Zborník vedeckých príspevkov z medzinárodnej vedeckej konferencie

Aktuálne výzvy v rozvoji ľudských zdrojov: dôsledky krízového obdobia 2024

14. - 15. novembra 2024
Trenčín
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Current Challenges in Human Resource Development: Implications of the Crisis Period 2024

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Slovak Republic

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Tematické okruhy/Conference Topics

1) HR in Small and Medium-sized Enterprises: Challenges of the 21st Century
2) Sustainable Development of Small and Medium-sized Enterprises
3) Application of Artificial Intelligence in Human Resources Management

Program

Štvrtok / Thursday - 14. November 2024:

Registration ***9^{30} - 10^{00}***

Opening ceremony and plenary session ***10^{00} - 18^{00}***

- ***Katarína HAVIERNIKOVÁ***
  Chairman of the Scientific Committee of the Conference, Alexander Dubček University of Trenčin

- ***Eva IVANOVÁ***
  Dean of Faculty of Social and Economic Relations, A. Dubček University of Trenčín

Keynote speakers:

- ***prof. Dr. habil. Andrea BENCSIK***
  " HR LEADERSHIP CHALLENGES FOR SUSTAINABLE KNOWLEDGE "
  J. Selye University Komarno, Slovakia; University of Pannonia, Veszprem Hungary

- ***dr Magdalena RACZYŃSKA***
  " MANAGING NEURODIVERSITY: A GREAT CHALLENGE FOR ORGANIZATIONS"
  Institute of Management and Quality Sciences at the Faculty of Economics, University of Warmia and Mazury in Olsztyn.

- ***Ing. Lukáš DANKO, PhD.***
  "VALUE, QUALITY AND PERTINENCE OF THE KNOWLEDGE SHARING IN ORGANISATIONS"
  Faculty of Management and Economy, Tomáš Baťa University Zlín.

- ***prof. JUDr. Daniela NOVÁČKOVÁ, PhD.***
  "FINANCOVANIE ROZVOJA ĽUDSKÝCH ZDROJOV: PRÁVNE ASPEKTY A POTREBY SÚČASNÉHO TRHU PRÁCE"
  Comenius University in Bratislava, Department of International Management, Faculty of Management.

- ***Ing. Mária MICHALČÍKOVÁ***
  "ZLEPŠENIE NÁVŠTEVNÍCKEJ SKÚSENOSTI V TURISTICKÝCH DESTINÁCIACH POMOCOU INTERPRETAČNÝCH NÁSTROJOV UNESCO DESTINÁCII"
  Interpret Europe.

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  " RCOH - SYSTÉMOVÉ RIEŠENIA PRE INTEGROVANÉ ZÁMERY ROZVOJA REGIÓNU"
  Regional Industrial Innovation Cluster Rimavská Kotlina - REPRIK.

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  " REALITA PRÁCE HR VČERA A DNES"
  Ynak, s.r.o.

- ***PhDr. Radoslav SEKERKA, PhD.***
  " AKO UDRŽAŤ A STABILIZOVAŤ ZAMESTNANCOV"
  DEKRA Arbeit, s.r.o.

- ***Mgr. et Mgr. Petra MICHÁLEKOVÁ***
  " KĽÚČOVÉ OBLASTI RIADENIA ĽUDSKÝCH ZDROJOV PRE LEPŠIU PRIPRAVENOSŤ NA BUDÚCE KRÍZY A ZMENY NA TRHU PRÁCE"
  AWIN, s.r.o.

- ***Mgr. Dana MIŇOVÁ, PhD.***
  " HR VO VÍRE TANCA? NIE. V ČASE ZMENY. MOJA DEKÁDA V TOP TRANSFOMÁCIÁCH NA SLOVENSKU"
  ExCHRO, s.r.o.

- ***Ing. Vladimír KRÁLIK***
  " ZAMESTNANCI V POĽNOHOSPODÁRSTVE A DUÁLNE VZDELÁVANIE, PRAKTICKÁ VÝCHOVA"
  PD Bošáca.

- ***Ing. Miroslav ILAVSKÝ***
  "PHISHING A SOCIÁLNE INŽINIERSTVO: AKO BEZPEČNOSTNÉ ŠKOLENIA A VZDELÁVANIE ZAMESTNANCOV PRISPIEVAJÚ K ZNÍŽENIU KYBERNETICKÝCH RIZÍK"
  CEO i-Secure, s.r.o.

Lunch	**12^{30} - 13^{30}**
Coffee break	**15^{35} - 16^{00}**
Dinner and social event	**18^{00} –**

<u>Piatok / Friday - 15. November 2024:</u>

Registration	***9^{00} - 9^{30}***
Plenary session	***9^{30} - 12^{30}***

Keynote speakers:

- ***prof. Dr. József POÓR, DSc.***
  "PARADIGM SHIFTS IN HUMAN RESOURCE MANAGEMENT - PAST, PRESENT AND FUTURE"
  Selye University Komarno, Slovakia;Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

- ***Ing. Zuzana Dinková GAŠPAROVIČOVÁ***
  "VYUŽÍVANIE DIGITÁLNYCH TECHNOLÓGIÍ NA ZVÝŠENIE EFEKTIVITY A PRODUKTIVITY ĽUDSKÝCH ZDROJOV A KONKURENCIESCHOPNOSTI MIKROPODNIKU"
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  Sensus Slovakia, Inc.

- ***Bc. Anna BEDNÁROVÁ***
  "DIGITÁLNA TRANSFORMÁCIA A JEJ DOPADY NA ROZVOJ TALENTOV A VZDELÁVANIA"
  Alexander Dubček University in Trenčín, Slovakia.

Lunch	**12^{30} - 13^{30}**
Conference sections	**14^{00} - 17^{30}**
Coffee break	**15^{35} - 16^{00}**

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Chair: JUDr. Andrej PORUBAN, PhD.

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  ZAMESTNANEC V AKTE O UMELEJ INTELIGENCIÍ

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- ***Marta SZCZEPAŃCZYK***
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- ***Mantas ŠVAŽAS***
  REGIONAL DEVELOPMENT THROUGH THE PERSPECTIVE OF RENEWABLE ENERGY

- ***Ieva PETROKE, Valentinas NAVICKAS***
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- ***Marcin SITEK***
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- ***Anna BINIEK-POSKART***
  THE KNOWLEDGE MANAGEMENT SYSTEM IN AUTOMOTIVE ENTERPRISE – CASE STUDY

- ***Marcel KORDOŠ***
  SMART CITY POLICY CONCEPTS ANALYSIS IN ITALY – BENEFITS AND CHALLENGES

- ***Marcel KORDOŠ***
  THE START-UP PROMOTION ENHANCEMENT POLICY IN SLOVAKIA

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Scientific conference for PhD students and young scholars

Chair: doc. Ing. Katarína Havierniková, PhD., Ing. Karol Krajčo, PhD.

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  ADDRESSING SMES' VULNERABILITIES IN COASTAL AND INLAND AREAS: PROSPECTS OF THE BLUE ECONOMY

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- ***Emília LAZAROVÁ, Jakub HOLÚBEK***
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Lunch	**12^{30} - 13^{30}**
Conference sections	**14^{00} - 17^{30}**
Coffee break	**15^{35} - 16^{00}**

OBSAH

Úvod

Medzinárodná vedecká konferencia „*Aktuálne výzvy v rozvoji ľudských zdrojov: dôsledky krízového obdobia 2024*“ nadväzuje na predchádzajúce úspešné konferencie „*Výzvy, trendy a inšpirácie na trhu práce*“ z minulých rokov 2018, 2019, 2020 a 2023, ktorých zborníky sú evidované v databáze Web of Science spoločnosti Clarivate Analytics (roky 2020, 2021 a 2022 v procese evaluácie). Ide o sériu tradične poriadaných podujatí Fakulty sociálno-ekonomických vzťahov v oblasti riadenia ľudských zdrojov, personálneho manažmentu a trhu práce. Konferencia sa koná v hybridnom režime na pôde Fakulty sociálno-ekonomických vzťahov Trenčianskej univerzity Alexandra Dubčeka v Trenčíne a online prostredníctvom platformy MS Teams. Konferencia a predkladaný zborník tvoria sériu výstupov v rámci projektov *VEGA č. 1/0718/22 “Rozvoj ľudských zdrojov v malých a stredných podnikoch v kontexte výziev 21. storočia”, VEGA č. 1/0369/24 „Právne, ekonomické a etické limity a výzvy umelej inteligencie pri riadení ľudských zdrojov“ a VEGA č. 1/0364/22 „Výskum eko-inovačného potenciálu malých a stredných podnikov v kontexte trvalo udržateľného rozvoja“*. Medzinárodná vedecká konferencia v prvý deň vytvára platformu pre vedcov, odborníkov a podnikateľov na výmenu skúseností a hľadanie inovatívnych riešení na zlepšenie riadenia ľudských zdrojov v malých a stredných podnikoch. Druhý deň konferencie je primárne určený akademickej verejnosti, ktorá bude v jednotlivých sekciách prezentovať výsledky svojej vedecko-výskumnej činnosti. Vedecká konferencia si kladie za cieľ vytvoriť platformu pre vedcov, odborníkov z praxe a podnikateľov na výmenu skúseností a identifikáciu inovatívnych riešení pre zlepšenie efektívnosti riadenia ľudských zdrojov v malých a stredných podnikoch. Účastníci vedeckej konferencie budú mať možnosť diskutovať o vývoji, aktuálnych trendoch a výzvach v oblastiach postupov riadenia rozvoja ľudských zdrojov, vplyvu rozvoja ľudských zdrojov na inovatívnosť, konkurencieschopnosť a výkonnosť malých a stredných podnikov. Cieľom konferencie je stanoviť základné otázky pre nezávislý základný výskum, ktorý bude realizovaný v rámci projektov VEGA, realizovaných na Fakulte sociálno-ekonomických vzťahov Trenčianskej univerzity Alexandra Dubčeka v Trenčíne. Medzinárodný vedecký a organizačný výbor zaručuje dosiahnutie vysokej kvalitatívnej úrovne uskutočnenej konferencie. Pod jeho vedením bude vydaný recenzovaný zborník príspevkov, ktorý bude zaslaný na indexáciu do databázy Web of Science spoločnosti Clarivate Analytics.

Introduction

The International scientific conference *"Current Challenges in Human Resource Development: Implications of the Crisis Period 2024"* builds on previous successful conferences *"Challenges, Trends and Inspirations within the Labor Market"* from previous years 2018, 2019, 2020 and 2023 of which proceedings are registered in the Clarivate Analytics Web of Science database (2020, 2021 and 2022 within the process of evaluation). It is a series of traditionally organized events at the Faculty of Socio-Economic Relations in the fields of human resources management, personnel management, and the labor market. The conference was held within the hybrid mode at the Faculty of Social and Economic Relations, Alexander Dubček University in Trenčín and online via the MS Teams platform. The conference and the presented proceedings belong to the series of outputs within the projects of Slovak Ministry of Education Grant Agency VEGA *reg. no. 1/0718/22 “Human resource development in small and medium-sized enterprises in the context of 21st century challenges”; VEGA reg. no. 1/0369/24 "Legal, economic and ethical limits and challenges of artificial intelligence in human resource management "; and VEGA reg. no. 1/0364/22 "Research into the eco-innovative potential of small and medium-sized enterprises in the context of sustainable development "*. The international scientific conference, scheduled for November 14, 2024, will serve as a forum for scientists, experts, and entrepreneurs to exchange experiences and identify innovative solutions to enhance human resource management in small and medium-sized enterprises. The second day of the conference is primarily dedicated to the academic public, who will present the results of their scientific research activities in individual sessions. The scientific conference aims to create a platform for scientists, practitioners and entrepreneurs to exchange experiences and identify innovative solutions to improve the effectiveness of human resource management in small and medium-sized enterprises. Participants of the scientific conference will have the opportunity to discuss developments, current trends and challenges in the areas of human resource development management practices, the impact of human resource development on the innovativeness, competitiveness and performance of small and medium-sized enterprises. The goal of the conference is to outline the principal questions set for the independent basic research, which will be executed under the VEGA projects being solved at the Faculty of Social and Economic Relations, Alexander Dubček University in Trenčín. The International Scientific and Organizing Committee guarantees to meet the high-quality level of the conference. Under its leadership, a peer-reviewed collection of papers within the Conference proceedings will be issued and published and submitted for indexing to Clarivate Analytics' Web of Science database.

PRÁVA A POVINOSTI ZAMESTNANCOV V AKTE O UMELEJ INTELIGENCII

THE EMPLOYEES' RIGHTS AND DUTIES IN THE ARTIFICIAL INTELLIGENCE ACT

Martin DAŇKO[1]
Andrej PORUBAN[2]

Abstrakt: *Cieľom príspevku je identifikovať prienik medzi právami a povinnosťami zamestnancov a reguláciou umelej inteligencie v právnom rámci Európskej únie. Osobitná pozornosť sa venuje otázke, do akej miery nové predpisy ovplyvňujú reálny výkon práv zamestnanca, najmä právo na súkromie, ochranu dôstojnosti a transparentné zaobchádzanie s dátami, pri rastúcom nasadzovaní umelej inteligencie na pracovisku. Príspevok skúma, ako zamestnávateľ musí zavádzať systémy umeleje inteligencie spôsobom, ktorý posilňuje dôveru zamestnancov v ich spravodlivosť a prehľadnosť. Zdôrazňuje sa potreba multidisciplinárneho prístupu a neustálej adaptácie legislatívy na rýchly technologický vývoj s dôrazom na ochranu základných práv a dôstojnosti zamestnancov. Navrhujú sa tiež odporúčania pre zabezpečenie etického a právne súladného využívania umelej inteligencie.*

Kľúčové slová: *AI Akt, pracovnoprávne vzťahy, transparentnosť, umelá inteligencia, zamestnanci*

Abstract: *"This paper aims to identify the intersection between employee rights and obligations and the regulation of artificial intelligence within the European Union's legal framework. It pays particular attention to how new AI regulations impact the actual exercise of employee rights, especially the right to privacy, the protection of dignity, and transparent data handling, amidst the increasing deployment of artificial intelligence in the workplace. The paper explores how employers can implement artificial intelligence systems in a manner that fosters employee trust in their fairness and transparency. It highlights the necessity of a multidisciplinary approach and the continuous adaptation of legislation to rapid technological advancements, emphasizing the protection of employees' fundamental rights and dignity. Furthermore, the paper proposes recommendations to ensure the ethical and legally compliant use of artificial intelligence.".*

Key words: *AI Act, employment relationships, transparency, artificial intelligence, employees*

JEL Classification: *K24, K31, K38*

1. ÚVOD

Zavádzanie umelej inteligencie (AI) do pracovného prostredia predstavuje jednu z najvýznamnejších výziev súčasnej digitálnej transformácie. Automatizované rozhodovanie, algoritmická analýza výkonu či prediktívne modely v oblasti riadenia ľudských zdrojov postupne menia tradičný rámec pracovnoprávnych vzťahov.

Tento vývoj vyvoláva otázky týkajúce sa ochrany základných práv zamestnancov, rovnováhy medzi efektivitou a dôstojnosťou na pracovisku, ako aj primeraného nastavenia práv a povinností zamestnancov pri interakcii s AI systémami. Európska únia (EÚ) zároveň predstavuje unikátny legislatívny rámec pre reguláciu AI, ktorý zdôrazňuje etické pravidlá, ochranu základných práv a prehľadnosť systémov umelej inteligencie. Akt o umelej inteligencii (AI Akt), spolu s ďalšími právnymi nástrojmi, umožňuje zadefinovať právne mantinely, ktoré majú usmerniť používanie AI v zamestnaneckom kontexte. Zamestnanec je síce povinný vykonávať prácu podľa pokynov zamestnávateľa podľa pracovnej zmluvy, no

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naďalej je nositeľom základných práv, ktorých zachovanie nemožno vylúčiť ani v pracovnoprávnom vzťahu. Práve nasadenie AI systémov, ktoré monitorujú, hodnotia alebo rozhodujú o zamestnancoch, predstavuje potenciálne riziko neprimeraného zásahu do ich súkromia či autonómie. Navyše, ak majú zamestnanci využívať AI systémy ako pracovný nástroj, je potrebné, aby voči týmto systémom existovala dôvera založená na transparentnosti, zrozumiteľnosti a nediskriminačnom fungovaní algoritmov.

Východiskové hypotézy článku sú:

i. Prijatie AI aktu významným spôsobom ovplyvňuje rozsah práv a povinností zamestnanca, predovšetkým v oblasti ochrany súkromia, dôstojnosti a práva na vysvetlenie automatizovaných rozhodnutí, čím vytvára nové výzvy pre pracovné právo a zamestnávateľov v EÚ.
ii. Zamestnávateľ je povinný zavádzať systémy umelej inteligencie do procesov riadenia a kontroly výkonu práce, ako aj do technologického vybavenia zamestnanca, spôsobom, ktorý posilňuje dôveru zamestnancov v ich spravodlivosť, prehľadnosť a nediskriminačné fungovanie podľa princípov spoľahlivej AI.

V prípadoch, keď zamestnávateľ zvažuje nasadenie AI do procesov riadenia a kontroly výkonu práce zamestnancov, musí zohľadniť nielen nové pravidlá vyplývajúce z AI Aktu, ale aj existujúce právne limity. Tieto vyplývajú najmä zo Zákonníka práce č. 311/2001 Z.z., ktorý stanovuje rámec výkonu právomoci zamestnávateľa, ako aj z Občianskeho zákonníka, ktorý chráni osobnostné práva jednotlivca vrátane jeho súkromia a ľudskej dôstojnosti. Nevyhnutná je preto komplexná právna analýza, ktorá zohľadňuje viaceré vplyvy regulačných režimov.

Druhá hypotéza vychádza z potreby zabezpečiť, aby nasadenie AI systémov na pracovisku nebolo len technickou otázkou, ale aj otázkou dôvery a rešpektu voči zamestnancom. Transparentnosť algoritmov a ich spravodlivé a nediskriminačné fungovanie sú základnými princípmi, ktoré sú podporené nielen legislatívou EÚ, ale aj širšími etickými rámcami používania umelej inteligencie. Ak zamestnávatelia nezohľadnia tieto princípy, hrozí nielen porušenie práv zamestnancov, ale aj zníženie ich dôvery v AI systémy, čo môže negatívne ovplyvniť pracovnú morálku, angažovanosť a celkovú efektivitu. Zavádzanie AI systémov, ktoré sú nedostatočne transparentné, nepochopiteľné alebo diskriminačné, môže viesť k pocitu nespravodlivosti a obáv zo strany zamestnancov, čo je v rozpore s cieľmi moderného pracovného práva a princípmi dôstojnosti a rešpektu na pracovisku. Preto je kľúčové, aby zamestnávatelia pri implementácii AI uplatňovali postupy a štandardy, ktoré posilňujú dôveru zamestnancov a zabezpečujú spravodlivé zaobchádzanie.

Metodológia výskumu je založená na kombinácii analýzy primárnych a sekundárnych právnych prameňov, vrátane AI Aktu, všeobecného nariadenia o ochrane údajov (GDPR), judikatúry Súdneho dvora EÚ a vybraných vnútroštátnych úprav. Okrem toho budú analyzované vedecké štúdie, politické stanoviská a aplikačná prax v členských štátoch EÚ.

2. ÚVOD DO REGULÁCIE UMELEJ INTELIGENCIE V EÚ

Európska únia si uvedomuje, že umelá inteligencia je jednou z najzásadnejších technologických inovácií 21. storočia, ktorá má potenciál zásadne ovplyvniť hospodárstvo, spoločnosť i pracovné prostredie. Vývoj a nasadenie AI zároveň prináša významné právne, etické a spoločenské výzvy, ktoré vyžadujú primeranú reguláciu.

História regulačného úsilia EÚ v oblasti umelej inteligencie začala systematicky naberať na intenzite v poslednom desaťročí. Už v roku 2018 vydala Európska komisia správu *Artificial Intelligence for Europe*, ktorá definovala kľúčové oblasti na podporu výskumu, inovácií a

zároveň nastavila princípy zodpovedného vývoja AI technológií s dôrazom na dôveru a ochranu základných práv občanov. V roku 2020 Komisia predstavila dokument *White Paper on Artificial Intelligence – A European approach to excellence and trust*, ktorý zdôraznil potrebu vyváženého prístupu k regulácii AI s cieľom podporiť inováciu a zároveň zaistiť bezpečnosť, prehľadnosť a ochranu základných práv používateľov.

Regulačné úsilie EÚ vyplýva z jasnej potreby vytvoriť jednotný trh pre AI technológie, ktorý je zároveň založený na rešpekte k základným hodnotám EÚ, ako sú ľudská dôstojnosť, sloboda, demokracia, rovnosť a právny štát (Článok 2 Zmluvy o fungovaní EÚ). V porovnaní s USA a Čínou, ktoré pristupujú k AI prevažne cez prizmu technologickej dominancie a ekonomického rastu, EÚ kladie zvýšený dôraz na etické a právne aspekty. Kým USA preferujú flexibilnejší pravidlá s dôrazom na trhové mechanizmy a inovačné prostredie, Čína implementuje štátom riadený prístup s rozsiahlym využitím AI v štátnej správe a kontrole občanov, čo vyvoláva otázky o ochrane súkromia a ľudských práv. EÚ si tak vyhradzuje pozíciu lídra v globálnom nastavení štandardov pre dôveryhodnú a ľudsky orientovanú umelú inteligenciu.

Dôvody pre prijatie komplexnej regulácie AI v EÚ sú preto definované potrebou:

- predchádzať rizikám spojeným s automatizovaným rozhodovaním, najmä v oblastiach s vysokým vplyvom na ľudské práva, akými sú napríklad pracovnoprávne vzťahy,
- zabezpečiť prehľadnosť a spravodlivosť AI systémov, aby nedochádzalo k diskriminácii,
- chrániť súkromie a osobnostné práva používateľov, najmä zamestnancov,
- podporiť dôveru verejnosti a zamestnancov voči AI technológiám.

2.1 AI Akt a jeho prepojenie s GDPR a ďalšími legislatívnymi nástrojmi

AI Akt, ktorého návrh predložila Európska komisia v roku 2021, predstavuje zásadný krok v smerovaní regulácie umelej inteligencie v Európskej únii. Jeho prijatie má zásadný význam z pohľadu ochrany práv a slobôd jednotlivcov, najmä v pracovnoprávnej oblasti, kde sa stále častejšie využívajú AI systémy na riadenie a hodnotenie výkonu zamestnancov. Hypotéza, že AI Akt významným spôsobom ovplyvní práva a povinnosti zamestnanca, predovšetkým v oblasti ochrany jeho súkromia a dôstojnosti, je preto opodstatnená.

Zamestnanec, hoci je povinný vykonávať prácu podľa pokynov zamestnávateľa, si zachováva osobnostné práva, medzi ktoré patrí aj právo na súkromie a ochranu pred neoprávneným zásahom do svojho súkromia. AI systémy používané na monitorovanie, hodnotenie alebo riadenie pracovných procesov predstavujú riziko zásahu do týchto práv, ak nie sú správne regulované a kontrolované. AI Akt preto vyžaduje, aby systémy s vysokým rizikom, akými sú aj tie využívané na hodnotenie zamestnancov, spĺňali prísne požiadavky týkajúce sa transparentnosti, zodpovednosti a ochrany základných práv. Konkrétne ustanovenia AI Akt, ako napríklad povinnosť prevádzkovateľov viesť podrobnú dokumentáciu (Článok 11) a zabezpečiť vysvetliteľnosť rozhodnutí AI (Článok 13), priamo podporujú ochranu súkromia zamestnancov a posilňujú ich dôveru v tieto systémy. Právo zamestnancov vedieť, ako a na základe akých kritérií sú ich pracovné výkony hodnotené, je potrebné pre zachovanie princípu dôstojnosti a rovnosti v pracovnom prostredí.

Ďalšou dôležitou dimenziou je druhá hypotéza, ktorá predpokladá, že zamestnávateľ musí implementovať AI systémy tak, aby posilňovali dôveru zamestnancov prostredníctvom transparentnosti a spravodlivosti algoritmov. AI Akt v tomto smere zdôrazňuje potrebu mechanizmov ľudského dohľadu nad AI systémami (Článok 14), ktoré umožňujú zásahy v prípade chýb alebo nespravodlivých rozhodnutí. Transparentnosť algoritmov a otvorenosť

voči používateľom – teda zamestnancom aj manažmentu – sú kľúčové pre zabezpečenie nediskriminačného prístupu a zamedzenie potenciálnych algoritmických predsudkov.

Z hľadiska právneho rámca je potrebné zohľadniť aj pravidlá GDPR, ktoré sú integrálnou súčasťou regulácie AI systémov. Najmä článok 22 GDPR, ktorý obmedzuje automatizované rozhodovanie bez ľudského zásahu, reflektuje požiadavku na zachovanie osobnostných práv a ochranu súkromia v pracovnoprávnom kontexte. Tieto pravidlá vytvárajú povinnosti pre zamestnávateľov implementujúcich AI technológie, aby vyvážili efektívnosť riadenia s ochranou zamestnancov.

Ďalej je potrebné upozorniť na synergické pôsobenie AI Aktu, GDPR, Zákonníka práce (napr. ustanovenie o ochrane osobnosti zamestnanca v § 13 a Občianskeho zákonníka (§ 11 a nasl.), ktoré spoločne vytvárajú komplexný rámec zameraný na zabezpečenie rovnováhy medzi efektívnosťou využitia AI a ochranou základných práv zamestnancov. V kontexte týchto regulácií platí, že zamestnávateľ je povinný nielen rešpektovať, ale aktívne chrániť práva zamestnancov implementáciou AI systémov, ktoré sú nielen technologicky efektívne, ale aj transparentné, spravodlivé a zodpovedné. Z tohto pohľadu možno konštatovať, že prijatie AI Aktu predstavuje významný impulz k nastoleniu takejto praxe, ktorá zodpovedá základným princípom európskeho práva a etiky v oblasti umelej inteligencie.

2.2 Etické princípy a štandardy pre AI v pracovnom prostredí

S rozširovaním využívania umelej inteligencie v pracovných procesoch rastie potreba jasne definovaných etických princípov, ktoré zabezpečia, že aplikácia AI bude nielen technicky efektívna, ale predovšetkým rešpektujúca základné práva a dôstojnosť zamestnancov. Medzi kľúčové etické pravidlá, ktoré sú dnes uznávané pri umelej inteligencii, patria:

- transparentnosť,
- spravodlivosť,
- nediskriminácia,
- zodpovednosť,
- dôvera.

Transparentnosť znamená, že zamestnanci majú právo vedieť, ako fungujú AI systémy, aké údaje sa o nich zhromažďujú, na základe akých kritérií sú ich výkony hodnotené a aké rozhodnutia systémy prijímajú. Transparentnosť je nevyhnutná na posilnenie dôvery v technológie a na umožnenie zamestnancom lepšie porozumieť procesom, ktorých sú súčasťou (Floridi, L., Cowls, J., Beltrametti, M., Chatila, R., Chazerand, P., Dignum, V., Vayena, E., 2018).

Spravodlivosť a nediskriminácia zabezpečujú, že AI systémy nebudú uprednostňovať alebo znevýhodňovať konkrétne skupiny zamestnancov na základe pohlavia, veku, etnického pôvodu, zdravotného stavu či iných osobných charakteristík. Tento princíp je zásadný na udržanie rovnosti príležitostí a na predchádzanie algoritmickej diskriminácii, ktorá by mohla viesť k porušeniu základných ľudských práv (*White Paper on Artificial Intelligence – A European approach to excellence and trust*).

Zodpovednosť sa týka jasného vyznačenia, kto nesie právnu a morálnu zodpovednosť za rozhodnutia prijaté AI systémami v pracovnom prostredí. Aj keď AI môže automatizovať mnohé procesy, konečné právne a etické dôsledky musia zostať pod kontrolou ľudí, ktorí tieto systémy navrhujú, prevádzkujú a spravujú (Jobin, A., Ienca, M., & Vayena, E., 2019).

Dôvera medzi zamestnávateľmi a zamestnancami je nevyhnutným predpokladom úspešného zavádzania AI do pracovných procesov. Dôvera je budovaná nielen na transparentnosti a spravodlivosti, ale aj na zodpovednom a etickom prístupe k implementácii AI technológií,

ktorý rešpektuje osobnostné práva zamestnancov a podporuje ich aktívnu účasť na procesoch hodnotenia a rozhodovania.

Dodržiavanie týchto etických princípov je kľúčové pre zachovanie ľudskej dôstojnosti a práv zamestnancov pri stále dynamickejšieho nasadzovaní AI. Ich implementácia je nielen právnou, ale aj morálnou povinnosťou všetkých aktérov v pracovnoprávnom prostredí. Na druhej strane, úmyselné porušovanie týchto princípov už zakladá protiprávne konanie, ktoré môže byť v rozpore s konkrétnou právnou normou – napríklad konanie, ktorého následok bol tak závažný, že by vytvoril zásah do osobnostných práv konkrétnej fyzickej osoby. Tento prechod z morálneho imperatívu do právneho rámca je nevyhnutný na zabezpečenie efektívnej ochrany zamestnancov a k tomu, aby práva a dôstojnosť človeka nezostali iba v rovine deklaratívnych zásad, ale boli aktívne chránené a presadzované.

3. PRÁVA A POVINNOSTI ZAMESTNANCA VO VZŤAHU K AI

Rozmach AI na pracovisku výrazne mení parametre vzťahu medzi zamestnávateľom a zamestnancom. Jeho redefinícia si vyžaduje nový pohľad na práva zamestnanca (s dôrazom na súkromie, dôstojnosť, autonómiu) a zároveň nové povinnosti (spolupráca s AI systémami, základná digitálna gramotnosť, porozumenie algoritmom).

3.1 Právo na prehľadnosť a vysvetliteľnosť algoritmických rozhodnutí

Transparentnosť algoritmických procesov je základným predpokladom dôveryhodnosti systémov umelej inteligencie v pracovnom prostredí. Zamestnanci majú legitímne právo poznať pravidlá a logiku, podľa ktorej AI rozhoduje o ich výkone, úlohách, kariérnom raste či odmeňovaní. Podľa článku 13 a 52 AI Aktu musí byť výstup algoritmu interpretovateľný a vysvetliteľný tak, aby bol zrozumiteľný aj pre nešpecialistu.

Tento princíp posilňuje aj čl. 5 ods. 1 písm. a), b), c) GDPR, kde sa kladie dôraz na spravodlivé, zákonné a transparentné spracúvanie údajov. Burrell upozorňuje, že „*neprehľadnosť algoritmov môže viesť k asymetrii moci*“, ktorá oslabuje práva jednotlivca. V podobnom duchu Selbst & Barocas varujú, že „*vysvetliteľnosť je lákavá, no nie vždy postačujúca – skutočným cieľom musí byť porozumenie a možnosť ovplyvniť rozhodnutie*“ (Selbst, A. D., & Barocas, S., 2018). Táto diskusia priamo podporuje prvú hypotézu, keďže bez transparentnosti algoritmu je ochrana súkromia a dôstojnosti zamestnanca ohrozená. Zároveň ide o kľúč k druhej hypotéze: vysvetliteľné AI systémy zvyšujú dôveru zamestnanca vo férovosť algoritmických rozhodnutí.

