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Job well robotized! – Maintaining task diversity and well-being in managing technological changes

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ABSTRACT

In an era of emerging service work robotization, this article investigates how workers perceive job diversity in robotized work, and how those perceptions relate to job satisfaction and the perceived meaningfulness of a job. The study used a nationwide Quality of Work Life survey (QWLS) data collected in Finland in 2018 (N = 4110), and its subsample of salary earners working in a robotized workplace at the time of the study (n = 535). The data were analyzed using a correlative cross-sectional study design, descriptive statistics, ANOVA, and OLS regression analysis. Against a common belief and previous studies, the findings show that intrinsic job satisfaction at work is on the average lower in robotized workplaces than in nonrobotized workplaces. The aggregate higher job satisfaction and perceived meaningfulness of work were mostly associated with perceived task diversity depending on whether, or how extensively, the employee worked with robots. The study contributes to the scientific robotization discussions with unique empirical evidence of job diversity and well-being. Moreover, the study produces information for working life, organizations, and change management by disclosing the importance of maintaining job diversity in and after implementing technological changes.

1. Introduction

The emerging automatization and digitalization of service work have sparked a lively and reasoned debate on the anticipated impact of robotic technology on job diversity and well-being at work. Themes range from philosophical definitions of meaningful work (Smids et al., 2019) to workers' strategies of accepting of new technologies (Edwards & Ramirez, 2016), and from smart factories with new collaborative and adaptive human–machine interfaces (Kumar & Lee, 2022) to impacts of artificial intelligence (AI) on worker well-being (Nazareno & Schiff, 2021). In management studies, the questions of job satisfaction and well-being are also included in debates concerning technological changes in various contexts and levels of jobs, such as retail sector jobs (Giannikis & Mihail, 2011) and healthcare services (Mihail & Kloutsiniotis, 2016).

While the well-being of employees has been identified as an important issue from the managerial perspective (Vakkayil et al., 2017), it is fair to say that evaluating robots' role in workers' well-being and in managerial processes is still at its infancy. Human-robot interaction has been studied more in laboratories and pilot-level trials than on the shop floor level. Psychological and behavioral aspects in organizations with various work settings have been dealt traditionally as a performance issue and mostly in human-human relationships. Today, however, employees are also expected of digital competence and skills to interact with machines varying in intelligence. Robotic technologies with AI are gradually employed into expert tasks, which means that they will be an equal challenge for managers faced with new types of organizational actors in terms of performance, job qualifications, skill demands, and their impact on human capital in the workplace (see e.g. Dixon et al., 2021).

This empirical study contributes to the theoretical discussion of the impact of robotic technology on job diversity and job well-being by investigating whether robotization has so far added to diversity or, on the contrary, made work into more monotonous, and furthermore, how this reflects on job satisfaction. The novelty of this study lies in on its focus of job satisfaction in robotization, which has remained an understudied topic, at least when it comes to study designs aiming for generalizability.

As a default, robotizing work does not exactly promise a flexible and diverse working environment for human employees. The robotic logic so far has required the operating space to be as standardized and scheduled as possible. Robotization as a planned organizational change (Van der

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Voet, 2014) is a case in point of a situation where the management has an acute need to (re-)formalize operations. In robotization, organizations need to formalize their operations and single processes to standardize various procedures and coordinate the actions of employees (Richter, & Brühl, 2020). Work can be regulated, optimized, and formalized to the point of a mechanistic structure (Volberda, 1996). Working pace, then, will typically be bound to the robot because robotization is, first and foremost, a significant investment expected to generate returns. Hence, when robots as mechatronic machines dictate the structure of work, it certainly follows a mechanistic structure instead of an organic, flexible, and creative working environment.

The discussions on diverse work are usually based on the premise that diversity is a resource that makes work more gratifying and prevents tediousness (Harju & Hakanen, 2016; Loukidou et al., 2009). A diverse job description is associated with interesting and challenging tasks as opposed to mundane routine work. Such job variability appears to enjoy appreciation in working life cross-culturally (Alasoini et al., 2014, p. 10; Gorenak, 2004; Kumar, 2018; Lavoie-Tremblay et al., 2008). There are examples of task diversity being integrated into everyday work by employers who have recognized the risk of demotivating 'routine traps' (Eriksson & Ortega, 2006; Mathe et al., 2011, p. 31). Job rotation is one of the ways to reorganize work and allow employees more variation in daily tasks. While job rotation has a long history of improving employee well-being (as well as productivity) in industrial manufacturing (Vickery & Wurzburg, 1998, p. 12), it has been less common in highly hierarchical organizations, especially those characterized by short-duration employment (Eriksson & Ortega, 2006).

However, empirical research on perceived job diversity, well-being at robotized work, and any comparative studies between robotized and nonrobotized work are lacking (Smids et al., 2019). In this study, we focus on the understudied questions of job diversity, job satisfaction, and perceived meaningfulness in robotized work and relate them to the research on technological changes conducted in sociology and psychology. Earlier studies on change readiness in the workplaces show how change management needs tools to predict the impacts of the change, not only on the conversion of the procedures but also on employees' perceptions and well-being (Abdinnour-Helm et al., 2003).

