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The impact of automation on the position of vulnerable groups in the labour market in Slovakia and Czechia: Conceptual Framework[1]

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Abstract

The world of labour has been experiencing unprecedented advancements in automation that are changing the working conditions and accelerating productivity. Nevertheless, automation brings uneven benefits to different social and demographic groups in the labour market; vulnerable groups encounter multiple difficulties in accessing digital technologies and skills (e.g., Higgins et al., 2023; Kitsara, 2022; OECD, 2025). Inequalities are a result of unequal access to education, a lack of institutional support in the social and educational sphere, or limited access to workers' representation (Piketty, 2014). Due to the accumulation of barriers, integration of vulnerable groups requires a holistic approach in labour integration and systemic coordination of key actors in providing social, health-care, and employment services (Mýtna Kureková et al., 2022; Greve, 2021). Nevertheless, it remains unclear how the automation will affect employment prospects and working conditions of vulnerable workers in Slovakia and Czechia, including socially marginalized communities, the elderly, or people with disabilities. Building on an intersectional theoretical and analytical framework of vulnerability (Atewologun, 2018; Crenshaw, 1990), this working paper presents a conceptual and analytical framework for understanding the impact of the automation on various population subgroups situated in the specific country context of Slovakia and Czechia.

Keywords: automation, digital divide, labour market, intersectional framework, vulnerable workers

JEL Codes: J01, J08, J24, J60, J70

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Introduction

Automation places industrial robots and novel technologies more at the center of work and consequently changes the world of labour and working conditions (Baptista et al., 2020; De Simone et al., 2022). Nevertheless, current evidence shows that digital transformation and automation bring uneven benefits to different social and demographic groups in the labour market; vulnerable groups encounter multiple difficulties in accessing digital technologies and digital education (e.g., Higgins et al., 2023; Kitsara, 2022; OECD, 2025). This, in turn, results in educational disparities and fewer job opportunities. Although the contemporary literature on the impact of automation on inequalities is focused on exploring variations across different occupational groups (e.g., Gihleb et al., 2022), more attention needs to be given to other vulnerable groups that may face obstacles in the access to employment and fair working conditions due to intersections of identities and other attributes (such as gender, educational attainment, age, ethnicity, etc.).

This working paper presents the conceptual framework for understanding the labour market position of the vulnerable groups through the lenses of intersectionality (Atewologun, 2018; Crenshaw, 1991) in the context of automation. Digital access and skills are affected by different demographic and socioeconomic attributes that need to be further explored within different national contexts (van Dijk, 2020). Inequalities are results of unequal access to education, a lack of institutional support in the social and educational sphere, or limited access to worker's representation (Piketty, 2014). Several studies show that, as a result of automation in production, the well-being is more deteriorated for low-skilled workers (e.g., Gihleb et al., 2022; Majzlíková and Vitáloš, 2021) and other studies indicate that high-skilled workers feel relieved from routine tasks (Abeliansky et al., 2024; Consoli et al., 2023). Additionally, older workers close to the retirement age seem to be more worried about job security as a result of automation compared to the younger cohorts (Abeliansky et al., 2024). Due to accumulation of barriers, vulnerable groups need holistic approach in the labour integration and systemic coordination of key actors in providing social, health care, and employment services (Mýtna Kureková et al., 2022; Greve, 2021). In this regard, it remains unclear how the automation will affect employment prospects and working conditions of vulnerable

workers in Slovakia and Czechia, including marginalised Roma communities, the elderly, or people with disabilities.

The current working paper is structured as follows: the first part discusses the impact of automation on workers' well-being and working conditions underlying differentials *vis-à-vis* various population subgroups. The second part presents the concept of *digital divide* in the context of vulnerable groups and automation, since it plays a substantial role in reinforcing educational disparities. The third part, the vulnerability in the context of automation trends, is positioned in the intersectional analytical framework that allows us to understand economic inequalities in the context of overlapping disadvantages. The complexity of disadvantages calls for a social ecosystem approach, which means that holistic solutions and cooperation of policy stakeholders address various causes of inequalities. Understanding the impact of the automation on various population subgroups, together with intersectional theory presents a conceptual framework for the qualitative inquiries of the project.