3.2 Právo na ľudský zásah

Článok 22 GDPR explicitne stanovuje, že fyzická osoba má právo nebyť predmetom rozhodnutia, ktoré je založené výlučne na automatizovanom spracúvaní, ak má toto rozhodnutie právne účinky alebo sa jej významne dotýka. Zamestnanci tak majú právo požadovať „ľudský zásah“, vyjadriť svoje stanovisko a napadnúť rozhodnutie. Goodman & Flaxman uvádzajú, že toto právo je esenciálne najmä tam, kde sú algoritmické rozhodnutia spojené s pracovným postavením, odmeňovaním alebo sankciami (Goodman, B., & Flaxman, S., 2017). Rovnako Calo argumentuje, že „*automatizácia rozhodovania bez spätnej väzby vedie k odcudzeniu a strate dôstojnosti pracovníka*“ (Calo, R., 2017). Z hľadiska prvej hypotézy je zachovanie tohto práva formou právnej poistky, ktorá bráni AI v plnom nahradení ľudského úsudku v citlivých oblastiach. Z hľadiska hypotézy druhej ide o nástroj na zachovanie dôvery a spravodlivosti voči zamestnancom.

3.3 Povinnosti zamestnanca pri interakcii s AI systémami

Zatiaľ čo väčšina diskusie o regulácii umelej inteligencie sa zameriava na práva zamestnancov, nemenej dôležité je upriamiť pozornosť aj na ich nové povinnosti v pracovnom prostredí. V kontexte hypotéz tohto článku, ktoré predpokladajú nevyhnutnosť posilňovania dôvery v AI a rešpektovania práv zamestnanca, sú tieto povinnosti kľúčovým nástrojom na vyváženie autonómie a zodpovednosti. Medzi základné povinnosti patria najmä:

i. Aktívne oboznámenie sa s fungovaním AI systémov, keďže bez základnej dátovej a algoritmickej gramotnosti nemožno očakávať zodpovedné rozhodovanie pri práci s výstupmi AI.
ii. Zodpovedné používanie výstupov AI, pričom sa kladie dôraz na pochopenie limitácií algoritmických systémov a ich správne uplatnenie v rozhodovacích procesoch.
iii. Absolvovanie školení, ktoré zamestnávateľ poskytuje ako povinnosť podľa AI Aktu.
iv. Spolupráca pri vývoji a hodnotení AI systémov, vrátane poskytovania spätnej väzby, ktorá je podstatná pre ich etické zdokonaľovanie.

Tieto povinnosti nie sú len organizačnými opatreniami, ale odrazom širšej spoločenskej potreby reagovať na meniaci sa charakter práce v digitálnom veku v súlade s cieľmi právnej a etickej regulácie. Podpora týchto povinností zo strany zamestnávateľa – najmä prostredníctvom školení, transparentnej komunikácie a technickej podpory – predstavuje podmienku pre zodpovedné a dôveryhodné nasadenie AI do pracovného prostredia.
Brynjolfsson & McAfee hovoria o tzv. „*hybridnej inteligencii*“, kde človek a stroj musia spolupracovať. Podľa nich „*úspešné využitie AI v práci závisí na schopnosti zamestnanca pochopiť a dopĺňať algoritmus*“ (Brynjolfsson, E., & McAfee, A., 2017). Zamestnanec sa tak stáva aktívnym spolutvorcom významu rozhodnutí AI, čo podporuje druhú hypotézu. Zároveň ide o rámec zodpovednosti, ktorý vyvažuje nové práva.

3.4 Otázka súhlasu, informovaného rozhodovania a autonómie

V pracovnoprávnom kontexte je otázka informovaného súhlasu špecifická. Hoci Článok 6 GDPR stanovuje zákonné základy spracúvania údajov, v prípade súhlasu ako právneho titulu existujú pochybnosti o jeho skutočnej slobode, najmä pre mocenský nepomer medzi zamestnávateľom a zamestnancom (Recitál 43 GDPR). Mittelstadt (2019) upozorňuje, že „*autonómia jednotlivca v AI systémoch je často ohrozená nie samotnou technológiou, ale absenciou právneho a etického rámca, ktorý zaručuje, že rozhodovanie ostáva pod kontrolou človeka*“ (Mittelstadt, B. D., 2019). Autonómia zamestnanca a jeho schopnosť informovane rozhodovať priamo súvisí s ochranou dôstojnosti (prvá hypotéza) a podporuje dôveru v systém (druhá hypotéza).

4. PRIENIKY A KONFLIKTY PRÁV A REGULÁCIE V PRAXI

4.1 Automatizované hodnotenia výkonnosti zamestnancov

Automatizované systémy na hodnotenie výkonnosti zamestnancov prinášajú efektívnosť a objektivitu do procesu riadenia ľudských zdrojov, no zároveň vyvolávajú otázky transparentnosti a spravodlivosti takýchto rozhodnutí (Nyathani, R., 2023). AI algoritmy často pracujú ako „*čierne skrinky*“, ktoré môžu byť nepochopiteľné pre samotných zamestnancov, čím vzniká riziko nedostatočného vysvetlenia kritérií a výsledkov hodnotenia. To môže mať negatívny dopad na dôveru zamestnancov a viesť k pocitu nespravodlivosti či dokonca diskriminácie.

4.*2 AI pri rozhodovaní o prijímaní, prepúšťaní a prideľovaní úloh*

Využívanie umelej inteligencie pri rozhodovaní o prijímaní nových zamestnancov, ich prepúšťaní alebo prideľovaní pracovných úloh musí spĺňať prísne kritéria férovosti a nediskriminácie (Larsson, S., White, J. M., Bogusz, C., 2024). Algoritmy môžu nevedomky udržiavať alebo prehlbovať existujúce predsudky, čo vyvoláva potrebu dôkladnej kontroly a auditov AI systémov. Právne predpisy EÚ, ako GDPR a AI Akt, preto stanovujú požiadavky na prehľadnosť, spravodlivé nakladanie s osobnými údajmi a zodpovednosť za rozhodnutia generované AI systémami.

4.3 Ochrana pred diskrimináciou a zneužívaním údajov

Ochrana osobných údajov a rovnaké zaobchádzanie so zamestnancami sú kľúčovými výzvami v súčasnom digitálnom pracovnom prostredí. Použitie AI môže zvýšiť riziko diskriminácie, najmä ak algoritmy pracujú s neúplnými alebo nevyváženými dátami. Právne rámce EÚ poskytujú síce základnú ochranu, no aplikácia týchto noriem do praxe si vyžaduje pravidelný monitoring a prispôsobovanie legislatívy dynamicky sa meniacim technológiám (Wachter, S., Mittelstadt, B., Floridi, L., 2017).

5. VÝZVY A ODPORÚČANIA

5.1 Identifikácia medzier v regulácii a aplikačnej praxi

V súlade s prvou hypotézou, že prijatie AI Aktu významne ovplyvňuje práva a povinnosti zamestnancov, je zrejmé, že v súčasnej aplikačnej praxi existujú medzery. Napriek ambicióznemu regulačnému rámcu chýbajú konkrétne štandardy pre kontrolu algoritmických rozhodnutí v pracovnom prostredí, čo môže viesť k asymetrii moci medzi zamestnávateľmi a zamestnancami. Osobitne rizikovou oblasťou sú techniky spätnej analýzy modelov (*model inversion attacks*), ktoré umožňujú rekonštrukciu osobných údajov na základe výstupov AI systémov (Veale, M., Binns, R., & Edwards, L., 2018). Tieto technologické hrozby vyvolávajú potrebu spresnenia interpretácie GDPR, najmä článkov 5 a 25, o princípoch spracúvania osobných údajov a ich ochrany. Zároveň platí, že princípy ako prehľadnosť, zodpovednosť či spravodlivosť zostávajú často len formálne deklarované bez ich dôsledného uplatňovania v praxi (Dignum, V., 2019).

5.2 Odporúčania pre zamestnávateľov, odbory a tvorcov politík

Na podporu druhej hypotézy, ktorá predpokladá potrebu budovania dôvery zamestnancov v AI systémy prostredníctvom ich transparentnosti a nediskriminačného charakteru, odporúčame:

Zamestnávateľom: Zavádzať AI technológie zodpovedne, s dôrazom na vysvetliteľnosť rozhodnutí, poskytovanie školení a zabezpečenie participácie zamestnancov pri nastavovaní systémov hodnotenia práce. Tieto kroky prispievajú k legitimizácii AI nástrojov a posilňujú akceptáciu zmeny na pracovisku (Brynjolfsson, E., & McAfee, A., 2017).
Odborovým organizáciám: Aktívne monitorovať dopad AI na zamestnancov, spolupracovať pri tvorbe kolektívnych zmlúv upravujúcich algoritmické riadenie práce a presadzovať etické zásady správy technológií (Cath, C. et al., 2018).

Tvorcom politík: Prijať osobitné podzákonné predpisy upravujúce používanie AI v pracovnoprávnych vzťahoch, inšpirované pravidlami GDPR, ale orientované na konkrétne kontexty ako prijímanie do zamestnania, monitorovanie výkonu alebo prepúšťanie.

5.3 Potreba medzisektorovej spolupráce a ďalšieho výskumu

Rozvoj umelej inteligencie v pracovnoprávnych vzťahoch vyžaduje medzisektorovú spoluprácu medzi právnikmi, vývojármi, HR manažérmi, a výskumnými inštitúciami vrátane oblasti etiky. Bez systematického výskumu a zberu empirických údajov o dopadoch AI systémov hrozí riziko, že formálna regulácia budú zaostávať za technologickým vývojom. Zvlášť dôležité je presadzovať osvetu o etických a morálnych dôsledkoch využívania AI v pracovnom prostredí, hoci morálne povinnosti nie sú vždy právne vynútiteľné, pri systematickej osvete a vytváraní organizačných kultúr môžu výrazne prispieť k prevencii zneužívania AI (Mittelstadt, B. D., 2019). Naopak, úmyselné porušovanie týchto princípov, ktoré je v rozpore s dobrými mravmi a právnymi normami, už predstavuje protiprávne konanie, ktoré má byť sankcionované.

6. ZÁVER

Zamerali sme sa na komplexný prienik práv a povinností zamestnancov s reguláciou umelej inteligencie v pracovnom prostredí. Naše analýzy potvrdili platnosť dvoch základných hypotéz.

Prvá hypotéza, že prijatie AI Aktu významným spôsobom ovplyvňuje práva zamestnancov, predovšetkým z hľadiska ochrany ich súkromia a dôstojnosti, poukazuje na rastúci význam právnej ochrany pri rozširujúcom sa využívaní AI systémov v pracovnom živote. Napriek existencii právnych rámcov je však ich praktická aplikácia stále náročná, čo zdôrazňuje na potrebu dôslednejšieho monitorovania a účinnejšej regulácie.

Druhá hypotéza zdôrazňuje, že zamestnávatelia musia pri zavádzaní AI systémov dbať na prehľadnosť a spravodlivosť na budovanie a udržiavanie dôvery zamestnancov. Toto je potrebné nielen pre etický a právny súlad, ale aj pre efektívne a dlhodobé prijatie týchto technológií v pracovnom procese. Transparentnosť algoritmov a zabezpečenie možnosti ľudského zásahu predstavujú základné piliere ochrany zamestnancov pred neoprávnenými zásahmi do ich práv a autonómie.

Identifikovali sme tiež kľúčové výzvy a medzery v súčasnej regulácii a aplikačnej praxi. Medzi ne patrí nejednotnosť implementácie regulácií medzi členskými štátmi EÚ, nedostatočné kapacity na kontrolu AI systémov, ako aj potreba zosúladenia legislatívnych aktov s rýchlym technologickým vývojom. V tejto súvislosti je kľúčové posilňovať spoluprácu medzi zamestnávateľmi, odbormi, tvorcami politiky a odbornou komunitou, čo umožní efektívnejšie a etickejšie riadenie AI v pracovnom prostredí. Budúci legislatívny vývoj by mal klásť dôraz na flexibilitu, ktorá umožní adaptovať pravidlá na nové technologické výzvy bez kompromisov v oblasti ochrany základných ľudských práv. Rovnako dôležité je rozvíjať systematickú osvetu a vzdelávanie všetkých zainteresovaných subjektov, čím sa posilní dôvera, prehľadnosť a zodpovedné využívanie umelej inteligencie. V konečnom dôsledku regulácia AI v pracovnom prostredí predstavuje nielen právnu a technickú výzvu, ale aj etický imperatív, ktorý si vyžaduje systematický, multidisciplinárny prístup so silným dôrazom na ochranu dôstojnosti a práv zamestnancov ako kľúčového subjektu pracovnoprávnych vzťahov.

Dodatok

Tento príspevok bol vytvorený v rámci projektu VEGA Právne, ekonomické a etické limity a výzvy umelej inteligencie pri riadení ľudských zdrojov reg. č. 1/0369/24.

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PERCEPCIA VYBRANÝCH PRAKTÍK ROZVOJA ĽUDSKÝCH ZDROJOV MALÝMI A STREDNÝMI PODNIKATEĽMI: SLOVENSKO - ČESKO

PERCEPTION OF SELECTED ASPECTS OF HUMAN RESOURCES DEVELOPMENT BY SMALL AND MEDIUM-SIZED ENTREPRENEURS: SLOVAKIA - CZECHIA

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Abstrakt: *Cieľom príspevku je identifikovať základné rozdiely v implementácii vybraných praktík rozvoja ľudských zdrojov (HR) ako sú vzdelávanie, odmeňovanie zamestnancov a flexibilita práce na základe komparácie vnímania týchto praktík v mikro, malých a stredných podnikoch (MSP) v Slovenskej (SR) a Českej republike (ČR). Na analýzu rozdielov bol použitý neparametrický Mann-Whitney U test. Výsledky ukázali, že české MSP vykazujú štatisticky významné pozitívnejšie hodnotenia v praktikách ako je poskytovanie flexibilnej práce a odmeňovanie. Naopak praktiky ako celoživotné vzdelávanie a hodnotenie zamestnancov boli vnímané veľmi podobne v oboch krajinách. Získané poznatky môžu prispieť k riadeniu rozvoja ľudských zdrojov pre manažérov, ale aj tvorcov legislatívy.*

Kľúčové slová: *ľudské zdroje, rozvoj ľudských zdrojov, MSP, vzdelávanie, odmeňovanie, flexibilita práce.*

Abstract: *The aim of the paper is to identify the key differences in the implementation of selected human resources (HR) development practices, such as training, employee remuneration, and work flexibility, based on a comparison of the perception of HR development practices in micro, small, and medium-sized enterprises (SMEs) in Slovakia (SR) and the Czech Republic (CR). The non-parametric Mann-Whitney U test was used to analyze these differences. The results showed that Czech SMEs exhibit statistically significantly more positive evaluations in practices such as providing flexible work arrangements and remuneration. Conversely, practices such as lifelong learning and employee performance evaluation were perceived very similarly in both countries. The insights gained can contribute to HR development management for managers as well as policymakers.*

Key words: *Human Resources, Human Resources Development, SMEs, Training, Remuneration, Work Flexibility.*

JEL Classification: M12, L26, O15

1. ÚVOD

Malé a stredné podniky sú často považované za kľúčovú zložku ekonomickej štruktúry a významný motor hospodárskeho rastu v rozvinutých ekonomikách. Predstavujú chrbticu ekonomík založených na trhových princípoch (Mura a Mazák, 2018). Zmeny vo výkonnosti firiem môžu byť úzko spojené s efektívnosťou správy znalostí a intelektuálneho kapitálu. Toto je obzvlášť relevantné pre malé a stredné podniky, ktoré vzhľadom na obmedzené fyzické a finančné zdroje dosahujú svoju konkurencieschopnosť a rast predovšetkým vďaka odborným vedomostiam, skúsenostiam a zručnostiam vlastníkov a zamestnancov (Giampaoli et al., 2019). Autori Çera et al. (2023) zistili, že efektívne získavanie ľudského kapitálu a implementácia vhodných personálnych politík a postupov, ktoré podporujú včasné zapojenie a udržanie zamestnancov, majú dlhodobý pozitívny vplyv na

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výkonnosť a produktivitu organizácie. Dimenzie systémov odmeňovania, ako sú odmeňovacia politika a uznávanie výkonu, majú významný a pozitívny dopad na výkonnosť organizácie (Okwuise a Ndudi, 2023). Výskum autorov Lai et al. (2017) odhalil priamy a pozitívny vzťah medzi formalizovanými praktikami riadenia ľudských zdrojov a výkonnosťou malých a stredných podnikov, hodnotenou prostredníctvom finančných ukazovateľov a produktivity práce. Ahmad et al. (2021) taktiež zdôrazňujú, že oblasti, ako sú procesy náboru a výberu, školenie a rozvoj zamestnancov, odmeňovanie a riadenie výkonnosti, vykazujú pozitívny vplyv na výkonnosť malých a stredných podnikov. Autori Wuen et al. (2020) identifikovali, že investície do školení a rozvoja zamestnancov majú zásadný dopad na výkonnosť malých a stredných podnikov. Okrem toho zistili, že zamestnanecká angažovanosť zohráva kľúčovú úlohu pri zlepšovaní výkonnosti týchto podnikov. Ich zistenia ďalej uvádzajú, že systém hodnotenia výkonu má iba čiastočný, ale stále významný vplyv na výkonnosť, a že úloha odborníka na riadenie ľudských zdrojov má tiež pozitívny, aj keď čiastočný vplyv na výkonnosť podnikov.

Investície do rozvoja ľudského kapitálu zohrávajú neoddeliteľnú úlohu pri vytváraní konkurenčnej výhody, ktorá môže byť ďalej posilnená prostredníctvom udržateľných a ekologických praktík. Pre podniky, ktoré sa snažia o rast a dosiahnutie konkurenčnej výhody, sú investície do ľudských zdrojov nevyhnutné (Routray & Padhi, 2020). Autori Uzhegova a kol. (2019) zistili, že sociálna zodpovednosť podnikov (CSR) pozitívne ovplyvňuje konkurencieschopnosť malých a stredných podnikov. Ďalej Shaikh a kol. (2024) tvrdia, že implementácia ekologických postupov riadenia ľudských zdrojov podporuje environmentálne povedomie a využitie analytických schopností v oblasti veľkých dát, umožňuje efektívnu transformáciu týchto postupov na praktické riešenia, čím sa dosahuje konkurenčná výhoda. Uznanie manažérskeho a environmentálneho záujmu posilňuje pozitívne environmentálne výsledky. Výskum autorov Shaikh a kol. (2024) potvrdil, že integrácia týchto prístupov zlepšuje environmentálny manažment, prevádzkovú efektívnosť a konkurencieschopnosť, čo je obzvlášť prínosné pre malé a stredné podniky zamerané na udržateľnosť a ziskovosť. Rovnako autori Omowole et al. (2024) vo svojej štúdii zdôrazňujú význam kľúčových zelených praktík, ako sú redukcia odpadu, zvýšenie energetickej efektívnosti a udržateľné riadenie dodávateľského reťazca. Tieto praktiky nielen prispievajú k znižovaniu environmentálnych dopadov, ale tiež zvyšujú prevádzkovú efektívnosť a konkurencieschopnosť malých a stredných podnikov.

Autori Llinas a Abad (2020) zistili, že postupy riadenia ľudských zdrojov majú silnú koreláciu s produktivitou a inováciami. Zároveň sa ukázalo, že stredné podniky vykazujú výrazný počiatočný rozdiel v produktivite, postupoch riadenia ľudských zdrojov a digitalizácii v porovnaní s inými krajinami. Efektívne postupy riadenia ľudských zdrojov zohrávajú kľúčovú rolu a mali by byť prioritou každej organizácie. Nam a Luu (2022) uvádzajú, že postupy riadenia ľudských zdrojov majú pozitívny vplyv na kvalitu ľudského a fyzického kapitálu v malých a stredných podnikoch. Tieto postupy zároveň významne prispievajú k inováciám, konkrétne pri uvádzaní nových produktov na trh a zlepšovaní existujúcich. Okrem toho aplikácia efektívnych riadiacich postupov v oblasti ľudských zdrojov prispieva k zvýšeniu produktivity práce a vytváraniu väčšej pridanej hodnoty. Postupy riadenia ľudských zdrojov sú významné ako strategický faktor rozvoja a inovácií v malých a stredných podnikoch v meniacich sa ekonomikách (Nam a Luu, 2022). Autori Meurs et al. (2024) zistili, že neformálne postupy riadenia ľudských zdrojov, ktoré sa zameriavajú na uspokojenie potrieb zamestnancov v oblasti kompetencií a autonómie, majú pozitívny vplyv na inovačnú výkonnosť malých a stredných podnikov v Európe.

Olubitan et al. (2023) zistili, že ľudské zdroje sú kľúčovým faktorom inovačnej schopnosti malých a stredných podnikov. Predchádzajúce vzdelanie, pracovné certifikácie a inovačný cyklus majú významný vplyv na vývoj nových produktov. Komponenty rozvoja ľudských zdrojov zohrávajú zásadnú úlohu pri tvorbe inovatívnych produktov a stimulujú inovačné schopnosti malých a stredných podnikov. Rovnako autori Aslam et al. (2023) zistili, že inovatívne postupy riadenia ľudských zdrojov, ako sú zamestnanecká účasť, hodnotenie výkonu, odmeňovanie, nábor a rekvalifikácia, majú významný vplyv na výkonnosť malých a stredných podnikov. Výsledky týchto autorov ukazujú, že väčšina inovatívnych postupov v oblasti riadenia ľudských zdrojov pozitívne ovplyvňuje produktivitu práce, inováciu produktov, procesov a marketingové inovácie. Sharma (2019) tvrdí, že inovatívne postupy riadenia ľudských zdrojov sú kľúčové pre podporu organizačných inovácií, pričom ich integrácia do inovačných procesov organizácie s funkciami HRM má významný pozitívny dopad na inovačnú výkonnosť. Islami a Mulolli (2024) identifikovali výrazné a priame prepojenie medzi troma kľúčovými postupmi riadenia ľudských zdrojov – školením a rozvojom, zdieľaním informácií a

návrhom pracovných miest – a inováciami v malých a stredných podnikoch. Ich zistenia podčiarkujú význam podpory kreatívnych zamestnancov prostredníctvom cielene implementovaných stratégií v oblasti riadenia rozvoja ľudských zdrojov.

Osobnostné črty, ako sú otvorenosť a svedomitosť, významne ovplyvňujú inovačnú výkonnosť a schopnosť generovať nové poznatky, čím sprostredkúvajú vzťah medzi charakteristikami podnikateľov a ich inovačnými výsledkami. Navyše, kariérne príležitosti posilňujú prepojenie medzi osobnostnými črtami, procesmi tvorby vedomostí a inovačnou výkonnosťou (Zhang et al., 2024). Vnímanie praktík riadenia ľudských zdrojov zamestnancami, ako sú školenia a rozvoj, riadenie odmeňovania a výkonnosti, významne ovplyvňuje angažovanosť zamestnancov. Zároveň bol zistený negatívny priamy vzťah medzi vnímaním týchto praktík a zámerom zamestnancov opustiť organizáciu. Tieto zistenia ukazujú, že efektívne riadenie ľudských zdrojov môže zlepšiť angažovanosť zamestnancov a zároveň znížiť ich úmysel opustiť pracovisko (Li a kol., 2019). Pohoda zamestnancov je kľúčová pre ich pracovnú spokojnosť a motiváciu dosahovať dlhodobé ciele organizácie. Flexibilné pracovné podmienky predstavujú jednu z hlavných stratégií, ktoré organizácie využívajú na podporu blaha zamestnancov. Napriek svojej motivačnej úlohe sa prepojenie flexibilných pracovných podmienok s inováciami na úrovni podniku často neberie do úvahy. Poskytovanie flexibilného pracovného času a voľna podporuje inovačné procesy tým, že poskytuje mentálny priestor a rôznorodosť potrebnú na tvorbu, zdieľanie a aplikáciu znalostí. Vysoká konkurencia na trhu má len obmedzený vplyv na pozitívny vzťah medzi flexibilnými pracovnými podmienkami a inováciami, avšak oslabuje spojenie medzi zdieľaním pracovných miest a inováciami. Manažéri malých a stredných podnikov by mali prioritizovať poskytovanie flexibilného pracovného času a voľna svojim zamestnancom, pretože tieto prístupy majú výrazný vplyv na inovačné kapacity podniku (Azeem a Kotey, 2023).

Postupy riadenia rozvoja ľudských zdrojov predstavujú strategický faktor, ktorý významne ovplyvňuje výkonnosť, konkurencieschopnosť a inovačnú schopnosť malých a stredných podnikov. Z výskumov vyplýva, že oblasti ako nábor, školenie, odmeňovanie a flexibilné pracovné podmienky pozitívne prispievajú nielen k zlepšeniu finančných ukazovateľov, ale aj k rozvoju ľudského kapitálu a podpore inovácií. Ekologické postupy a sociálna zodpovednosť podnikov navyše umožňujú MSP nielen znižovať negatívne environmentálne dopady, ale tiež dosahovať konkurencieschopnosť prostredníctvom udržateľných riešení. Flexibilita a dôraz na angažovanosť zamestnancov sú ďalšími kľúčovými faktormi, ktoré stimulujú inovačné procesy a dlhodobú prosperitu podnikov.

V literatúre však nachádzame malé množstvo empirických štúdií, ktoré sa zameriavajú na porovnanie HR praktík v MSP medzi Slovenskou a Českou republikou. Aj napriek skutočnosti, že tieto krajiny majú spoločné historické pozadie, podobné ekonomické a kultúrne podmienky, ale aj legislatívne prístupy, môžu viesť k odlišným HR praktikám. Vzhľadom na uvedené je výkumná otázka stanovená nasledovne: Aké sú rozdiely vo vnímaní vybraných praktík rozvoja HR v MSP medzi slovenskými a českými podnikateľmi?

Naledujúca časť príspevku je rozdelená nasledovne. Druhá kapitola popisuje stanovenie cieľa príspevku a popis metodológie realizovaného prieskumu, analyzovania a hodnotenia získaných výsledkov. Tretia kapitola pojednáva o zisteniach získaných z realizovaného dotazníkového prieskumu a diskusii. V Závere sa nachádza finálna sumarizácia zistených poznatkov, popis limitov prieskumu a zameranie ďalšieho výskumu.

2. CIEĽ A METODOLÓGIA SKÚMANIA

Cieľom príspevku je identifikovať základné rozdiely v implementácii rozvojových HR praktík ako sú školenia, odmeňovanie zamestnancov a flexibilita práce na základe komparácie vnímania týchto praktík v mikro, malých a stredných podnikoch v Slovenskej a Českej republike.

Príspevok je jedným z výstupov riešenia projektu VEGA 1/0718/22 Rozvoj ľudských zdrojov v malých a stredných podnikoch v kontexte výziev 21. storočia, v rámci ktorého sa realizoval dotazníkový prieskum v Slovenskej a Českej republike v období rokov 2023 a 2024. Pre výber respondentov bola použitá metóda náhodného výberu. Veľkosť vzorky sme pre použite neparametrického Mann-Whitney U testu (MWU) vypočítali použitím softéru G*Power 3.1.9.2. Zvolené parametre zahŕňali obojstranný test (two-tailed), veľkosť efektu d=0,8 (veľký efekt), hladinu významnosti α=0,05, štatistickú silu 1−β=0,8 (80 %). Vzhľadom na nerovnomerný pomer veľkostí

skupín medzi respondentmi zo Slovenska a Česka (N2/N1=3) boli požiadavky na minimálny počet respondentov upravené. Výsledky výpočtu ukázali, že na dosiahnutie požadovanej štatistickej sily pri uvedených parametroch je potrebné mať v SR minimálne 18 respondentov a vo väčšej skupine (ČR) 54 respondentov. Skutočný počet respondentov v tomto výskume, kde SR reprezentuje 127 respondentov a ČR 300 respondentov, výrazne prevyšuje tieto minimálne požiadavky. Táto skutočnosť zabezpečuje dostatočnú presnosť a robustnosť analýzy a znižuje pravdepodobnosť chýb v dôsledku nedostatočnej vzorky. V ČR bol prieskum realizovaný prostredníctvom agentúry MNFORCE, s.r.o. Oslovených bolo 300 MSP v každom štáte, pričom návratnosť dotazníka bola v SR 42,33% (127 MSP) a ČR 100%. Oslovené MSP pôsobia v sektore služieb a výroby.

Dotazník obsahoval dve časti:

1. Úvodnú, v ktorej bolo popísané k čomu prieskum slúži a na čo budú dáta v projekte použité. Obsahoval tiež informácie o dôvernosti poskytnutých údajov. Respondentov sme sa pýtali na základné charakteristiky ako sú pozícia v podniku, veľkosť podniku, zameranie podniku, dĺžka pôsobenia na trhu.
2. Respondenti sa v druhej časti dotazníka mohli vyjadriť k 45 tvrdeniam, ktoré súviseli s výkonnosťou podniku, vysoko výkonnostnými pracovnými systémami, work-life balance, reputáciou a sociálnou hodnotou. Pre potreby spracovania príspevku sme sa zamerali na tvrdenia z oblasti vysokovýkonnostných pracovných systémov a zamerali sme sa na tvrdenia súvisiace s rozvojom HR (T1-T6).

Respondenti sa k tvrdeniam vyjadrovali na Likertovej stupnici 1 až 5 (1 – rozhodne nesúhlasím, 2 nesúhlasím, 3 – neutrálny postoj, 4 – súhlasím, 5 rozhodne súhlasím). Tvrdenia sú uvedené v názvoch jednotlivých tabuliek.

Pre dosiahnutie cieľa príspevku sme stanovili výskumnú hypotézu: Vo vnímaní stanoveného tvrdenia medzi malými a strednými podnikmi v Slovenskej a v Českej republike existuje významný rozdiel.

Hypotéza bola overená pre každé tvrdenie použitím neparametrického MWU testu.

3. VÝSLEDKY A DISKUSIA

V nasledujúcej časti príspevku sa venujeme vyhodnoteniu výsledkov získaných v rámci dotazníkového prieskumu v troch oblastiach: rozvoj zamestnancov, odmeňovanie zamestnancov a flexibilita zamestnania. V tabuľkách sú zaznamenané vyjadrenia respondentov k 6 tvrdeniam.

V tabuľke 1 sú uvedené odpovede respondentov k Tvrdeniu 1: Zamestnancom zabezpečujeme profesionálny kariérny rast. V SR toto tvrdenie považuje za najviac významné 7,2% respondentov a v ČR 9,3% respondentov. Za najmenej významné toto tvrdenie považuje 1,90% slovenských respondentov a 3,7% českých respondentov. Ako ďalej z tabuľky vyplýva českí respondenti vo všeobecnosti vnímajú zabezpečenie profesionálneho kariérneho rastu zamestnancom pozitívnejšie než slovenskí respondenti. Vidíme to na označení hodnôt 4 a 5. To naznačuje, že českí respondenti môžu klásť väčší dôraz na vytváranie príležitostí pre rozvoj zamestnancov. Jedným z hlavných cieľov vedenia v oblasti HR je zlepšiť podmienky, za ktorých sa pozoruje latentný talent zamestnancov, čo zvyšuje dosahovanie cieľov organizácie (Kumar et al., 2022). Predchádzajúce štúdie potvrdili význam kariérneho rastu zamestnancov, ktorý prispieva ako k udržaniu zamestnancov, tak i k dosahovaniu cieľov podniku (Amah & Oyetuunde, 2020).

Tabuľka 1 T1: Zamestnancom zabezpečujeme profesionálny kariérny rast

Hodnotenie	Počet/%	SR	ČR	Spolu
1	**Count**	8	16	24
	% of Total	1,9%	3,7%	5,6%
2	**Count**	18	32	50
	% of Total	4,2%	7,5%	11,7%
3	**Count**	46	96	142
	% of Total	10,7%	22,4%	33,2%
4	**Count**	24	117	141

	% of Total	5,6%	27,3%	32,9%
5	**Count**	31	40	71
	% of Total	7,2%	9,3%	16,6%
Total	**Count**	127	301	428
	% of Total	29,7%	70,3%	100,0%

Zdroj: výpočty autorov

Výsledky MWU testu (tabuľka 2) ukázali, že rozdiel medzi týmito dvoma skupinami nie je štatisticky významný (p = 0,665). To znamená, že nemôžeme potvrdiť, že respondenti v SR a ČR vnímajú zabezpečenie kariérneho rastu zamestnancov odlišne. Priemerné poradie odpovedí je relatívne vyrovnané, čo podporuje záver, že zabezpečenie profesionálneho kariérneho rastu zamestnancov má v oboch krajinách podobnú úroveň. Tento výsledok môže odrážať podobné legislatívne, ekonomické prípadne kultúrne podmienky, ktoré formujú manažérske prístupy v SR a ČR.

