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Labour Market Diversification through Digital and Sustainable Work

Marzena Fryczyńska[1], **Małgorzata Skrzek-Lubasińska**[2]

[1] SGH Warsaw School of Economics, Collegium of Business Administration, Niepodległości 162, 02-554 Warszawa, Poland, e-mail: mfrycz@sgh.waw.pl, ORCID: https://orcid.org/0000-0001-5882-7017

[2] SGH Warsaw School of Economics, Collegium of Business Administration, Niepodległości 162, 02-554 Warszawa, Poland, e-mail: mskrze@sgh.waw.pl, ORCID: https://orcid.org/0000-0003-0162-1311

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ABSTRACT

Objective: The aim of this article is to examine the diversification of the labour market in Poland based on sustainability and digitalisation of work in the context of remote jobs.
Research Design & Methods: The study employs a quantitative methodology, to analyse data from 1,035 workers whose jobs can be performed remotely (outside the company's premises, using modern technologies) with ICT support.
Findings: The study identified four distinct cohorts representing varying levels of digital and sustainable work. Results show significant differences in demographic and employment characteristics, with income, sector, and working hours influencing digitalisation and sustainability. The findings highlight the uneven distribution of digital and sustainable work across the labour market, emphasising the need for targeted strategies to bridge these gaps.
Implications/Recommendations: The study concludes with recommendations for expanding digitalisation opportunities and implementing tailored practices to boost work sustainability. This research underscores the need for strategic considerations and further research in this evolving field.
Contribution: This research contributes to the understanding of the complex relationship between digitalisation and work sustainability. It provides valuable insights into labour market

diversification and offers practical recommendations for enhancing work sustainability in the digital age. The findings of this study have implications for policymakers, employers, and workers navigating the evolving digital landscape.

Article type: original article.

Keywords: digital work, sustainable work, digitalisation, sustainability, self-employment, labour market.

JEL Classification: F66, J2, J8, O15, O3, Q01.

1. Introduction

The labour market is presently confronting novel challenges that have the potential to fundamentally reshape its dynamics. These changes are not evolutionary; rather, they are of an unprecedented magnitude in world history and transpire over a remarkably brief period.

New technologies are expected to reduce the demand for labour (Roubini, 2023). Machines, robots, and artificial intelligence contribute to unprecedented productivity surges across various sectors. Historically confined to manufacturing, this trend has recently accelerated to encompass service industries, including those within the creative domain previously reserved exclusively for human involvement. Banerjee and Duflo (2019) or Srnicek and Williams (2015) predict that the displacement of jobs in traditional sectors, even with the creation of new roles in innovative sectors, necessitates a continuous adaptation of workers' skills to evolving conditions, changes to work processes, and at workplaces. This protracted process engenders labour market frictions attributable to structural mismatches between the workforce and available positions.

Compounding this issue is the imperative for change associated with the climate crisis and the necessity for sustainable development – one that forestalls both ecological and social degradation of the global environment and its resources. In EU countries, including Poland, the proportion of older people is increasing while the birth rate is decreasing, resulting in a shrinking group of economically active individuals. Hence, solutions are sought to maintain a large and qualitatively high reservoir of workforce by promoting sustainable work, i.e., work that, by being performed, does not deplete the resources required for future work. Sustainable work requires long--term and lifelong perspectives (Ehnert & Harry, 2012; Van der Heijden *et al*., 2020), which, at the same time, necessitate urgent, specific, common, and persistent action at workplaces. Digitalisation aims to streamline organisational processes and work processes; however, according to Rózsa *et al*. (2023), a recent study suggests that new technologies often lead to reduced sustainability of work performance.

The aim is to examine the degree of co-occurrence of work sustainability and work digitalisation for labour market diversification. We want to elaborate on it, referring to work and the labour market in Poland. A deeper analysis is performed based on a quantitative study including only those workers whose jobs can be performed remotely (outside the company's premises, using modern technologies) with ICT support.

In the first part of the article, we define the scope of the research field, focusing on digital and sustainable work, based on a critical analysis of the literature. After formulating the prepositions, we verified them based on quantitative data collected in survey-based empirical research among 1,035 workers in Poland. Finally, we draw conclusions, limitations and recommendations.