Our key question in this study is whether diverse job design is associated with job satisfaction and the meaningfulness of work in robotized job descriptions. We also ask if the extent of working with robots plays a role in the relationship between diverse job design and job satisfaction and perceived meaningfulness. The objectives are to present empirical evidence for the theoretical debate on robotized work and to elaborate on the concepts of diverse job, job satisfaction, and perceived meaningfulness of work. The study focuses on robotization as a form of work-related technological change that proceeds more as a marathon than a quick and one-time race (Santilli, 2012; Wang et al., 2017). Robotization has specific relevance at a time when robots – after 60 years of evolution – are also emerging in various services, possibly renewing even human-centered work as we know it.

The next section of the article presents the background of sociotechnical changes at workplaces, industries, and societies. Accepting that robotization is a society-wide phenomenon extending its coverage from traditional industries toward the fields of the service sector, we emphasize the need to include social scientific examination into the palette of robotization studies. This is necessary for the actualized innovations in the workplace are never just about technologies, but rather complex combinations of technical and social factors. In the empirical part of the article, we seek information about how robotization is reforming the world of work. The discussion section provides an analysis of job diversity and job satisfaction after robotization and suggests implications for how robotization should be sociotechnically managed in workplaces.

2. Inclusive, rewarding, and meaningful work in robotization

2.1. Historical perspective

Since the 1960s and 1970s, investments in technological innovations have accelerated in the developed industrial countries to speed up economic performance (Lindbeck & Snower, 2000). This, together with rising sociotechnical values acknowledging the interplay between technological, personal, and community aspects, have led to major efforts to improve the quality of working life, improve employee participation, and utilize employees' skills in implementing technological innovations (Trist, 1981). Advanced development programs were created to simultaneously improve the quality of working life and labor productivity (Emery, 1982; Koistinen, 1989; Trist, 1981).

Beside technological innovations, organizational innovations have played an essential role in industrial development (Koistinen, 1989, p. 261) and the robotization of services hardly will make an exception. A sound way to design and implement robots for unstructured or semi-structured service environments includes a broad understanding of the characteristics of the work and human resources. Robotization has the potential to shake our traditional conceptions of manual and mental work. Understood as forms of digital automation, increasing "computer capital" (Autor et al., 2003), or "computerization" (Frey & Osborne, 2017), robots are predicted to affect not only the content of manual blue-collar jobs but also white-collar office jobs. How to define the probability of future automation (Coelli & Borland, 2019) or predict the displacement of labor (Acemoglu & Restrepo, 2019) in different occupations and professions rely on futurology, but it seems that, along with robotization, categories of routine and nonroutine jobs are losing their self-evident characters. Robots as a form of automation, and especially service robots as a form of interactive automation, extend the academic debates about changing work and workplaces, but they also extend the organizational issues into new levels of individual reasoning.

The very question of how human behavior can contribute to productive operations has been discussed in organizational studies. Many managerial interpretations, theories, and strategies have been proposed to explain how to make human contributions best serve the purposes of productive and profitable goals. The early schools of Scientific Management, Taylorism, and Fordism analyzed and subsumed the human traits rationally to the conditions of mechanized mass production. In schools of industrial and work psychology, such as the human relations movement of the 1930's, the personal well-being of workers was likewise a factor of productivity. As Daniel Bell – one of the prominent critics of the human relations school (see Simpson, 1989) – put it in the 1950's, in Taylorism "each man's work could be measured by itself; the time in which an operation could be performed could be established 'without bargaining' as an impersonal 'standard time'." (Kerr & Staudohar, 1986, p. 113).

During and after WWII, in the wake of profound ideological and political reconstructions of industrial economies, consensual bargaining processes were adopted throughout advanced industrial countries. The participative role of labor unions was widely acknowledged, and mutually binding collective agreements became a new model in industrial relations. A need to achieve social stability in unstable conditions motivated these social political innovations, but soon the effects of intensified mass production and automation also called for new skills, roles, and qualifications from the workers. On the other hand, it was not all explicit that human work should be shaped by new technologies in a rewarding way.

Already 70 years ago, the question was raised whether automation would lead to an increased specialization of jobs, narrowing the scope of workers' tasks and, hence, decreasing the meaningfulness of work (Walker, 1950). Starting from James Burnham's managers (Burnham, 1972; McLaren, 2011), Peter Drucker's knowledge workers (Drucker, 2002; Cortada, 1998), or Bell's (1973) visions of the postindustrial society, it was knowledge intensiveness (e.g., Fagerberg et al., 2012) that

was now a widely referenced social, political, and economic frame for rethinking industrial relations, labour markets, and the use of human capital in managerial processes (e.g., Brint, 2001).

New managerial strategies were developed to respond with ideas such as job enrichment and job enlargement (e.g., Chung & Ross, 1977). In the 1960s and 1970s, organizational and behavioral studies focused on computer-aided automation of work and the concerns of future employment. The introduction of new technologies started to call for new types of "technology agreements", that is, agreements on how to evaluate the roles and effects of automation in negotiations between workers and management (Child, 1980). Robotization is understood as requiring active change management and as a planned and widescale change, it is highly dependent on the style of leadership (Buchanan, 1982; Van der Voet, 2014).