Tabuľka 2 MWU Test - T1: Zamestnancom zabezpečujeme profesionálny kariérny rast

Mann-Whitney U	18627,000
Wilcoxon W	26755,000
Z	-,434
Asymp. Sig. (2-tailed)	,665

Zdroj: výpočty autorov

Výsledky v tabuľke 3 (tvrdenie T2: Investujeme do školení) ukázali, že odpovede respondentov v SR a v ČR, sú rozdelené pomerne podobne. Najviac respondentov v oboch krajinách vybralo hodnotenie 4 (súhlasím), čo predstavuje 37,9 % z celkového počtu respondentov.

Tabuľka 3 T2: Investujeme do školení

Hodnotenie		SR	ČR	Total
1	**Count**	12	22	34
	% of Total	2,8%	5,1%	7,9%
2	**Count**	14	23	37
	% of Total	3,3%	5,4%	8,6%
3	**Count**	33	68	101
	% of Total	7,7%	15,9%	23,6%
4	**Count**	27	135	162
	% of Total	6,3%	31,5%	37,9%
5	**Count**	41	53	94
	% of Total	9,6%	12,4%	22,0%
Total	**Count**	127	301	428
	% of Total	29,7%	70,3%	100,0%

Zdroj: výpočty autorov

Podobné výsledky zdôraznila aj autori Kumar et al. (2022), ktorí vo svojej štúdii potvrdili súvislosť medzi vzdelávaním a úspechom organizácie. Významnosť vzdelávania zamestnancov potvrdili aj autori Demirkan et al. (2022), ktorí uvádzajú, že investície do vzdelávania zamestnancov nie sú plytvaním zdrojov, skôr takéto investície môžu zvýšiť pravdepodobnosť prežitia mnohých z týchto firiem prostredníctvom ich pozitívneho vplyvu na inováciu produktov.

Vypočítaná p-hodnota MWU testu (p=0,843) v Tabuľke 4 je väčšia ako stanovená hladina významnosti (α=0,05), čo znamená, že rozdiely medzi odpoveďami slovenských a českých respondentov nie sú štatisticky významné.

Tabuľka 4 MWU Test - T2: Investujeme do školení

Mann-Whitney U	18891,000
Wilcoxon W	64342,000
Z	-,198
Asymp. Sig. (2-tailed)	,843

Zdroj: výpočty autorov

Zamestnanci môžu zvýšiť svoju zamestnateľnosť, produktivitu, adaptabilitu a profesionálny rast prostredníctvom školenia, ktoré zvyšuje šance na úspech v osobnej aj profesionálnej sfére (Šulc & Dvořáková, 2023). Výsledky v Tabuľke 5 (T3: Realizujeme celoživotné vzdelávanie zamestnancov) ukazujú, že vnímanie realizácie celoživotného vzdelávania zamestnancov je mierne pozitívnejšie v ČR v porovnaní so SR, avšak rozdiely nie sú výrazné. V ČR pozitívne hodnotilo ponuku celoživotného vzdelávania pre zamestnancov 32,2 % respondentov (23,8 % pre hodnotenie 4 a 8,4 % pre hodnotenie 5). Na Slovensku pozitívne hodnotilo celoživotné vzdelávanie 12,4 % respondentov (4,7 % pre hodnotenie 4 a 7,7 % pre hodnotenie 5). Autori Mustafa & Lleshi (2024) vo svojej štúdii potvrdzujú, že získavanie nových kompetencií a vedomostí pozitívne ovplyvňuje produktivitu, inovácie a celkovú odbornosť práce. Štúdia navyše odhalila, že záväzok k celoživotnému vzdelávaniu prispieva nielen k zlepšeniu individuálneho výkonu, ale ovplyvňuje aj organizačné výsledky. Organizácie, ktoré podporujú kultúru neustáleho vzdelávania, vidia vyššiu úroveň zapojenia zamestnancov, nižšiu mieru fluktuácie a vyššiu úroveň inovácií a flexibility. Pracovisko zamerané na vzdelávanie, vedie k zlepšeniu výkonnosti organizácie a konkurenčnej výhode na trhu.

Tabuľka 5 T3: Realizujeme celoživotné vzdelávanie zamestnancov

Hodnotenie		SR	ČR	Total
1	**Count**	21	27	48
	% of Total	4,9%	6,3%	11,2%
2	**Count**	23	39	62
	% of Total	5,4%	9,1%	14,5%
3	**Count**	30	97	127
	% of Total	7,0%	22,7%	29,7%
4	**Count**	20	102	122
	% of Total	4,7%	23,8%	28,5%
5	**Count**	33	36	69
	% of Total	7,7%	8,4%	16,1%
Total	**Count**	127	301	428
	% of Total	29,7%	70,3%	100,0%

Zdroj: výpočty autorov

Aj keď vyjadrenia respondentov ukazujú, že českí respondenti hodnotia realizáciu celoživotného vzdelávania zamestnancov pozitívnejšie (väčší podiel odpovedí v kategóriách 4 a 5), štatistická analýza v Tabuľke 6 nepreukázala ($p = 0,534$), že tieto rozdiely sú významné. To naznačuje, že MSP v oboch krajinách pristupujú k realizácii celoživotného vzdelávania zamestnancov relatívne podobne, pričom v oboch prípadoch sú najčastejšie hodnotenia neutrálne, čo poukazuje na priemernú úroveň vnímania tejto oblasti.

Tabuľka 6 MWU Test - T3: Realizujeme celoživotné vzdelávanie zamestnancov

Mann-Whitney U	18407,000
Wilcoxon W	26535,000
Z	-,623
Asymp. Sig. (2-tailed)	,534

Zdroj: výpočty autorov

Použitie merania výkonnosti sa pokúša identifikovať silné a slabé stránky zamestnancov a motivovať ich k zlepšeniu ich výkonu. Meranie výkonu zamestnancov preukazuje priaznivý vzťah medzi hodnotením výkonu a motiváciou zamestnancov. Schémy hodnotenia výkonu by mali byť navrhnuté tak, aby poskytovali priestor pre vhodné postavenie k ostatným kolegom a na dosiahnutie vlastných cieľov zamestnanca (Vuong & Nguyen, 2022). Výsledky v Tabuľke 7 (T4: Uskutočňujeme hodnotenie výkonu zamestnancov) ukazujú, že vnímanie realizácie hodnotenia výkonu zamestnancov sa medzi slovenskými a českými respondentmi čiastočne líši. Údaje v tabuľke 7 naznačujú, že českí MSP hodnotia realizáciu hodnotenia výkonu zamestnancov pozitívnejšie (v prípade hodnoty 4 až 29,9% respondentova v prípade hodnoty 5 to bolo 12,4% respondentov) než slovenskí (v prípade hodnoty 4 iba 8,6% respondentov a hodnoty 5 iba 8,4% respondentov).

Tabuľka 7 T4: Uskutočňujeme hodnotenie výkonu zamestnancov

Hodnotenie		SR	ČR	Total
1	**Count**	11	14	25
	% of Total	2,6%	3,3%	5,8%
2	**Count**	8	30	38
	% of Total	1,9%	7,0%	8,9%
3	**Count**	35	76	111
	% of Total	8,2%	17,8%	25,9%
4	**Count**	37	128	165
	% of Total	8,6%	29,9%	38,6%
5	**Count**	36	53	89
	% of Total	8,4%	12,4%	20,8%
Total	**Count**	127	301	428
	% of Total	29,7%	70,3%	100,0%

Zdroj: výpočty autorov

Výsledky MWU testu (Tabuľka 8) však ukazujú, že tieto rozdiely nie sú štatisticky významné (p=0,499). To naznačuje, že napriek rozdielom v podieloch odpovedí je vnímanie hodnotenia výkonu zamestnancov medzi MSP v ČR a SR podobné a rozdiely môžu byť výsledkom náhodných faktorov.

Tabuľka 8 MWU Test - T4: Uskutočňujeme hodnotenie výkonu zamestnancov

Mann-Whitney U	18358,000
Wilcoxon W	63809,000
Z	-,675
Asymp. Sig. (2-tailed)	,499

Zdroj: výpočty autorov

Výsledky v Tabuľke 9 (T5: Mzdu podmieňujeme faktormi ako výkonové ukazovatele, časové obdobie, kvalifikácia, vzdelanie a podobne) ukazujú rozdiely medzi slovenskými a českými respondentmi vo vnímaní tvrdenia, či mzda zamestnancov závisí od faktorov, ako sú výkonové ukazovatele, časové obdobie, kvalifikácia a vzdelanie. Kým v ČR až 43,9 % respondentov (32,2 % pre hodnotenie 4 a 11,7 % pre hodnotenie 5) uviedlo, že mzda je podmieňovaná týmito faktormi, v SR to bolo iba 19,2 % respondentov (6,1 % pre hodnotenie 4 a 13,1 % pre hodnotenie 5). Českí respondenti oveľa častejšie hodnotia mzdu ako viac závislú od uvedených faktorov.

Tabuľka 9 T5: Mzdu podmieňujeme faktormi ako výkonové ukazovatele, časové obdobie, kvalifikácia, vzdelanie a podobne

Hodnotenie		SR	ČR	Total
1	**Count**	7	13	20
	% of Total	1,6%	3,0%	4,7%
2	**Count**	11	30	41
	% of Total	2,6%	7,0%	9,6%
3	**Count**	27	70	97
	% of Total	6,3%	16,4%	22,7%
4	**Count**	26	138	164
	% of Total	6,1%	32,2%	38,3%
5	**Count**	56	50	106
	% of Total	13,1%	11,7%	24,8%
Total	**Count**	127	301	428
	% of Total	29,7%	70,3%	100,0%

Zdroj: výpočty autorov

MWU test v Tabuľke 10 potvrdzuje, že tento rozdiel nie je náhodný, ale štatisticky významný (p=0,002). Českí respondenti teda častejšie vnímajú mzdu ako úzko naviazanú na výkonnostné a kvalifikačné faktory, čo môže odrážať rozdiely v mzdových politikách, prístupoch k odmeňovaniu alebo legislatívnych podmienkach medzi SR a ČR.

Tabuľka 10 MWU Test - T5: Mzdu podmieňujeme faktormi ako výkonové ukazovatele, časové obdobie, kvalifikácia, vzdelanie a podobne.

Mann-Whitney U	15579,500
Wilcoxon W	61030,500
Z	-3,159
Asymp. Sig. (2-tailed)	,002

Zdroj: výpočty autorov

Pandémia COVID-19 zvýšila dopyt po atypických a flexibilných modeloch práce. Výsledky ukazujú, že flexibilná práca je vo všeobecnosti hodnotená pozitívne v oboch krajinách (SR a ČR), pričom však českí respondenti vykazujú o niečo vyšší podiel pozitívnych odpovedí, viď Tabuľka 11 (T6: V našom podniku je možná flexibilná práca), pričom vyšší podiel z nich uvádza hodnotenia v kategóriách 4 (28,7%) a 5 (15,4%). Ako sa uvádza aj v štúdii Šmíd a Navrátilová (2018), český právny rámec umožňuje využívanie rôznych flexibilných foriem práce, čo prispieva k pozitívnejšiemu vnímaniu týchto foriem zamestnávania v ČR. V prípade SR, ako sa ďalej v článku uvádza, je miera skrátených pracovných foriem úväzkov nižšia ako v ČR, čo naznačuje nižiu úroveň implementácie flexibility v pracovnom prostredí.

Tabuľka 11 T6: V našom podniku je možná flexibilná práca

Hodnotenie		SR	ČR	Total
1	**Count**	7	14	21
	% of Total	1,6%	3,3%	4,9%
2	**Count**	16	33	49
	% of Total	3,7%	7,7%	11,4%
3	**Count**	25	65	90
	% of Total	5,8%	15,2%	21,0%
4	**Count**	25	123	148
	% of Total	5,8%	28,7%	34,6%
5	**Count**	54	66	120
	% of Total	12,6%	15,4%	28,0%

Total	**Count**	127	301	428
	% of Total	29,7%	70,3%	100,0%

Zdroj: výpočty autorov

MWU test (Tabuľka 12) potvrdil, že tento rozdiel je štatisticky významný (p=0,048). To naznačuje, že české podniky pravdepodobne poskytujú viac možností pre flexibilnú prácu, alebo je flexibilná práca v Česku lepšie vnímaná než na Slovensku.

Tabuľka 12 MWU Test – T6: V našom podniku je možná flexibilná práca

Mann-Whitney U	16893,000
Wilcoxon W	62344,000
Z	-1,974
Asymp. Sig. (2-tailed)	,048

Zdroj: výpočty autorov

4. ZÁVER

Výsledky získané realizovaným dotazníkovým prieskumom priniesli zaujímavé poznatky v oblasti vybraných praktík rozvoja ľudských zdrojov a poskytujú odpoveď na stanovenú výskumnú otázku: Aké sú rozdiely vo vnímaní vybraných praktík rozvoja HR v MSP medzi slovenskými a českými podnikateľmi? Výsledky prieskumu naznačili rozdiely v niektorých praktikách ako je oblasť odmeňovania a flexibilná práca, kde sa potvrdili štatisticky významné rozdiely medzi vnímaním respondentov zo SR a ČR. Českí respondenti hodnotili vybrané aspekty skôr pozitívnejšie, čo poukazuje na progresívnejší prístup k rozvoju ľudských zdrojov. Na druhej strane aspekty ako celoživotné vzdelávanie a hodnotenie výkonu zamestnancov nevykazovali štatisticky významné rozdiely. To poukazuje na podobnú úroveň prístupu MSP v týchto oblastiach, čo môže byť ovplyvnené spoločnou historickou a legislatívnou základňou.

Výsledky štúdie popísané v tomto príspevku majú aj svoje limity, ktoré spočívajú najmä v nízkom počte respondentov zo SR. Zapojenie väčšieho počtu a rovnomernejšie rozloženie respondentov v budúcich výskumoch by mohlo prispieť k presnejšiemu formulovaniu záverov.

Zistenia poukazujú na potrebu ďalšieho skúmania faktorov, ktoré ovplyvňujú implementáciu flexibilnej práce a spôsobu a foriem odmeňovania v SR a ČR v ďalšom výskume.

Dodatok

Tento príspevok bol vytvorený v rámci projektu VEGA reg. č. 1/0718/22 Rozvoj ľudských zdrojov v malých a stredných podnikoch v kontexte výziev 21. storočia

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THE IMPACT OF JOB CRAFTING ON EMPLOYEE ENGAGEMENT IN SME'S IN THE ERA OF DIGITAL TRANSFORMATION

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Abstract: *The current era of digital transformation brings new challenges that have a profound impact on traditional business operations. Enterprises are forced to invest in modern technologies and develop strategies to strengthen the digital competencies of their employees. These steps can lead to feelings of stress and frustration and an overall decrease in engagement. One solution to this problem is job crafting. Job crafting is the concept of redesigning the workplace, which reimagines the shifting of task, cognitive and social boundaries. This allows employees to customize their jobs based on their strengths and interests, while changing the way they perceive their work, thereby increasing their level of engagement. Despite numerous research studies, few reflect on how job crafting affects employee engagement in SMEs in the digital transformation era. Therefore, the aim is to examine the impact of job crafting on employee engagement in SMEs. We analysed data from 342 employees from SMEs using the structural equation modelling method Partial Least Squares PLS-SEM. The results of the analysis showed that job crafting has the greatest impact on engagement. Task crafting represents a way of adapting the physical environment to one's preferences. Cognitive crafting, which represents a change in the way employees perceive their work, had a slightly weaker impact. Social crafting, and thus the creation of interpersonal relationships in the workplace, had the weakest impact. Our results contribute to the development of job crafting theory and its impact on employee engagement in the context of SMEs.*

Key words: *job crafting, Engagement, SME'S*

JEL Classification: *M10, M11, M12*

1. INTRODUCTION

Today, we are witnessing how digitalisation is increasingly affecting the functioning of small and medium-sized enterprises (SMEs). As a result of technological developments, changes are being made to the way processes are carried out, which have a significant impact on human capital activities (Hossain et al., 2024) which is expected to actively adapt to new technological changes (Stephany & Teutloff, 2024). Adapting to even the most basic ways of using new technologies imposes a financial burden on human capital (Hossain et al., 2024; Moncada et al., 2024)which can lead to states of frustration and stress, and ultimately to a decline in engagement (Olafsen et al., 2024; Rózsa et al., 2023).

One promising approach to addressing these challenges is job crafting, a concept that refers to changes that employees themselves initiate in their job roles to increase meaning, satisfaction and engagement in their work (Holman et al., 2024). Research suggests that job crafting improves performance and positively influences outcomes such as job satisfaction, job engagement, job security, and overall well-being (Buonocore et al., 2020; Noesgaard & Jorgensen, 2024). In addition, individuals who actively shape their work roles report a stronger sense of meaning and fulfilment at work (Berg et al., 2013; Berger et al., 2022; Costantini, 2022). Employees engage in job role shaping through a variety of strategies such as changing the scope of tasks, redefining work relationships, or changing their perceptions of the purpose of their roles. These adjustments may include modifying role boundaries,

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changing the knowledge and skills required for the role, or limiting interactions with undesirable clients (Meijerink et al., 2020). Holman et al., (2024) identify three basic types of job crafting: task crafting, cognitive crafting and social crafting. Task crafting involves redefining the boundaries of job tasks by increasing the control or variety of activities, for example by changing the amount, scope or nature of specific duties (Clinton et al., 2024). In contrast, cognitive crafting involves deliberate efforts to change how employees perceive their tasks in order to increase the meaning and purpose of their work. This may involve aligning daily activities with personal values (Costantini, 2022). Social crafting focuses on reshaping workplace interactions by modifying the nature or extent of relationships with colleagues, clients or other stakeholders (Demerouti et al., 2021; Geldenhuys et al., 2021).

Although job crafting has shown the potential to increase employee engagement (Guo & Hou, 2022; Jindal et al., 2023) in general, its specific impact on SMEs remains understudied. SMEs are uniquely positioned in the era of digital transformation, as their smaller scale and often dynamic structures offer fertile ground for job crafting practices. However, questions about how job crafting affects employee engagement in these organisations remain unanswered. To address this gap, our study examines the relationship between job crafting and employee engagement in SMEs in the era of digital transformation. Specifically, we examine three hypotheses:

H1: Task crafting has a positive impact on employee engagement

H2: Cognitive crafting has a positive impact on employee engagement

H3: Social crafting has a positive impact on employee engagement

Using a partial least squares structural equation modeling (PLS-SEM) approach, we analyze data from 342 employees who participated in the survey using a 5-point Likert scale. Our findings contribute to the growing body of literature on job crafting by providing insights into its role as a tool to promote employee engagement in SMEs. In the following chapters, we describe our methodology in detail, discuss our findings, and explore implications for theory and practice.

2 METHODS

2.1 Participants and data collection

The core population consists of employees from SMEs in central Europe. To determine the minimum base sample, we used the G*Power program. Based on the PLS-SEM method used, the F-test Linear multiple regression: fixed model, R^2 deviation from zero was used. Based on the number of 3 predictors that represent the independent variables, G*Power defines the following outputs:

F tests - Linear multiple regression: fixed model, R^2 deviation from zero

Analysis:	A priori: Compute required sample size		
Input:	Effect size f^2	=	0,15
	α err prob	=	0,05
	Power (1-β err prob)	=	0,95
	Number of predictors	=	3
Output:	Noncentrality parameter λ	=	17,8500000
	Critical F	=	2,6834991
	Numerator df	=	3
	Denominator df	=	115
	Total sample size	=	119
	Actual power	=	0,9509602

The result of the F-test showed a minimum of 119 measurements are needed to achieve 95% confidence level, which means that a minimum sample size of 119 respondents is needed. For the research, we used data collected by MNForce for the Early Stage Grants D05_2024 Job crafting and sustainable employee performance project, from which we took specific results that relate to SME workers and focused only on a particular variety of variables. In total, we worked with a total of 342 fully completed questionnaires from SMEs workers. The questionnaire consisted of validated ways of measuring each variable, with respondents having the opportunity to express their attitudes using a 5-point Likert scale, where 1 indicated "almost never" and 5 "very often".

2.2 Independent variables

Task Crafting (TC) (Geldenhuys et al., 2021; Slemp & Vella-Brodrick, 2013): (TC1) I am introducing new approaches to improve my work. (TC2) I change the scope or type of work tasks I perform. (TC3) I introduce new work tasks that better suit my abilities or interests. (TC4) I participate in the decision to take on additional work tasks. (TC5) I prefer work tasks that match my abilities or interests.
Cognitiv Crafting (CC) (Geldenhuys et al., 2021; Slemp & Vella-Brodrick, 2013): (CC1) I think about whether my work gives meaning to my life. (CC2) I remind myself of the importance of my work to the success of the organisation. (CC3) I remind myself of the importance of my work to the wider community. (CC4) I think about how my work positively impacts my life. (CC5) I reflect on the role my work plays in my overall well-being.
Social Crafting (SC) (Geldenhuys et al., 2021; Slemp & Vella-Brodrick, 2013)A: (SC1) Trying to get to know people well at work. (SC2) I organize or participate in work-related social events. (SC3) I participate in organizing special events at work (e.g., a co-worker's birthday party). (SC4) I mentor new colleagues (officially or unofficially). (SC5) I make friends at work with people who have similar skills or interests.

2.3 Dependent variables

Work Engagement (WE) (Moreira et al., 2020; Navarro-Abal et al., 2023; Wojcik-Karpacz, 2018)A: (WE1) I feel full of energy at work. (WE2) I find the work I do meaningful. (WE3) When I work, time flies fast. (WE4) I feel strong and full of energy at work. (WE5) I am excited about my work. (WE6) When I work, I forget about everything else around me. (WE7) When I get up in the morning, I feel like going to work. (WE8) I feel happy when I work hard. (WE9) I am absorbed in my work. (WE10) I can work continuously for a very long time. (WE11) My work challenges me. (WE12) I get carried away by my work. (WE13) I am mentally very resilient in my work. (WE14) It's hard to tear myself away from my work. (WE15) I always persevere at my work, even when things don't go well. (WE16) My work inspires me. (WE17) I am proud of the work I do.

2.4 Statistical analysis

The data obtained from the questionnaire survey were analyzed using the partial least squares structural equation modeling (PLS-SEM) method, which is suitable for complex models and higher order constructs (Ringle et al., 2023). This method provides higher statistical power compared to CB-SEM and uses advanced methods such as bootstrapping. For the analysis, we used the statistical software SmartPLS 4 (Hair et al., 2021). The PLS-SEM process consisted of two main steps: a scaling model, which verifies the underlying assumptions, and a path model, which expresses the relationships between variables. In the first step, we verified indicator loadings, validity, and reliability using tests such as Cronbach's alpha and composite reliability (Sarstedt et al., 2021). We tested convergent validity with AVE, divergent validity

with Heterotrait-Monotrait test and Fornell-Larcer test. In a second step, we performed a bootstrapping test with 1,000 samples and examined R2 values and path coefficients based on confidence intervals of $p<0.05$ and t-statistics (Hair et al., 2021; Ringle et al., 2023; Sarstedt et al., 2021).

3. RESULTS AND DISCUSSION

3.1 Mesurement model

Within the measurement model, we tested the factor loadings of the individual indicators that measured the variables under study. We tested the factor loadings of individual indicators at a level >0.708. Indicators reaching the same or higher level are appropriate for our model because they explain more than 50% of the total variance of the indicators. We did not consider indicators that did not reach the required level.

Table 13: Factor analysis

SC		CC		SC	
TC_1	0.855	**CC_2**	0.839	**SC_1**	0.769
TC_2	0.788	**CC_3**	0.818	**SC_2**	0.801
TC_3	0.878	**CC_4**	0.835	**SC_3**	0.789
TC_4	0.808	**CC_5**	0.814	**SC_4**	0.786
				SC_5	0.758
		EE			
EE_1	0.834	**EE_2**	0.813		
EE_10	0.815	**EE_4**	0.850		
EE_11	0.793	**EE_5**	0.848		
EE_12	0.827	**EE_6**	0.713		
EE_13	0.724	**EE_7**	0.807		
EE_16	0.863	**EE_8**	0.838		
EE_17	0.822	**EE_9**	0.838		

Source: Processed results of the questionnaire survey by the authors in SmartPLS 4

Table 1 contains the indicators for each variable that achieve the desired level of 0.708 or above. We further subjected the indicators listed in the table to reliability and convergent validity tests.

Table 14: Reliability and convergent validity testing

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
CC	0.846	0.848	0.896	0.683
EE	0.961	0.962	0.965	0.663
SC	0.840	0.842	0.886	0.610
TC	0.853	0.856	0.901	0.694

Source: Processed results of the questionnaire survey by the authors in SmartPLS 4

Table 2 contains the results of reliability and convergent validity testing. Reliability was tested using Cronbach's Alpha test and rho_a and rho_c composite reliability tests. We validated the results of the reliability and composite reliability tests at the >0.700 level. All variables tested achieved excellent internal consistency values, with the reliability tests reaching the >0.700 level in all cases. We validated the results of the AVE convergent

validity test at the >0.500 level, with all variables tested scoring above the required level. In addition to convergent validity, we subjected the data to tests of divergent validity using the Heterotrait-monotrait racio (HTMT) test and the Fornell-Larcer criterion (FL) test. The divergent validity tests test for correlations between the variables under study, with a high correlation value being unacceptable.

Table 15: Heterotrait-monotrait racio test

	CC	EE	SC	TC
CC				
EE	0.629			
SC	0.853	0.606		
TC	0.815	0.648	0.813	

Source: Processed results of the questionnaire survey by the authors in SmartPLS 4

We validated the results of the HTMT test at the <0.850 level, and this value was slightly exceeded within the SC and CC relationship. The measured correlation is minimal and appears between the variables that make up the job crafting complex. Given these facts, we decided to keep the variables in our tested model.

Table 16: Fornell-Larcer criterion test

	CC	EE	SC	TC
CC	0.827			
EE	0.570	0.814		
SC	0.721	0.549	0.781	
TC	0.693	0.588	0.691	0.833

Source: processed results of the questionnaire survey by the authors in SmartPLS 4

We validated the results of the FL test at a level less than the square root of the convergent validity of the AVE. For the divergent validity testing, Table 4 contains the results of the FL test, where the upper diagonal shows the values of the square root of the AVE. The results of the individual relationships do not show correlation values that are greater than the square root of the AVE, confirming divergent validity.

3.2 Path model

Within the úath model, we obtained the overall path coefficient results through bootstrapping. For a given number of variables, we assumed a bootstrapping subsample value of 1,000.

Table 17: Path coefficient

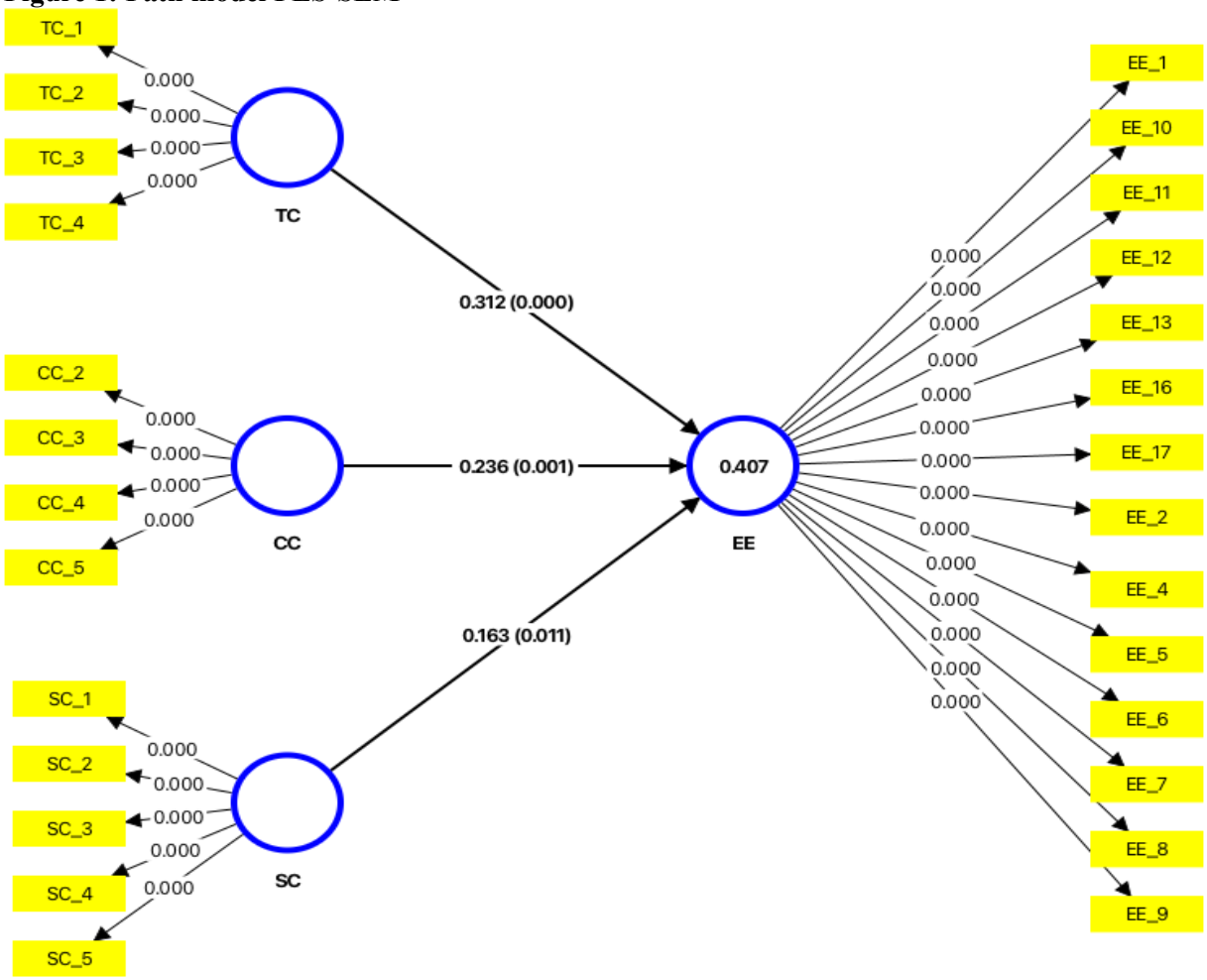
	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
CC -> EE	0.236	0.238	0.073	3.222	0.001
SC -> EE	0.163	0.162	0.071	2.300	0.011
TC -> EE	0.312	0.312	0.063	4.943	0.000

Source: Processed results of the questionnaire survey by the authors in SmartPLS 4

Table 5 contains the results of the path coefficient of PLS-SEM. Specifically, it contains the results of the hypothesized relationships between the job crafting variables and employee engagement in SMEs. The tested relationship between CC and EE exhibits robustness to the path coefficient values of 0.236 for the original sample and 0.238 for the mean sample, where

both samples take almost the same value. The standard deviation value explains a deviation of 0.073 units from the path coefficient, indicating its consistency across multiple bootstrapping patterns. The T statistic result reached >1.64 with a p-value of 0.001, indicating a statistically significant effect between CC and EE. The relationship between SC and EE shows equally strong robustness, with the standard deviation of the sample mean representing a deviation of 0.071 units from the path coefficient, indicating its strong robustness. The t statistic took a value >1.64, with a statistical significance of p=0.011. The relationship between TC and EE shows the strongest robustness, where the deviation of the sample mean from the path coefficient oversaturates the standard deviation value by 0.063 units. The T statistic value reached a level of >1.64 at statistical significance of p=0.000. All tested relationships show strong statistical significance.