2. The Concepts and Definitions of Sustainable Work and Digital Work

Sustainable work has featured in Agenda 2030 *Transforming Our World: The 2030 Agenda for Sustainable Development* (United Nations, 2016) in UN Sustainable Development Goals to be accomplished by 2030 (Goal 8 – Decent work and economic growth) (United Nations, 2024). It is also one of the pillars of The Human-centred Agenda by the ILO Global Commission on the Future of Work (Silva, 2022) and in the European Commission's (2019) Annual Sustainable Growth Strategy. It is also a reference to profound transformations in the world of work in the ILO's (2019) Centenary Declaration for the Future of Work. Based on that, Eurofound (2015) defined sustainable work over the life course as working and living conditions that support people in engaging and remaining in work throughout an extended working life. These conditions enable a fit between work and the characteristics or circumstances of the individual throughout their changing life, and must be developed through policies and practices at work and outside of work.

The notion of sustainable work came to prominence in the late 20th century within the literature, framing it as work that is effective while concurrently protecting the long-term health and fostering the development of employees (Joss, 1995; van Eijnatten, 1999). Abrahamsson and Ennals (2022) enumerated the key factors contributing to sustainable work, encompassing elements such as: healthy and inclusive workplaces, good work in a lifelong perspective, employee-driven innovation, workers' co-determination. As mentioned by Fostervold, Koren and Nilsen (2018), the concept of sustainable work can be defined from different perspectives: company/organisation/group (as a production and work system), employees (individual level) or society (social level – as sustainable development). Subsequently, sustainable work has become the focal point of examination in numerous scholarly investigations. Through decades of research, diverse definitions

of the concept have been formulated, as exemplified by Khallash and Kruse (2012), Peters *et al*. (2015), Littig (2018), and Pawłowska (2019). Despite the aforementioned scientific concepts we follow the meaning and the definitions of sustainable work proposed by Eurofound (2015).

The concept of digital work is expansive, marked by a notable absence of a universally accepted definition (Messenger & Gschwind, 2016; Wibowo, Deng & Duan, 2022). The term "digital work" has become a focal point of extensive discourse at both the European Union and individual Member State level. Although no EU-level legislation precisely delineating and addressing digital work exists, there are legislative provisions explicitly pertinent to digital working conditions. Various terms have been employed to characterise this multifaceted phenomenon, encompassing digital workplace, teleworking, telecommuting, e-working, remote working, and agile working. In a comprehensive literature review, Wibowo, Deng and Duan (2022) provided an exhaustive examination of diverse definitions of digital work found in scholarly discourse. Within these definitions, certain elements consistently emerge as prerequisites for categorising work as digital, typically encompassing the utilisation of digital technologies, a remote operational setting, flexibility in working hours, and, somewhat less frequently, consideration of contractual arrangements. Our article fits into remote working, as an exemplification of digital work.

The advent of digitalisation and the ensuing digital revolution carries profound implications for the labour market. In a recent study by Rózsa *et al*. (2023), they contend that there are grounds to believe that new technologies frequently contribute to diminished sustainability of work performance:

1) increased risk of job loss (in the digital world the workers are hired mainly on a short-term basis (Fornino & Manera, 2022),

2) deepening of inequalities (dualisation of the labour market, earlier deactivation of 50+ employees) (Greve, 2019; ten Berge *et al*., 2020; Bonacini, Gallo & Scicchitano, 2021; Pensiero, 2022),

3) significant changes in job roles and responsibilities (Industry 4.0 reduces room for employees' autonomy and increases forms of management control) (Cirillo *et al*., 2021),

4) the need to acquire new skills (Acemoglu, 2002),

5) changes in management procedures (Lau & Höyng, 2023).

The escalating prominence of digital work underscores the imperative for a more nuanced understanding and examination of the concept of sustainable work. As digitalisation becomes increasingly integral to the labour market, the confluence of these dynamics accentuates the pressing need for further research and strategic consideration to ensure the sustainability of work amidst the evolving ICT technological landscape.

The labour market should strive to create sustainable work by leveraging trends, phenomena, and tools that increase the level of work digitalisation. Despite the recommended direction of changes into digital and sustainable work in one, the labour market also encompasses labour forces for which sustainable work remains a goal, as well as growing digitisation of work is an unrealistic characteristic. Therefore, we formulate a thesis about two directions of change in the labour market: towards increasing sustainability and digitalisation of work. This is illustrated by the four internally differentiated cohorts of the labour market presented in Figure 1.