1 The impact of automation on workers

Ongoing introduction of robotics and artificial intelligence in the production processes alters the work organisation and working conditions. This process has implications for the structure of organisations and adaptation of workplaces that have been evolving from novel technological advancements (Baptista et al., 2020). As the capabilities of industrial robots and various digital tools have been expanding in the last decade, a higher share of work tasks are being carried out by technologies (Willcocks, 2019; Peeters and Plomp, 2022), which deliberately changes the role of operators in industrial production (Körner et al., 2019).

Human capital plays a key role in understanding the vulnerabilities in the labour market. Literature on human capital generally postulates that an increase in human capital of the workforce is associated with increased productivity (e.g., Mincer, 1984; Riddell, 2006) and, in turn, more favourable employment outcomes and position of the individuals in the labour market. Human capital variables, such as work experiences, formal or informal educational attainments, are generally associated with better work opportunities (Frenette and Frank, 2020; Lábaj et al., 2024) and, eventually, better well-being of workers (Petersen et al., 2022). Similarly, automation is being implemented to increase

productivity and economic outcomes. At the individual level, low education is associated with greater automation risk, since the routine tasks are more likely to be replaced by technologies (Autor et al., 2003). Also, the complexity of tasks is on decline and further tasks, previously labelled as complex, are more likely to become routine, meaning that cognitive and interactional tasks might be replaced by advanced technologies (Frey and Osborne, 2017). On the contrary, occupations characterised by a high level of human capital investments are at lower risk of automation since for them the technology serves as complementary tools that support the efforts of the labour force (Shestakofsky, 2017).

The impact of automation and digitalisation varies across occupations and tasks, when industrial robots may change manufacturing by increasing productivity and precision without increasing costs, enabling machines and equipment to be better connected to each other and execute tasks more effectively, allowing computer programmes to control and operate machine parts remotely (Roberts, 2015). As a result, the robotisation may lead to replacing human labour on a greater scale compared to technologies previously utilised at the workplace (Howcroft and Taylor, 2022). The most prevalent tasks that have been automated in industrial production present assembling, dispensing, handling, processing or welding. At the same time, data-driven decision making based on using big datasets and a large variety of information has been shaping R&Ds and stimulating productivity across industries (Roberts, 2015).

While a part of the academic debate about the effect of automation centers around the displacement and replacement rates or impact on productivity, an increasing share of scholarship explores the role of automation in the well-being of workers. According to the recent research, industrial automation and well-being of workers are significantly associated, since the increased capabilities of robots have an adverse impact on feelings of job security (Abeliansky et al., 2024; Gorny and Woodard, 2020; Patel et al., 2018; Schwabe and Castellaci, 2020) and the level of job satisfaction (Gorny and Woodard, 2020). Moreover, the increased use of robots may cause worries about the future work and fear of being replaced (Colantone et al., 2020).

Automation may have also positive effects on the well-being of workers in terms of reducing routine work or physically demanding work (Welfare et al., 2019). Gunadi and Ryu (2020) show that low-skilled workers in the US claim to have better physical health outcomes and fewer disabilities due to automation. On the contrary, Abeliansky et al. (2024) postulate that the effects of automation on different aspects of work and job

satisfaction remain unclear; while robots take over some routine, dull, and also dangerous tasks, they could as well increase pressure on workers as the overall production has speeded up. The work pace increased and the workers need to fulfill certain tasks at more strictly designated time (Popp, 2018; Welfare et al., 2019). Thus, the automation is linked to increased time pressure and, in turn, lower level of job satisfaction (Bolli and Pusterla, 2021).