Figure 1: Path model PLS-SEM



Source: Processed results of the questionnaire survey by the authors in SmartPLS 4

The path model in Figure 1 illustrates the testing of the assumed haptic relationships. The individual relationships between the variables are expressed by the path coefficient and the significance level P. Overall, the individual job crafting variables show a positive relationship on employee engagement in SMEs. Specifically, task crafting shows the strongest effect followed by cognitive crafting. The weakest influence on employee engagement was shown by social crafting indicating that the creation of interpersonal relationships in the workplace does not currently have a significant impact on employee engagement in SMEs. The variance value of EE was $R^2 = 0.407$, indicating that job crafting explains 40.7% of the total variance in employee engagement.

Table 18: Hypothesis testing

	Standardised coefficient
H1: Task crafting has a positive impact on employee engagement	0,312 (0,000)
H2: Cognitive crafting has a positive impact on employee engagement	0,236 (0,001)
H3: Social crafting has a positive impact on employee engagement	0,163 (0,011)

Source: Processed results of the questionnaire survey by the authors in SmartPLS 4

Table 6 contains the results of hypothesis testing. The standardized coefficient expresses the path coefficient association and the level of statistical significance. Based on the PLS-SEM results, we do not reject the stated hypotheses. Our results indicate that job crafting promotes employee engagement in SMEs even in the digital era when SMEs face numerous challenges.

3.3 Discussion

The aim of our research was to investigate the impact of job crafting on employee engagement in small and medium-sized enterprises (SMEs). Based on an analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM), we found that task crafting has a significant impact on employee engagement, with cognitive crafting being a similarly important factor. In contrast, social crafting showed minimal to negligible impact on engagement. These findings are consistent with the conclusions Baghdadi et al. (2021)who identified job crafting as a strong driver of work engagement. Equally, research Iida et al. (2024), confirmed the positive impact of job crafting on employees' work engagement and commitment. Results Jindal et al. (2023) moreover, suggest that in addition to work engagement, job crafting has a significant impact on employees' meaningfulness of work and well-being, which is supported by research (Chen et al., 2024).

Our findings enrich the theory of job crafting (Demerouti et al., 2021; Geldenhuys et al., 2021; Wrzesniewski & Dutton, 2001) from two perspectives. First, the research focuses on the SME context, where more emphasis should be placed on task crafting and cognitive crafting, which have shown the most significant impact on engagement among SME employees. Second, the results suggest that social relationships in the workplace are no longer a key determinant of employee engagement.

From a practical perspective, it is essential that companies design jobs so that employees can tailor aspects of their work to exploit their strengths and interests. At the same time, it is important to adapt the organisational culture of companies towards clarifying the importance of individual job roles, in particular by emphasising the contribution of specific roles to the overall functioning of the company.

4. CONCLUSION

Our research confirms that job crafting significantly promotes employee engagement in small and medium-sized enterprises (SMEs). In particular, the physical adaptation of the work environment, referred to as task crafting, showed a significant impact on the level of employee engagement, thus proving to be a key aspect of job crafting in the SME context. Cognitive crafting, which involves changing the way employees perceive their work, also contributed to engagement, although not to the same extent as task crafting. This process involves employees understanding the meaning of their work within the broader context of how the business operates, thereby reinforcing its meaningfulness. Social crafting, i.e. building interpersonal relationships in the workplace, also had a positive impact, but less significant compared to task crafting and cognitive crafting. The results of our research indicate that tailoring the work environment and processes to the individual needs of employees is a crucial factor in increasing employee engagement.

However, we identify some limitations with respect to the methodology used. When using the PLS-SEM method, model misspecification can lead to biased results. In addition, this method also analyses relationships outside the original model, which may cause a deviation from the main research topic. The number of bootstrap samples may also affect the results, with too large a number of samples leading to bias in the main conclusions.

For future research, we recommend focusing on the impact of job crafting on employee engagement in the public sector. It would also be beneficial to investigate the negative factors of job crafting or the barriers that arise from employees or organisations in the job crafting process.

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THE ROLE OF EMPLOYEE TRAINING IN ENHANCING SME FINANCIAL PERFORMANCE: A SLOVAK PERSPECTIVE

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Abstract: *Effective human resource management, particularly through targeted training initiatives, is a key factor in improving the financial performance and long-term sustainability of small and medium-sized enterprises (SMEs). The aim of this analysis is to examine the relationship between training (TR) and financial performance (FP) in SMEs. The data, collected from enterprises operating in the Slovak Republic, were subjected to statistical analysis using Kendall's Tau-b method. The results indicated a statistically significant moderate positive correlation between the variables examined, suggesting that educational activities have a positive impact on the financial performance of SMEs. Future research should focus on examining the long-term effects of learning on the sustainability of enterprises as well as its impact on employee engagement and innovation processes.*

Key words: *financial performance, training, human resources, SMEs*

JEL Classification: *L25, M53, O15*

1. INTRODUCTION

Research in the area of training and development is increasingly demonstrating its crucial impact on the financial performance of enterprises, particularly small and medium-sized enterprises (SMEs). Indeed, effectively implemented development programmes make a significant contribution to enhancing the productivity, financial performance and overall competitiveness of these enterprises. For instance, Nduhura, et al. (2024) reported that continuous learning and quality training positively affect employee productivity. Similarly, Gupta, et al. (2024) find that upgrading and supportive training programs have a positive impact on the financial performance of firms. According to Natamba, et al. (2024), performance is enhanced by implementing methods such as job rotation, mentoring and training. Nurhayati et al. (2024) used a tree model to demonstrate the link between personality traits, competencies and behaviours that are key to successful employee development. Huang et al. (2024) identified that an inclusive leadership style along with increased self-efficacy significantly improve the work performance of nurses in China, thereby enhancing organizational performance. Similarly, Kareem (2019) highlights the importance of HR strategies such as talent development, training, and career advancement that significantly impact business effectiveness. Salem Al Qaydi & Aris (2021) state that several factors including HR practices, training and development, compensation, work environment and ethical values have a significant impact on organizational performance. Lei and Wu (2024) also add that human resource management practices such as recruitment, training, performance appraisal, motivation and job satisfaction significantly affect overall business performance. According to Voca and Havolli (2019), career development, training and motivation of employees play an important role in enhancing organizational performance. Similarly, Wuen et al. (2020) and Abu Rumman et al. (2020) report that training and development processes, as well as meetings in which employees are actively involved, have a positive impact on employee performance in small and medium-sized enterprises (SMEs Within specific HR practices, training, academic career development, teamwork, and mentoring are important and significantly enhance job performance. Sharmila &

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Chinnathambi (2024), Hussain et al. (2016) & Dewa et al. (2024) found that businesses that focus on development initiatives and invest in training, mentoring and continuous learning improve both individual and organizational performance. When differentiating between training by type Idris et al. (2020) found that on-the-job and off-the-job training are positively and significantly related to performance, but when these types of training are taken simultaneously, their effect is amplified. Finally, AlMuhayfith & Shaiti (2020) reported that management support, user satisfaction and training significantly influence the effective use of enterprise resource planning (ERP) system, which enhances the performance of SMEs. Researches in the field of training, education and development increasingly prove their significant impact on the financial performance of companies, however, there is a lack of empirical evidence on the relationship between training and financial performance of SMEs in the Slovak Republic.

The first part of the paper introduces and reviews the existing literature on the subject. The second part defines the problem and explains the methodological approach. The third part focuses on the presentation and discussion of the results. The final section summarizes the main findings of the study, identifies limitations, and suggests possible directions for further research.

2. PROBLEM FORMULATION AND METHODOLOGY

The aim of this study was to examine the relationship between training (TR) and financial performance (FP) in SMEs. The existence of empirical evidence on this relationship in the context of SMEs in the Slovak Republic is limited. In order to address this research gap, the following research question was formulated:

RQ1: What is the relationship between training and financial performance in SMEs?

The data were collected from small and medium-sized enterprises (SMEs) operating in various industrial sectors, with a total of 128 respondents. The respondents were invited to indicate their level of agreement with a series of statements using a 5-point Likert scale (1 = totally disagree, 5 = totally agree). Following the analysis of the data, it was determined that categories 1 and 2 should be combined into a single group, as should categories 4 and 5. This resulted in a new scale with three values: 1 (disagree), 3 (don't know), and 5 (agree). This facilitates more efficient data processing and interpretation.

The variables in the present study were as follows: 1) financial performance (ordinal variable) and 2) training (ordinal variable). Due to the ordinal nature of the variables and the limited number of categories, the crosstab method was applied in conjunction with Kendall's tau-b coefficient, a method that is suitable for square tables. The study variables were non-parametric (Abu Bakar and Rosbi, 2017) and for this reason, Kendall's Tau-b was selected for correlation analysis. The data analysis was conducted using this method in SPSS Statistics. In the context of a normal distribution, the hypotheses for Kendall's Tau-b are:

- Null hypothesis (H_0): The data follow a normal distribution.
- Alternative hypothesis (H_1): The data do not follow a normal distribution.

Table 1: Test of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
FP	,315	128	,000	,750	128	,000
TR	,333	128	,000	,723	128	,000

Source: own processing

In order to conduct the analysis, the individual variables were tested for normality using the Kolmogorov-Smirnov test (n > 50). The outcomes of this analysis indicated that the p-value for each observation was less than the significance level $\alpha = 0.05$. Consequently, the null hypothesis (H0) was rejected and the alternative hypothesis (H1) was accepted, thereby confirming that the data do not follow a normal distribution.

3. PROBLEM SOLUTION / RESULTS / DISCUSSION

This section presents the outcomes of an analysis exploring the correlation between training (TR) and financial performance (FP) in small and medium-sized enterprises (SMEs). The study examines whether training initiatives positively influence financial outcomes, thereby providing insights into the role of human capital development in enhancing SME competitiveness and growth.

Table 2: Case Processing Summary (TR-FP)

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
TR * FP	128	100,0%	0	0,0%	128	100,0%

Source: own processing

Table 2 provides an overview of the case processing for the analysis of the TR-FP relationship. This analysis is based on a total sample size of 128 cases, with the proportion of valid cases accounting for 100% of the sample. This guarantees that no data were excluded or missing, and the analysis was conducted using the full dataset. This enhances the reliability and accuracy of the results.

Table 3: Crosstabulation (TR-FP)

			FP			Total
			1	3	5	
TR	1	Count	15	7	15	37
		Expected Count	8,7	9,8	18,5	37,0
		Adjusted Residual	2,9	-1,2	-1,4	
	3	Count	6	13	5	24
		Expected Count	5,6	6,4	12,0	24,0
		Adjusted Residual	,2	3,4	-3,2	
	5	Count	9	14	44	67
		Expected Count	15,7	17,8	33,5	67,0
		Adjusted Residual	-2,8	-1,5	3,7	
Total		Count	30	34	64	128
		Expected Count	30,0	34,0	64,0	128,0

Source: own processing

Ass illustrated in Table 3, the results of respondents' answers are presented in a contingency table format. A total of 44 respondents indicated that current training was associated with an enhancement in financial performance. Conversely 15 respondents stated that they did not observe any improvement in financial performance related to ongoing training.

The following hypotheses are proposed in relation to Kendall's Tau-b:

- Null hypothesis (H0): There is no statistically significant positive relationship between TR and FP.

- Alternative hypothesis (H1): There is a statistically significant positive relationship between TR and FP.

Table 4: Kendall's tau-b (TR-FP)

		Value	Asymptotic Standardized Error[a]	Approximate T[b]	Approximate Significance
Ordinal by Ordinal	Kendall's tau-b	,285	,081	3,495	,000
N of Valid Cases		128			

Source: own processing

Kendall's tau-b has a value of 0.285, indicating a moderate positive correlation between the two variables. This finding indicates that higher TR values are associated with an upward trend in FP. The statistical significance of this correlation is supported by a p-value below 0.05, which indicates a confidence level of 0.05. Consequently, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted, confirming a significant relationship between TR and FP among the analysed SMEs. These findings address the research question RQ1: *What is the relationship between training (TR) and financial performance (FP) in small and medium-sized enterprises (SMEs)?*

In light of the findings of our study, we are now in a position to provide a comprehensive response to research question 1. The analysis reveals a statistically significant positive relationship between training (TR) and financial performance (FP) in small and medium-sized enterprises (SMEs). Kendall's tau-b value of 0.285 indicates a moderate positive correlation between the two variables. The null hypothesis (H0) is rejected, and the alternative hypothesis (H1) is accepted, at the 0.05 level of significance, thus confirming that training exerts a significant positive effect on financial performance in the analysed SMEs.

This result is consistent with the findings of previous research. For instance, Nduhura et al. (2024) and Gupta et al. (2024) demonstrated that quality training and employee support positively impact productivity and financial outcomes. Furthermore, Natamba et al. (2024) and Nurhayati et al. (2024) emphasised the role of mentoring, job rotation, and personality development in enhancing employee success, thereby supporting the conclusion that the training improves financial performance. Furthermore, studies by Kareem (2019), Salem Al Qaydi & Aris (2021), and Lei & Wu (2024) highlight that HR practices such as training, career development, and employee motivation significantly influence business performance, aligning with our findings. Furthermore, Voca & Havolli (2019) and Abu Rumman et al. (2020) reported that training, in conjuction with active employee engagement, improves SME performance. In addition, Sharmila & Chinnathambi (2024) and Idris et al. (2020) found that combining various training approaches enhances effectiveness, further supporting the conclusion that training positively affects SMEs' financial performance.

4. CONCLUSION

The aim of this study was to examine the relationship between training (TR) and financial performance (FP) in SMEs. The methodology employed included tools designed to analyse relationships between non-parametric variables, specifically Kendall's tau-b and contingency tables, which facilitated the interpretation of respondents' answers. The findings of the study indicated a statistically significant, moderately strong positive correlation between TR and FP. The contingency table revealed that the majority of respondents acknowledged current training as a contributing factor to improved financial performance. This study makes a significant contribution to the extant body of scientific knowledge in human resources by offering empirical evidence of the connection between training and company performance.

Moreover, the application of Kendall's tau-b enhances methodological diversity by demonstrating its suitability for analyzing non-parametric data. From a practical perspective, the study recommends that SMEs prioritize the implementation of effective training programs, as investments in training have been shown to improve financial performance. This finding is of particular value to managers and business leaders in making strategic decisions regarding employee development and training investments. Future research should explore the long-term effects of training to assess whether such initiatives lead to sustainable improvements in financial performance. Furthermore, subsequent studies could investigate the impact of training on other organisational outcomes, such as employee engagement and the promotion of an innovation-driven culture, both of which are vital for the adaptability and success of SMEs. However, it is important to note that the limited number of respondents in this study restricted the use of more advanced statistical methods, which could provide even deeper insights.

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SMART CITY POLICY CONCEPTS ANALYSIS IN ITALY – BENEFITS AND CHALLENGES

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Abstract: *Smart cities have gained significant attention in recent years, as urban areas grapple with the challenges of rapid population growth, infrastructure utilization, energy consumption, and environmental pollution. In Italy, the government has launched the Smarter Italy Program, which aims to meet smart requirements capable of improving the quality of life of citizens and generating a significant impact on the efficiency of the operation of the public administration. The program focuses on areas such as smart mobility, cultural heritage, and social and personal well-being, to improve the mobility and logistics of Italian cities according to the "smart city" paradigm. The goal of the paper is to explore the Spanish smart regions policy analyses and its further development and to find out the successful stories and practices as well as negative aspects barriers and limits. In general, this paper will handle the problematic aspects regarding the economic and social issues within the Italian regional development policy covering the smart regions policy development tools implementation processes. The ways of synthetic and analytic methods will be used in the paper such as the analysis and comparison to illustrate the Italian smart regions policy environment, synthesis and logical deduction to discuss the impact of Italian smart city policy elements implementation on Italian regional development within the smart regions policy development issues. The recommendations provided serve as a strategic guide to fortify the development of smart cities in the country. This analysis proves indispensable in comprehending the impact of smart initiatives in Italy, their symbiosis with the smarter Italy program and smart city projects in Italy, and in identifying areas of improvement and opportunities for the nation's future sustainable development.*

Key words: *Italian smart regions policy development, circular economy, new technologies implementation, smart cities, waste management*

JEL Classification: *O36, R11, H83*

1. INTRODUCTION

Smart cities have gained significant attention in recent years, as urban areas grapple with the challenges of rapid population growth, infrastructure utilization, energy consumption, and environmental pollution. As cities continue to expand and evolve, they have become significant drivers of climate change, posing a threat to the planet if proactive measures are not taken. With approximately 70% energy consumption and 70% of CO2 emissions attributed to urban areas, the consequences of climate change are increasingly impacting cities with strong heat waves and extreme weather events. In response to these challenges, urban planning has shifted towards the concept of the "smart city," which aims to improve urban life while aligning with the goals of the United Nations to minimize pollution, climate change, and high waste of resources through technological innovations. The United Nations has drafted 17 sustainable development goals, with goal 11 specifically focusing on sustainable cities and communities. These goals encompass a wide range of initiatives, including access to safe and sustainable transport systems, inclusive and sustainable urbanization, protection of cultural and natural heritage, and the promotion of economic, social, and environmental connections between sites. In Italy, the government has launched the Smarter Italy Program, which aims to meet smart requirements capable of improving the quality of life of citizens and generating a significant impact on the efficiency of the operation of the public administration. The program focuses on areas such as smart mobility, cultural heritage, and social and personal well-being, to improve the mobility and logistics of Italian cities according to the

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"smart city" paradigm. Overall, the concept of smart cities and the integration of smart city solutions in waste management and circular economy represent a pivotal shift towards creating sustainable and efficient urban environments. By leveraging innovative technologies and embracing the principles of a circular economy, smart cities can create practical avenues for enhancing waste management, promoting efficient systems, and contributing to sustainable urban living. (Jaskova, Haviernikova, 2020; Bilan, et al. 2019; Ivanova, Masarova, Koisova, 2020).

The fundamental purpose of this paper is to carry out a comprehensive analysis of several crucial aspects. Firstly, we will examine the level of implementation of Smart Regions in Italy, evaluating the effectiveness of the strategies adopted. Next, we will dive into the smart city policy concepts analysis in Italy analysis including its benefits of smart city solutions in Italy and limits and barriers. Additionally, we will explore the particular projects such as smarter Italy program and smart city projects in Italy assessing the national challenges that arise in the process, identifying the barriers and needs associated with the deployment of intelligent solutions and the achievement of sustainable goals. To achieve these objectives, the structure of the work is broken down into specific sections that address each aspect in detail. Through this analysis, we seek to contribute to the understanding of how Smart Regions in Italy are not only redefining technological geography but also influencing the trajectory of national development towards a more sustainable and equitable future.

2. THEORETICAL BACKGROUND

Firstly, we will deal with the smart region concept issue from the theoretical aspect. In a world scenario marked by globalization and accelerated technological advancement, the concept of "Smart Region" emerges as an innovative proposal aimed at revolutionizing and improving the quality of life of citizens. In its essence, a Smart Region stands as a model that seeks strategic transformation through the effective implementation of Information and Communications Technologies (ICT). This approach translates into the search for technological solutions to address specific challenges, promote sustainable development and optimize resource management at the regional level. A Smart Region goes beyond the simple adoption of advanced technologies; involves the integration and synchronization of infrastructure, services and resources to create more efficient, sustainable and inclusive urban and rural environments. This concept encompasses the implementation of intelligent systems that impact crucial areas such as mobility, energy management, public administration, education and health. The fundamental premise is to strategically use technology to improve the quality of life, efficiency and sustainability of the region (Belas, et al. 2020; Kljucnikov, Mura, Sklenar, 2019).

The smart city is used more frequently and is popular with urban planners. Smart cities are seen as the future of urbanism. Billions are invested in them worldwide, but what exactly is a smart city? There are many definitions and approaches, but no universal descriptions. It is, more or less, one vision or expectation of the ideal city of tomorrow, with the current problems cities experience but with a lot of innovative technology solutions. Most of the definitions focus on the areas of quality of life, information technology, and community. More terms emerging from the smart city have developed, such as eco-city, climate-neutral city, green city, and sustainable city, indicating the current environmental awareness trends. The smart city in urban planning and architecture is a set of urban planning strategies aimed at optimizing and innovating public services to connect the material infrastructure of cities "with the human, intellectual and social capital of their inhabitants" through the widespread use of new technologies in communication, mobility, environment, and energy efficiency, to improve the quality of life and meet the needs of citizens, businesses, and institutions. Urban performance depends not only on the city's endowment of physical infrastructure (physical

capital) but also, increasingly, on the availability and quality of communication, knowledge, and social infrastructure (intellectual capital and social capital). The latter form of capital in particular is crucial for urban competitiveness (Gruzauskas, Baskutis, Navickas, 2018).

The concept of the smart city was introduced in this context as a strategic device to contain modern urban production factors within a common framework and to emphasize the growing importance of information and communication technologies (ICTs), and social and environmental capital in defining the competitiveness profile of cities, moving towards sustainability and ecological measures of both control and energy saving, optimizing mobility and security solutions. The significance of the two assets (of social and environmental capital) highlights the need for a long way to go to distinguish smart or intelligent cities from those with a greater technological burden, drawing a clear line between them, what goes under the name of smart cities and digital cities respectively. The aim is to build enough living space relatively quickly while ensuring mobility and quality of life. There is no perfect city. This raises the question of how life in a city is most sustainable or efficient to satisfy most people and create a basis for future generations (Mura, Marchevska, Dubravska, 2018; Navickas, Svazas, 2017).

When it comes to smart cities and sustainability, between 2050 and 2060, the world population will reach 10 billion. From a global perspective, as the population grows, so does the number and size of cities. With increasing inhabitants, infrastructure utilization, energy consumption, and environmental pollution also increase. Cities are significant drivers of climate change; therefore, they threaten our planet without further action. Urban areas are responsible for approximately 70% of energy consumption and 70% of CO2 emissions. The consequences of climate change mean cities are increasingly afflicted by strong heat waves and extreme weather events. These and many other developments are associated with problems, new challenges, and opportunities. Urban planning is therefore focused on a new guiding principle named the “smart city”. It should improve life in the city and meet the goals of the United Nations, thus minimizing pollution, climate change, and high waste of resources, with the help of technological innovations. To enable a better and more sustainable future for all, the United Nations drafted 17 goals. They generally deal with the global challenges of humanity. The interconnected goals should be achieved by 2030. Goal 11, sustainable cities and communities is the most important city-related goal (Eurostat, 2025; Gajda, Svazas, Navickas, 2019):

- access adequate, safe, affordable housing, ensure basic services, and upgrade slums.
- access to safe, cheap, and sustainable transport systems for everyone and expand public transport.
- inclusive and sustainable urbanization and the ability for participatory-integrated and sustainable settlement planning and administration improvement in all countries.
- they are intensifying efforts to protect and safeguard cultural and natural heritage.
- reduce the number of deaths caused by disasters and people affected by them, focusing on protecting the poor and those in vulnerable situations.
- they reduce human environmental impact and pay special attention to air quality and waste disposal.
- they are securing access to green spaces and public spaces.
- they promote economic, social, and environmental connections between sites by supporting national and local development planning.
- the number of cities and settlements that plan to increase resource efficiency mitigation and adaptation to climate change, and risk management.

– assistance to the least developed countries through financial and technical assistance in building more sustainable and resilient buildings using local materials.

3. PROBLEM FORMULATION AND METHODOLOGY

The research task deals with the analysis of the problematic aspects of Italian smart regions policy development and find out its consequences. The research will be focused on exploring the Spanish smart regions policy analyses and its further development and to find out the successful stories and practices as well as negative aspects barriers and limits. In general, this paper will handle the problematic aspects regarding the economic and social issues within the Italian regional development policy covering the smart regions policy development tools implementation processes. The particular issues will consist of following aspects including the level of implementation of Smart Regions in Italy, evaluating the effectiveness of the strategies adopted.

The ways of synthetic and analytic methods will be used in the paper such as the analysis and comparison to illustrate the Italian smart regions concept, synthesis and logical deduction to discuss the impact of the level of implementation of Smart Regions in Italy, evaluating the effectiveness of the strategies adopted in Spanish regional development policy issues. Subsequently, the analysis will lead to synthesis and prognosis by means of abstraction method eliminating the less important factors to set general statements and opinions. In particular, to estimate the next obstacles to be faced within smart region components implementation issues and to recommend the activities for Italian state and regional authorities, entrepreneurs and companies to eliminate the negative impacts of smart regions policy implementation that would affect their businesses. For the most objective assessment of the changes being awaited by Italian Agenda 2030 approach due to the implementation of smart regions policy along with the smarter Italy program and smart city projects in Italy, the theoretical analysis method has been chosen as the basic research method the researchers were approached by.

4. RESULTS AND DISCUSSION

The evolution of Smart Regions in Italy has undergone a significant transformation over recent decades, showing the country's commitment to innovation, sustainability and regional development. In the last two decades of the 20th century, Italy experienced a transition towards a more technology and knowledge-oriented economy, marking the beginning of a growing interest in the concept of "Smart Regions". This change was aligned with the need to address emerging challenges and promote equitable development throughout the national territory. Government initiatives played a fundamental role in promoting Smart Regions in Italy. As the country faced integration into the European Union and globalization, the Government adopted strategies to strengthen regional competitiveness by implementing policies that foster innovation, technology and efficiency. The creation of research centers, technology parks and programs to support the digitalization of companies was established as an integral part of these strategies, laying the foundations for the development of smarter and more connected regions. In the 21st century, Italy continued to advance its commitment to Smart Regions, closely aligning them with the 2030 Agenda. The implementation of information and communication technologies (ICT) in public services, the promotion of renewable energies and the adoption of sustainable practices They became fundamental pillars of government policies. Programs such as the Digital Agenda for Spain and the Italian Smart Cities Strategy highlight the continued commitment to digital transformation and sustainable development (Belas, et al. 2023; Rózsa, et al. 2023).

The Italian experience in the development of Smart Regions was not without challenges. Regional disparity, the need for greater social inclusion and resource optimization emerged as critical aspects to address. The focus on territorial equity and citizen participation were consolidated as key elements to maximize the benefits of smart initiatives and guarantee that no territory was left behind in this transformation process. The history and development of Smart Regions in Italy reveal a trajectory marked by adaptation to the changing demands of the global environment and commitment to achieving sustainable objectives. The government initiatives and strategies adopted reflect a continuous effort to promote innovation, efficiency and equity throughout the territory, significantly converging with the fundamental principles of the 2030 Agenda. This context provides the necessary framework to analyze the implementation, socioeconomic impact and national challenges associated with Smart Regions in Italy in the context of this research (Rozsa, et al. 2022; Nijenhuis, Leung, 2017).

4.1 Smart City Policy Concepts Analysis in Italy

Italy has been actively embracing the concept of smart cities, integrating technology and innovation into urban development and governance to enhance the quality of life for its citizens. Several key policy concepts have been instrumental in shaping Italy's approach to smart cities (Addas, 2023):

- Urban Regeneration: Italy's smart city policies often focus on urban regeneration, aiming to revitalize existing urban areas by leveraging technology and sustainable development practices.
- Environmental Sustainability: Smart city initiatives in Italy prioritize environmental sustainability, promoting energy-efficient infrastructure, waste management systems, and green spaces to mitigate environmental impact and enhance overall urban sustainability.
- Digital Innovation: The integration of digital innovation is a central pillar of Italy's smart city policies, encompassing the development of digital infrastructure, data-driven decision-making, and the implementation of IoT (Internet of Things) solutions to optimize urban services and utilities.
- Public Participation: Italy emphasizes public participation in smart city initiatives, fostering citizen engagement through digital platforms and participatory decision-making processes to ensure that urban policies align with the needs and preferences of the community.

These policy concepts collectively contribute to Italy's ongoing efforts to develop and advance smart cities, enhancing sustainability, resilience, and the overall well-being of urban residents. In Italy, the market of Smart Cities - the “intelligent” and sustainable cities - grew significantly in 2022 (+23% compared to 2021) reaching 900 million euros, with one in five Italian municipalities launching smart projects last year. This is what emerges from research conducted by the Smart City Observatory of the School of Management of the Milan Polytechnic, which testifies to the growing interest in the development of Smart Cities in the country. In detail, the growth is due to investments in fundamental applications for Smart cities such as “intelligent” public lighting (24%), smart mobility (21%), remote reading and remote management systems for electricity, water, and gas (smart metering) together with smart buildings (12%), with funds coming from Italian NRRP (National Reprise and Resilience Plan) pushing investments also towards innovative solutions in the energy sector (13%) such as renewable energy communities. Furthermore, local administrations have launched initiatives for the “smart transformation” in recent years (89%) are willing to further invest in “smart” projects, focusing on smart mobility, smart building, and analysis of data related to tourism, mobility, and events in cities. However, a minority of Municipalities have not yet understood the value of the transformation into a Smart City. Consequently, to make all the advantages offered by “intelligent” cities understood, it is necessary to create and develop a culture of innovation in Italy to make the most of the dedicated funds of the NRRP

(to which 100 billion euros will be added from EU programs) and make urban centers throughout the territory "cleaver" and sustainable (Christofi, Iaia, Marchesani, 2021; McDaniel, 2023; Moreno, 2023; Smartcityweb, 2025).

When it comes to the funds of Italian NRRP for Smart Cities development, the funds of NRRP which affect and will affect the Italian Smart Cities amount to 17.1 billion euros, divided as follows ():

- 9 billion within the scope of Mission 1, i.e for the digitization of the Public Administration which includes a series of enabling interventions for Smart Cities;
- 7 billion for Mission 2, which includes the ecological transition and the "green revolution", intended to increase energy efficiency and sustainability with interventions for the reduction of hydrogeological risks, the creation of renewable energy communities in small urban centers, and integrated monitoring of the territory;
- billion included in Mission 5, which provides specific funding for cities, intended for Integrated Urban Plans. The goal is to make the peripheral areas of 14 Metropolitan Cities "smart" and sustainable through the creation of new services for citizens and the digitization of infrastructures;
- 1 billion for projects aimed at urban regeneration.

4.2 Smart Cities: The World Ranking

Determining the level of intelligence of cities accurately is a difficult task, as there are no unique criteria for an accurate assessment. However, for years, universities and research centers have drawn up rankings and ratings that can be taken as a reference. In this sense, one of the internationally recognized indicators is the Smart City Index (CSCI) calculated annually by the Smart City Observatory, an expression of the World Competitiveness Center (WCC) of the Swiss management school IMD together with the Singapore University of Technology and Design (SUTD). A rating that, in addition to economy and technology, also considers other characteristic aspects of a Smart City such as inclusiveness and quality of life. According to the 2023 edition of the Smart City Index the top three places in the rankings are occupied by Zurich, Oslo, and Canberra, with Copenhagen overtaking Lausanne in fourth position and London slipping from third to sixth place. Further back is Italy with only two cities in the top 100: Bologna in 51st position and Milan which, from 52nd place in 2019, has dropped to 82nd. In Italy, the ICity Rank - which indicates the level of digitization of cities - represents the main reference for following the evolution of Smart Cities. The research conducted annually by FPA - a company of the Digital 360 Group - evaluates the digital transformation index of the 108 Italian provincial capitals based on the arithmetic mean of eight indicators (online services, social channels, enabling platforms, open data, openness, public Wi-Fi, municipal apps and IoT and network technologies). In the ranking reported to 2022 for the third consecutive year Florence is the Italian most digital city ahead of Milan, followed by Bergamo, Bologna, Cremona, Modena, Rome Capitale, and Trento - all tied for third place. The ninth position is shared by Cagliari and Venice, with Turin and Parma cohabiting in 11th place (Addas, 2023; Christofi, Iaia, Marchesani, 2021; Smartcityweb, 2025).