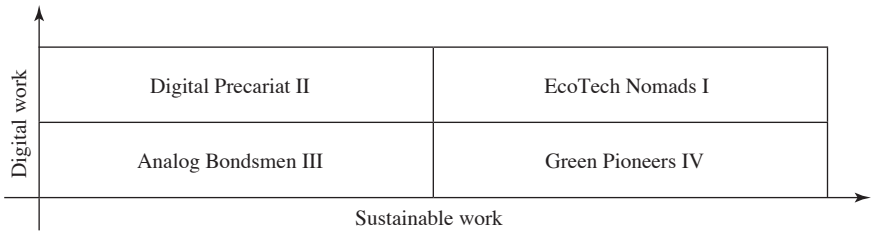

Fig. 1. Cohorts of the Labour Market in Relation to the Sustainability and Digitalisation of Work
Source: the authors.

Four cohorts of workers were identified based on results obtained in the dimensions of sustainable work and digital work. The EcoTech Nomads cohort (I) consists of individuals with the highest scores on both scales. The Digital Precariat cohort (II) includes workers with the highest level of digitalised work but lower scores in sustainable work. Among the Analog Bondsmen cohort (III), low levels of both work digitalisation and sustainability are observed. Meanwhile, the Green Pioneers cohort (IV) represents individuals with lower levels of work digitalisation but higher levels of work sustainability.

3. Research Analysis

3.1. Research Method and Sample Characteristics

A quantitative study was conducted in August 2023 using the computer-assisted web interviewing (CAWI) technique, on a randomly stratified sample of residents of Poland. Respondents were acquired through the controlled survey panel of Opinia 24. A total of 1,035 respondents were surveyed. The study group consisted of individuals who were professionally active and declared that the work they currently perform could be done outside the company's premises using new technologies. Among them, 43% represented organisations where work could be entirely performed remotely, while 57% could be partially performed remotely. Respondents were employees capable of and engaged in remote work utilising a digitised work

environment. Thus, the study examined individuals for whom work digitalisation is an organisational possibility.

The study involved 523 men and 512 women (N = 1,035), among whom 159 were aged 16–29; 579 were aged 30–49 – more than half of the sample (55.4%); and 304 were aged 50+. They represented various industries, with the most represented respondents being from IT and technology (9.0%), finance (6.9%), education (10.4%), trade and sales (12.8%), and manufacturing (11.9%). Among the participants, single employment status stated 94.7%. Among them 69.4% were employed under employment contracts, 7.7% under civil-law contracts, and 17% operated as individual entrepreneurs. One-fourth (26.2%) declared holding managerial positions, and one-third (33%) worked in public institutions. The study included participants from organisations of various sizes: 74.4% were from the micro, small, and medium-sized enterprise (MSME) sector, while the rest were from large and very large enterprises.

3.2. The Variables of Sustainable Work and Digital Work

To achieve the research aim, a proprietary measurement tool for sustainable work was developed, drawing on the concept advocated by Eurofound (2015). Using a seven-point scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"), participants evaluated 14 statements encompassing the variable. Assessing the level of work sustainability included considerations of social relationships, the meaningfulness, and significance of the work performed, the utilisation and development of competencies, work productivity and profitability, appreciation and satisfaction at work, social security, balancing private and professional roles, and physical and mental well-being at work. For example, statements included "Work is a place where others value my input," "Work is rewarded in a way that ensures appreciation," or "Work provides me with social security." The variable was derived as the aggregated mean of all statements, with its reliability measured using Cronbach's standardised alpha, yielding a value of 0.933.

The level of work digitalisation was assessed for those who work remotely or in a hybrid manner. Among the important aspects of work digitalisation, participants evaluated the ability to work remotely, the extent of the employer's use of information technology systems, remote supervision, organisation and control of work, processing of official administrative matters, participation in developmental activities, and the use of information technology tools for maintaining internal and external relationships. For example, statements included "Remote monitoring of work intensity," "Work exclusively through an information technology system (application, software) required by the company, the employer," or "Utilisation of information technology tools for establishing or maintaining relationships outside

the organisation." Using a continuous scale (slider in the CAWI application) ranging from 1 to 100, participants evaluated 8 statements. For the present analyses, an aggregated indicator was calculated as the mean. All 8 statements in these studies constitute a measurement scale that achieved high reliability (Cronbach's alpha = 0.917).

3.3. Analysis

A statistical analysis of the collected quantitative data was conducted using IBM SPSS 29. In the first step, the sample of N = 1,035 was divided into four cohorts based on levels of sustainable work (M = 4.9, SD = 1.04) and digital work (M = = 46.8, SD = 25.95). The mean values were included in the cohorts where the results were higher, considering the observed skewness of –0.378 and 0.128, respectively. As a result, cohort I included n = 307 workers (29.7%), cohort II included n = 215 (20.8%), cohort III included n = 286 (27.6%), and cohort IV included n = 227 (21.9%) workers (see Fig. 2).