Additionally, introduction of robots, although they reduce routine and manual tasks which benefit workers, incurs demands for continuous supervision and monitoring which is another cause of work-related stress. That may be mentally stimulating as they require applying knowledge and making decisions but and may also pose a stress factor along with increased workload, reduced control over tasks, lower skill mobilisation and increased work pace (Smids et al., 2020; Warm et al., 2018). The constant need to analyse the huge inflow of information and decision-making is also viewed as a stress factor (Carissoli et al., 2024). Employment instability and unclear future work prospects are one of the main sources of psychological distress as it creates unfavourable working conditions (Balogh et al., 2024; Van Aerden et al., 2014).

Mental workload and work-related stress are present specifically in human-robot collaboration when operators, side by side with industrial robots, carry out work tasks in the same work environment. In this context, mental workload is associated with suboptimal workload (Young et al., 2015), the resources the worker needs to use to execute the tasks (Wilson and Sharples, 2015). Long-term consequences of permanent mental workload may result in a range of health problems such as mental fatigue, decreased performance and efficiency at the workplace, lower attention levels (Lagomarsino et al., 2022; Wixted and O'Sullivan, 2014) as well as mental stress and physiological effects (Alsuraykh et al., 2019; Gjoreski et al., 2017). Collaborating and coexisting with industrial robots at the same workplace also cause various detrimental effects on workers wellbeing; efficiency of robots may invoke concerns about the job security (Abeliansky and Beulmann, 2019), physical proximity to robots reduces the feelings of safety at the workplace (De Simone et al., 2022), and the constant cooperation with robots may soar mental workload (Lu et al., 2022).

The effect of automation varies across demographic workers' groups. Several studies show that well-being is more deteriorated for low-skilled workers (e.g., Gihleb et al., 2022), and other studies indicate that high-skilled workers feel relieved from routine tasks

(Abeliansky et al., 2024; Consoli et al., 2023). As a result of automation, according to Lankisch et al. (2019), the low-skilled are more likely to suffer in terms of lower employment integration rate and economic gains, while the high-skilled may even increase financial benefits resulting from automation. Additionally, older workers close to the retirement age seem to be more worried about job security as a result of automation compared to the younger cohorts (Abeliansky et al., 2024).

At the same time, as found by Vries et al. (2020), the rise of robots adoption is significantly associated with a fall of employment share of routine manual task-intensive jobs, which was observed mainly in high-income countries, but not in the transition and emerging economies. According to Majzlíková and Vitáloš (2022), the Slovak labour market is likely to be disrupted by automation; it shows that workers with lower income are more likely to lose their jobs, while the risk of automation is lower in districts with higher unemployment rates. The character of automation makes a difference, too; it appears that automation of routine tasks may increase wage inequality, while the automation of non-routine tasks may decrease it (Upreti and Sridhar, 2024).

2 Digital divide and vulnerable groups

Social inequality is characterised by uneven and unfair distribution of opportunities and resources across diverse social groups. Technological transformation may mitigate or reinforce social inequality and may lead to the digital divide. That means that certain social groups do not benefit from the advantages of the digital transformation and beyond. Digital tools present instruments used at the workplace. Furthermore, they refer to access to digital (private and government) services, access to knowledge, training, and education, and also a way to participate in the civic participation since involvement in the civic and cultural life has moved to social media platforms that amplify voices of those who can actively use them (e.g., Norris, 2021). Therefore, the digital divide reflects already existing social inequalities.

According to Van Dijk (2020), the digital divide refers to both access and the ability to use digital tools with a purpose to achieve economic and social empowerment. Some authors argue that digital transformation exacerbates social inequalities of those who are already marginalised (e.g., Brynjolfsson and McAffee, 2014;). Brynjolfsson and McAffee (2014) claim that while increased use of digital tools is associated with economic growth, at the same time, they deepen income inequalities since high-skilled workers benefit from the use of digital technologies more than low-skilled workers.