The ranking also highlights important changes. The average level of digitization in the country has increased, with the smallest realities and those of the South which, albeit late, are recovering. Messina leads the ascent occupying the 28th place compared to the 62nd in 2021, "gaining" 34 positions. Encouraging figures confirm that the path towards the transformation of Italian cities into Smart Cities is at a good point, also thanks to open innovation and the consequent contribution of innovative startups. The ranking of the Smart City Index also highlights the well-known gap between the cities of the north and the cities of the south, at last place in the ranking. One of the main reasons for the gap is certainly the lack of

infrastructure and the low willingness of the community to use the services. The car-sharing service, for example, has failed and has also caused damage to vehicles. In general, sustainability in transport, in the environment, in the economy, in construction, and the management of the natural resources of the territory, is easier to obtain in medium-sized cities, more operational and organized.

4.3 Benefits of Smart City Solutions in Italy

Smart city solutions in Italy offer numerous benefits, especially in the context of sustainable waste management and circular economy initiatives. These solutions address the challenges of waste management in urban areas, taking into account the economic, environmental, and social aspects of resource use and waste generation. According to the University of Padua the benefits of Smart City solutions can be grouped as follows (Christofi, Iaia, Marchesani, 2021; Rebecchi, 2021).

- Improved Waste Management: Smart city solutions in Italy focus on optimizing waste management processes, including collection, sorting, and recycling. This leads to reduced environmental impact, improved resource efficiency, and lower carbon emissions. For example, the implementation of advanced waste sorting technologies has resulted in a significant increase in recycling rates, with some cities achieving up to 70% diversion of waste from landfills.
- Citizen Engagement and Participation: Smart city solutions prioritize citizen engagement and participation in waste management processes. Through the use of digital platforms and communication strategies, citizens are encouraged to participate in recycling programs, waste reduction initiatives, and sustainable consumption practices. As a result, there has been a notable increase in environmental awareness and a shift towards more sustainable behaviors among residents.
- Circular Economy Integration: Smart city solutions in Italy are aligned with the principles of the circular economy, aiming to minimize waste generation and maximize resource recovery. This includes the promotion of reuse, repair, and remanufacturing activities, as well as the development of local circular supply chains. As a result, there has been a reduction in the amount of waste sent to landfills and an increase in the utilization of recycled materials in various industries.
- Technological Innovation: Smart city solutions leverage technological advancements to improve waste management processes. This includes the implementation of smart waste collection systems, sensor-based monitoring of waste streams, and the use of data analytics to optimize resource allocation and operational efficiency. These innovations have led to cost savings, improved service quality, and a more sustainable approach to waste management.
- Economic Opportunities: The adoption of smart city solutions has created economic opportunities in the waste management sector. This includes the development of green jobs, the growth of the recycling industry, and the establishment of circular economy business models. In addition, implementing sustainable waste management practices has led to cost savings for municipalities and businesses, as well as potential revenue generation from the sale of recycled materials.

Overall, smart city solutions in Italy have demonstrated significant benefits in terms of environmental sustainability, citizen engagement, circular economy integration, technological innovation, and economic opportunities. These initiatives have contributed to the transformation of urban areas into more sustainable and resilient communities, setting an example for other cities and regions to follow.

The benefits also concern community services, sustainability, and livability. Taking Milan as an example, every citizen of the smart city could save 3 days a year, the ones he/she needs

today in the search for a free parking space and could reduce carbon dioxide emissions with positive impacts on the environment.

4.4 Limits and Barriers

The limits and barriers for Smart City solutions in Italy are multifaceted and include various factors such as complexity, numerous stakeholders and shareholders, differing demands from policymakers, industries, and citizens, and the need to identify responses that benefit all. As the article "Assessing environmental sustainability of local waste management policies in Italy from a circular economy perspective. An overview of existing tools." highlights, there are five main limitations that Italy faces regarding this issue (Addas, 2023; Christofi, Iaia, Marchesani, 2021; Smartcityweb, 2025).

Limit 1: Complexity and Stakeholder Involvement

One of the limitations of Smart City solutions in Italy is the complexity of the urban environment, especially in megacities or smart cities with limited historical and social backgrounds. This complexity poses challenges in implementing and managing smart city initiatives. Additionally, there are numerous stakeholders and shareholders involved in the decision-making process, including policymakers, industries, and citizens, each with different demands and interests. This complexity can hinder the smooth implementation of smart city solutions.

Limit 2: Economic and Market Factors

Another barrier is the economic choices of consumers, which greatly influence production patterns. Consumer demand for new materials, such as bioplastics, is necessary for the success of sustainable products. However, the output of waste management processes needs to be marketable, and citizens may be unwilling to pay for waste management services. This economic factor can impact the adoption of smart city solutions aimed at promoting sustainability and resource efficiency.

Limit 3: Lack of Environmental Awareness

A significant barrier is the lack of environmental awareness and sustainable local demand for goods. Citizens may not feel directly connected to the environmental and health benefits of waste management, leading to reluctance to participate in sustainable practices. This lack of awareness and demand for sustainable products and services can hinder the adoption of smart city solutions focused on promoting environmental sustainability.

Limit 4: Cultural and Behavioral Challenges

Cultural and behavioral challenges also pose limitations to smart city solutions in Italy. Virtuous environmental behavior by individuals, such as requesting products without chemicals, following a conscious diet, and reusing clothes, requires a shift in cultural and behavioral norms. Additionally, critical rebound effects may arise from positive technical and behavioral changes, impacting the effectiveness of smart city initiatives.

Limit 5: Regulatory and Policy Constraints

Regulatory and policy constraints, such as the need for supporting regulations and incentives, can also act as barriers to the implementation of smart city solutions. The lack of supportive policies, subsidies, and financial resources may hinder the development and adoption of sustainable and circular economy initiatives in smart cities.

To sum up, the complexity of the urban environment, economic factors, lack of environmental awareness, cultural and behavioral challenges, and regulatory constraints are significant limits and barriers to smart city solutions in Italy. Overcoming these limitations will require a comprehensive approach that addresses the diverse challenges and stakeholders involved in promoting sustainable and circular economy initiatives in smart cities. Furthermore, according

to the Intesa Sanpaolo Innovation Center, the benefits of smart cities in Italy are not yet clear to everyone. Despite the numerous experiments launched, the projects are still poorly integrated and sometimes do not have a clear territorial development strategy. The barriers to their development include the lack of sufficient economic resources and adequate skills and the presence of unclear governance models. These are the main reasons why most of the projects are abandoned after the first experimental phase. What is needed to solve the problem is a shared national strategy. Commitments and priorities must be established for the municipalities and the right compromise must be found to avoid the excessive centralization that is currently taking place. A valid project analysis model is based on four variables: the maturity of the municipalities, the maturity of the offer, the use of the data collected, and the public-private partnership. The analysis shows, in fact, the level of maturity of the municipalities is much lower than that of the offer. In a nutshell, the municipalities are not adequately prepared for the challenge, and the number of public-private collaborations is still too small.

4.5 Smarter Italy Program

In this troubled period of economic crisis, the government is pursuing a program of significant value for the recovery of the automotive world. This is the Smarter Italy Program, launched with the Ministry of Economic Development's decree of 31 January 2019 (Allocation of resources from the Sustainable Growth Fund for the implementation of smart public demand tenders - GU n.67 of 20-03-2019) and became operational with the agreement between MISE and AgID for the implementation of smart public demand tenders in July 2019. The aforementioned decree allocated EUR 50 million to finance calls for tenders that aim to meet smart requirements capable of improving the quality of life of citizens, and/or the business environment, and/or generating a significant impact on the efficiency of the operation of the Public Administration; the budget may be supplemented with additional resources from other entities that choose to join the program. In addition to the funds initially envisaged by the Decree of 31 January 2019, the implementation of the innovation contracts may be financed with resources from Operational Programs co-financed with Structural and European Investment Funds or with ordinary budgetary resources of the central and local Administrations concerned (McDaniel, 2023; Padova Soft City, 2025; Intesa Sanpaolo Innovation Center, 2023).

The first areas of intervention of the program identified by the Ministry for Economic Development were the following:

- Smart Mobility: substantial improvement of services for the mobility of people and things in urban areas;
- Cultural Heritage: economic and tourist enhancement of areas of historical and artistic importance;
- Social and personal well-being (Wellbeing): improvement of the psycho-physical state of citizens;

The Smart Mobility intervention area envisages, as a first action, the definition of one or more innovative tenders for the development of solutions to improve the mobility and logistics of Italian cities according to the 'Smart city' paradigm. The action was preceded by a series of meetings held at the Ministry of Economic Development between December 2019 and March 2020, involving 11 municipalities that have joined the experimentation of the 5G network (Bari, Cagliari, Catania, Genoa, L'Aquila, Matera, Milan, Modena, Prato, Rome, Turin), which expressed their needs for innovation in terms of traffic, pollution, liveability of historic centers, and usability of industrial districts. Based on the needs that emerged, it was decided to launch a public consultation with market operators (companies, start-ups, universities, and research centers), through a dedicated digital platform, made available on the AgID website. To this end, the Agenzia per l'Italia Digitale, the contracting station of the program, published

on 5 May 2020 in the Official Journal the notice of the launch of the market consultation on the topic 'Smart Mobility' (Christofi, Iaia, Marchesani, 2021; Rebecchi, 2021).

The consultation thus opens up the Public Administration to the comparison with market operators to acquire all the useful elements for the preparation of the tender. The objectives of the market consultation are:

- to allow AgID to acquire useful elements for the preparation of the Smart mobility tender;
- to make operators aware of the need for innovation in the Smart mobility sector that the Administrations promoting the initiative (Ministry of Economic Development, the Ministry of University and Research, and the Department for Digital Transformation of the Presidency of the Council of Ministers) believe they can satisfy by resorting to the market.

At the end of the consultation, an innovative tender of approximately EUR 20 million will be launched, aimed at the research and development of new tools for forecasting and managing traffic flows, of solutions to meet the mobility needs of areas with weak or less populated demand, and for improving the mobility of goods in cities and towns. Participation is open to all operators, be they companies, universities, research centers, third-sector organizations, individuals, etc., who will offer original solutions and their development in the following areas (McDaniel, 2023; Smartcityweb, 2025; City Vision, 2025):

1. Innovative predictive/adaptive solutions for Smart Mobility able to foster urban mobility by offering:
   - simulation tools supporting the planning of interventions aimed at preserving or improving quantitative or qualitative aspects of urban mobility and enabling integrated public transport planning;
   - monitoring, proactive and predictive near-real-time functionalities for the dynamic optimization of vehicle traffic and related infrastructural elements (e.g. parking spaces, city car parks, reserved parking spaces - disabled, loading and unloading of goods - bicycle lanes, electric charging stations, etc.);
2. Innovative solutions for improving goods mobility by reducing its impact on urban traffic, but respecting the following parameters:
   - guaranteeing quantities and delivery times with orders of magnitude compatible with market needs;
   - being economically and environmentally sustainable, preserving people's quality of life and transport.
3. Innovative solutions for improving sustainable mobility in areas of low demand, i.e. innovative ideas for facilitating the movement of people within areas with low or medium-low transport demand, characterized by considerable spatial and temporal dispersion.
4. Innovative solutions for improving mobility in historic centers and villages, i.e. in urban contexts that have developed without the application of a homogeneous land-use plan and/or in territorial contexts with an uneven orchestra that enable the achievement of levels of demand satisfaction that are not inferior to the average levels of urban areas not so characterized, guaranteeing:
   - the preservation of the artistic, architectural, and landscape heritage;
   - a low environmental impact;
   - economic sustainability for both the public administration and users.

The chosen solutions will be tested on the territories of the proposed municipalities, which will thus become truly advanced laboratories about the intelligent mobility of people and goods. The first public meeting was held on 15 June, during which the need for innovation in the field of transport management and logistics, which forms the basis of the 'Smart Cities, Smart Mobility & Logistics' call for tenders, was presented. The presentation of the needs took place with the collaboration of the 11 municipalities already involved in the definition phase of the needs and the future place of experimentation of the proposed solutions. The discussion was attended by almost 500 participants, including companies, universities, research centers, third-sector organizations, individuals, public administrations, professionals, and start-ups, who had the opportunity to speak and make themselves known. The Minister for Innovation and Digitization, Paola Pisano, emphasized that: "with the implementation of Smart mobility, the State has the opportunity to make innovative modes of public transport available to citizens". The initiative aims to encourage the development of solutions that are better able to meet users' travel needs and to do so in an environmentally friendly manner. Improving the management of traffic flows through intelligent, autonomous, and connected mobility will have positive repercussions both for the daily lives of citizens, particularly in urban centers and for the productive fabric, given that many companies are already active in the sector. The digitization of the country, the implementation of which has been accelerated by the needs dictated by the lockdown, is no longer a goal towards a better future, but a necessity for better living in the present, especially in urban mobility (Addas, 2023; Rebecchi, 2021; Intesa Sanpaolo Innovation Center, 2023).

4.6 Smart City Projects in Italy

Smart city projects in Italy show an increased awareness of the importance of the topic compared to the past. Nevertheless, applications continue to weigh less than 8% in the IoT (Internet of Things) market. However, the number of smart city projects is increasing compared to previous years, with more stable and innovative initiatives. However, there are still many barriers to the general development of smart cities throughout Italy. The survey by the Internet of Things Observatory shows that 36% of the major Italian municipalities have started at least one smart city project in the last three years, most of which are still in the experimental phase. The trials often take place independently and in an uncoordinated manner (Christofi, Iaia, Marchesani, 2021; McDaniel, 2023; Padova Soft City, 2025; Smartcityweb, 2025; City Vision, 2025):

4.6.1 Milan

Milan is always among the first Italian cities in the ranking, with excellent positions in the field of economic solidity, research, and development, as well as sustainable mobility. It is also at a good level in terms of the consumption of the soil and of the quality of the air and water. Its position on governance and environmental protection can be improved. One of the highlights of Milan is the Bosco Verticale, the tower designed by architect Mario Cucinella. This building, equipped with artificial intelligence, is innovative both in terms of the materials used and its energy efficiency. It has a double skin that insulates it from the cold in winter and protects it from the heat in summer. At the heart of energy efficiency is also EU-GUGLE. This is the EU-funded pilot project for the intelligent refitting of entire buildings to reduce energy needs and integrate renewables.

4.6.2 Florence

In terms of resilience, the ability to adapt to change is at the heart of the smart city model adopted by Florence. In addition to its consolidated credentials as an attractive tourist and cultural destination, it boasts Italy's top ranking when it comes to digital transformation in the ICity Rate, which relates to sustainable mobility, economic stability, education, civic participation, and energy. This is an urban development strategy looking ahead to 2030. It focuses on three key points:

- connection;
- innovation;
- e-mobility.

A good example is the recent Smart City Control Room project. It is an integrated processing system that uses geo-referenced data from across the city. It enables real-time mobility management that can respond quickly to emergencies. The OpenRu system already allows citizens to receive traffic information in real-time, as well as provide advance notification of public projects approved by the administration.

4.6.3 Venice

A Venetian province and maritime city of 250,000 inhabitants, Venice is a unique city, built on the sea and characterized by the total absence of roads and cars circulating within its perimeter; movements take place employing boats navigating along the canals that cross its entire surface. This is how it ranks in all the smart dimensions: economy 33rd, people 63rd, governance 68th, mobility 32nd, environment 52nd, and living eighth. As Venice is a tourist city par excellence, it needs tools that help to control the amount of people who circulate through its streets every day. That is why in 2020 they installed the 'Venice Smart Room', which the newspaper 'il Post' defines as a 'control tower or control room' of the city. It is an innovative and integrated monitoring of flows, behavior, and phenomena of people in the city, and it can also provide information on weather, tides, and air quality. If we talk about ICT and communications, Venice can enjoy more than 300 Wi-Fi hotspots with the latest generation. Moreover, even the municipal administration also seems to want to push electric mobility by proposing advantages and subsidies to all electrically powered boats: Mayor Brugnaro's goal is to gradually move to all-electric navigation. Finally, one cannot fail to mention MOSE, which, although it has a lot of controversy behind it, is a fundamental engineering project to stop the phenomenon of high tides that lead to the complete flooding of the city area.

4.6.4 Verona

Veneto province and a city rich in history located in the hinterland of the Po Valley, Verona has 255,000 inhabitants. This is how it ranks in all smart dimensions: economy 25th, people 57th, governance 61st, mobility 45th, environment 66th and living 28th. Verona began its journey towards a smart future in 2016 when the first time the 'Verona Smart City' project was undertaken: the municipal administration, aware of the city's main problems, decided to launch this initiative to innovate and gradually renew the entire fabric of the city. Verona Smart City is a project consisting of 12 different initiatives to which a total investment of 23,745,000 euros has been allocated. The main initiatives of the administration are:

- to involve all players in the city fabric and the Veronese territory to imagine a city model that responds to the needs of our time;
- exploit the location to become a logistical pole of the peninsula and improve transport conditions in Verona;
- increase the presence of multinationals despite being the first city in Veneto with 80 branches.

Improving the quality of life of citizens is the ultimate goal of a smart city project and Verona, due to its nature, size, and number of inhabitants, lends itself well to a series of actions that implement, at the same time, technology, innovation and environmental sustainability. Among the projects we can find: the general centralization of traffic light systems; an info mobility service to enable the channel for publishing mobility-related content on portable devices; a service for e-bikes throughout the city; and a free high-speed Wi-Fi service throughout the city using the city using the 'VeronaSmartCity' app.

4.6.5 Padua

This city is also a province of Veneto, located near Verona in the Po Valley hinterland. Padua has a population of 206,000 inhabitants, which is, however, increased by the fact that it is a

university city full of out-of-town students. Here is how it ranks in all smart dimensions: economy 34th, people 44th, governance 75th, mobility 60th, environment 73rd, and living 45th. Padua is ranked seventh in Italy for total investments in smart projects (171 million for a total of 57 projects). According to ISTAT, Padua is the city with the network of tracks largest bicycle path network in Italy: in fact, the 'Bici Masterplan' is a plan implemented from 2010 to 2015 to promote cycling as the most efficient means of transport; in addition, there are bike sharing services and electric scooters to further reduce the environmental impact and favor the circulation city circulation. The 'Padua Soft City' is another major project pushed by the Padua administration, which aims at "the intention and desire to make Padua a more 'European', innovative and ecological city". It is therefore a multidimensional project that aims to improve several aspects of the city:

- innovation, through the expansion of car/bike sharing networks, free Wi-Fi, and an increase in the number of recharging stations for electric cars;
- environmental issues, by enhancing green areas and creating new street trees;
- design, increasing vertical and horizontal signposting, creating horizontal signs, creating information points and spaces dedicated to street art;
- accessibility through the removal of architectural barriers and the creation of new cycle paths. In addition, there is the intention to create a control room just like the one in the city of Venice to increase safety and general monitoring of citizens.

4.6.6 Trento

Trento is a city located in the mountains of northern Italy in the Trentino-Alto Adige region and has a population of 117,000 inhabitants. Here is how it ranks in all dimensions of smart: economy 43rd, people 48th, governance 74th, mobility Trento to date is one of the most virtuous examples of SC in Italy: according to the Smart City Index 2020 by Ernst & Young, the most sustainable infrastructure in Italy, i.e. transport, energy territory, and environment, are located in Trento. Many projects have been undertaken in Trento projects, including two main ones: the Qrowd project, which has been concluded; and the Stardust project, which is currently being implemented. The first set itself the objective of mapping in detail all the city's commuting habits in detail, dividing them by the means of transport used, collecting as much data as possible on the positioning and efficiency of parking spaces, yellow strips, and bicycle racks, and the creation of a dashboard to create a map to visualize all trips that take place in the city. The Stardust project, on the other hand, is broader and more ambitious. The city of Trento aims to promote mobility and electric public transport. There is a push towards an increase in electric charging stations, the installation of car-sharing systems and electric bicycles and scooters, the allocation of incentives for electric cars and taxis, and setting emission limits for vehicles circulating within the city perimeter. city limits. The Stardust project also includes actions on the ICT front, such as the installation of a network of sensors to collect data on the environment, energy, mobility, safety, and waste collection, and the installation of several smart points, advanced information points that make the data collected by the sensors and provide other services such as smart street lighting. In addition, a portal is planned for citizens where they can participate and contribute to the sustainable development of the city in real-time.

4.7 The awarded municipalities

During the 'Stati Generali delle città intelligenti' (General States of Smart Cities), five best practices carried out by five municipalities were also awarded, selected from the numerous spontaneous applications in response to the call launched by City Vision to valorize concrete projects linked to sustainability and digitalization (Christofi, Iaia, Marchesani, 2021; Intesa Sanpaolo Innovation Center, 2023; City Vision, 2025).

- Gradara: a redeveloped district with people at its center. This municipality of 5,000 inhabitants in the province of Pesaro and Urbino (Marche) received City Vision's Special

Good Practice Award for its project concerning the Variation to the General Regulatory Plan (PRG) in via Canellina.

- Gualdo Tadino: a new tourism destination to discover and enhance the territory. This municipality of 14,000 inhabitants in the province of Perugia (Umbria) has been awarded for its Stand Up Gualdo Tadino project, which aims to promote environmental and nature tourism in the mountainous area of the Umbria-Marche Apennines.
- Lecce: more people cycling, thanks to an app. The regional capital of Salento has been awarded for its Reactivity project, whose main objective is to stimulate a change in citizens' travel habits by rewarding those who move around by green means. The project was nominated and funded as part of the Future Mobility 2023 call, promoted by EIT Urban Mobility, an initiative of the European Institute of Innovation and Technology (EIT), an EU body. The company Pin Bike has developed a web platform that certifies all sustainable means of transport in urban areas.
- Riviera del Brenta municipalities: cycle tourism and bike-friendly services. The Unione dei Comuni Città della Riviera del Brenta (which brings together Campagna Lupia, Campolongo Maggiore, Camponogara, Dolo, Fiesso d'Artico, Fossò, Mira, Pianiga, Stra and Vigonovo in the Metropolitan City of Venice) received the Special Good Practice Award from City Vision for two smart transformation projects in the area. Thanks to the contribution of partner Emoby, the administration will expand the development of mobility by promoting the creation of an integrated system of services for cycling tourism in an area devoted to green holidays.
- Trezzano sul Naviglio: drainage against climate change and river protection. This municipality of 21 thousand inhabitants in the Metropolitan City of Milan (Lombardy) has been awarded for the Spugna project, promoted by the Cap Group, Assimpredil Ance, and the Metropolitan City of Milan. The aim is to decrease the vulnerability of natural systems, starting with rivers, and strengthen the resilience of the territory, especially in areas characterized by high levels of sealing and high urban density.

4. CONCLUSION

In conclusion, the concept of smart city solutions in waste management and circular economy has the potential to significantly improve the socio-economic quality of life by promoting sustainability, enhancing environmental protection, and fostering a more efficient and eco-friendlier urban environment. By integrating innovative technological solutions with community-centered approaches, smart cities can lay the groundwork for a sustainable lifestyle, create cleaner, more efficient, and environmentally friendly urban environments, and contribute to economic growth and social well-being. The review of scientific papers on waste management and circular economy in Italy highlights the increasing focus on sustainable waste management and circular policies. The literature explores the integration of the circular economy with other tools such as material flow analysis (MFA), industrial ecology (IE), life cycle thinking (LCT), and environmental impact assessment (EIA). The combination of these tools provides a comprehensive framework for evaluating the sustainability of waste management strategies and circular economy initiatives. It emphasizes the importance of using life cycle thinking as a promising tool for assessing the multidisciplinary effects of policies and evaluating circular economy characteristics both operationally and strategically. However, there are also limitations and barriers to the implementation of smart city solutions in Italy. These include complexity and stakeholder involvement, economic and market factors, lack of environmental awareness, cultural and behavioral challenges, and regulatory and policy constraints. Overcoming these limitations will require a comprehensive approach that addresses the diverse challenges and stakeholders involved in promoting sustainable and circular economy initiatives in smart cities.

Despite the challenges, smart city solutions in Italy have demonstrated significant benefits in terms of environmental sustainability, citizen engagement, circular economy integration, technological innovation, and economic opportunities. These initiatives have contributed to the transformation of urban areas into more sustainable and resilient communities, setting an example for other cities and regions to follow. Furthermore, the Smarter Italy Program, launched by the government, aims to pursue a program of significant value for the recovery of the automotive world. This program seeks to address the barriers to the development of smart city solutions in Italy, such as the lack of sufficient economic resources and adequate skills, and the presence of unclear governance models. A shared national strategy, commitments, and priorities must be established for the municipalities, and the right compromise must be found to avoid excessive centralization.

To sum up, smart city solutions in waste management and circular economy have the potential to create a more sustainable and prosperous urban environment. By leveraging innovative technologies and embracing the principles of a circular economy, smart cities can create practical avenues for enhancing waste management, promoting efficient systems, and contributing to sustainable urban living. The integration of smart waste management within smart cities offers promising opportunities to address environmental issues and amend deficiencies in existing waste management practices, ultimately contributing to a more sustainable and eco-friendly future.

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THE START-UP PROMOTION ENHANCEMENT POLICY IN SLOVAKIA

Marcel KORDOŠ [11]

Abstract: *The European Union (EU) and Slovakia have implemented various Start-up promotion policies, aiming to create favorable conditions for new businesses to emerge and scale. This paper explores the different startup promotion policies in Slovakia and the EU, describing the financial incentives, regulatory frameworks. The goal of the paper is to explore the problematic aspects of startup promotion policies analysis in Slovakia in terms of Slovak national economic policy development elements implementation and find out its consequences. The research will be focused on exploring the startup promotion policies analysis in Slovakia and its further development under the EU framework. The ways of synthetic and analytic methods will be used in the paper such as the analysis and comparison to illustrate the Slovak startup promotion policy environment, synthesis and logical deduction to discuss the startup promotion activities in Slovakia. the comparative analysis of startup promotion policies in Slovakia and the EU highlights both the opportunities and challenges that define the Slovak startup environment. While Slovakia benefits from EU funding programs, innovation initiatives, and regulatory frameworks, it continues to face significant obstacles such as limited venture capital access, bureaucratic hurdles, and talent migration.*

Key words: *Sturt-up, economic policy, TBL, Crowd-funding platforms, New Technologies Implementation, digitization*

JEL Classification: *O33, O38, O32*

1. INTRODUCTION

Startups play a vital role in modern economies by fostering innovation, job creation, and economic competitiveness. As economies become increasingly digital and technology-driven, startup environments have gained prominence in shaping regional and national economic growth. The European Union (EU) and Slovakia have implemented various startup promotion policies, aiming to create favorable conditions for new businesses to emerge and scale. This paper explores the different startup promotion policies in Slovakia and the EU, describing the financial incentives, regulatory frameworks, and support structures in both environments. The objective is to identify key strengths, weaknesses, and opportunities that can enhance Slovakia's startup environment in alignment with broader European initiatives. By understanding how Slovakia's startup environment compares to the EU's broader framework, policymakers, investors, and entrepreneurs can develop strategies that foster sustainable growth and innovation. The paper also provides recommendations for strengthening Slovakia's position in the European startup landscape (Belas, et al. 2020; Mathur, Agarwal, 2023).

The fundamental purpose of this study is to carry out a comprehensive analysis of several crucial aspects. Firstly, we will examine the theoretical aspects of Sturt-ups regarding their significant role in the economy. Next, we will dive into the level of implementation of Sturt-ups in Slovakia, evaluating the effectiveness of the strategies adopted within the national economy in terms of startup promotion policies analysis in Slovakia. Additionally, we will explore the national challenges that arise in the process, identifying the barriers and needs associated with the deployment of intelligent solutions and the achievement of sustainable goals within the brief comparison of Slovak and the EU startup promotion policies effectiveness. To achieve these objectives, the structure of the work is broken down into specific sections that address each aspect in detail. Through this analysis, we seek to

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contribute to the understanding of how the promotion enhancement policy in Slovakia could reinforce the Sturt-up performance within the EU environment.

2. THEORETICAL BACKGROUND

A startup is a newly established business venture that is in the early stages of its operations. These businesses are typically founded by entrepreneurs who aim to develop a new product, service, or business model that meets an existing market gap or disrupts an industry. Unlike traditional businesses, startups are characterized by rapid growth potential, high levels of innovation, and scalability. Startups generally face high initial costs and limited revenue, requiring substantial external funding. This capital can come from angel investors, venture capitalists, crowdfunding platforms, or government grants. Additionally, many startups lack a fully developed business model and require several years to become profitable. The startup environment thrives on creativity, risk-taking, and adaptability. Founders must often pivot their business strategies in response to market changes, consumer preferences, or technological advancements. Silicon Valley in the U.S. remains a global hub for startups, but Europe and Asia are rapidly catching up, with growing investment in emerging startup environments (Nolan, 2024; Bilan, et al. 2019).

Startups differ from traditional businesses in several ways:

- Innovation: They introduce new products, services, or business models that improve existing solutions or create entirely new markets.
- Scalability: Startups are designed to grow rapidly, often expanding from local to international markets.
- Flexibility: Unlike established companies, startups can quickly adapt to changing market conditions.
- High-Risk, High-Reward: Many startups fail, but successful ones can become highly valuable companies.
- Investment-Driven Growth: Most startups rely on external funding to scale operations, conduct research, and expand their market reach.

2.1 Economic Significance of Startups

Startups play a crucial role in economic development by driving innovation, job creation, and competitiveness. Their impact can be seen in several key areas (Nolan, 2024; Biswas, et al. 2021; Gajda, et al. 2019):

Job Creation - Startups contribute significantly to employment, offering opportunities for skilled professionals, freelancers, and entrepreneurs. As they grow, they expand their workforce and stimulate job markets in various sectors.

Innovation and Technological Advancement - many startups introduce new technologies, digital solutions, and AI-driven innovations. Europe, for instance, has seen rapid growth in startup investment, with an annual growth rate of 13%, surpassing the U.S. in some AI-related investments.

Attracting Investment and Capital Flow - Startups attract both domestic and foreign investments, strengthening financial markets. However, access to funding remains a challenge, with many promising startups relocating to regions like Silicon Valley for better capital access and market expansion.

Economic Resilience and Regional Development - Startups contribute to the resilience of economies, particularly during economic downturns or market shifts. European policymakers

are now emphasizing regulatory reforms to simplify cross-border operations and enhance startup support.

Market Disruption and Competition - Startups challenge traditional industries by introducing cost-effective, customer-focused solutions. These forces established companies to innovate and improve efficiency, fostering a competitive market landscape.

2.2 Challenges faced by startups

One of the most critical barriers to startup success is securing adequate financial resources. Unlike established businesses, startups often lack financial history, collateral, or stable revenue streams, making it difficult to attract investors, obtain bank loans, or secure venture capital funding. This funding gap can lead to limited resources for research and development, marketing, and operational expansion, ultimately slowing down growth or causing failure. In 2024, economic conditions remain challenging, with investors becoming more selective. Startups must now present strong business models, well-researched financial strategies, and clear paths to profitability to attract funding. Competition for venture capital, angel investments, and government grants is increasing, with early-stage startups often struggling the most. Diversifying funding sources through venture capital, crowdfunding, and government grants can help mitigate financial risk. A well-structured pitch deck with a clear market opportunity and revenue model is essential to secure investor confidence. Establishing strong financial management practices and maintaining a lean operational model can further improve cash flow sustainability (Kljucnikov, et al. 2019; Slaper, Hall, 2011).