The importance of shared leadership, also called the participatory management style (Laihonen, 2015), emerged in the 2000s. Now the goals of management were viewed more as empowering the employees, emphasizing mutual confidence, and enhancing the autonomy and meaningfulness of work by sharing decision-making with individual workers and self-organizing production units or teams (Lee et al., 2014; Zhang & Bartol, 2010). Indeed, in empirical studies, shared leadership has been found to enhance employees' autonomy and the opportunities to enrich and craft their work both on a daily basis and in the long run (Mäkikangas et al., 2016; Wrzesniewski & Dutton, 2001). From the employees' perspective, job crafting refers to modifying the elements of the job to better fit their personal motivation, skills, and interests (Harju & Hakanen, 2016). From the organization's perspective, job crafting entails allowing task diversity and the staff members to take more proactive roles in their jobs, e.g., learning new skills and employing individual strengths at work (Harju & Hakanen, 2016; Mäkikangas et al., 2016).

2.2. Diverse work

The framework of this study originates from theories of job enrichment and its associations with job satisfaction and perceived meaningfulness (Clark & Oswald, 1996; Fahr, 2011; Lysova et al., 2019; Parker & Grote, 2019). We adapt the theoretical framework to the specific context of robotization. Job enrichment is understood as a managerial strategy toward a diverse job design and enhanced employee well-being. Garcia et al. (2019) showed how job enrichment orientation in the workplace benefits particularly the individuals' intrinsic job satisfaction, that is feelings about the work itself, while enrichment efforts do not have the similar effect when it comes to extrinsic job satisfaction (e.g., compensations and the security of the job).

In this article, diverse work is considered as a subjective evaluation of job's "richness" as a counterpart to monotonous work. Hence, diverse work is not to be confused with a dichotomy between wide-range and specialized skills. Regarding robotization, the perceived repetitiveness of work forms a most relevant research topic. Industrial robots usually take over certain elements of a mechanistic job, giving human workers the more passive or operative role of controlling and monitoring the machine(s). Operating a robot in manufacturing production has shifted people from, say, assembling and packaging goods manually to occupying beside an automatic line or in a monitoring center. As opposed to job enrichment, the change may result in reduced diversity of tasks and responsibilities when multisensory and haptic work is replaced by monitoring work emphasizing only visual vigilance.

Furthermore, depending on the contextual factors, such as the line of work, monitoring work may be either more passive or require constant attentiveness. For instance, Tzafestas (2010, p. 31) has argued against the claim that automation reduces workload and evidenced that monitoring work requires a considerable amount of mental resources, vigilance, and management. If robotizing means that monitoring tasks will take over a major part of the work, it would then increase the employee's cognitive workload instead of realizing the promise of robots increasing well-being by liberating workers from monotonous routine work (cf., Moor, 2006).

In some cases, robotization replaces repetitive work, and in other cases, it is the cause of repetitive work. In a similar vein, robotization can be a threat to psychological well-being but can also support the feelings of meaningfulness and increase job satisfaction if employees find that their work is changing and can be crafted in a positive and constructive direction (Nygren et al., 2020). During technological changes, people do value increased productivity, accuracy, and safety (Hancock, 2014). However, as essential as efficiency and safety are in robotized work, they are not sufficient when measuring the satisfactory reorganization of robotized work (Maurice et al., 2018). We argue that a varied job description is one of the factors that management should take into account in and after robotization. Changes in task diversity can be seen as either support or threaten job satisfaction and job's perceived meaningfulness.

Challenges in monotonous versus diverse job descriptions are similar to those identified in prior debates concerning organizations in automated production. However, with service robots, we will face much more volatile contexts for automated machines and operations. In a factory, it is the overall machinery that defines the rationale and pace of human actions. People are trained and accustomed to orient and operate in ways that support the machinery's expedient and synchronized technical functions. In services, the way machines and AI could give added value to operations is not as evident. The first dilemma in human-centered service work derives from the extraordinary variation of possible human responses in the extreme variation of social environments.

When it comes to the workers in service organizations, they are more likely to be experts in human and social conducts than in technology. As the first arduous efforts to program expert knowledge into computers in the 1980's aptly showed, to implant human know-how of everyday chores into artificially intelligent machines is not an easy task. Nor is it easy today, although both the hardware and AI have taken their obvious, giant leaps. Even though the technical challenges may be solved in time, the question remains whether the service worker of the future must understand and co-design the logic of behavioral algorithms that define or frame the elements of the job. Ensuring job satisfaction in robotized service environments may require quite novel and collaborative approaches in assessing their interconnected sociotechnical requirements.

2.3. Job satisfaction

Job satisfaction refers to individuals' general attitudes toward their work and the evaluation of the benefits derived from working (Clark & Oswald, 1996; Ghani & Jayabalan, 2000). However, in some cases, such as in this article, job satisfaction is restricted to refer to the intrinsic, psychosocial job satisfaction (Engström et al., 2005). Here, extrinsic motivators, such as the monetary values of work, have been excluded from the concept of job satisfaction (Ruuskanen et al., 2016). Thus, an individual with a high level of job satisfaction is considered to have positive attitudes toward the working environment and the job itself.

Subjective perceptions and attitudes of employees are emphasized in participatory change management. In organizational changes, it is possible only to perceive the behavior of the employees, not the underlying acceptance and job satisfaction, which are the measures of the internal feelings about the changes – and which also will dictate the personal level of commitment toward the (changed) work (Riketta, 2009). When considering job satisfaction as a psychosocial construct, that is, consisting of cognitive, affective, and behavioral dimensions, low job satisfaction has been associated with decreased work motivation in the form of quitting, absenteeism, and lower productivity (Hulin & Judge, 2003). Hence, it is important for the change management to predict also the nonvisible, underlying factors that could threaten a successful change in the workplace.