The concept of digital divide appears in studies across diverse scientific disciplines. As early as in 2011, Copeland (2011) recognised that bridging the digital divide should be one of the central tasks of diplomacy, particularly science diplomacy. Kitsara (2022) applies the notion to artificial intelligence. In recent scholarship, the digital divide is associated with a concept of digital exclusion, which is considered a multi-layered phenomenon (van Dijk, 2013; Zhao, Collier and Deng, 2014). It refers not only to material possibilities to acquire digital skills (such as the ability to purchase devices or have access to networks) but also to aversion to obtain these new skills, lack of motivation or willingness to learn about modern technologies.

The gaps caused by the digital divide can be identified on three levels, namely,,*between industrialized and developing countries, metropolitan and rural areas, and more and less privileged individuals and groups,"* (Kitsara, 2022). According to OECD, the digital divide is spread across several dimensions, such as age, geography, firm size, income, or education (OECD, 2025). The United Nations Development Programme (UNDP) identified five groups of people who may not possess sufficient digital skills and access to digital tools. These population groups are people with disabilities, seniors, internal migrants, households with low income, and rural or remote households. Within the UNDP research framework, five indicators were assessed, particularly the following: problem solving; information and data literacy; collaboration and communication; creation of digital content; and safety. Some research participants mentioned financial difficulties when acquiring new devices and high-speed Internet. As for the lowest digital skills, senior citizens and persons with disabilities demonstrated the lowest score (UNDP, 2021).

The inability of some vulnerable groups to safely operate in digitalised settings was examined in other studies, too (e.g. Silvennoinen and Rantanen, 2023). Another conclusion of the UNDP's research is that persons with disabilities are most likely to experience the digital divide (UNDP, 2021). Silvennoinen and Rantanen (2023, p. 7) argue that individuals,,*in a disadvantaged position in society, are more likely to be marginalised in relation to digitalization*." Studies conclude that several vulnerable groups face obstacles when utilising digital services particularly the unemployed, immigrants, or individuals with mental health issues. These groups of people are even threatened by digital exclusion (Silvennoinen and Rantanen, 2023).

Other studies focus on the digital divide in the context of a specific (or vulnerable) group. One such qualitative study found that older people with ailments are willing and capable of utilising some smart, technological devices and IT (Choudrie, Zamani and Obuekwe, 2022). Fairlie's research points out that the digital divide between distinct races and ethnicities in the US has not disappeared throughout two decades. The cited research further demonstrates a lower probability among African-Americans and Latino-Americans to use the Internet on their smart devices (Fairlie, 2017). Access to the Internet in the US was also investigated in relation to the aspect of gender (linked to race and ethnicity) (Campos-Castillo, 2014). The gap regarding usage of the Internet in Israel, while considering gender, age and ethnicity, was discussed by Enoch and Soker (2006). The socially excluded communities seem to be deprived of having access to digital skills and devices in specific national contexts (Sylvester et al., 2017; Haenssgen, 2018), while the digital divide is also associated with ageing when the elderly benefit less from the digitalisation (Choi et al., 2020).

Except for studies focusing on digital inclusion of specific groups or marginalised communities, some research on the providers of digital skills training for the respective groups exists. Faye and Ravneberg (2024) recently conducted research on the role libraries and civic and public organisations play in the provision of digital training aimed at refugees and other vulnerable groups. Participation in such educational activities can enhance the digital inclusion of those involved. Improvements in digital inclusion can further promote social inclusion. However, as the authors conclude, both digital and social inclusion are processes requiring a lot of time. Digital inclusion goes far beyond mere access to the Internet, as is incorporates elements such as digital literacy, i.e. certain abilities (Faye and Ravneberg, 2024).

Supporting digital inclusion, i.e. to prevent digital exclusion, is critical. As far as recommended policies are concerned, authors suggest a wide spectrum of measures, such as regional development, steps targeted at prevention from school drop-outs, or programmes of digital literacy designated specifically for marginalised, vulnerable populations (Silvennoinen and Rantanen, 2023). Regarding access to digital public services, it is recommended to identify necessary competences, address obstacles and barriers, and then create inclusive programmes. In the process of bridging the digital divide, education is of paramount importance. Essential for effective utilisation of digital public services are primarily three factors, namely a high level of education, access to the Internet, and possessing at least elementary level of digital skills (Morte-Nadal and

Esteban-Navarro, 2025). Finally, the importance of maintaining in-person services in the digital world is highlighted (Silvennoinen and Rantanen, 2023).