Attracting and retaining skilled employees presents another major challenge for startups. Larger corporations offer higher salaries, better benefits, and greater job security, making it difficult for startups to compete for top talent. Many startups struggle to provide clear career progression paths, leading to high employee turnover rates and difficulty in maintaining a cohesive and experienced team. In highly technical fields such as artificial intelligence, blockchain, and cybersecurity, the shortage of qualified professionals makes talent acquisition even more competitive. Startups can address this challenge by offering alternative incentives such as stock options, a dynamic and flexible work environment, and opportunities for rapid career advancement. Creating a strong company culture that emphasizes innovation, and collaboration can also make a startup more attractive to skilled professionals. Networking with industry mentors and participating in incubator and accelerator programs can help connect startups with potential hires and advisors who align with their vision (Gruzauskas, Baskutis, Navickas, 2018; Blakey, 2025).

Market competition is another significant challenge, as startups often enter industries dominated by well-established companies with strong brand recognition and loyal customer bases. Competing with these industry giants requires startups to differentiate themselves through innovative business models, superior customer service, or unique value propositions. Without proper market validation and customer acquisition strategies, startups risk struggling to gain traction and sustain long-term growth. To succeed in competitive markets, startups must conduct thorough market research to understand consumer needs and refine their product-market fit. Strategic partnerships with complementary businesses can help expand their reach and credibility. Leveraging social media and AI-driven marketing tools can provide cost-effective ways to build brand awareness and attract customers. Rapid adaptation to market trends and continuous customer engagement are crucial for staying relevant in dynamic industries (Kenton, 2023; Mynarzova, Stverkova, 2015).

Regulatory compliance poses another obstacle for startups, particularly those operating in highly regulated industries such as finance, healthcare, and data privacy. Navigating complex and evolving legal frameworks requires significant resources, and non-compliance can result in fines, legal liabilities, and reputational damage. In Europe, 47% of startup founders cite regulatory hurdles as a major barrier to growth, with fragmented laws across different

jurisdictions making expansion difficult. To address regulatory challenges, startups must prioritize compliance from the outset, seeking legal expertise to understand industry-specific regulations. Establishing internal policies for data protection, intellectual property management, and consumer rights can prevent potential legal risks. Engaging with regulatory bodies and industry associations can provide guidance on policy changes and help startups stay compliant with evolving laws (Nolan, 2024; Ivanova, Cepel, 2018).

Scaling a startup presents another set of difficulties. While many startups experience initial success with a small customer base, expanding operations requires additional resources, infrastructure, and personnel. Scaling too quickly without proper planning can lead to financial strain, operational inefficiencies, and quality control issues. To scale successfully, startups must develop scalable business models with clear expansion strategies. Investing in technology to automate processes and improve efficiency can facilitate growth. Establishing strong partnerships with distributors, suppliers, and investors can provide the necessary support for scaling operations. Continuous monitoring of financial performance and market trends is essential to ensure sustainable expansion while mitigating risks (Mura, Marchevska, Dubravska, 2018; Navickas, Svazas, 2017).

Cybersecurity and data privacy have become critical concerns for startups as they increasingly rely on digital solutions and remote work environments. Cyber threats such as data breaches, ransomware attacks, and phishing scams can compromise sensitive customer information and damage a startup's reputation. Implementing robust cybersecurity measures, such as encryption, multi-factor authentication, and regular security audits, is essential to protect business and customer data. Startups should also invest in employee training to raise awareness about cybersecurity risks and best practices. Collaborating with cybersecurity firms or adopting cloud-based security solutions can further enhance protection against cyber threats (Ivanova, Masarova, Koisova, 2020; ESNA Forum, 2023).

Despite these challenges, startups can navigate the complex business landscape through resilience, adaptability, and strategic planning. Building strong networks, leveraging technology, and fostering a culture of continuous innovation can help startups overcome obstacles and position themselves for long-term success. Governments and financial institutions also play a role in supporting startup environments by reducing bureaucratic complexity, providing funding opportunities, and implementing policies that encourage entrepreneurship and innovation (Nolan, 2024; Jaskova, Haviernikova, 2020).

3. PROBLEM FORMULATION AND METHODOLOGY

The research task deals with the analysis of the problematic aspects of startup promotion policies analysis in Slovakia in terms of Slovak national economic policy development elements implementation and find out its consequences. The research will be focused on exploring the startup promotion policies analysis in Slovakia and its further development under the EU framework. In general, this paper will handle the problematic aspects regarding the economic and social issues within the startup promotion policies analysis in Slovakia covering the national policy elements development tools implementation processes. The particular issues will consist of following aspects including the startup promotion policies analysis in Slovakia within the brief comparison of Slovak and the EU startup promotion policies effectiveness.

The ways of synthetic and analytic methods will be used in the paper such as the analysis and comparison to illustrate the start-up concept, synthesis and logical deduction to discuss the impact of the startup promotion policies analysis in Slovakia. Subsequently, the analysis will lead to synthesis and prognosis by means of abstraction method eliminating the less important factors in order to set general statements and opinions. In particular, to estimate the next obstacles to be faced within smart region components implementation issues and to

recommend the activities for Slovak government and regional authorities, entrepreneurs and companies to eliminate the negative impacts of start-up policy implementation that would affect their businesses. For the most objective assessment of the changes being awaited by the EU authorities approach due to the implementation of Slovak start-up promotion policy, the theoretical analysis method has been chosen as the basic research method the researchers were approached by.

4. RESULTS

Slovakia has implemented various initiatives and policies to support startup development, with a strong emphasis on fostering entrepreneurship, providing financial assistance, and promoting innovation. The government, in collaboration with the European Union and private investors, has established multiple programs aimed at assisting startups in their early stages, helping them scale, and facilitating their integration into international markets.

One of the primary organizations driving startup support in Slovakia is the National Business Centre (Národné podnikateľské centrum), which operates under the Slovak Business Agency. It provides several key programs designed to support entrepreneurs at different stages of their business journey. The Acceleration Program helps aspiring entrepreneurs refine their business ideas through individual consultations, workshops, and networking opportunities. The Incubation Program offers office space and professional guidance, including coaching and mentorship, to early-stage startups. For companies looking to expand, the Growth Program provides strategic consultancy and events aimed at scaling businesses locally and internationally. The Internship Program allows entrepreneurs to gain international experience through business incubators, professional institutions, and technology parks abroad. Another initiative, Creative Point, provides access to modern prototyping technologies, such as 3D printers and CNC milling machines, to encourage innovation in product development.

Slovakia also benefits from EU-backed programs that provide funding and entrepreneurial coaching. The EIT RawMaterials initiative supports early-stage startups with a focus on industrial innovations, sustainable energy solutions, and material sciences. The Start-up and SME Booster helps validate business models and connects startups with international partners, while the RawMaterials Accelerator improves the success rate of market entry for scalable startups by addressing market risks and providing business coaching on a pan-European level. Additionally, Slovakia hosts several Business and Innovation Centers (BICs), located in cities such as Bratislava, Banská Bystrica, and Košice, which provide services like business consulting, financing guidance, and technology transfer support. These centers play a crucial role in fostering entrepreneurship and enhancing the innovation potential of regional economies.

Access to capital is a significant factor influencing the success of startups, and Slovakia has developed various financial instruments to support entrepreneurs. Startups can access funding through risk capital, debt financing, microloans, and bank guarantees. The National Holding Fund (Národný holdingový fond), managed by the Slovak Business Agency, has been a key source of public funding, providing more than €10 million to over 140 firms. Within this fund, the Fund for Innovations and Technologies (Fond inovácií a technológií - FIT) specializes in startup investments, allocating between €20,000 and €1.5 million per startup, with an investment horizon of four to six years. FIT primarily focuses on startups in environmental sustainability, renewable energy, industrial innovations, e-commerce, IT, telecommunications, and software development (Ministry of Economy of SR, 2025).

In addition to the National Holding Fund, Slovakia benefits from JEREMIE (Joint European Resources for Micro to Medium Enterprises), a European initiative aimed at improving access to financing for small and medium enterprises. Under JEREMIE, two key Slovak investment firms, Neulogy Ventures and Limerock, provide funding opportunities. Neulogy Ventures

offers seed capital ranging from €50,000 to €200,000, while its follow-up investments range from €300,000 to €1.5 million. It primarily supports startups in IT, energy, and medical diagnostics. Limerock, on the other hand, provides investment amounts of up to €2.75 million per company, with a typical investment horizon of four to six years (MIRRI, 2021a).

For startups in need of credit financing, the Slovak Guarantee and Development Bank (Slovenská záručná a rozvojová banka - SZRB) offers specialized loans for young entrepreneurs, female entrepreneurs, and young farmers. The Microloans Program (Mikropôžičkový program), managed by the Slovak Business Agency, provides loans ranging from €2,500 to €50,000, with repayment periods between six months and four years. Additionally, SZRB provides bank guarantees to support small and medium-sized enterprises (SMEs) in securing financial stability and fostering sustainable business growth (MIRRI, 2020).

To further enhance innovation and economic performance, Slovakia has implemented Inovujme.sk, a national project co-financed by the European Union. This initiative aims to increase the innovation capacity of the Slovak economy by providing advisory services and fostering entrepreneurship across various regions. Regional consultation centers have been established in major cities such as Bratislava, Nitra, Banská Bystrica, Žilina, and Košice, where entrepreneurs receive expert guidance on innovation strategies, research, and development. The project also focuses on raising awareness about innovation through workshops, conferences, and hackathons. By the end of 2023, over 474 innovation projects had been supported through seven different funding schemes, with a total reimbursement of €7.54 million. Some of the notable innovations funded include a biomechanical prosthetic finger, a "growing" children's bicycle, and a smart patient appointment scheduling system.

Slovakia also encourages startup promotion through educational and competitive initiatives. The Inovujme.sk project has organized over 280 innovation workshops, engaging 6,540 students in practical sessions on business development and creative problem-solving. The program has also facilitated hackathons, where participants tackle real-world challenges such as financial literacy and misinformation. These activities not only enhance entrepreneurial skills but also help bridge the gap between academia and industry (European Commission, 2023).

Additionally, Slovakia aims to integrate its startup environment into the broader European innovation network. The Beyond Fragmentation report highlights the need for harmonizing regulations across the EU, improving access to funding, and increasing talent mobility. Slovakia’s participation in the Pan-European Startup Framework seeks to streamline regulatory processes and facilitate cross-border investments. Efforts are also being made to introduce a Startup Talent Visa Program, which would attract skilled entrepreneurs and reverse brain drain by incentivizing local talent to remain in Slovakia (MIRRI, 2021b).

Through a combination of government initiatives, EU funding, private investment, and educational programs, Slovakia continues to strengthen its startup environment. By providing access to financial resources, innovation support, and international networking opportunities, the country aims to position itself as a competitive hub for entrepreneurship in Central Europe. However, challenges such as bureaucratic complexity, fragmented regulations, and limited venture capital availability remain areas for improvement. Moving forward, enhancing collaboration between startups, policymakers, and investors will be essential to ensure sustained growth and innovation in Slovakia’s startup sector.

4.1 Government and Ministries

Slovakia’s government plays a key role in supporting startups and fostering innovation through various ministries and strategic initiatives. The Ministry of Economy of the Slovak Republic (MHSR), in coordination with other governmental institutions, has developed a Concept for Supporting Startups and Developing the Startup Environment in Slovakia, which

outlines strategic measures to enhance entrepreneurship and innovation. This initiative aligns with broader economic growth policies at both the national and European levels, ensuring that Slovakia remains competitive in the global startup landscape. Government efforts to improve the startup environment in Slovakia have evolved since 2013, when the public sector began actively engaging in startup support. Prior to that, the startup scene was driven mainly by private sector initiatives. However, a lack of comprehensive state support mechanisms led some startups to seek better conditions abroad, particularly in Prague, Budapest, and Warsaw, contributing to a "brain drain" effect (Ministry of Economy of SR, 2025).

The Ministry of Economy leads most startup-related initiatives, focusing on regulatory improvements, financial support, and infrastructure development. Key objectives include reducing administrative barriers for startups, improving access to capital, and strengthening startup-related services such as mentorship, incubation, and acceleration programs. The Ministry of Finance plays a complementary role by developing financial mechanisms to help startups overcome funding challenges, particularly during the critical “Death Valley” phase, where most startups fail due to insufficient cash flow and investment.

The Ministry of Education, Science, Research, and Sports supports startups through programs aimed at commercializing research and fostering collaboration between universities and the private sector. Initiatives focused on technology transfer and research-driven entrepreneurship are crucial for Slovakia’s long-term competitiveness in innovation-intensive industries. Additionally, the Ministry of Foreign and European Affairs facilitates international expansion opportunities by connecting Slovak startups with global markets through trade missions, international networking programs, and EU-funded initiatives (Ministry of Economy of SR, 2025).

Slovakia's startup support policies are influenced by successful models implemented in other countries. For example, the United States runs the “Startup New York” program, which offers 10-year tax breaks for businesses. Israel prioritizes tech incubators and venture capital incentives, matching $6 of public funding for every $1 of private investment. The United Kingdom and Germany provide tax incentives for angel investors, a crucial component of early-stage startup financing. Meanwhile, neighboring countries such as the Czech Republic, Poland, and Hungary have established national programs that actively support startups, including initiatives focused on international expansion into Silicon Valley.

To strengthen Slovakia’s startup environment, the government has outlined three key strategic goals. First, creating a favorable business environment by reducing bureaucratic obstacles and streamlining startup-related regulations. Second, providing comprehensive support services and infrastructure to help startups grow and scale. Third, addressing the funding gap in the “Death Valley” phase, ensuring that promising startups receive the financial backing needed to survive and expand. Additionally, digital economy initiatives such as Open Data and e-Government play an essential role in enhancing startup activity and economic performance (Ministry of Economy of SR, 2025).

Slovakia’s government ministries and agencies continue to refine their startup support framework, aligning policies with European innovation strategies and leveraging EU funding mechanisms to promote entrepreneurship. The long-term goal is to create a thriving, innovation-driven economy, where startups can access financial resources, professional mentorship, and global networking opportunities while benefiting from a favorable regulatory environment. Moving forward, strengthening public-private collaboration, increasing venture capital availability, and enhancing international connectivity will be critical for positioning Slovakia as a regional leader in startup development.

4.2 Agencies and Organizations

The Slovak Business Agency (SBA) plays a key role in fostering the startup environment in Slovakia by supporting entrepreneurs, facilitating funding opportunities, and organizing

startup-related events. As the most significant institution focused on small and medium-sized enterprises (SMEs) in Slovakia, SBA provides advisory services, mentorship, and networking opportunities for emerging businesses (Slovak Business Agency, 2025).

SBA supports multiple competitions and programs that promote innovation and help startups gain visibility in the Slovak and European markets. One of the most prestigious startup competitions in Slovakia is the Business Idea of the Year, held annually in collaboration with the Association of Young Entrepreneurs of Slovakia and supported by government and corporate partners. This competition recognizes high-potential business ideas and connects entrepreneurs with investors and mentors. Another key event, StartupAwards.SK, is an annual showcase for technology startups in Slovakia. It focuses on celebrating innovation, supporting creative business ideas, and encouraging technological advancement. The SBA also supports initiatives like Do You Have an Idea? Present Your Startup, a competition for young entrepreneurs initiated by the TUKE Startup Center at the Technical University of Košice. This initiative aims to help students and aspiring entrepreneurs transform ideas into commercially viable products or services. On a broader scale, the Pioneers Festival, originally launched in Vienna in 2009, has grown into a renowned European technology event. Thanks to SBA's support, Slovak startups have had the opportunity to present their businesses on an international stage, gaining increased exposure to investors and media. Within Slovakia, the Pioneers Bratislava Competition highlights the most promising local startups (SBA Agency, 2024).

In addition to competitions, SBA contributes to knowledge-sharing and networking through events like Startup Factory Slovakia, a conference bringing together global experts in finance, investment, and technology. The event features notable speakers such as Alfredo Coppola, Co-CEO of the US Market Access Center, and Radoslav Vašina from the Innovation and Technology Fund, who provide valuable insights into startup financing and development. Another impactful initiative, Startup or Shutdown, is a competitive pitching event where ten selected startups from Slovakia and the Czech Republic present their business ideas to a panel of experts, investors, and business managers, offering them a platform for securing funding and mentorship opportunities.

SBA's involvement in these programs has significantly contributed to the growth of Slovakia's startup environment by enabling networking, improving access to funding, and fostering international collaboration. By partnering with universities, government institutions, and global investors, SBA ensures that Slovak startups have the necessary resources to scale and compete on both the European and global levels. Furthermore, SBA actively reduces entry barriers for startups by providing expert guidance on business model development and risk management (Slovak Business Agency, 2024). These initiatives are crucial in strengthening Slovakia's position in the European innovation landscape and supporting entrepreneurs in their journey from ideation to market success.

4.3 Financial Support and Grant Schemes

Slovakia has developed a comprehensive financial support system for startups, combining public funding, private investment, and European Union grant schemes to foster innovation, economic growth, and technological advancement. Startups in Slovakia can access capital through venture capital funds, government-backed loans, microloan programs, crowdfunding, and EU-funded grants, with a particular focus on digital transformation, research and development (R&D), and early-stage business support.

One of the most significant investment funds supporting Slovak startups is the Venture to Future Fund (VFF), which recently increased its capital by €15.3 million through the Recovery and Resilience Plan. This additional investment, provided via Slovak Investment Holding, extends VFF's ability to fund startups until 2026 and addresses key market gaps, particularly in bridge financing. Many Slovak startups struggle to secure funding, especially

in high-risk sectors, due to the lack of private investors willing to take on early-stage financial risks. The VFF co-invests with private investors under equal conditions, with investment amounts ranging from €400,000 to €7 million. The fund prioritizes tech startups with global potential, having already supported 16 companies, including Photoneo (3D imaging and robotics), Sensoneo (waste management technology), and Powerful Medical (AI-driven cardiovascular diagnostics) (Regional Innovation Scheme, 2023).

Beyond private investment funds, Slovakia's Recovery and Resilience Plan plays a crucial role in strengthening research, innovation, and startup financing. The Component 9 of the plan, focused on efficient management and financing of R&D and innovation, provides extensive financial support to entrepreneurs, research institutions, and small and medium-sized enterprises (SMEs). In addition, Component 17, known as Digital Slovakia, funds projects that aim to accelerate the digitalization of businesses and public services.

A key funding mechanism under the Recovery and Resilience Plan is the voucher system, which includes innovation, patent, and digital vouchers. These financial instruments allow startups and SMEs to access up to €200,000 over a period of three years for activities such as R&D collaboration, market expansion, intellectual property protection, and digital process improvements. The Innovation Voucher fosters cooperation between SMEs, universities, and private research institutions, covering expenses related to certifications, testing, and market entry procedures. The Digital Voucher supports companies in implementing tailored IT solutions, enhancing cybersecurity, e-commerce, and enterprise resource planning (ERP) systems. The Patent Voucher assists startups in patent filings, intellectual property management, and legal protections for proprietary technologies.

In addition to vouchers, Slovakia has introduced Fast Grants and Hackathons to support rapid innovation and problem-solving. These grants are designed to bring together corporations, startups, researchers, and students to develop and test practical solutions to societal challenges. The initiative aims to improve the innovation culture, increase the adoption of digital solutions, and enhance public sector modernization.

Startups in Slovakia can also access loan-based financial support, including the Digital Loan Program, which provides financing between €10,000 and €200,000 with repayment terms ranging from 12 to 84 months. This program promotes digital transformation by funding investments in modernizing IT infrastructure, implementing AI-driven solutions, and enhancing business cybersecurity. A grant mechanism covering 10-30% of the loan amount is also available, encouraging further investments by SMEs. For early-stage startups, Slovakia offers "Early-Stage" Research Grants, providing €100,000 per year for PhD graduates and young researchers to develop scientific and technological innovations. These grants, awarded over a period of one to two years, help researchers transition from academic projects to market-ready solutions, ultimately boosting Slovakia's competitiveness in cutting-edge industries ().

The Slovakia Program (2021-2027) represents another significant EU-backed funding initiative supporting startups, SMEs, and digital transformation projects. The program allocates over €12 billion across five EU cohesion policy objectives, with priority given to research, innovation, and advanced technology adoption. One of its key focuses is increasing the innovation capacity of Slovak businesses by financing intelligent energy systems, cybersecurity solutions, AI-driven industrial applications, and digital public services. Startups can also access funding for market expansion, prototyping, and R&D collaboration through the program's tailored financial instruments (Innovate Slovakia, 2025).

Beyond government grants and loans, Slovak entrepreneurs can seek funding through private equity and alternative financing options such as venture capital, crowdfunding, and specialized investment funds. The Slovak Business Agency (SBA) plays a crucial role in managing microloan programs, offering loans ranging from €2,500 to €50,000 with

repayment terms of up to four years. These microloans, available at interest rates between 0.61% and 9.67%, are particularly beneficial for small startups lacking traditional collateral.

Slovakia also actively promotes alternative business financing models, including crowdfunding and venture capital investment. Crowd-funding platforms such as Kickstarter, Indiegogo, and Startovac.cz allow startups to raise funds directly from the public without giving up equity. Meanwhile, venture capital firms such as Neulogy Ventures and Limerock provide early-stage investments ranging from €50,000 to €2.75 million, focusing on startups in IT, medical diagnostics, and sustainable energy (Regional Innovation Scheme, 2023).

A recent development in Slovakia's startup financing landscape is the introduction of the Simple Joint-Stock Company (JSA) legal structure, designed to facilitate investment in early-stage companies. This hybrid corporate form combines features of limited liability and joint-stock companies, making it easier for startups to attract investors while maintaining flexibility in corporate governance. The JSA model is particularly attractive for startups seeking venture capital funding and strategic partnerships (OECD, 2021).

Slovakia's government and financial institutions continue to expand funding opportunities and refine grant schemes to make startup financing more accessible and efficient. The combination of state-backed loans, EU-funded grants, private investments, and alternative financing methods provides Slovak entrepreneurs with a diverse range of capital options to launch, develop, and scale their businesses. Moving forward, further simplification of administrative processes, improved coordination between public and private sectors, and greater integration into European and global investment networks will be essential in strengthening Slovakia's position as a startup-friendly country.

5. DISCUSSION

When it comes to discussion of potential solutions or strategies to overcome these barriers, there are several challenges. The European Union and Slovakia have implemented various policies and initiatives to foster entrepreneurship, innovation, and economic growth through startup promotion. While Slovakia, as an EU member state, benefits from European funding mechanisms and policy frameworks, it also has its own national startup support initiatives tailored to the country's specific economic and regulatory landscape. This chapter provides a comparative analysis of the startup promotion policies in Slovakia and the broader EU, examining key similarities, differences, and areas for improvement.

5.1 Key Similarities in Start-up Promotion

Both Slovakia and the EU share common objectives in startup promotion, focusing on financial support, regulatory simplification, and fostering an innovation-friendly business environment. Key similarities include (Gonzalez, 2024):

- Financial Support Mechanisms: Both Slovakia and the EU provide funding opportunities for startups through grants, venture capital, and public-private partnerships. Slovakia benefits from EU funding programs such as Horizon Europe, the European Investment Fund (EIF), and regional development funds that provide access to capital for high-potential startups.
- Incubators and Accelerators: Slovakia has established business incubators and accelerator programs that resemble similar EU-wide initiatives, such as the European Startup Nations Alliance (ESNA). These programs focus on mentorship, networking, and investment facilitation for emerging entrepreneurs.
- Regulatory Frameworks Supporting Innovation: Both Slovakia and the EU have recognized the need to streamline administrative processes, reduce bureaucratic barriers, and create more startup-friendly regulations. For instance, Slovakia's Simple Joint-Stock

Company (JSA) model aligns with the EU's efforts to harmonize corporate structures to attract investors.

– Talent Development and International Networking: Slovakia and the EU both prioritize talent development through educational programs, startup competitions, and cross-border collaborations. Slovakia's Inovujme.sk initiative, which provides educational workshops and hackathons, aligns with EU-wide talent programs like Erasmus for Young Entrepreneurs.

5.2 Differences Between Slovakia and the EU

While Slovakia aligns with many EU policies, there are notable differences in funding access, scalability potential, and the regulatory environment. Slovakia faces a shortage of venture capital and later-stage funding, which forces many startups to seek investment in larger European hubs like Berlin, London, or Paris. In contrast, the EU has well-developed venture capital networks supported by programs such as the European Innovation Council (EIC) and the Capital Markets Union (CMU), which aim to increase private-sector investment in startups. Many Slovak startups struggle with complex administrative procedures and slow company registration processes, which can delay their market entry. In comparison, the EU has introduced initiatives like the Startup Nations Standard (SNS) to reduce bureaucratic obstacles and harmonize business regulations, making it easier for startups to operate across borders. Although Slovakia has a growing startup environment, it lacks the global recognition and connectivity of established EU startup hubs. Countries like Germany, France, and the Netherlands provide better access to international investors, research institutions, and high-growth markets, making them more attractive locations for scaling businesses (Garcia, 2025).

6. CONCLUSION

Based on the analysed and discussed findings we arrived at conclusion that the comparative analysis of startup promotion policies in Slovakia and the EU highlights both the opportunities and challenges that define the Slovak startup environment. While Slovakia benefits from EU funding programs, innovation initiatives, and regulatory frameworks, it continues to face significant obstacles such as limited venture capital access, bureaucratic hurdles, and talent migration.

The paper concludes that successful EU startup environments - such as those in Germany, France, and the Netherlands—offer stronger financial backing, more mature venture capital markets, and streamlined regulatory processes. To remain competitive, Slovakia must adopt best practices from leading European startup hubs, ensuring easier market entry, increased funding opportunities, and a supportive innovation culture.

The following key recommendations can help strengthen Slovakia's startup environment:

– Expanding access to venture capital and late-stage funding through public-private investment incentives.

– Simplifying administrative processes to enable startups to operate efficiently and scale faster.

– Developing stronger international networks by partnering with European accelerators and investors.

– Enhancing talent retention by offering more attractive startup incentives and support programs.

To sum up, by implementing these measures, Slovakia can position itself as a regional leader in innovation and entrepreneurship, benefiting both local startups and the broader European startup environment. Furthermore, this paper has meticulously identified the primary

obstacles and needs for the implementation of startup promotion enhancement policies in Slovakia. These encompass the imperative for investment in technology, digital inclusion, sensitive data management, and strengthened public-private collaboration. The key recommendations put forth, including technological standardization and the implementation of specific programs to bridge the digital divide, are pivotal in ensuring equitable access to smart solutions.

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CHALLENGES IN HUMAN RESOURCE MANAGEMENT IN AGRICULTURAL SMES IN THE ERA OF DIGITALIZATION

Katarína KRÁĽOVÁ[12]

Abstract: *The aim of the paper is to outline possible challenges in the field of human resource management in Slovak small and medium-sized agricultural enterprises under the influence of digitalization, the onset of which was significantly accelerated due to the COVID-19 pandemic, which brought a number of solutions supporting the process of digitalization of business. Our study is based on data collected from a wide range of official sources in conjunction with research work that examined aspects of cooperation between agricultural and food SMEs during 2023, where part of the questionnaire survey also focused on the issue of digitalization of agricultural enterprises and its impact on the workforce. The result of the questionnaire survey was that SMEs are not yet considering a more massive implementation of digital and technologies, and thus employees do not feel increased pressure due to concerns about job loss.*

Key words: *digitalization, human resources, small and medium-sized enterprises, agriculture*

JEL Classification: *J21, L26, O13, O32*

1. INTRODUCTION

A well-motivated workforce with the necessary knowledge and skills plays a fundamental role in the economic development of a country and its competitiveness. Even today, agriculture still remains a fundamental element in ensuring the food security of the country and various sustainable development goals. Despite its importance, agriculture is currently facing many challenges, against the backdrop of the industrialization era, such as the social devaluation of agriculture and rural life, which reduces the interest in engaging in agricultural activities. All this results in high costs for farm owners. The COVID-19 pandemic has seriously affected the functioning of businesses due to lockdowns, mobility restrictions and requirements to maintain personal distance. This has accelerated the change in the production models of SMEs and has also accelerated the process of digitalization. Since then, digital skills have become a basic requirement for human resources and working from home has become a common way of operating in many businesses (Marí-Dell'Olmo et al., 2021). The pandemic has highlighted the importance of digital resources for the country's economy (networks, connectivity, data exchange, artificial intelligence, etc.). One of the few positive economic effects of the pandemic has been the increased awareness of the importance of digitalization by SMEs (Gavrila Gavrila & de Lucas Ancillo, 2021). Digitalization is broadly defined as the transition to technologies that are based on the fourth industrial revolution (Abdulai, 2022). These include the Internet of Things, artificial intelligence, cyber-physical systems, virtual reality and augmented reality, as well as some mobile technologies, devices and others. The application of digital technologies in agriculture can increase the performance of agricultural enterprises by strengthening sustainability, productivity and resilience, in particular through IoT technologies, sensors, data analytics (e.g. based on artificial intelligence) and decision support systems, leading to better tailored and more accurate agricultural operations. (Digitalisation of the European agricultural sector | Shaping Europe's digital future, 2024). Digitalisation brings many benefits. It affects the efficiency, quality and stability of the processes implemented, thus achieving a higher quality level. It also allows for better control over operational activities and the effects of these activities. Digitalisation of SMEs is a means of achieving more flexible and competitive production, which is adapted to

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the modern reality of the emerging digital world, based on the use of new technologies aimed at radically improving production and increasing the expansiveness of the enterprise (Brozzi et al., 2021). The following table 1, prepared on the basis of EU material, also points out the benefits and challenges that digitalisation of SMEs in agriculture brings.

Table 1: Benefits and challenges of digitalization in agriculture

Benefits and challenges of digitalization in agriculture	
Benefits	**Challenges**
• Better animal welfare • Improved working conditions • Increased transparency • Increased competitiveness • Production optimization	• Lack of information • Lack of skills • Digital divide • Lack of cost-effectiveness • Mistrust and concerns about data protection and ownership • Interoperability gaps

Source: based on data from the material Digitizing the European agricultural sector (Digitizing the European agricultural sector | Shaping Europe's digital future, 2024)

The digitization of SMEs in agriculture is undoubtedly important and also a great contribution to the more efficient and competitive functioning of these enterprises, but it also has its shortcomings. In particular, the lack of human resources in SMEs, lack of financing, insufficient planning and control, as well as training and adaptation of information systems (Amaral & Peças, 2021; Eller et al., 2020). The application of new technologies in the workplace in SMEs requires a higher level of digital skills from current employees and, at the same time, the recruitment of new employees with higher digital literacy. This can lead to digital inequality in the market (Buhr, 2017), as the workforce, depending on origin, gender or age, may not always have the same opportunities to increase their digital literacy (Marí-Dell'Olmo et al., 2021). This inequality is particularly pronounced for jobs in primary sectors (this work is often performed by vulnerable people with low levels of education or immigrants), which are gradually being fully integrated into the digitalization process (Zheng & Walsham, 2021). Therefore, it can be stated that the process of digitalization not only in agricultural SMEs affects job opportunities (Prince et al., 2022). In OECD countries, where the level of mechanization and digitalization of agriculture is most advanced, employment in agriculture has fallen sharply in recent decades to only 4.4 percent of total employment (in Slovak that is 2.4% of total employment) (World Bank Open Data, n.d.). Nevertheless, agricultural employment is still important for rural economies and their development. Furthermore, even though total agricultural employment has decreased, the agricultural workforce remains key to agricultural production and food supply (Prause, 2021). Many scientific studies and public debates on digital agriculture have discussed the potential benefits as well as threats of digital technologies for the productivity and sustainability of production processes in agricultural enterprises (Rotz et al., 2019; Wolfert et al., 2017), but almost no attention has been paid to the social impacts (Rose et al., 2021). Few existing studies discuss the potential benefits or losses of agricultural employment due to digitalization. In general, these studies suggest that digital technologies could contribute to the creation of new high-skilled jobs in agriculture, while also displacing some forms of low-skilled migrant labor (Christiaensen et al., 2020).