According to a bibliometric analysis on research done in 2015–2019,

job satisfaction is considered to be an important goal in technological changes (Santana & Cobo, 2020). That is to say, besides the productivity gains, organizations look for other sociotechnical values in technological changes. In the emphasis of sociotechnical values, robotization and its acceptance among employees is not only about the technology but also about work-related social practices (Yuan et al., 2019). In successful robotization, robots are implemented in the workplace with consideration for individual and community well-being.

Robots contributing to working life as improving people's well-being and job satisfaction is an issue that has received commendable attention, but unfortunately only in theoretical studies. Already 35 years ago, Hollon and Rogol (1985) made a case for the need of empirical studies about how increasing robotization affects people and society. In their groundbreaking paper, they concluded that psychological and social research have been steamrollered by the predominance of technological research. Only three empirical nontechnical studies were discovered that concerned psychosocial factors of robotization (Hollon & Rogol, 1985). What is quite noteworthy is that this picture has not changed very much over the decades. One study from the late 1980s stated that computer-aided manufacturing (CAM) causes industrial workers stress and dissatisfaction because of constant monitoring and arbitrary error conditions (Edwards, 1989). A couple of years later, Gamst and Otten (1992) reported that there was a minimal or nonexistent difference in job satisfaction between the employees in robotized and nonrobotized workplaces.

All in all, job satisfaction or any other dimensions of psychological well-being in and after robotized industrial work have received only little attention. As reviewed by Savela et al. (2017), studies concerning social acceptance of work-related robotics have focused almost entirely on novel robots in the service sectors (e.g., care robots and educational robots), not robots in the manufacturing industry, where they have established a rooted and constant status.

Job satisfaction has been acknowledged playing as a part in successful organizational changes (Ghani & Jayabalan, 2000). However, the empirical findings do not always appear particularly consistent. While some studies show that job satisfaction correlates positively with attitudes toward technological changes in the workplace (Lipińska-Grobelny & Papieska, 2012), among Finnish nurses, higher job satisfaction was found to be associated with lower attitudinal readiness for robotization (Turja et al., 2019). This controversy implies that there are more profound aspects when it comes to robotizing various fields of work. These underlying aspects can refer to industrial qualities and differences, such as the level of technological advancement and the role of individually perceived autonomy and meaningfulness in various occupations.

2.4. Meaningful work

When work is perceived as meaningful, it arouses positive feelings such as a sense of achievement and a feeling that the work is worth the effort and commitment (Nelson & Simmons, 2003; Steger et al., 2012). It has been found that management can enhance the motivation and proactivity, especially those employees who perceive their work as meaningful (Binyamin, & Brender-Ilan, 2018). A recent review article further shows that job crafting opportunity is one precursor for meaningful work (Lysova et al., 2019). At the same time, low level of autonomy can decrease the feeling of meaningfulness. Thus, robotization has characteristics that make it both a potential promoter and a threat to autonomy and meaningful work (Naastepad & Mulder, 2018; Parker & Grote, 2019). The ideal situation would be for employees to be able to choose and delegate tasks to robots. However, in robotized industrial work, robot use is mandatory for those whose jobs are essentially connected to the robotized production line. In these cases, autonomy and meaningful work can still be promoted by sharing leadership to smaller units in the organization.

Smids et al. (2019) opened a scientific discussion about the possible contradiction between robotization and maintaining work as meaningful. They argue that robots can support the employees' perception of the meaningfulness of work if the robots replace just the right amount of the laborious and monotonous tasks. Too little assistance would detract from the purpose of using a robot, and too much assistance could generate feelings of meaningfulness because "apparently a robot can do my job". The favorable amount of robotic assistance would allow employees to delegate routines to a robot but at the same time withhold the gratifying tasks for themselves. Indeed, meaningful interaction at work is relevant when it comes to human-human interaction *versus* human-robot interaction. A common argument for the introduction of service robots is that they will release human resources from routine tasks to meaningful human-human interaction by allowing professionals to do more of what they have expertise on. But will, say, care personnel have more time to socialize with patients if robots take over some of their tasks (cf., Parks, 2010)? Such optimistic expectations have often paved the way for the integration of technological innovations into workplaces, but what are the actual gains and advantages? The working time saved by automation may as well be allocated elsewhere or have it rationalize the decrease in employee dimensioning.

2.5. Research questions and hypotheses

By focusing on the effects of a diverse job description and robotization on job satisfaction and perceived meaningfulness of work, we follow the approaches of Clark and Oswald (1996) and later Fahr (2011), where job design – and, more precisely, job enrichment – has a positive impact on job satisfaction. It is first investigated how workers perceive their task diversity in robotized and nonrobotized work, and secondly how that perception is connected to their intrinsic job satisfaction and the perceived meaningfulness of their jobs (JOB-SATM).

Combining findings of job enrichment predicting job satisfaction and perceived meaningfulness (Fahr, 2011; Lysova et al., 2019; Parker & Grote, 2019), we hypothesize that JOB-SATM is reported higher among employees with more varied job descriptions in robotized and nonrobotized workplaces.

H1. Job diversity associates positively with JOB-SATM.

Next, we add robotization as an interaction variable following the theorization of Smids et al. (2019), where robots are viewed as enabling work's meaningfulness if they take over monotonous tasks and thus give the human employees the opportunity to use the extra time for performing more pleasant and socially rewarding tasks. We hypothesize an interaction between job diversity and the extent of working with robots, and we presume that those employees who have less varied jobs and who work with robots more extensively have a lower level of JOB-SATM.