3 Intersections of vulnerabilities in the labour market

Intersectional analytical framework postulates that inequalities in the labour market result from an interplay between social categories (such as gender, ethnicity, nationality, social class, disabilities) that overlap and may place individuals in a disadvantaged position (Atewologun, 2018; Crenshaw, 1991; Hankivsky and Kapilashrami, 2020; Curtis et al., 2017). These social categories not only intersect but also exist within structures of power, institutional and legal frameworks that contribute to experiences with privileges or oppression. Hence, the intersectional analytical framework posits that various political and social identities are interconnected and result in varying modes of discrimination or economic and social advantages (Crenshaw, 1991). The intersectionality, as derived from gender studies and critical race theory, underlines women's experiences with inequality. Nevertheless, the current research on inequality uses the conceptual framework to explore and understand the position of various disadvantaged groups in the labour market and beyond.

Crenshaw (1991) argues that women from ethnic minorities encounter various structural barriers in accessing employment, education, and other areas of life. Specific social positions are determined by social divisions and identities that may even modify over time, such as gender, ethnicity, disability, migrant status, age or class (Davis, 2008; Hancock, 2007). Thus, intersectional inequality has also been studied in the context of access to social entitlements. Fraser (1994) posits that to explore the inequality from the intersectional perspective, it is necessary to take into account intersections between the struggles for redistribution (wealth, access to social rights, income) and struggles for recognition of a social group´s dignity and decent social position in society. Thus, struggles for recognition take place in a materialistic world defined by wealth, access to education, health care, social services, or even leisure time. Struggles for recognition and redistribution, thus, do not present distinct categories of inequality, but rather interconnected concepts of justice. As a result of these specific social positions and intersecting identities, various groups of society may encounter varying experiences of welfare provision (Cho et al., 2013).

Intersectionality, thus, serves as an analytical tool for capturing the complexities of the dynamics and structures of power (Cho et al., 2013) and allows us to understand determinants of inequalities in a more complex and multidimensional way. In this respect, an intersectional analytical approach explores structures of power, institutions and policies that have a role in reinforcing or, on the other hand, mitigating social inequalities, or access to resources (Cho et al., 2013). Instead of understanding the inequality in the labour market from the perspective of one separate category (such as a lack of skills or ethnic discrimination), labour market precariousness is perceived as a consequence of intricately linked categories.

The groups of workers divided based on gender, educational attainment levels are not homogenous and they do not experience identical employment outcomes (Croucher et al., 2018). Thus, the differentiated labour market outcomes depend on a plethora of factors, such socio-economic, demographic, as well as identities that intersect within the broader policy and regulatory frameworks. Also, the visibility of the minority status is another factor adding to the (dis)advantaged positions of individuals (Petersen et al., 2022).

The impact of automation is differential *vis-à-vis* subgroups due to intersections of inequalities. In Central and Eastern Europe (hereinafter CEE), the ethnic minority members seem to be overrepresented among the low-skilled workers and thus, their work positions are more likely to face a greater risk of automation (Kureková, 2015). One of the largest ethnic minorities in CEE is the Roma, encountering difficulties in access to employment and, eventually, poor living conditions and quality of life (e.g., Kahanec, 2014; Kureková 2015; Filčák and Stager, 2014; Hora et al., 2023). The disadvantages the marginalised Roma encounter are manifold; they range from discriminatory practices and other barriers in access to education (Kureková et al., 2022; Miškolci et al., 2017; Vasilevich, 2025), which results in low skills needed in the labour market (Kureková, 2015). At the same time, the Roma encounter barriers in access to health care (Hidas et al., 2022), which, together with poor housing conditions, contributes to low quality of life and well-being. Spatial segregation also has a detrimental effect on the economic inequalities of the Roma and reinforces other modes of disadvantages and discrimination, such as access to services, access to economic and educational opportunities (Škobla and Filčák, 2018; Matoušek and Sýkora, 2011). As a result, these disadvantages are multi-

layered, which calls for complex policy solutions that would address various roots of social inequalities.