2. PROBLEM FORMULATION AND METHODOLOGY

In our research, after selecting the research topic, we continued with the study of relevant articles, followed by the analysis and synthesis of various literary sources. Based on a systematic review and study of the available literature, we asked ourselves the following questions:

• The challenges faced by SMEs in the development of digitalization in agriculture are the lack of financial resources, the cost of introducing new digital technologies in enterprises (Amaral & Peças, 2021; Eller et al., 2020). Therefore, we were interested in whether SMEs consider investments in digitalization as their priority in business, or whether they also include investments in the digitalization of processes in their enterprise in their financial plans.

• The benefits that digitalization brings to enterprises, such as increased competitiveness, transparency, or optimization of production processes (Shaping Europe's digital future, 2024), can significantly positively affect the functioning and operation of enterprises. Therefore, we were interested in whether the company has a digital vision, whether it is dedicated to introducing digital trends in the company and whether it also has employees who are dedicated to implementing digitalization in the company.

• Some studies suggest that digital technologies in agriculture could contribute to the creation of new highly skilled jobs in agriculture and at the same time displace some forms of low-skilled labor (Christiaensen et al., 2020), so we were interested in whether employees are not worried about their jobs.

Then, we surveyed a sample of randomly selected SMEs with a questionnaire survey to find out their attitudes and experiences with digitalization in their companies. The questionnaire survey was conducted in 2023. The questionnaire was distributed online to SME owners in the agricultural sector via www.survio.com. The sampling technique used was random. The number of completed questionnaires in this study was 171. SME owners and managers were asked polytomous questions, closed questions with multiple-choice answers. Subsequently, the scales were evaluated as percentages.

3. PROBLEM SOLUTION / RESULTS / DISCUSSION

Through a questionnaire survey, we found that up to 52.05% of the surveyed companies in our sample consider insufficient financial security to be an obstacle to the use of digitalization in business processes. According to the surveyed companies, the second problem in implementing digitalization in a company is the time aspect, the high busyness of entrepreneurs and managers. The third and also very significant problem is the lack of qualified labor. Up to 25.73% of the surveyed companies responded that they do not have access to a workforce that would have the necessary digital knowledge and skills and at the same time was willing to work in an agricultural company.

Table 2: Evaluation of polytomous questions from the questionnaire survey

question	*strongly agree, agree*	*neither agree nor disagree*	*disagree, strongly disagree*
Investments in digitalization are part of our business priorities.	23,98 %	28,65%	47,37%
Our business has a digital transformation vision because it needs new markets.	27,49%	26,9%	45,61%
In the company, selected employees are dedicated to implementing digital processes.	17,54%	21,05%	61,41 %

In the company, we strive to use digitalization at all levels of management.	25,15%	33,33%	41,52%
Investments in digitalization are part of our company's business priorities.	23,98%	28,65%	47,37%

Source: own processing based on a questionnaire survey

The questionnaire survey also revealed that companies do not consider investments in digitalization as their priority. Although the implementation of digital technologies can save operating costs in the company in the long term, they do not consider using them. There may be several reasons for this. This may be due to the high financial cost of acquiring the technologies, the lack of a workforce with the necessary skills, technical problems associated with the use of digital technologies, or lack of trust. Of course, this also relates to the answer to the next question: whether the company has a digital vision, whether it is dedicated to introducing digital trends in the company, and whether it also has employees who are dedicated to implementing digitalization in the company. Based on the answers, it is clear that companies have not yet developed digital visions and are not actively implementing digital technologies into production processes.

Table 3: Evaluation of polytomous questions from the questionnaire survey

question	***strongly agree, agree***	***neither agree nor disagree***	***disagree, strongly disagree***
We use digital tools in the company to manage knowledge and improve employee skills.	29,82%	23,39%	46,79%
Robotization and digitalization will not affect the jobs of our employees, because their job content cannot be fully replaced by digitalization and robotization.	46,79%	14,61%	38,60%
If we introduce robotization of some types of activities, we will have to lay off some employees.	26,32%	23,39%	50,29%
Employees express support for the digital transformation of our company.	28,66%	29,82%	41,52%
Our employees are able to use digital tools for collaboration and remote connectivity.	29,82%	33,33%	36,85%

Source: own processing based on a questionnaire survey

The last part of the survey was devoted to employees and their possible concerns about job loss due to the application of robotization and digitalization in the company. The survey clearly showed that they are not afraid of dismissal and job loss. Employees in the companies that were involved in the survey do not support digital transformation. This may be due to the fact that they are not sufficiently informed, do not understand the essence and importance of these processes, or it may be concern and fear of new things, etc. It may also be related to the structure and age of employees in the companies. The average age of employees in agriculture in the Slovak Republic is 46.3 years. The average age of men is 45.2 years and that of women is 48.7 years (Green Report of the Ministry of Agriculture and Rural Development of the Slovak Republic, 2024). This is a generation of employees that largely lacks digital knowledge and skills. What are the challenges in human resource management in SMEs in agriculture against the backdrop of digitalization? There is certainly a need for a digital workforce with new skills needed to use digital technologies. That is, to train and educate your employees. Given the average age of employees (Green Report 2024), acquiring such new skills may be more challenging for the older generation of farmers and workers than for the technically savvy younger generation, and this may cause fragmentation of the agricultural

workforce within the enterprise. The ability or lack of ability to use digital tools and learn digital skills may widen the gap between the older generation of farmers, employees and the younger generation. The implementation of digital devices in the enterprise may lead to increased competition among workers and contribute to the fragmentation of workers by age (Prause, 2021), possibly by gender, and thus increase gender inequality. Another challenge is to increase the attractiveness of agricultural activity for the younger generation, attracting young and educated workers. Digitalization and the growth of technology and innovation in the agricultural sector can help this. It is also an opportunity to increase the participation of women in agricultural activities. The presence of young people will also support generational change, greater ability to adapt to change, as well as greater openness to innovation and technological inclusion. Another challenge for human resource management is also increasing the qualifications and skills of personnel workers themselves, who, in order to actively support the application of new technologies in the company, will have to increase their own level of digital skills. Because digitalization makes it possible to make work easier for human resource management today, e.g. increase work efficiency, reduce administration and costs, provide relevant personnel data in real time, which will allow them to better decide on current needs, or network employees within the organization.

4. CONCLUSION

It is clear that digital technologies such as artificial intelligence, cloud and edge computing, satellite-based services, robotics, drones, blockchain, the Internet of Things, 4G and 5G internet services and digital transport have the potential to increase the efficiency of agriculture, achieve greater sustainability, improve the quality of life in rural areas and ensure food production. However, this also requires changing the human resource factors of people involved in the agricultural sector to facilitate the use of these digital technologies, and this is the task of human resource management in the enterprise. It is necessary to adapt the processes of education, onboarding, offboarding, motivating and rewarding employees, searching for talents in the labor market, improving the employer image, etc. to the new needs of the digital era in agriculture.

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MLADÍ ĽUDIA V SITUÁCII NEET V TRENČIANSKOM KRAJI

YOUNG PEOPLE NEET IN THE TRENČÍN REGION

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Abstrakt: *Ľudské zdroje sú jedným z nevyhnutných predpokladov dosahovania ekonomického rastu štátov a regiónov. Ich nevyužívanie je spojené s nevyužívaním ľudského potenciálu, a tým mrhaním vzácnych zdrojov. Jednou z rizikových skupín na trhu práce sú mladí ľudia, osobitne tí, ktorí nie sú zamestnaní, ani neštudujú, ani sa nezúčastňujú odbornej prípravy (NEET). Ich neschopnosť zaradiť sa včas na trh práce a nájsť si vyhovujúce uplatnenie môže spôsobiť ich chudobu, sociálne vylúčenie i zdravotné problémy, pričom negatíva tohto javu sa prejavujú aj na celospoločenskej úrovni. Skúmanie počtu a štruktúry uvedenej skupiny mladých ľudí je kľúčové pre správne nastavenie vhodných nástrojov na zmiernenie tohto nepriaznivého javu. Cieľom príspevku je preskúmať početnosť mladých ľudí v situácii NEET v Trenčianskom kraji a zhodnotiť rozdiely v jednotlivých okresoch Trenčianskeho kraja, na základe údajov zo Sčítania 2021.*

Kľúčové slová: *NEET, nezamestnaný, osoba v domácnosti, podiel NEET*

Abstract: *Human resources are one of the indispensable prerequisites for achieving economic growth of states and regions. Their underuse is associated with underuse of human potential, and thus a waste of precious resources. One of the risk groups on the labour market are young people, especially those who are not employed, not in education, not in training (NEET). Their inability to enter the labour market in time and find a suitable job can cause them poverty, social exclusion and health problems, while the negative effects of this phenomenon are also reflected at the societal level. Examining the number and structure of the group of young people is key to correctly setting appropriate tools to mitigate this adverse phenomenon. The aim of the paper is to examine the number of young NEETs in the Trenčín Region and to evaluate the differences in individual districts of the Trenčín Region, based on data from the 2021 Census.*

Key words: *NEET, NEET rate, person in household, unemployed*

JEL Classification: *E24, J24, R23*

1. ÚVOD

Mladí ľudia predstavujú dôležitý zdroj súčasnej a budúcej pracovnej sily (Šipikal, Némethová, 2023) a tvoria špecifickú skupinu obyvateľstva, s ktorou sú spojené podmienky strednodobého a dlhodobého sociálno-ekonomického vývoja spoločnosti. Ako uvádzajú Avanesian et al. (2024), pri prechode do dospelosti sa mladí ľudia stretávajú s problémom pri hľadaní slušnej práce zodpovedajúcej ich dosiahnutému vzdelaniu. Kým časť mladých ľudí si nájde vhodné zamestnanie, pri ktorom maximálne využíva svoj ľudský kapitál, iná časť mladých ľudí začína pracovať v zamestnaniach, ktoré nedosahujú ich kariérne očakávania. Okrem toho sú tu aj mladí ľudia, ktorí už neštudujú ani si nerozvíjajú odborné zručnosti a sú neúspešní na trhu práce.

Posledná uvádzaná skupina mladých ľudí, t.j. mladí ľudia v situácii NEET, predstavujú nevyužitý potenciál, aktivizácii ktorého je potrebné venovať dostatočnú pozornosť. Keďže ide o špecifickú, veľmi heterogénnu skupinu, z ktorej podstatná časť nie je ani registrovaná na úradoch práce, stáva sa pre verejné orgány ťažko dosiahnuteľná (Assmann et al., 2021). Pritom spoľahlivé analýzy stavu a štruktúry počtu mladých ľudí v situácii NEET sú nevyhnutné pre stanovenie vhodnej stratégie pre riešenie nepriaznivej situácie týchto mladých

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ľudí. Najčastejšie používaný ukazovateľ - miera NEET ukazuje efektívnosť prechodu mladých ľudí zo štúdia do zamestnania a ich účasť na sociálno-ekonomickom živote (Avanesian et al., 2024).

V odbornej literatúre sa stretávame s viacerými štúdiami o mladých ľuďoch v situácii NEET na národnej úrovni, avšak podrobné regionálne analýzy o počte a štruktúre mladých ľudí v situácii NEET nie sú dostatočné. Cieľom tohto príspevku je preto preskúmať početnosť mladých ľudí v situácii NEET v Trenčianskom kraji a zhodnotiť rozdiely v jednotlivých okresoch Trenčianskeho kraja. Východiskom sú údaje zo Sčítania obyvateľov, domov a bytov z roku 2021.

2. TEORETICKÉ VÝCHODISKÁ

Mladí ľudia, ktorí už nie sú súčasťou vzdelávacieho systému, ale nie sú ani súčasťou trhu práce, sa označujú ako mladí ľudia v situácii NEET (ani vo vzdelávaní, v zamestnaní alebo odbornej príprave).

Spočiatku sa koncept NEET používal len pre úzko definovanú vekovú skupinu mladých ľudí vo veku 16-18 rokov, no neskôr sa rozšíril na ďalšie vekové skupiny, čo viedlo k narastajúcej heterogenite skupiny NEET (Furlong, 2006).

Ako uvádzajú Pacelli et al. (2023), kategória NEET zahŕňa širokú škálu zraniteľných skupín mládeže, od nezamestnaných, cez ekonomicky neaktívnych, k odradeným pracovníkom, ale zahŕňa aj tých, ktorí sú v tzv. prechodnom období, napr. medzi školou a ďalším vzdelávaním, medzi dočasnými zmluvami, medzi školou a zamestnaním, ale aj tých, ktorí nie sú zamestnaní ani neštudujú, pretože sa starajú o svojich príbuzných. Napriek vyššie uvedenej širokej škále osôb, ktoré kategória NEET zahŕňa, Furlong (2006) konštatuje, že skupina osôb NEET nezahŕňa osoby, ktoré sú v neistom alebo slabo platenom zamestnaní alebo sú zapojení do krátkodobých vzdelávacích programov.

Dôvody, pre ktoré sa mladí ľudia ocitnú v kategórii NEET, možno kategorizovať do viacerých skupín. Warburton et al. (2024) uvádza, že hlavné faktory neexistencie zamestnania, vzdelávania alebo odbornej prípravy sú spojené so zlým zdravotným stavom a sociálnym vylúčením. Assamann et al. (2021) medzi základné dôvody uvádzajú najmä individuálne charakteristiky: nízke vzdelanie, predčasné ukončenie školskej dochádzky, osamelé rodičovstvo, zdravotné postihnutie, ale tiež bydlisko v odľahlej oblasti, príp. štatút migranta. Za kľúčový faktor považujú rodinné zázemie, čo vysvetľujú tým, že ak rodičia mladých ľudí tiež zažili nezamestnanosť, alebo majú nízku úroveň vzdelania, sú chudobní alebo boli rozvedení, ich deti majú tiež vyššie riziko, že sa stanú osobami v situácii NEET. K tomuto názoru sa prikláňajú aj Quinlan-Davidson et al. (2024), ktorí dopĺňajú faktory ako nízke sebavedomie, neisté bývanie a mladé rodičovstvo. Maynou et al. (2022) medzi kľúčové faktory, ktoré vedú k situácii NEET, zaraďujú rodovú diskrimináciu, nízke mzdy, neisté pracovné miesta, pretrvávajúcu nezamestnanosť, zraniteľnosť voči vplyvom finančnej krízy, neefektívny prechod zo školy do zamestnania, či nedostatočnú odbornú prípravu na pracovisku.

Rahmani et al. (2023) kategorizovali rizikové faktory situácie NEET do ôsmich hlavných skupín: individuálne charakteristiky, vzdelanie a škola, práca, zdravie, závislosť, sociálne faktory, rodina a prostredie. Z ich výskumu vyplynulo, že najmä vzdelanie a rodinné podmienky majú zásadný vplyv na mladých ľudí v situácii NEET. Za najkritickejšie ukazovatele považujú úroveň vzdelania, pracovné skúsenosti a zručnosti, fyzické a duševné zdravie, rodinný stav, chudobu a sociálne nerovnosti, životnú situáciu, príjem rodičov a postavenie v zamestnaní.

Dôležitosť skúmania heterogénneho pohľadu na mladých ľudí v situácii NEET vzhľadom na pohlavie, miesto bydliska, typ intervencie, dostupnú finančnú podporu či zdravotné

postihnutie prezentujú vo svojom výskume aj Paabort et al. (2023). Uvádzajú, že mladí ľudia v situácii NEET majú zvyčajne skúsenosť s nezamestnanosťou, viac nezamestnaných priateľov ako iní mladí ľudia a pochádzajú z rodín s obmedzenými finančnými príležitosťami, pričom ich rodičia majú zväčša nízku úroveň vzdelania. Osobitne takejto situácii čelia ženy, pretože často preberajú kľúčovú úlohu opatrovateľov rodiny a príbuzných. S uvedeným súhlasia aj Veldman et al. (2024), ktorí konštatujú, že ženy s nízkym dosiahnutým vzdelaním, nízkym sociálno-ekonomickým zázemím rodičov, niekoľkými negatívnymi životnými udalosťami a problémami duševného zdravia sú najčastejšie postihnuté situáciou NEET.

Výskum v oblasti mladých ľudí v situácii NEET sa zameriava jednak na vyššie uvedené príčiny vzniku NEET, ale tiež na štruktúru skupiny NEET, rozdiely medzi štátmi či v rámci štátov, alebo na vplyv rôznych externých faktorov na úroveň NEET.

Vo svojej štúdii Norvell Gustavsson et al. (2024) skúmali vplyv pandémie COVID-19 na úroveň NEET vo Švédsku, pričom konštatujú jej zhoršenie počas pandémie. Petrescu et al. (2024) zasa analyzovali vplyv hospodárskej a finančnej krízy, ktorá zasiahla štáty EÚ od roku 2008, na situácii mladých nezamestnaných. Uvádzajú, že krízy zväčša postihujú tých, ktorí sú na trhu práce noví.

Assamann et al. (2021) skúmali rozdiely v štruktúre NEET v členských štátoch EÚ. Zistili, že veľký počet mladých ľudí s opatrovateľskými povinnosťami sa nachádza v krajinách s nedostatkom služieb súvisiacich s rodinou v spojení so slabou formalizovanou dlhodobou starostlivosťou, ako je to väčšinou v krajinách strednej a východnej Európy. Naproti tomu vysoká miera NEET so zdravotným postihnutím prevláda najmä v krajinách severnej Európy, kde existujú veľkorysé a neefektívne systémy dávok pre osoby so zdravotným postihnutím, ktoré vytvárajú falošné stimuly, aby zostali mimo trhu práce. Napokon, vysoký podiel nezamestnaných a odradených mladých NEET sa nachádza v krajinách najviac zasiahnutých krízou a s vysokou nepružnosťou trhu práce, nízkou odbornou špecifickosťou a nedostatkom aktívnych politík trhu práce, ako je to v krajinách južnej a niektorých krajín strednej a východnej Európy.

V rámci svojho výskumu sa Warburton et al. (2024) zamerali na skúmanie toho, či opatrenia v oblasti školskej pripravenosti v Anglicku vplývajú na úroveň NEET. Zistili, že väčšina mladých ľudí, ktorí neboli pripravení na školu, sa neskôr dostali do situácie NEET. Z toho vyplýva, že rizikové faktory NEET sa vyskytujú už v ranom veku. Preto opatrenia v oblasti pripravenosti na školu by sa mohli použiť ako včasné indikátory rizika dlhodobých problémov fyzického a duševného zdravia spojených s NEET.

Kleif (2020) upozorňuje na dôležitosť riešenia problému NEET z dlhodobého hľadiska. Uvádza, že namiesto skúmania jednotlivých epizód nezamestnanosti a nečinnosti je nevyhnutné zvážiť, ako takéto epizódy zapadajú do dlhodobej kariéry na trhu práce.

Vzťah medzi zamestnaneckými podmienkami mladých dospelých (vrátane NEET) a subjektívnou pohodou v podmienkach Talianska skúmali Felaco a Parola (2022). Predpokladali, že mladí ľudia v situácii NEET s väčšou pravdepodobnosťou majú nižšiu subjektívnu pohodu. Zistili, že orientácia na budúcnosť zohráva dôležitú úlohu v psychologickom procese, ktorý vedie k zmierňovaniu negatívnych vplyvov medzi stavom nezamestnanosti a blahobytom.

Nevyhnutnosť skúmania a riešenia problematiky mladých ľudí v situácii NEET vyplýva z vyššie uvedených faktorov, pričom na túto skupinu ľudí osobitne nebezpečné sú sociálno-ekonomické dopady spojené so sociálnym vylúčením a chudobou, ale tiež zdravotné a psychologické dopady, ktoré môžu viesť k zvýšenému stresu, depresii a iným zdravotným problémom. V prípade, že sa mladí ľudia nedokážu včas zaradiť na trh práce a nájsť si vyhovujúce uplatnenie, môže to mať negatívne dopady nielen na nich (napr. hrozba celoživotného sociálneho vylúčenia), ale aj na spoločnosť (Šipikal, Némethová, 2023). Na spoločenskej úrovni vysoký počet NEET dlhodobo poškodzuje hospodárstvo tým, že ho

vystavuje riziku nedostatku ľudských zdrojov a vytvára tlak na systémy sociálnej ochrany (Ralston et al. 2022).

Mladí ľudia v situácii NEET sa tak stávajú globálnym problémom, a preto sa problematika mladých ľudí a ich začlenenia do pracovného života dostáva aj do pozornosti jednotlivých politík v rámci EÚ, a čoraz väčšia pozornosť sa jej venuje aj na Slovensku.

3. CIEĽ A METODOLÓGIA

Vzhľadom na dôležitosť skúmania a hodnotenia situácie v oblasti mladých ľudí NEET je cieľom tohto príspevku preskúmať početnosť mladých ľudí v situácii NEET v Trenčianskom kraji a zhodnotiť rozdiely v jednotlivých okresoch Trenčianskeho kraja. V rámci výskumu sme sa zamerali na mladých ľudí vo veku 15-29 rokov, pričom v rámci tejto vekovej skupiny sme osobitne hodnotili vekové skupiny 15-19, 20-24 a 25-29 rokov.

V našom výskume sme si stanovili tieto výskumné otázky:

1. Ktoré faktory sú v odbornej literatúre uvádzané ako najčastejšie príčiny, prečo sa mladí ľudia dostávajú do situácie NEET?

2. Aké sú rozdiely v úrovni mladých ľudí v situácii NEET v okresoch Trenčianskeho kraja?

Pri spracovaní príspevku sme vychádzali zo štatistických údajov dostupných vo verejných databázach a z údajov poskytnutých na požiadanie. Pri zisťovaní vývoja a aktuálneho počtu mladých ľudí v okresoch Trenčianskeho kraja bola využitá databáza DataCUBE Štatistického úradu SR. Ďalej boli využité údaje zo Sčítania obyvateľov, domov a bytov 2021, ktoré sú dostupné na stránke www.scitanie.sk, v časti Obyvatelia – Rozšírené výsledky. Keďže nie všetky údaje zistené v Sčítaní sú voľne dostupné v členení podľa nami skúmaných vekových skupín, resp. podľa okresov, požiadali sme o poskytnutie detailnejších údajov. Údaje zo Sčítania boli najviac prínosné pre spracovanie detailnej analýzy mladých ľudí v situácii NEET, pretože v danej štruktúre sa zisťovania nerobia na ročnej báze, iba v rámci sčítaní obyvateľov. Z toho dôvodu sú tieto údaje uvádzané k 1.1.2021.

Na spracovanie údajov a vyhodnotenie cieľových ukazovateľov boli použité základné štatistické metódy:

- Výpočet percentuálneho podielu: Percentuálny podiel jednotlivých skupín NEET, resp. vekových skupín bol vypočítaný ako pomer počtu osôb v danej kategórii k celkovému počtu osôb, vynásobený 100. Tento výpočet umožnil porovnať relatívne zastúpenie jednotlivých skupín v rámci NEET, resp. populácie.
- Výpočet miery NEET: Miera NEET bola stanovená ako podiel mladých ľudí vo veku 15–29 rokov, ktorí nie sú zamestnaní, nevzdelávajú sa ani sa nezúčastňujú odbornej prípravy, na celkovom počte mladých ľudí v danej vekovej skupine.

Okrem toho bola využitá metóda komparácie na porovnanie úrovne NEET v okresoch Trenčianskeho kraja a metóda syntézy na uskutočnenie zhrnutia a formulovanie záverov.

4. VÝSLEDKY

Trenčiansky kraj patrí medzi ekonomicky vyspelejšie regióny Slovenska, no napriek tomu má problémy s udržaním mladých ľudí v regióne. Demografický vývoj, blízkosť štúdia v Českej republike, lepšie sociálno-ekonomické podmienky v iných štátoch EÚ a ďalšie faktory spôsobujú pokles počtu mladých ľudí v kraji. Dlhodobý trend vývoja počtu obyvateľov Trenčianskeho kraja ukazuje mierny pokles, z 610 135 osôb v roku 1996 na 568 102 osôb v roku 2023, čo predstavuje pokles o 6,89%. Počet mladých ľudí sa však znižuje oveľa výraznejšie, keď v roku 1996 bolo v Trenčianskom kraji celkom 146 685 mladých ľudí vo

veku 15-29 rokov, avšak v roku 2023 ich bolo už iba 80 001, t.j. pokles o viac ako 45%. Z uvedeného dôvodu aj výrazne klesá podiel mladých ľudí na celkovom počte obyvateľov kraja, a to z 25,10% v roku 2002 na 14,08% v roku 2023 (Štatistický úrad SR, 2024).

Okrem výrazného poklesu počtu mladých ľudí v Trenčianskom kraji je ďalším závažným problémom uplatniteľnosť mladých ľudí na trhu práce. Špecifickou skupinou sú mladí ľudia v situácii NEET. Analýzu mladých ľudí v situácii NEET budeme uskutočňovať na základe údajov zo Sčítania obyvateľov, domov a bytov 2021. Východiskom pre skúmanie štruktúry mladých ľudí v situácii NEET je celková štruktúra mladých ľudí podľa ekonomickej aktivity k dátumu sčítania, t.j. k 1.1.2021 (tabuľka 1).

Tabuľka 1: Štruktúra mladých ľudí v Trenčianskom kraji podľa ekonomickej aktivity k 1.1.2021)

Ekonomická aktivita	15 - 19 rokov	20 - 24 rokov	25 - 29 rokov	spolu 15-29 rokov	podiel na celkovom počte (%)
žiak základnej školy	2365			2365	2,67
žiak strednej školy	17648	620	22	18290	20,68
študent vysokej školy	996	7330	1069	9395	10,62
nezamestnaný	387	1666	2083	4136	4,68
osoba na materskej dovolenke	1	141	671	813	0,92
osoba na rodičovskej dovolenke	2	218	1059	1279	1,45
osoba v domácnosti	720	3155	3632	7507	8,49
dôchodca	80	466	578	1124	1,27
pracujúci (okrem dôchodcov)	1063	13526	25922	40511	45,80
pracujúci dôchodca	7	114	376	497	0,56
príjemca kapitálových príjmov		14	37	51	0,06
dôverné	45	86	79	210	0,24
iné	7	59	106	172	0,19
nezistené	896	539	676	2111	2,39
Spolu	**24217**	**27934**	**36310**	**88461**	

Zdroj: SODB (2021), vlastné spracovanie, vlastné prepočty

Spomedzi 88461 mladých ľudí vo veku 15-29 rokov v Trenčianskom kraji takmer polovica bola v okamihu sčítania pracujúca (46,36%), viac ako 30% študovalo na stredných a vysokých školách. Nezamestnaných bolo 4,68% a v domácnosti 8,49%.

V našej ďalšej analýze sa už budeme venovať konkrétne mladým ľuďom v situácii NEET, pričom túto skupinu skúmame zo širšieho hľadiska, kedy za osoby v situácii NEET považujeme tieto skupiny: nezamestnaní, nepracujúci dôchodcovia (t.j. osoby so zdravotným znevýhodnením), osoby na materskej a rodičovskej dovolenke, osoby v domácnosti a poberatelia kapitálových príjmov. Na základe údajov zo SODB 2021 bolo v Trenčianskom kraji zistených celkom 14910 mladých ľudí vo veku 15-29 v situácii NEET, z toho 9979 žien (66,93%) a 4931 mužov (33,07%). Počet NEET v jednotlivých okresoch závisí od počtu obyvateľov okresu. Počet a štruktúra mladých ľudí v situácii NEET vo veku 15-29 rokov v jednotlivých okresoch Trenčianskeho kraja k okamihu sčítania je obsahom tabuľky 2.

Tabuľka 2: Názov tabuľky (Times New Roman, 11pt, Hrubé písmo, zarovnané vľavo)

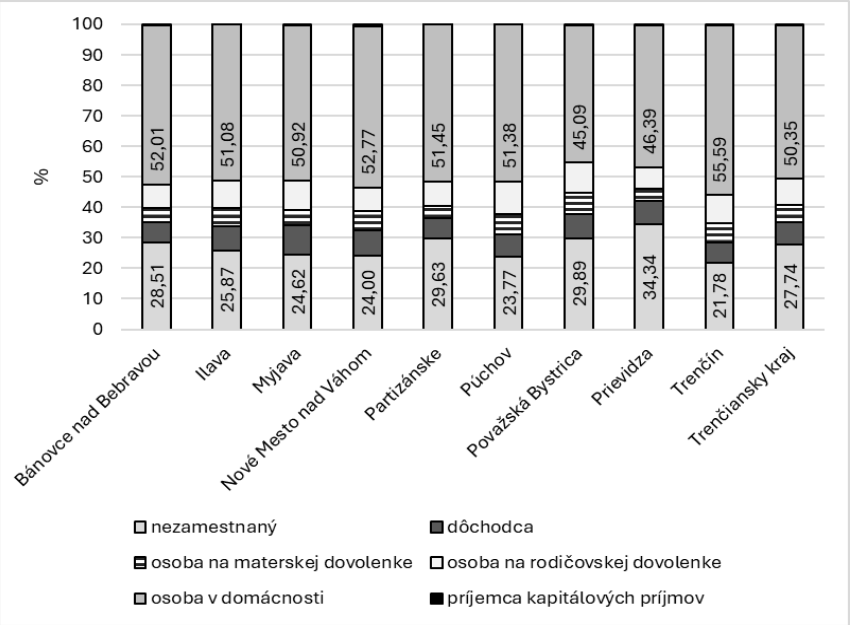
okres	nezamestnaný	dôchodca	osoba na materskej dovolenke	osoba na rodičovskej dovolenke	osoba v domácnosti	príjemca kapitálových príjmov	Spolu
Bánovce nad Bebravou	262	60	42	73	478	4	919
Ilava	348	105	83	121	687	1	1 345
Myjava	160	62	32	63	331	2	650

Nové Mesto nad Váhom	372	130	98	122	818	10	1 550
Partizánske	357	83	49	95	620	1	1 205
Púchov	284	88	80	127	614	2	1 195
Považská Bystrica	484	127	113	160	730	5	1 619
Prievidza	1 283	290	148	268	1 733	14	3 736
Trenčín	586	179	168	250	1 496	12	2 691
Trenčiansky kraj	**4 136**	**1 124**	**813**	**1 279**	**7 507**	**51**	**14 910**

Zdroj: SODB 2021, vlastné spracovanie

V Sčítaní obyvateľov, domov a bytov v roku 2021 až 7507 osôb vo veku 15-29 rokov v Trenčianskom kraji uviedlo status „osoba v domácnosti“, čo predstavuje 50,35% z počtu NEET v tejto vekovej skupine. V jednotlivých okresoch sa tento podiel pohybuje od 45,09% v okrese Považská Bystrica po 55,59% v okrese Trenčín (obrázok 1). Podiel nezamestnaných je najvyšší v okrese Prievidza (34,34%), naopak v okrese Trenčín iba 21,78%. Najvyšší podiel nepracujúcich dôchodcov (vo veku 15-29 rokov) je v okrese Ilava, a to 9,54%.