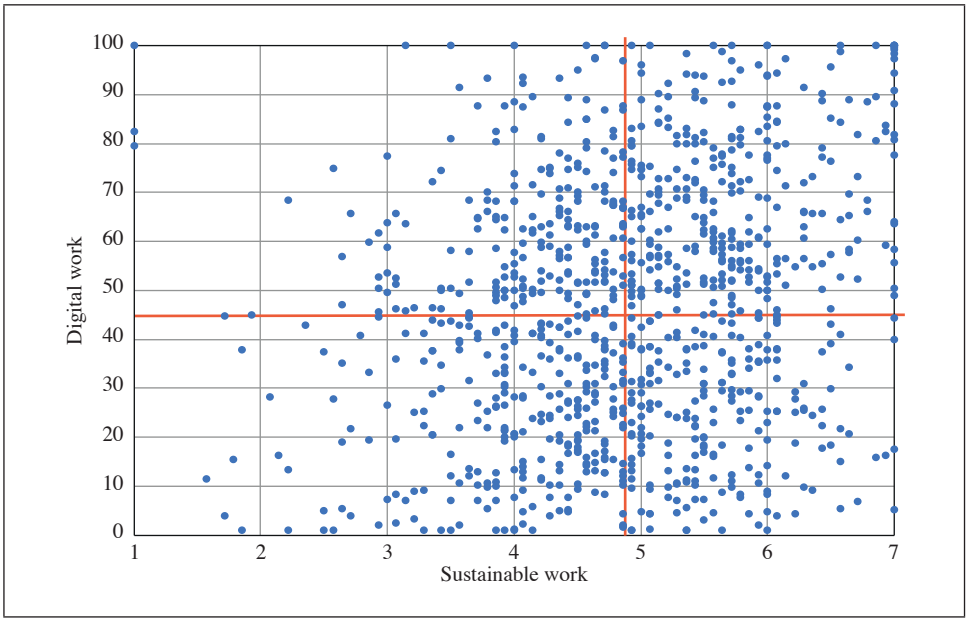

Fig. 2. Dispersion of Workers Based on the Extent of Sustainable and Digital Work
Source: the authors, based on gathered empirical data.

To assess cohort segmentation, two analyses were conducted. First, the diversity of the cohorts in terms of demographic and employment characteristics was exam-

ined. Second, the demographic and employment characteristics that differentiate sustainable work and digital work levels within each cohort were analysed, offering insights into the distribution of workers within each cohort. The differentiating variables included gender, age, educational attainment, income level, weekly working hours, managerial or non-managerial position, work contract, company size, and sector.

The demographic-employment diversity analysis within cohorts revealed no significant variation in terms of gender – $\chi^2(3) = 0.207$, $p = 0.976$; education – $\chi^2(6) = 11.882$, $p = 0.065$; weekly working hours – $\chi^2(9) = 12.716$, $p = 0.176$; and company size – $\chi^2(12) = 18.419$, $p = 0.104$. For the remaining variables, the distribution across cohorts was significantly different, with $p < 0.001$. Over- and under-representation within certain variable categories are presented below.

In response to the second question – how the examined variables differentiated sustainable work and digital work outcomes in each cohort – variance analyses were conducted. The results of the Shapiro-Wilk test for sustainable work and digital work in each cohort were statistically significant, indicating that their distributions significantly deviated from normality. However, it should be noted that the skewness of all variables did not exceed the threshold of 2, as suggested by George and Mallery (2016), indicating relatively symmetrical distributions. Details are provided in Table 1. Additionally, Welch's correction was applied when assumption of equal variances was violated (assessed with statistically significant Levene's test) and reported in tables. Consequently, parametric tests (ANOVA or *t*-tests) were used to analyse mean differences. The results of the analysis for significantly differentiating variables and categories are presented for each cohort.

Table 1. Exploration Results of Sustainable and Digital Work in Four Cohorts

Descriptive Statistics	Cohort I		Cohort II		Cohort III		Cohort IV	
	Sustainable work	Digital work	Sustainable work	Digital work	Sustainable work	Digital work	Sustainable work	Digital work
Mean	5.75	70.21	4.14	65.88	3.98	24.63	5.62	25.15
Skewness	0.569	0.364	–1.968	0.739	–1.111	–0.097	0.586	–0.153
Shapiro-Wilk	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$

Source: the authors, based on gathered empirical data.