Another vulnerable group is the people with disabilities who also face multiple disadvantages, such as a scarcity of flexible and short-term employment contracts (Kureková et al., 2022), little *know-how* on the side of employers about how to adjust working environments to their needs, lack of policy tools to tackle barriers these people face, such as policies supporting transitions from the sheltered employment to the open labour market (Holubová et al., 2024; Sedláková and Pavelková, 2022; Sedláková, 2024), biases against people with disabilities from the side of employers, and others (Ondrušová et al., 2020).

One of the main reasons for economic inequalities of vulnerable groups in the CEE is a lack of policy tools that would address the multi-faceted character of social exclusion. The current evidence shows that in Slovakia, active labour market policies are not well-equipped to address barriers of the long-term unemployed; first of all, poor implementation of the proper profiling of the vulnerable unemployed groups does not allow for identifying specific and multiple barriers in the access to employment (Kahanec, 2014; Kahanec et al, 2020; Kureková et al., 2022). One of the most dominant ALMPs is Activation Works, with a high rate of participation of the long-term unemployed with low educational attainments; however, several studies (Kureková et al., 2014) show that Activation Work Programmes lack upskilling elements that would allow the participants to advance their skills needed in the labour market. At the same time, there is a poor implementation of the second-chance education programmes due to a lack of financial means and the whole support system (Rigová et al., 2021).

The problem of social exclusion is being accelerated during economic and social crisis since pre-existing poverty and social exclusion were amplified, especially for the marginalised communities due to their previous unstable position in the labour market and securitisation and militarised quarantine provisions (Hidas et al., 2022; Surová, 2022). The pandemic also had a negative impact on the work opportunities for both the homeless people and inhabitants of Roma marginalised communities since they are dependent on the ad hoc labour opportunities often positioned in the shadow economy (Kureková et al., 2022).

One of the approaches in the literature in tackling multiple barriers in the access to employment and social integration is the so-called *social ecosystem* approach (Shaw et al., 2022). The main principle of social ecosystem is that social integration, and specifically labour integration, is built on the chain of interventions that address particular sources of inequalities such as upskilling training, health care, housing policies, etc. This requires collaboration of relevant policy stakeholders having various expertise and policy tools that shape integration processes at various levels of governance (Nevala et al., 2015; Saltkjel et al., 2023). Implementing social ecosystem approach allows to both identify target groups that are the most vulnerable in the labour market as well as specific barriers to the access to employment, and use policy tools that are effectively addressing these particular barriers. Such an approach calls for the cooperative strategies between stakeholders such as trade unions, business companies, state agencies involved in the integration of people with disabilities, interest groups representing the rights of the target groups, and others. The collaboration of policy stakeholders operates within the welfare state settings, and institutional framework (Holubová et al., 2024) and also social norms that shape the attitudes towards vulnerable individuals.

Conclusion

Although automation has been yielding various challenges for the well-being and employment prospects of the population, it remains unclear how automation will affect employment prospects and working conditions of vulnerable workers in Slovakia and Czechia, including marginalised communities, the elderly, or people with disabilities. Due to the digital divide, pre-existing social inequalities and discrimination, a lack of employment and educational policies well-tailored to the needs of the disadvantaged, automation may amplify the unstable position of the labour market of the vulnerable groups and reinforce poverty and social exclusion. In addition, intersections of identities, socio-economic and demographic attributes make disadvantages complex and require holistic approaches in policy-making. Since the inequalities in the world of labour are characterised by their complexities, the intersectional analytical framework and social ecosystem approach allows to understand the accumulation of barriers positioned in the concrete labour market contexts of Slovakia and Czechia. Thus, automation does not stand in a void but is embedded in the policy and regulatory frameworks, and its impact needs to be explored as such.

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