetary rewards	1–4	Monetary lever
Performance appraisal		
To be evaluated positively, how important is it that employees show the following behavior?		
Helping colleagues without being asked	1–4	Collaboration-oriented
Making suggestions for improving the way things are done in the company	1–4	performance appraisal
Intrinsic motivational practices		
How often are the following practices used to motivate employees?		
Communicating a strong mission and vision, providing meaning to our work	1–4	
Providing interesting and stimulating work	1–4	Intrinsic levers
Providing opportunities for training and development	1–4	
Information sharing		
Does this establishment make use of suggestion schemes?	Yes/No	Suggestion program
Which of the following practices are used to involve employees in how their work is organized?		
Meetings between employees and manager	1–3	Knowledge-sharing

(*continued*)

Table A1. Model's variables and measures

HPWS		
Description	Item scale	Variable
Meetings open to all employees	1–3	
Dissemination of information	1–3	
Discussions with employees on-line	1–3	
Job design		
For how many employees in this establishment does their job include finding solutions to unfamiliar problems? (% of employees)	1–7	Work time discretion and problem-solving
For how many employees does their job include independently organising their own time? (% of employees)	1–7	
Which of these two statements best describes the general approach to management? Managers control employees or employees can autonomously carry out their tasks	0–1	Work method discretion
Digital technology		
How many employees use personal computers or laptops? (% of employees)	1–7	Computer use
Does this establishment use robots?	Yes/No	Robots
Does this establishment use data analytics to improve the process of production?	Yes/No	Data analytics
Continued		
Does this establishment use data analytics to monitor employee performance?	Yes/No	Data analytics
Employee participation		
In your opinion to what extent have employees directly influenced management decisions in the following areas?		
The organization and efficiency of work processes	1–4	
Dismissals	1–4	
Training and skill development	1–4	
Working time arrangements	1–4	
Payment schemes	1–4	
Firm innovation		
Since the beginning of 2016, has this establishment introduced?		
Any new or significantly changed product or services:	0–1	Product innovation
New to the market		
New to the establishment but not to the market		
Any new or significantly changed process:		Process innovation
New to the market		
New to the establishment but not to the market		
Control variables		
How many people work in this establishment?		Size
Since what year has this establishment been carrying out this activity?		Years
Establishment's main activity category		Sector
How important is to regulatory developing new product, services or processes?		Strategy
How competitive the market is?		Market competitiveness
Country of the establishment		Country

Table A1. **Source:** Authors' own creation, questions and items courtesy of European Company Survey 2019