Cohort I: EcoTech Nomads

Among the examined variables in the cohort I, the most notable differences were observed in work income and job position. A significantly higher percentage of individuals earn a net income of 8,000 or more (26.8%) compared to 16.4% for the entire population. Another significant difference is the overrepresentation of

managerial positions (59.7%) compared to 30.9% for the whole sample, with a corresponding underrepresentation of non-managerial roles.

The mean level of sustainable work in this cohort was 5.75, while the mean level of digitalised work was 70.2. Age ($F(2, 304) = 4.95$; $p = 0.008$; $\eta^2 = 0.03$), weekly working hours ($F(3, 303) = 3.02$; $p = 0.03$; $\eta^2 = 0.03$), and work income ($F(3, 272) = 3.11$; $p = 0.027$; $\eta^2 = 0.08$) significantly differentiated the level of digitalised work in this cohort. These results highlight how demographic and employment factors, particularly age, working hours, and income, influence the extent of digitalised work in the first cohort, with older workers being less employed in digitalised work tasks than younger cohorts.

Workers aged 50 and older performed the least digitalised work, with a mean score of $M = 65.07$, which was significantly lower than their counterparts aged 16–29 years (by 7.41) and 30–49 years (by 6.29) (see Table 2).

Table 2. Mean-variance of Digital Work by Age Groups (Cohort I)

Dependent Variable	Group	*n*	*M*	*SD*	*F*	*df*	*p*	η^2
Digital work	16–29 years	55	72.48	14.49	4.95	2, 304	0.008	0.03
	30–49 years	186	71.36	15.87				
	50 years and more	66	65.07	13.50				

Dependent Variable	Compared Groups	*M*1–*M*2	*SE*	*p*	95% *CI*	
					LL	*UL*
Digital work	50 years and more – 16–29 years	–7.41	2.77	0.023	–14.07	–0.75
	50 years and more – 30–49 years	–6.29	2.17	0.012	–11.52	–1.06

Notes: The Bonferroni *post-hoc* test was applied.

Source: the authors, based on gathered empirical data.

Interestingly, the highest level of work digitalisation is reported by those working up to 30 hours per week ($M = 76.39$), while the lowest level is observed among those working 51 hours or more per week ($M = 65.56$). This between-group difference (+/– 10.83) is statistically significant ($p = 0.041$), as shown in Table 3. This suggests that jobs with higher levels of digitalisation tend to correspond with reduced working hours.

A strong and significant effect of mean comparisons ($\eta^2 = 0.08$, $p = 0.013$) for work digitalisation was also noted for the variable of net income from work. Interestingly, those EcoTech Nomads earning between 2,001–4,000 PLN report the highest level of digitalised work ($M = 70.29$), while those earning between

6,001–8,000 PLN report the lowest levels of digitalised work (see Table 4). This finding is particularly important given the overrepresentation of high-income earners within this category.

Table 3. Mean-variance of Digital Work by Weekly Working Hours (Cohort I)

Dependent Variable	Group	*n*	*M*	*SD*	*F*	*df*	*p*	η^2
Digital work	up to 30h	36	76.39	18.12	3.02[a]	3, 303	0.003	0.03
	31–40h	171	70.28	14.58				
	41–50h	76	68.59	16.12				
	51h and more	24	65.56	11.14				

Dependent Variable	Compared Groups	*M*1–*M*2	*SE*	*p*	95% *CI*	
					LL	*UL*
Digital work	up to 30h – 51h and more	10.83	4.01	0.044	0.19	21.46

[a] The Levene test result was statistically significant – the result was reported with Welch's correction.

Notes: The Bonferroni *post-hoc* test was applied.

Source: the authors, based on gathered empirical data.

Table 4. Mean-variance of Digital Work by Work Income (Cohort I)

Dependent Variable	Group	*n*	*M*	*SD*	*F*	*df*	*p*	η^2
Digital work	2,001–4,000 PLN	63	74.74	16.03	3.11[a]	3, 272	0.027	0.08
	4,001–6,000 PLN	94	68.81	15.84				
	6,001–8,000 PLN	45	66.44	10.04				
	8,001 PLN and more	74	70.29	15.73				

Dependent Variable	Compared Groups	*M*1–*M*2	*SE*	*p*	95% *CI*	
					LL	*UL*
Digital work	2,001–4,000 PLN – 6,001–8,000 PLN	8.3	2.31	0.031	0.49	16.12

[a] The Levene test result was statistically significant – the result was reported with Welch's correction.

Notes: The Bonferroni *post-hoc* test was applied.

Source: the authors, based on gathered empirical data.