H2. Working extensively with robots while having a less diverse work description associates negatively with JOB-SATM.

The hypotheses are also illustrated in Fig. 1 presenting the research model.

3. Data and methods

This study uses the Finnish QWLS data collected in 2018. This survey, undertaken by Statistics Finland, yielded national interview data and provides a large and presentative sample of Finnish wage earners (N = 4110). QWLS surveys have been conducted since the year 1977. The survey includes questions about these workers' physical, mental, and social well-being and the working environment and the content of work. The most recent QWLS data used in this study included, for the first time, a module on robotizing work.

For this study, we took a subsample of wage earners working in a robotized workplace at the time of the study (n = 535). The sample consisted of various fields of work. The largest group (n = 152) of the respondents were industrial or construction workers, while 123 of the

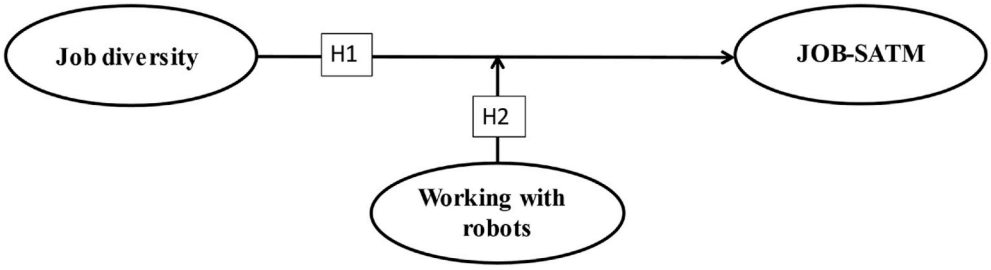

Fig. 1. Research model where job diversity and the extent of working with robots are associated with intrinsic job satisfaction and perceived meaningfulness of work (JOB-SATM).

respondents worked in science and technology and 114 in business and retail. The rest of the respondents (n = 146) worked for example in the healthcare and social sector or in agriculture.

3.1. Dependent variable

Departing from general approaches to job satisfaction, we constructed a sum variable that observes a set of specific nonmonetary, psychosocially emphasized dimensions of job satisfaction and meaningfulness (cf. Ruuskanen et al., 2016). The JOB-SATM items in the QWLS include questions such as how meaningful and important respondents perceive their work, and how satisfied they are with their jobs or with the social relationships in the workplace. Perceived meaningfulness consisted of one direct question, and job satisfaction included seven items. The items of JOB-SATM are described in Appendix A. The Likert scales from 1 to 5 were equalized among the eight items, after which the higher scores indicated a higher level of JOB-SATM.

In our data, job satisfaction and perceived meaningfulness reached a good internal consistency ($\alpha = 0.78$) that would not have been decreased if the item of meaningfulness had been excluded. The use of a joint-measure variable can be rationalized when a significant positive correlation exists between the two (Inglehart & Klingemann, 2000), which was realized here ($r_s = 0.39$; $p < .001$). Moreover, this composite variable is theoretically justified because both job satisfaction and perceived meaningfulness can be viewed as measuring the same latent phenomenon of motivation psychological, subjective well-being at work.

3.2. Independent variables

Of the 535 respondents who worked in a robotized workplace, 264 (49%) worked personally with robots. The majority of the respondents (79%) came from manufacturing industries while 21% worked in services. The extent of working with robots was applied in the multivariable analysis using three categories: not working with robots firsthand, working with robots half or less than half of the working time, and working with robots most of the time. Not working with robots was used as a reference category because of the meaningful interpretation and since it had the greatest number of observations.

Job diversity was measured with a statement "Do you find your work more varied or monotonous?" and a response scale from 1 to 4. The identical question form has been proved reliable and valid while used in previous waves of the QWLS, after careful pretesting for comprehensibility and appropriateness. As a more robotization-specific question, the respondents were asked if, in their opinion, robots had freed them to do more interesting tasks at work.

The distributions of age, gender, and education in the samples depending on robotization are presented in Appendix B. The control variables used in the multivariable models that included respondents in robotized workplaces were age (Range 16–68; M = 43; SD = 11.31) and gender (65% male). The high percentage of male respondents in this subsample is a result of the gender imbalance in different lines of work. Most robotized work can be found in the manufacturing and construction industries. Level of education and the employment years with current employer (M = 10.7; SD = 12.1) were dropped from the presented analysis as insignificant control variables. However, the regression models are controlled by four background variables: age, gender, education, and working history.

3.3. Analysis

Descriptive results are reported in percentages, means (*M*), standard deviations (*SD*), and Spearman's correlation coefficients (r_s). Differences between groups were tested with ANOVA (*F*) complemented by the Bonferroni post hoc tests. The OLS regression analyses are reported by unstandardized (*B*) and standardized (*Beta*) coefficients, standard errors (*SE*), statistical significance (*p*), and the predictive power of the model (R^2). To test our second hypothesis, an illustration of a two-way interaction between job diversity and the extent of working with robots was produced.

4. Results

The analysis in this study began by describing the data and the distributions of JOB-SATM. Before limiting the analysis to robotized workplaces, the difference in JOB-SATM between robotized and nonrobotized workplaces was tested. JOB-SATM was higher among employees in nonrobotized workplaces ($M = 35.17$; $SD = 0.77$) than in robotized workplaces ($M = 34.25$; $SD = 5.26$; $F(1) = 16.49$; $p < .001$).