Workers in this cohort rate the sustainability of their work highly. Among them, the individuals who appear at the top of the digitalisation scale are younger, work fewer hours, and earn lower net incomes from their work. These results highlight the nuanced relationship between work digitalisation and various demographic and employment factors, particularly income, age, and working hours.

Cohort II: Digital Precariat

Cohort II, characterised by high levels of digital work and lower levels of sustainable work, includes a significantly higher proportion of workers in the private sector (74.4%, compared to 67% for the entire sample). There are notably fewer individuals employed under labour code employment contracts (62.3% compared to 69% for the whole group) and nearly twice as many working under civil contracts (14% versus 7%).

In this cohort, the average level of sustainable work ($M = 4.14$) varies significantly across sectors ($t(213) = 2.96$; $p = 0.003$; $d = 0.65$). The average level of digitalised work ($M = 65.88$) also shows significant differences in terms of gender ($t(213) = -2.72$; $p = 0.007$; $d = 0.37$) and income ($F(3, 180) = 4.07$; $p = 0.008$; $\eta^2 = 0.06$).

Workers in the private sector report higher levels of sustainable work ($M = 4.22$; $n = 160$) than those in the public sector ($M = 3.92$; $n = 55$). This indicates that private sector employees are closer to the average value of sustainable work, while public sector employees fall towards the lower end of the spectrum. In terms of digitalised work, women report significantly higher levels ($M = 68.52$; $n = 106$) compared to men ($M = 65$; $n = 109$) (details in Table 5). A similar trend is observed in income comparisons, with the highest earners (8,001 PLN and above) reporting the highest levels of digitalised work ($M = 73.35$). This level is significantly higher ($p = 0.006$) than that reported by the lowest earners ($M = 62.20$), as Table 6 shows.

In summary, workers in the private sector within cohort II are closer to the mean in terms of sustainable work levels. Meanwhile, women and high-income earners are positioned at the higher end of the digitalisation spectrum due to their higher scope of digitalised work.

Table 5. Mean-variances of Sustainable Work by Sector and Digital Work by Gender (Cohort II)

Dependent Variable	Independent Variable	*M*	*SD*	*M*	*SD*	*t*	*p*	95% *CI*		Cohen's *d*
								LL	*UL*	
Sustainable work	sector	public ($n = 55$) 3.92	0.82	private ($n = 160$) 4.22	0.59	–2.96	0.003	–0.5	–0.1	0.65
Digital work	gender	man ($n = 109$) 63.32	13.14	woman ($n = 106$) 68.52	14.77	–2.72	0.007	–8.95	–1.44	0.37

Source: the authors, based on gathered empirical data.

Table 6. Mean-variance of Digital Work by Work Income (Cohort II)

Dependent Variable	Group	*n*	*M*	*SD*	*F*	*df*	*p*	η^2
Digital work	2,001–4,000 PLN	60	62.2	11.73	4.07	3, 180	0.008	0.06
	4,001–6,000 PLN	66	67.51	14.98				
	6,001–8,000 PLN	33	65.36	13.95				
	8,001 PLN and more	25	73.35	15.91				

Dependent Variable	Compared Groups	*M*1–*M*2	*SE*	*p*	95% *CI*	
					LL	*UL*
Digital work	2,001–4,000 PLN – 8,001 PLN and more	–11.15	3.32	0.006	–20.01	–2.29

Notes: The Bonferroni *post-hoc* test was applied.

Source: the authors, based on gathered empirical data.

Cohort III: Analog Bondsmen

In the cohort characterised by the lowest levels of sustainable work (M = = 3.98) and digital work (M = 24.63), there is a significantly higher proportion of individuals employed in the public sector (43% compared to 33% for the overall sample). Additionally, this cohort includes more individuals earning a net income of 2,001–4,000 PLN (around minimal wage), holding non-managerial positions (78.5% compared to 69.1% for the entire sample), and those aged 50 and above (44.1% compared to 29.3% for the total population).

Table 7. Mean-variance of Sustainable Work by Weekly Working Hours (Cohort III)

Dependent Variable	Group	*n*	*M*	*SD*	*F*	*df*	*p*	η^2
Digital work	up to 30h	38	4.01	0.70	3,021	3, 282	0.030	0.03
	31–40h	134	4.06	0.69				
	41–50h	81	3.99	0.74				
	51h and more	33	3.64	0.79				

Dependent Variable	Compared Groups	*M*1–*M*2	*SE*	*p*	95% *CI*	
					LL	*UL*
Digital work	31–40h – 51h and more	0.42	0.14	0.018	0.047	0.79

Notes: The Bonferroni *post-hoc* test was applied.

Source: the authors, based on gathered empirical data.

Internal variation within this cohort is observed in sustainable work based on weekly working hours ($F(3, 282) = 3.021$; $p = 0.030$; $\eta^2 = 0.03$). The highest levels

of sustainable work among Analog Bondsmen are reported by individuals working 31–40 hours per week ($M = 4.06$). These results are significantly higher ($p = 0.018$) than those for individuals working the longest hours (over 51 hours per week), with a difference of approximately 0.42. These findings suggest that working moderate hours in this cohort is associated with a relatively higher level of sustainable work, which may indicate a more favourable work-life balance compared to those working excessive hours.

Cohort IV: Green Pioneers

In cohort IV, there is a significantly higher proportion of self-employed workers (23.3% compared to 17.6% for the total sample) and older workers (44.1% compared to 29.3% for the total population). The levels of sustainable work ($M = 5.62$) and digital work ($M = 25.15$) within this cohort do not show significant variation across any of the analysed variables.

These findings indicate that this cohort has a distinctive demographic profile, particularly in terms of self-employment and age. This suggests a certain uniformity in work conditions within this group, despite demographic differences.

4. Discussion

Our analysis focused on the aim of examining the degree of co-occurrence of work sustainability and work digitalisation for labour market diversification, bringing conclusions, limitations, and recommendations.

1. The study's identification of four cohorts mirrors previous findings on labour market stratification driven by digitalisation. Roubini (2023) and Srnicek and Williams (2015) emphasised that new technologies reshape job roles and responsibilities, often leading to segmentation. The EcoTech Nomads and Digital Precariat cohorts reflect these divisions, wherein digitalisation creates both high-tech job opportunities and precarious employment with limited sustainability. Rózsa *et al.* (2023) suggest that digitalisation does not uniformly enhance sustainable job quality, which is supported by this study's finding that sustainable work shows more variation across cohorts. These results align with earlier assertions that digitalisation alone does not guarantee improvements in work sustainability and can exacerbate inequalities, especially in less regulated labour markets (Greve, 2019; Bonacini, Gallo & Scicchitano, 2021).

2. The study's findings that income and occupational status differentiate cohorts, with higher income and managerial roles clustered in the EcoTech Nomads, are consistent with theories on the dualisation of the labour market (Bonacini, Gallo & Scicchitano, 2021). As digital and sustainable work intertwine, economically privileged workers can access better working conditions, while the Analog Bondsmen experience stagnant conditions in low-skilled, low-paid jobs. This duality is also

highlighted in the report of Eurofound (2023), which notes that older and lower--income workers often face barriers to upskilling and adapting to new technological demands, thereby remaining in roles with lower digitalisation and sustainability. The present findings suggest a need to address the uneven distribution of digital resources and training opportunities, as suggested by Acemoglu (2002) in the context of labour market adaptation.

3. The study's finding that public sector workers are overrepresented in the Analog Bondsmen cohort resonates with previous research showing that public sector jobs often lag in digital transformation and sustainable work practices (Haug, Dan & Mergel, 2024). The private sector is more inclined toward implementing advanced digital solutions and flexible work arrangements, which corresponds with the overrepresentation of private sector workers in the Digital Precariat and EcoTech Nomads cohorts. This sectoral discrepancy suggests that while private enterprises may be at the forefront of digital innovation, they may also contribute to precarious employment conditions due to short-term contracts and project-based work (Fornino & Manera, 2022).

4. The overrepresentation of older workers in the Analog Bondsmen and Green Pioneers cohorts points to age-related disparities in accessing digital work (Greve, 2019; Komp-Leukkunen *et al*., 2022). This finding is consistent with Bonacini, Gallo and Scicchitano (2021), who argue that the digital divide is exacerbated for workers aged 50 and above, especially in contexts where lifelong learning and continuous professional development are not systematically supported. The results suggest that older workers either lack digital skills or are employed in roles that have not yet undergone digital transformation, which aligns with Abrahamsson and Ennals' (2022) call for more inclusive workplace innovations that cater to the aging population, thereby mitigating the risk of workforce withdrawal among older workers (Yamashita *et al*., 2024).