Altogether 264 respondents reported working personally with robots in robotized workplaces and 19 percent of them worked with robots for most of the working time. The same proportion (19%) of respondents worked with robots up to half of their working time and 63 percent less than that. A quarter of those (n = 97) who worked with robots for more than a quarter of their working time reported that robots had freed them up to do more interesting tasks at work, while half of them stated the opposite and a quarter could not tell if there was a difference.

Those reporting that robots had freed time for more interesting tasks had a higher JOB-SATM ($M = 35.19$; $SD = 5.41$) than those who thought robots had not freed time for more interesting tasks ($M = 31.61$; $SD = 5.53$; $F(3) = 2.97$; $p < .05$). Consistently, JOB-SATM also had a moderate correlation with job diversity ($r_s = 0.274$; $p < .001$), thereby lending support to our hypothesis H1.

The regression analysis in Table 1 provides evidence that supports hypothesis H2. In robotized workplaces, higher JOB-SATM was associated with the diversity of the job depending on how much of the employee's time was spent working with robots. The variables in the model explained nine percent of the variance in the JOB-SATM (adjusted $R^2 = 0.085$).

Diverse job description and the extent of working with robots together had significant explanatory power in explaining JOB-SATM. The two factors depended on each other in a co-explanatory model of JOB-SATM implying that higher job satisfaction and meaningfulness are associated with more varied job description, depending on how extensively the employee works with robots. This mechanism was further

Table 1
Job satisfaction and meaningfulness in robotized workplaces (N = 534).

	Unstandardized Coefficients		Standardized Coefficients	
	B	SE	Beta	P
(Constant)	30.669	.462		<.001
Age	−.006	.006	−.014	.344
Female	−.705	.147	−073	<.001
Extent of working with robots (not at all)				
Less than half of the working time	−1.946	1.293	−.089	.132
More than half of the working time	−6.151	2.316	−.138	.008
Job diversity	1.824	.104	.277	<.001
Job diversity * Does not work with robots	−.127	.092	−.021	.166
Job diversity * Works with robots <50% of the time	.265	.402	−.039	.509
Job diversity * Works with robots >50% of the time	2.051	.821	.130	.012

examined by drawing the slopes of the two-way interaction.

The interaction effect between working with robots and job diversity predicting JOB-SATM is presented in Fig. 2. Those respondents who did not work personally with robots drew an almost perfect linear slope, indicating that the more varied the job is the greater the job satisfaction. However, as the most significant finding, those who worked extensively with robots and found their work lacking in variability were at risk of having very low JOB-SATM. As the gray line indicates, in that scenario, JOB-SATM is at its lowest, and as job diversity increases, JOB-SATM also reaches higher levels.

5. Discussion

This study examined perceived job satisfaction and meaningfulness in robotized jobs by focusing on the question of how job diversity is perceived in different-level robotized work. We first learnt that JOB-SATM was on average lower in robotized workplaces than in non-robotized workplaces. Moreover, we found that in robotized workplaces, JOB-SATM was on average lower among those working with robots than among those not working with robots. The finding is partly due to work perceived as monotonous. Supporting our first hypothesis, JOB-SATM was higher among those employees who reported having more diverse job descriptions than among those with less diverse job descriptions. Thus, our study provides additional evidence on how job diversity and job enrichment have positive impact on well-being at work (Clark & Oswald, 1996; Fahr, 2011; Harju & Hakanen, 2016; Loukidou et al., 2009). Only this time, we can show that this is also evident in workplaces that have robotized their operations.

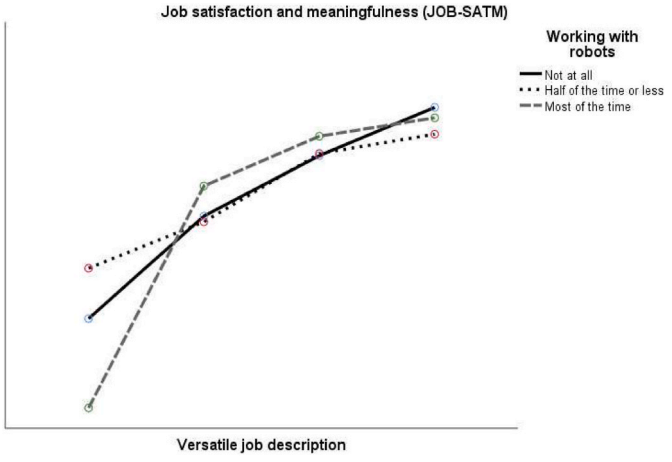

Fig. 2. Interaction between working with robots and job diversity predicting JOB-SATM.

The importance of job diversity on well-being at robotized work was emphasized when JOB-SATM was found to be higher among male respondents who worked extensively with robots but reported having a more diverse job. This supported our second hypothesis because, among workers who spent more than half of their working time with robots, JOB-SATM depended on the amount of job variability. In other words, higher well-being in the form of JOB-SATM was reported by those who worked extensively with robots but who could still maintain or increase the diversity of their job descriptions. Conversely, JOB-SATM decreased when diversity in robotized work was perceived as poor. In robotized workplaces, job diversity and the extent of working with robots explained, together with gender, about ten percent of the variation in JOB-SATM. This is considered a noteworthy result of predictive power since job satisfaction is obviously also strongly dependent on other internal and external aspects and stressors besides robotization.