5. The study's observation that women in the Digital Precariat cohort engage in more digitalised work than men may initially appear contrary to conventional assumptions about gender inequality in digital fields (Kamberidou & Pascall, 2020). However, Messenger and Gschwind (2016) argue that while digital work may offer flexibility, it often coincides with lower sustainability due to less job security and increased remote monitoring. This finding aligns with Cirillo *et al*. (2021), who contend that digitalisation can reinforce managerial control and limit worker autonomy, disproportionately affecting women who may seek flexible work arrangements to balance caregiving responsibilities. While digitalisation offers a variety of opportunities for female empowerment and for enhancing women's participation in labour markets, financial systems, and entrepreneurship (Krieger-Boden & Sorgner, 2018), it is essential to ensure that these advancements do not push women into unsustainable or precarious forms of work.

6. The study finds that shorter weekly working hours correlate with higher levels of sustainable work, especially in the EcoTech Nomads cohort. This aligns with the Eurofound's (2015) definition of sustainable work, which emphasises work-life balance and manageable workloads as key components. The association of higher digitalisation levels with shorter working hours suggests that digital tools may enable more efficient work processes, reducing the need for extended working hours (van Eijnatten, 1999). However, this potential benefit may not extend to all workers, as shown by the lower levels of both digital and sustainable work among those in the Analog Bondsmen cohort, who often work longer hours without corresponding improvements in work conditions.

Implications

The study contributes to the academic discourse by providing empirical evidence on the coexistence of digitalisation and sustainable work. It challenges existing assumptions that increased digitalisation inherently leads to more sustainable work (Rózsa *et al*., 2023). The results suggest that while digitalisation can facilitate certain efficiencies, it does not automatically enhance job quality or sustainability across all worker segments. This finding calls for a more nuanced understanding of the conditions under which digitalisation can support or hinder sustainable work, expanding current theoretical frameworks (Eurofound, 2015).

The identification of four distinct cohorts (EcoTech Nomads, Digital Precariat, Analog Bondsmen, and Green Pioneers) adds to the labour market segmentation literature. It illustrates that the digital divide and sustainable work are not evenly distributed, which aligns with dual labour market theories (Bonacini, Gallo & Scicchitano, 2021). Future research can build on this framework to explore the specific mechanisms driving these disparities, such as the role of organisational practices, sectoral differences, and individual employee characteristics (Greve, 2019).

The study highlights the variability in the experiences of digital work, suggesting that the concept of digital work lacks a universally applicable definition (Messenger & Gschwind, 2016). The findings support the call for a more context-specific understanding of digital work, where factors like employment type, sector, and age influence how digitalisation is experienced in practice. This can guide future research in developing more refined, context-sensitive measures of digital work.

Companies should not view digitalisation solely as a means to increase productivity but as an opportunity to foster sustainable work practices. Employers should adopt strategies that combine digital solutions with policies promoting work-life balance, fair compensation, and employee development (van Eijnatten, 1999). For instance, offering shorter workweeks and flexible hours could help workers in more digitally intensive roles achieve higher levels of sustainable work. The segmentation observed in the study implies that policy interventions are needed to reduce inequalities in access to sustainable and digital work. Policies should promote

digital skills training, particularly for older workers and those in lower-income or public sector roles, to ensure they are not left behind in the digital economy (Bonacini, Gallo & Scicchitano, 2021). Additionally, regulatory frameworks should support sustainable work conditions, such as limiting excessive remote monitoring and ensuring fair work contracts in highly digitalised roles. The study's findings suggest that public sector organisations lag in digital adoption and sustainable work practices, as evidenced by the overrepresentation of public employees in the Analog Bondsmen cohort. The public sector should prioritise digital transformation initiatives while also investing in sustainable work policies, such as job security measures, continuous training, and inclusive workplace practices to close the gap with the private sector (Haug, Dan & Mergel, 2024).

Limitations

The study is not free of limitations. Firstly, the study focuses on workers in Poland who can perform their jobs remotely with ICT support. While this provides valuable insights, the findings may not be generalisable to all labour market segments, especially those in roles that cannot be digitalised, such as certain manufacturing or service jobs. Future research could expand the scope to include more diverse worker groups to improve generalisability. Secondly, although the study used reliable scales to measure digitalisation and sustainable work, there may still be limitations in capturing the validity of these constructs. For instance, the reliance on self-reported measures may introduce bias, and future research could benefit from incorporating more objective indicators gathered in companies. Thirdly, since the study is conducted in Poland, the findings may be influenced by the specific economic, cultural, and regulatory context of the country. The relationship between digitalisation and sustainable work might differ in other regions with different labour market structures and policies. Comparative studies across countries would help validate the results and provide a more global perspective.

Authors' Contribution

The authors' individual contribution is as follows: Marzena Fryczyńska 60%, Małgorzata Skrzek-Lubasińska 40%.

Conflict of Interest

The authors declare no conflict of interest.

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