Those who were working extensively with robots showed the greatest increase in JOB-SATM via improved job diversity. In fact, job diversity in robotized workplaces does not seem to form a significant predictive factor of JOB-SATM unless the employee personally works with a robot most of the working time. Again, higher job diversity emerges as a significant factor in JOB-SATM. This supports the views where the content of work should be deliberately and methodically enriched when work is at risk of regressing into monotonous and unsatisfactory routines. This is in line with the classical theories of job design (Emery, 1982; Koistinen, 1989; Trist, 1981) and a European study, where job satisfaction was concluded to be reached more probably by a modern job design of job enrichment than by Tayloristic job design and clear yet tedious unitasking (Fahr, 2011). On a practical level, this would suggest a change to the current situation where those who work with robots seem to have on the average less opportunities for learning and development (Zubrycki & Granosik, 2016). Instead of continuous learning at work, robotization may have disposition to over formalize work, where optimized operations are dictated top down (cf., Richter, & Brühl, 2020).

The increased JOB-SATM as an indicator for psychosocial well-being at work can be partly explained by a higher sense of meaningfulness when the technologized work with its novel demands has given employees opportunities to grow and learn new ways of performing their work (Smids et al., 2019). At the same time, those who worked with robots most of the time, and perceived having lower-level job diversity, had very low levels of JOB-SATM. This profile of workers working extensively with robots can be considered as a vulnerable group of workers when it comes to technological changes, and hence, in special need of employer engagement (Santana & Cobo, 2020). The importance of preventing work from degenerating into total repetitiveness must be emphasized, even in cases of robotization and automatization.

Indeed, as an almost cautionary finding, this study showed how an extensive amount of working with robots can affect employees' job satisfaction if the robot makes the work repetitive. This finding sets the expectations of emerging service work robotization in a special light. For example, care robots are considered to have the potential to free nurses from routines and allow them to spend more time with patients. Yet, at least for now, robotization has not been able to replace dull tasks with more interesting tasks, as our results demonstrate. On what grounds is this expected from service robotization, then? Can service robotization escape the routine trap by allowing the workers more diversity and job crafting? Keeping work from degenerating into monitoring tasks is a significant part of this challenge. According to Tzafestas (2010, p. 31), monitoring work has a negative quality whether it is unstimulating and dull or requires a high level of vigilance.

The respondents who reported using robots for only half of their working time or less, had only little variation in JOB-SATM. This finding underlines the importance of moderation when it comes to changes in work. It would be important to consider moderation in both the amount of work with robots and the golden mean between routine work and more challenging tasks in order to support well-being at work. Balancing

the routines and more challenging tasks to enhance well-being at work needs more research. One important reason for this is that routine work seems to have a particularly bad reputation these days. Almost as a myth to be debunked, future robotization and digitalization are narrated as something that liberates people from routines to do only cognitively demanding work. For what reason this is understood as a positive development, is questionable.

It is staggering how Hollon's and Rogol's observations from 1985 still fit the current situation, where robotization is discussed in two extreme camps with opposite expectations: the enthusiasts believe that robots will free us forever from meaningless routine work, and the skeptics dread the dystopia of meaningfulness, when all work will be done by robots. The discourse where robots are advocated as multitasking and autonomous actors who will free us of dull work obligations is certainly ahead of its time. In the era of unitasking robots, it is more valid to assess the challenges and possibilities in the interplay between humans and robots. One of these is the *opportunity* to maintain diversity of work even when working with robots – or the *risk* of work and its pace being determined solely by robots.

As Lindbeck and Snower (2000) suggest, the introduction of computerized machines not only created new demands but also brought new assets to employees and organizations. Today, when it is almost commonplace to speak of intelligent and socially interactive machines as new generation robots, we can even go further and say that computerization in organizations also has a kind of reverse implication. Along with self-learning and co-operative robots and robotic systems, the production procedures, and especially services, must be designed to be more responsive and sensitive to human behaviors.

Flexibility of workers must comply with flexibilities of robotic applications, where the borders between human and robotic tasks do not necessarily remain constant, as has been the case in traditional automation. At least in principle, the division of labor can change and evolve through the learning processes of *both* humans *and* machines. Workers must also learn about how their machines can learn. Therefore, we think it is important to study and understand more profoundly the individual perceptions and interpretations of reorganizing work in increasingly flexible work contexts.

Robotization is the latest and perhaps the most sophisticated phase in a long and pervasive road toward automated, productive work. Nowadays, it includes also service tasks, which are traditionally personal and even sensitive in their nature. While robotization changes the nature of these tasks, nursing homes will not be called "factories" or "production units". It seems evident that, instead of relying on the old concepts, new automation trends must be modified and adapted to fit for new, post-factory realities. The scope of robot applications will be diversified, and hence their use options must be diversified, too (cf., Smids et al., 2019).

Technologies have always both intended and unintended consequences, which means that their development is more or less a trial-and-error-game. This makes an obvious challenge for workplaces and change management. Even though corrective moves after hasty decisions are sometimes the reality in technological changes (Sanchez & Heene, 1997; Santilli, 2012), the change intended strategies benefit from knowledge-based management building on bottom-up information. Shared leadership and employee participation are viewed as building blocks for successful organizational changes (Döös & Wilhelmson, 2021). In the complexity of technological changes, it is most rationalized to move from hierarchies to networks (Laihonen & Huhtamäki, 2020).

As a limitation, the data did not allow organization-level analysis. One direction for future research is to take up this topic in individual organizations, whether in case studies or multilevel study designs. More information is needed on how the perceived job diversity correlates with robot acceptance and job satisfaction among employees. Cross-culture comparisons would be important to gain information about how job diversity associates with macro-level factors such as technology, skill intensity, and productivity in a country. The findings in this study are generalizable to the Finnish salary-earner population only and would benefit from additional cross-cultural evidence. However, the problem lies in availability of comprehensive comparison data. In general, the knowledge about the effects of new generation robots on working life has been quite limited. Further research is essential to produce predictions of humans and robots working together in a socially acceptable manner.

Finally, as one limitation of the study, we cannot claim more than theoretical causality between job diversity and well-being at work. Repeated cross-sectional study designs modeling JOB-SATM and its explanatory factors will become possible in the future, after the new waves of QWLS. When evaluating the results, it is also good to remember that in 2018, only 21% of those working in robotic workplaces worked in the service sector. It is to be expected that this share will increase in the future, and at the same time technological applications will be diversified.

6. Conclusions and implications

From the perspective of employee well-being, work can be considered well robotized when it is reorganized in such way that it succeeds to maintain the diversity of work. Diversity can be achieved by managing changes in collaboration with the personnel and, for example, seeking a balance between routine work and more challenging tasks in individual job descriptions. Our study shows how maintaining diverse work is something to strive for in change management, especially in cases where most of the working hours include working with a robot. For organizations to hold on to Tayloristic views of human workers as a part of the machinery is not an appropriate mindset at this time and age, where increased flexibility is a virtue for workplaces, men and machines alike (Laihonen & Huhtamäki, 2020). According to our findings, working mechanically with a robot carries a risk of lower job satisfaction and perceived meaningfulness of the work, which can result in negative attitudes toward the work or the workplace, as opposed to commitment and motivation. On the other hand, working with new technologies can be viewed as a possibility to life-long learning at work.

Beside the empirical approach contributing to the scientific discussions, our study provides important information for workplace level actors about the extent to which robotized work affects task diversity and well-being at work. By forwarding this information to change management, we trust that it will give employers opportunities to make efforts to promote change readiness and job satisfaction among their employees (Abdinnour-Helm et al., 2003). What this study particularly implies is that in the objective of minimizing risks of employees' negative reactions in technological changes, it is important to prevent jobs regressing into tedious routines.

In goals of improving diversity and well-being at work without compromising productivity, one practical solution is job rotation with an additional preference of sharing leadership among different teams or units. Since this is not a case of 'one solution fits all' and because of the great variation in the motivational needs of different employees in different organizations and various sectors of work, the advisable thing is to plan robotization, and any organizational changes, together with the personnel. As experts by experience, the employees hold much of true knowledge about the practices related to everyday work.

The research on supporting job crafting to allow employees to tailor their needs is decidedly convincing (Dubbelt et al., 2019; Harju & Hakanen, 2016), and this becomes especially relevant during technological and other organizational changes. What would be a more relevant time and place to reorganize work? Job rotation, integration of tasks, and learning across tasks have been acknowledged methods in sharing leadership among different level employees. New technology emerging in a wider range of working sectors calls for such dynamic operations more than ever before. Understanding the human and social factors in robotization is essential in the objective of accomplishing organizational changes in a successful and socially acceptable manner.

Returning to David A. Buchanan's (1982) notion of the pivotal role of

management in technological changes, we are inclined to propose a what would be a dawning management style in increasingly robotized working life. Managing technological changes should be based more on job-tailoring than Taylorism, which implies an objective of both giving emphasis to human and social factors in principle and sharing leadership in practice. When it comes to the theory building of managing robotization, this study shows that diversity in robotized work associates with job satisfaction. However, this entails an ambivalent premise where robots can either decrease or increase routine work. This ambivalence should be acknowledged as a factor in every empirical study and the variety of contexts in robotization.

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Statements on ethics and conflict of interest

The study was conducted according to the ethical norms and data management plan.

Declaration of competing interest

None.

APPENDIX A

Job satisfaction and the perceived meaningfulness of job (JOB-SATM) was measured in a sum variable consisting of the following items:

Item	*Mean*	*SD*
How satisfied are you with your current job?	4.13	0.76
How satisfied are you with the possibilities of professional development?	3.74	0.94
How satisfied are you with the appreciation you receive as a professional?	3.98	0.91
How satisfied are you with the level of influence you have in the workplace?	3.76	0.99
How satisfied are you with the tasks and content of your job?	4.09	0.79
How satisfied are you with the social relations at your workplace?	4.15	0.84
How satisfied are you with the current working environment?	3.84	1.07
How meaningful do you find your current job?	3.30	0.64
JOB-SATM	35.05	4.84

APPENDIX B

Distributions of age, gender, and education in robotized and nonrobotized work and workplaces.

	N	Age: Mean (SD)	Gender: Male %	Education: University level %
Nonrobotized workplaces	3560	44.39 (11.88)	45.6	52.5
Robotized workplaces	535	43.00 (11.31)	64.7	44.7
Working with robots	264	41.23 (11.05)	67.8	35.2
Not working with robots	271	44.72 (11.31)	61.6	53.9
Total	4110	44.20 (11.82)	48.1	51.5

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