Obrázok 1: Štruktúra NEET vo veku 15-29 rokov v okresoch Trenčianskeho kraja k 1. 1. 2021 podľa ekonomickej aktivity

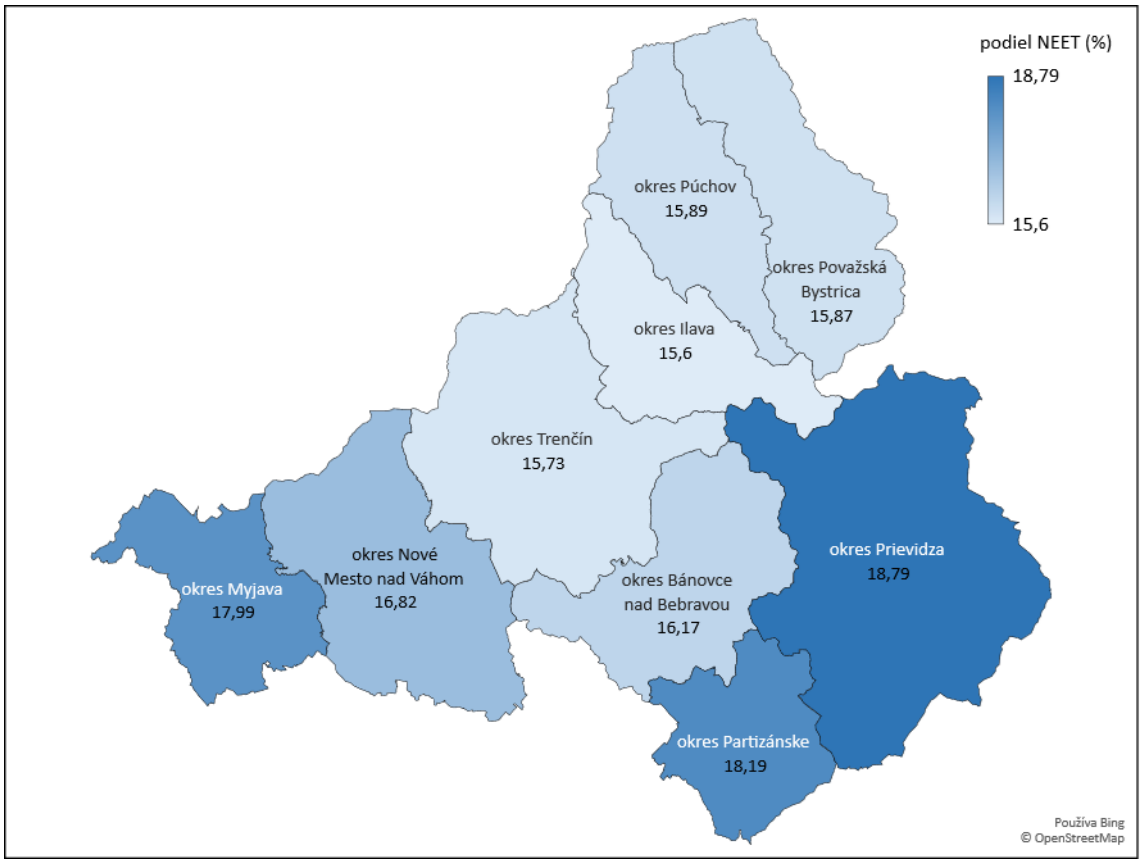


Zdroj: SODB 2021, vlastné prepočty

Z predchádzajúceho textu je zrejmé, že najväčší podiel na počte NEET osôb v jednotlivých okresoch Trenčianskeho kraja majú osoby v domácnosti a nezamestnaní. Ak by sme zhodnotili podiely jednotlivých skupín mladých ľudí NEET vo vekových skupinách 15-19, 20-24 a 25-29 rokov, zistili by sme zaujímavé skutočnosti. Vo vekovej skupine 15-19 rokov v okrese Trenčín predstavujú osoby v domácnosti až 74,40%, čo je veľmi znepokojujúci stav. Vysoká hodnota podielu v tejto vekovej skupine bola zaznamenaná aj v okrese Púchov, 72,82%. V prípade nezamestnaných do 19 rokov najvyššie podiely dosahujú okresy Bánovce nad Bebravou a Prievidza, viac ako 40%. Podiely osôb na materskej a rodičovskej dovolenke sú prirodzene najväčšie vo vekovej skupine 25-29 rokov. V okrese Púchov je podiel NEET na rodičovskej dovolenke vo veku 25-29 najvyšší, takmer 16%.

Na lepšie porovnanie úrovne NEET v rôzne zaľudnených regiónoch sa používa podiel NEET, ktorý sa v okresoch Trenčianskeho kraja pohybuje od 15,60% v okrese Ilava do 18,79% v okrese Prievidza (obrázok 2), pričom priemerný podiel NEET v Trenčianskom kraji k okamihu sčítania dosiahol hodnotu 16,85%.

Obrázok 2: Podiel mladých ľudí v situácii NEET v okresoch Trenčianskeho kraja (%)

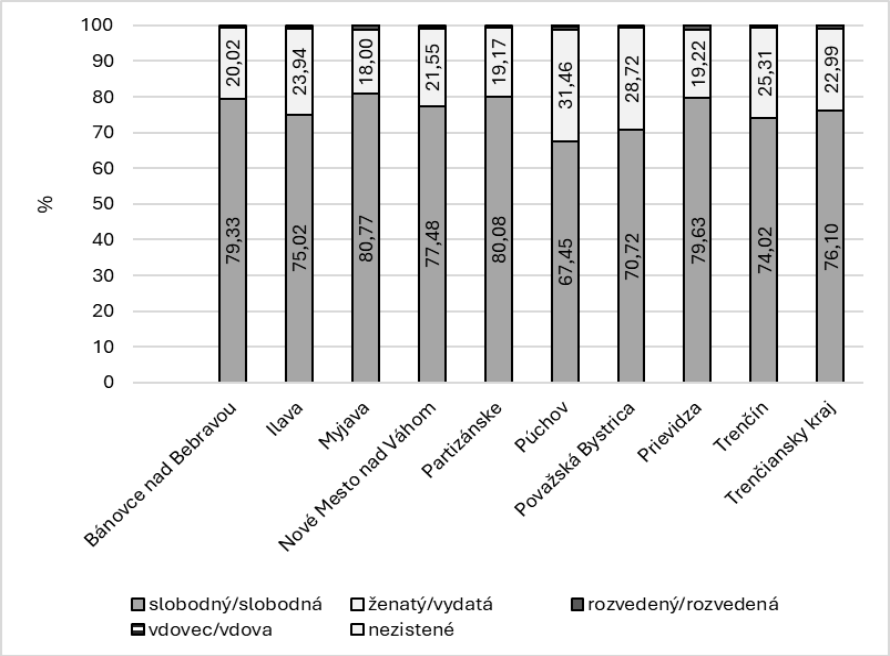


Zdroj: SODB 2021, vlastné prepočty, vlastné spracovanie

Z obrázku 2 je zrejmé, že vyššia miera NEET bola v okrajových okresoch Trenčianskeho kraja, kým v okresoch Ilava, Trenčín, Považská Bystrica a Púchov bola pod úrovňou 16%.

Vzhľadom na skutočnosť, že medzi základné faktory, ktoré vplývajú na úroveň NEET sú vzdelanie a rodinné prostredie, v ďalšej časti sa zameriame na štruktúru mladých ľudí v situácii NEET v Trenčianskom kraji podľa rodinného stavu a vzdelania (obrázok 3 a 4).

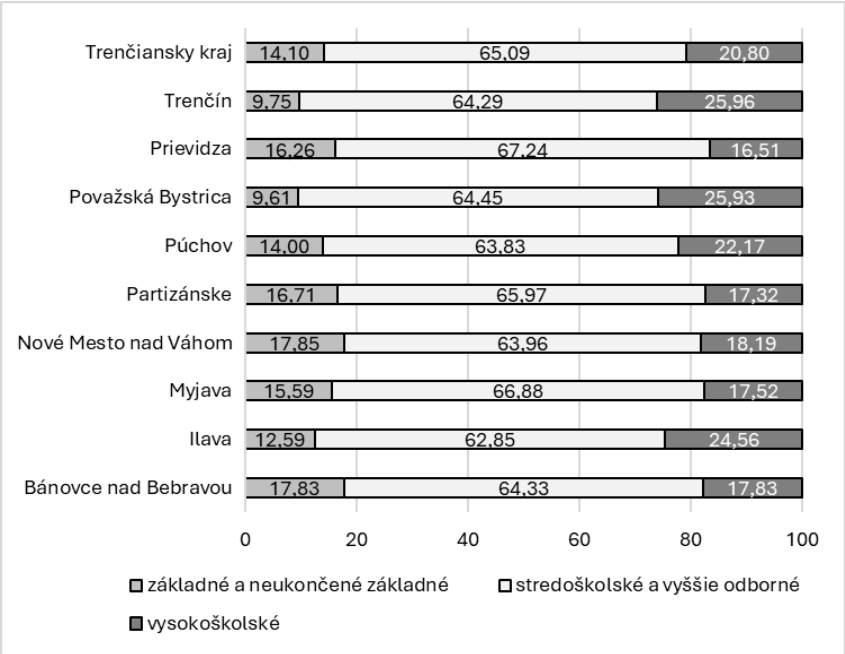
Obrázok 3: Štruktúra NEET vo veku 15-29 rokov v okresoch Trenčianskeho kraja k 1. 1. 2021 podľa rodinného stavu



Zdroj: SODB 2021, vlastné prepočty

Spomedzi mladých ľudí v situácii NEET k 1.1.2021 v Trenčianskom kraji bolo 11347 slobodných, t.j. 76,10%. V okresoch Myjava a Partizánske bol tento podiel vyšší, tvoril viac ako 80%. Ženatých, resp. vydatých NEET v Trenčianskom kraji bolo 3428, čo tvorilo 22,99%, avšak v okrese Považská Bystrica až 31,46%. Rozvedených bolo 118, spomedzi okresov kraja bol podiel rozvedených najvyšší v okrese Myjava, 1,08%.

Obrázok 4: Štruktúra NEET vo veku 15-29 rokov v okresoch Trenčianskeho kraja k 1. 1. 2021 podľa vzdelania



Zdroj: SODB 2021, vlastné prepočty

Viac ako 14% spomedzi NEET osôb vo veku 15-29 rokov v Trenčianskom kraji malo základné alebo neukončené základné vzdelanie. Najväčšia časť, ako 65% malo ukončené

stredoškolské vzdelanie, kým vysokoškolské vzdelanie dosiahlo necelých 21% osôb v situácii NEET (v okresoch Trenčín a Považská Bystrica takmer 26%). V prípade vysokoškolsky vzdelaných NEET sme celkový počet podrobili podrobnejšej analýze podľa pohlavia a skupiny, pričom sme zistili, že z 2443 osôb bolo 2060 žien, z nich 326 bolo na materskej dovolenke, 440 na rodičovskej dovolenke a 908 v domácnosti. V prípade osôb vo veku 15-19 rokov so základným vzdelaním bolo 348 osôb v domácnosti, 122 nezamestnaných a 58 nepracujúcich dôchodcov, z celkového počtu 530 osôb.

5. ZÁVER

Pri vstupe na trh práce sa mladí ľudia stretávajú s mnohými prekážkami, ktoré určitej skupine z nich znemožnia ich primerané uplatnenie a využitie ich ľudského kapitálu. V rámci skúmania mladých ľudí na trhu práce je dôležité identifikovať príčiny a prekážky, ktoré bránia mladým ľuďom vstúpiť na trh práce a nájsť si primerané zamestnanie. Dôkladná identifikácia a následné riešenie problémov NEET môže neskôr zabrániť dlhodobým negatívnym dôsledkom pre jednotlivcov aj spoločnosť ako celok.

Naša analýza bola zameraná na Trenčiansky kraj. Počet obyvateľov v Trenčianskom kraji sa za posledné roky mierne znížil, v rokoch 1996-2023 bol zaznamenaný pokles o 6,89%, avšak v uvedenom období sa počet osôb vo veku 15-29 rokov znížil o viac ako 45%. Z uvedeného dôvodu je nevyhnutné venovať tejto vekovej skupine pozornosť, osobitne z hľadiska ich uplatnenia na trhu práce.

Na základe výsledkov so sčítania žilo k 1.1.2021 v Trenčianskom kraji celkom 14910 mladých ľudí v situácii NEET vo veku 15-29 rokov. Podiel počtu NEET na celkovom počte mladých ľudí v Trenčianskom kraji bol 16,85%, najvyšší bol v okrajových okresoch Trenčianskeho kraja, konkrétne v okresoch Prievidza, Partizánske a Myjava. Spomedzi mladých ľudí v situácii NEET až 2/3 tvoria ženy. Z hľadiska vzdelanostnej úrovne viac ako 14% NEET vo veku 15-29 rokov má základné alebo neukončené základné vzdelanie, viac ako 65% má ukončené stredoškolské vzdelanie, vysokoškolské vzdelanie má necelých 21% osôb v situácii NEET.

Na základe uskutočnených analýz konštatujeme významné rozdiely v počte a štruktúre mladých ľudí v situácii NEET v jednotlivých okresoch Trenčianskeho kraja, ktoré vyplývajú z ekonomických, sociálnych i geografických charakteristík jednotlivých okresov.

Vzhľadom na zistené skutočnosti konštatujeme, že mladí ľudia v situácii NEET si vyžadujú osobitnú pozornosť, a uskutočnená analýza počtu a štruktúry tejto skupiny mladých ľudí môže byť východiskom pre tvorbu politík a programov, ktoré by mohli zlepšiť ich pozíciu. Vzhľadom na skutočnosť, že mladí ľudia v situácii NEET sa stali cieľovou populáciou pri tvorba politík v Európe, je potrebné, aby sa na túto skupinu viac zamerali aj jednotliví aktéri práce s mládežou pôsobiaci v kraji, prípadne aby vznikli nové inštitúcie priamo zamerané na prácu s touto skupinou mladých ľudí, ako predpoklad rozvoja inkluzívnej a prosperujúcej spoločnosti, kde majú mladí ľudia vytvorené podmienky na sebarealizáciu..

Dodatok

Príspevok je súčasťou projektu VEGA č. 1/0448/24 „Výskum kľúčových determinantov ľudského kapitálu a ekonomického rastu v podmienkach rozvoja digitálnej ekonomiky“. Podrobná analýza mladých ľudí v situácii NEET v Trenčianskom kraji bola uskutočnená v rámci projektu „Regionálna analýza o mladých ľuďoch ohrozených situáciou NEET a v situácii NEET na území Trenčianskeho kraja“, ako súčasť projektu „Vytvorenie regionálnej analýzy a regionálnych partnerstiev s cieľom identifikovania potrieb a lokalít vhodných na zriadenie centier pre prácu s mládežou na území TSK“.

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IMPACT OF TRANSFORMATION OF CONTROLLING PROCESSES ON THE ORGANIZATION'S HUMAN RESOURCES

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Abstract: *Controlling is a key tool for effective management of the organization, while its implementation and innovation are essential to ensure the long-term competitiveness and success of the company. The main aim of our research was to assess the effectiveness of the steps in the implementation of the transformation of controlling in a large business concern. For this purpose, we carried out qualitative research in 12 electrical engineering companies, located in 6 countries. Data collection was carried out through questionnaires and interviews, and the Activity Structure Analysis (ASA) and Six Sigma methods were applied in their analysis. The transformation of controlling focused on the standardization and transfer of repetitive tasks between business partners and the centre of expertise. The implementation of the transformation enabled optimization of processes and estimated savings in personnel costs thanks to the transfer of activities to the centre of expertise.*

Key words: *activities, controlling, optimization, processes, transformation*

JEL Classification: *D24, L15, M40, M49*

1. INTRODUCTION AND THEORETICAL BACKGROUND

Organizations face the pressure of competition, rising costs and an unstable economic situation, increasing the share of innovation (Micieta et al., 2019) or global instability, which leads to the constant improvement of management systems and the introduction of new controlling functions (Foltínová et al., 2011; Raišienė et al., 2020). Management needs extensive information and systems to identify risks and opportunities. Traditional accounting, including financial and managerial accounting, is therefore supplemented by controlling, which analyses and processes data (IGC, 2010).

Controlling mainly includes planning, control and management, which form the so-called "control circuit". The plan determines the direction of the company for the following year, while reporting enables control and analysis of the causes of deviations. Management ensures the implementation of the plan (Rasoloniaina et al., 2014; Vollmuth, 2004). The role of controlling is also to ensure that methods, assumptions and processes are consistent within the overall planning. Controlling critically examines the data and assumptions in the plans in terms of their plausibility and attainability. The main quality criteria of plans include realism, completeness, consistency and compliance with other plans (Eschenbach and Siller, 2012).

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The most important tool for effective company management is the planning of all company activities. For this purpose, the controller compiles a planning system that covers all areas. This data leads to other plans such as investment planning and financial planning. The goal is to prepare a balance sheet and a profit and loss statement for the planning period. The expected key figures can then be calculated from this. The controller will compare them with the values required by the company's management. If the values are not achieved, the planning process must be repeated (IGC, 2010). Control is the process of processing information, the quality of which depends on how up-to-date and complete the results of the control are. The most important goals are primarily the control of compliance with plans and the level of goal achievement, reporting to management, planning preventive and corrective measures, starting learning processes according to deviations and managing behaviour based on the awareness that there may be controls (Eschenbach and Siller, 2012). Management means that, based on the analysis of deviations, it must be found where countermeasures should be implemented in order to achieve the jointly set goals. In order to achieve the desired direction of development, management should be goal-oriented and future-oriented (Vollmuth, 2002). Planning, control and management form a regulatory circuit, but an equally important function also belongs to reporting. Reporting is a modern method of performance evaluation within the company. Reporting represents one of the most important operational controlling tools that is currently used in business practice. Reporting synthesizes information for the management of the company as a whole and its basic organizational units. An important part of the reporting is also the determination of the key performance indicators of the company, which are regularly monitored and evaluated within the report, most often on a monthly basis, and compare the achieved reality with the set goals. The tasks of reporting include the selection, processing, formalization and distribution of the necessary information for managers, depending on the activities that the given employee can influence (Fibírová and Šoljaková, 2010).

Monitoring is a systematic process that takes place throughout the lifetime of performance monitoring. It should be carried out at every stage of the activity, with data collected, analysed and continuously used. The evaluation takes place at the end, but ongoing monitoring is also important. It is necessary to plan the monitoring system from the beginning to ensure the maximum reliability of the data, while the initial data are key (Mnestudies, 2020). The results of one monitoring serve as input for another. In monitoring, we evaluate indicators that help identify problems and optimize solutions (Department of conservation 2020).

Lean administration focuses on the optimization of the business process, which must first be analysed in detail. Analysis is the first step of transformation and involves the detailed recording, measurement and naming of each step of the process. Activities are categorized into three types: value-added activities, non-value-added activities, and redundant activities (Wiegand and Franck, 2006). The optimization of these activities leads to the improvement of processes and the identification of necessary measures. The goal of lean administration is the efficient organization of processes that contribute to satisfying customer needs, but not directly to the creation of added value (Kopták, 2014).

Many authors deal with the topic of lean administration implementation (Eliferov and Repin, 2019; Alnadi and McLaughlin, 2021; Spieler, 2023). In most cases, however, it is about the introduction of lean administration within one company, where elimination, simplification of processes, or automation is mainly used. The transformation requires an analysis of the processes within controlling to be done gradually in all companies in business concern. The goal of process analysis is to find processes that have the same basis, where standardization will subsequently be developed within all processes in the controlling departments.

2. MATERIALS AND METHODS

The main aim of the research was to assess the effectiveness of the steps in the implementation of the transformation of controlling in companies in business concern.

Data collection was carried out in 12 companies belonging to a global concern within the electrical industry. Direct qualitative research was carried out in selected companies in Europe, America and Asia in the form of an empirical study. The companies that participated in data collection are located in Italy, Germany, Slovakia, the Czech Republic, China and the United States of America. As part of the research, several methods were used for obtaining, collecting and processing information. The purpose of using these methods and tools is to achieve the main goal of qualitative research. In order to obtain primary data, exploratory methods (questionnaire form, interviews, observation) and also the ASA (Activity structure analysis) method were used. ASA activity structure analysis is a lean management tool and serves to record all employee activities during a defined time period. Analysis of the structure of activities is carried out either externally or by self-observation (Multimomentanalysis, 2022). We used this method when analysing information from individual companies that we obtained through the questionnaire form. Another used approach was the Six Sigma method, which increases the efficiency of processes in the company. Six sigma is a quality improvement system aimed at reducing the number of errors and keeping them low (Sixsigma, 2024). We used the mentioned method in the implementation of the empirical study. Another method used was ESSA (Eliminate, Simplify, Standardize and Automize), a method whose main goal is to eliminate process waste, standardize, simplify and automate business processes. In qualitative research, the DMAIC (Define, Measure, Analyze, Improve and Control) method was also used as a method of solving problems and improving processes. We used the methods of descriptive statistics to interpret the data (graphs, tables), as they allow clear processing of the obtained and collected information (Gavora, 2023).

3. RESULTS AND DISCUSSION

We started the analysis by creating a form that was supposed to be used for a detailed analysis of individual monitored activities. The analysis was done in accordance with the principles of lean administration. The ASA method was chosen for data collection. The aim of the analysis was to find out how the various tasks are distributed among individual employees. The activities have been sorted into categories to give us an overall view. The respondents were heads of controlling departments in companies in which the transformation of controlling was taking place. The created form was sent to respondents via e-mail. For a period of 4 weeks, the controlling specialists filled in the individual activities that are part of their daily work according to default categories, the form is shown in Table 1.

Table 1: Representation of the form that was filled in during the activity analysis

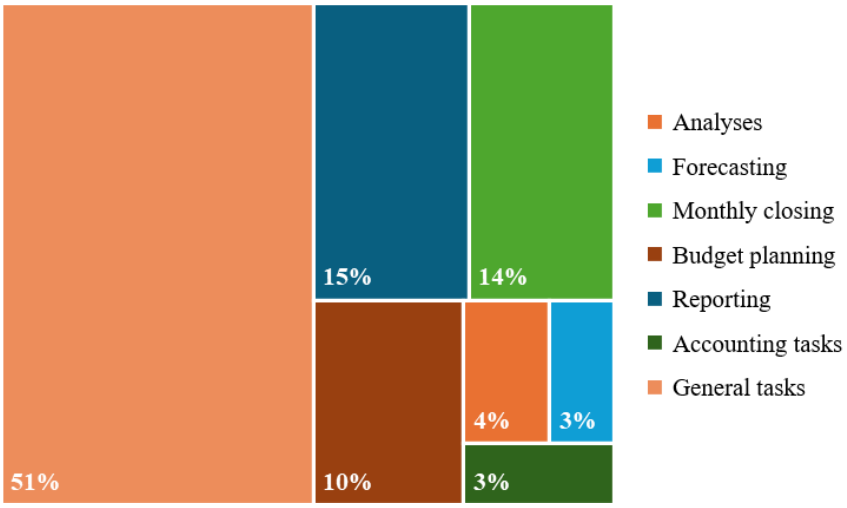
Activity category	Activity description	Controller						Future state	
		1	2	3	4	5	6	Centre of expertise	Business partner
Analyses									
Forecasting									
Monthly closing									
Budget planning									
Reporting									
Accounting tasks									
General tasks									

Source: (own elaboration, 2021)

In Table 1, the categories of activities are divided into 7 groups, while their order is arranged alphabetically (in the Slovak language) and not according to importance. The share of

individual controlling activities obtained through a questionnaire survey based on task defragmentation is shown in Figure 1.

Figure 1: The share of individual controlling activities based on the defragmentation of tasks from the collected questionnaires



Source: (own elaboration, 2021)

As can be seen from Figure 1 general tasks represent the largest range. On the contrary, the fewest activities are related to accounting tasks and forecasting.

Based on the performed analysis, we divided individual activities into general, recurring and specific. As a part of the research, the provided information and activities from each company were analysed. All data were unified. Subsequently, all activities were assigned to either a business partner or a centre of expertise. Depending on whether controller performed more general or specific activities, the members of the controlling team were also divided into members of the centre of expertise or business partners. The analysis showed that the centre of expertise spends the most time on analyses.

Controlling activities that were originally carried out by the centre of expertise were to be transferred to business partners as part of the transformation, as well as activities that were originally covered by business partners were to be moved to the centre of expertise. Individual companies within the concern were in various stages of implementation of this transformation. Overall, we can assess that companies have gradually started to enter the first stages of implementation. Based on the findings of the implementation results, we conclude that the coordination was insufficient. The last phase of implementation was to be carried out in 2021. Despite the fact that the entire transformation was organized within the business concern, the implementation progress was significantly delayed and there was uncertainty among individual employees regarding the introduction of changes and the fulfilment of their timetable. We can critically assess that the initial phase of the controlling transformation was not successful. There was only a change of individual activities from a business partner to a centre of expertise and vice versa, but only within the same company, which did not bring any added value. High demands were placed on the centre of expertise and they faced an immense challenge. The centre of expertise consisted of controllers who had the "know-how" to perform controlling activities. However, the aforementioned experts had no experience with the transformation of controlling and the inplementation of lean management. No controlling transformation methodology was developed, no internal or external consultants were invited. It was a disparate team, in which there were always 2 members from the given company within the global concern. Each company promoted its logic of controlling processes as only model. There was no elimination, simplification, standardization or automation within such a team.

The implemented transformation failed, and based on these findings, we conclude that the controlling system was not at all prepared for this controlling transformation. It was traditional controlling, the main task of which was the evaluation of retrospective data. These analyses were time-consuming and since there was no standardization of individual activities, it was not possible to come to a strategic conclusion based on the consolidation of these analyses. The second phase of the transformation of the controlling system was focused on the analysis of financial and non-financial advantages of the transformation of controlling. Many manufacturing companies have fully embraced the lean management philosophy, but their finance and controlling departments must also adapt to this trend. Over time, controlling takes place through many changes, while reporting is no longer the most important function of controlling, but only an important part of it. The transformation was carried out in the same group of 12 companies as in the first phase of the iimplementation. Here, too, we started with a detailed analysis of individual activities in accordance with Lean administration.

We used the ASA method for data collection, which was also used in the previous phase, but the pre-prepared form contained more options for choosing categories, activities and descriptions of specific tasks to avoid too many activities being classified as general tasks. The activities were sorted into categories, at the same time some blank fields were left for each type of activity. The listed free fields allowed employees to add their own activities that are important from their point of view. Compared to the form sent in the second supporting research, the table contained the following new columns:

- number of occurrences per year,
- frequency,
- processing time for one activity in minutes.

The ASA analysis took place within each production company and was anonymous. The reason why ASA was anonymous is that within this analysis it was not a matter of monitoring the work tasks, methods and efficiency of the employees. The initial task was to obtain evidence of the time devoted to individual activities. The secondary task was the calculation of costs for individual activities. The structure of the collected data is shown in Table 2.

Table 2: Overview of data collection structure

Activity category	Activity description	Controller						Occurrence of activity per year	Frequency	Process time per activity in minutes	Total process time = number of frequencies x pairing time per activity per hour.	Total time per year in hours
		1	2	3	4	5	6					
Analyses												
Forecasting												
Monthly closing												
Budget planning												
Reporting												
Accounting tasks												
General tasks												

Source: (own elaboration, 2021)

Within the controlling department, each employee was asked to analyse his own work. Data collection lasted 4 weeks. The task of the employee was to summarize what activities he performed during the day and to record how often, for how long and at what intervals during the year he performed these activities. Activities that occur only on a quarterly or annual frequency must also be taken into account. After four weeks, all anonymized forms were collected and checked. The analysis was performed in relation to each function and category. Subsequently, the data were consolidated as shown in Table 3.

Table 3: Overview of total processing time in hours

Categories of process activities	Total processing time in hours
Support & Ad hoc topics	26 693
Month-end closing	17 006
General	13 200
Planning	10 620
Accounting transactions	7 992
End of business period	5 010
Adjustment / maintenance in the system	4 570
Forecast	3 773
Cost tracking - projects	2 413
Calculation of savings	1 843
Reporting	1 758
Team Leading	1 439
Forecast update	862
Year-end report	45
Sum	**97 224**

Source: (own elaboration, 2022)

It can be seen from Table 3 that the most hours are devoted to the category of process activities - support and Ad hoc topics. Analysis of the structure of activities showed us how long individual activities last. Thanks to the information that was obtained about the processes, activities and time estimates, we investigated which activities can be moved to the centre of expertise and where the ESSA approach can be applied. Based on the mentioned step, we will get closer to the desired optimization. The potential for saving process time, which is obtained by moving to the centre of expertise, is for the items of process activities: Month-end closing (8994 hours), Forecast (2447 hours), Support and Ad hoc topics (2319 hours), End of business period (1481 hours), Planning (929 hours), Team Leading (359 hours), Forecast updating (351 hours), Reporting (261 hours), Savings calculation (86 hours), Accounting transactions (70 hours). From the data above, it is clear that the transfer of activities to the centre of expertise will save 17,298 hours, which represents the work activities of 9 employees. The potential for saving process time that we get thanks to the ESSA approach is calculated as follows: Support and Ad hoc topics (8425 hours), General activities (2670 hours), Monthly closing (1252 hours), Adjustment/Maintenance in the system (937 hours), Forecast (580 hours), Team Leading (580 hours), Planning (393 hours), Accounting transactions (121 hours), Ending the business period (15 hours). From the data above, it is clear that the ESSA approach can lead to the elimination of 14,971 hours in the first step, which represents the work activities of almost 8 employees.

In addition to the analysis of individual categories and activities, it is important to have an overview of the total costs for individual processes. Table 4 shows the total annual personnel costs by individual process categories in EUR within the analysed companies.

Table 4: *Overview of total annual personnel costs in EUR*

Categories of process activities	Total annual personnel costs in EUR
Support & Ad hoc topics	1 089 847 €
Monthly closing	721 604 €
General	678 792 €
Planning	451 285 €
Accounting transactions	362 832 €
End of business period	257 654 €
Adjustment / maintenance in the system	154 978 €
Forecast	143 522 €
Cost tracking - projects	107 749 €
Calculation of savings	90 387 €

Reporting	60 908 €
Team Leading	52 480 €
Forecast update	44 306 €
Year-end report	2 316 €
Sum	**4 218 660 €**

Source: (own elaboration, 2022)

It can be seen from Table 4 that the highest annual personnel costs are represented by the category of process activities - support and Ad hoc topics. The transfer of activities from countries with higher personnel costs to the centre of expertise, which is located in Slovakia, plus the application of the ESSA approach in all production companies within the controlling departments will bring not only savings in the number of employees, but also savings in personnel costs, as we are moving activities out of the country with higher personnel costs to a country with lower personnel costs.

The presentation of the preliminary estimate of the savings in personnel costs in the case of moving activities to the centre of expertise is as follows: monthly closings (€375,025), Forecast (€98,432), Support and Ad hoc topics (€76,185), End of business period (€55,000), Planning (€21,874), Team Leading (€18,062), Forecast Update (€13,431), Reporting (€8,514), Savings Calculation (€2,036) and Accounting Transactions (€1,666). In total, the estimated savings in personnel costs for all categories of process activities is €670,223. From the analysed data, it is clear that the highest cost savings in the case of transferring activities to the centre of expertise are achieved within the monthly closing.

The representation of the preliminary estimate of the saving of personnel costs in the case of the implementation of the ESSA approach is as follows: Support and Ad hoc topics (€367,809), General (€137,279), monthly closing (€52,731), Adjustment / maintenance in the system (€27,444), Forecast (22,146 €), Team Leading (€20,842), Planning (€9,148), Accounting Transactions (€2,798) and Closing the Business Period (€772). In total, the estimated savings in personnel costs in euros for all categories of process activities is €640,969.

We conclude that by moving process activities to the centre of expertise and implementing the ESSA approach, it is possible to reduce the number of process hours by 32,269 per year and personnel costs by 1,311,192 euros per year.

Within the framework of the use of lean administration, the principles of elimination, standardization and simplification, we implemented the next phase, which dealt with the monitoring of controlling. In the last phase of the qualitative research, we checked the introduction of standardization and elimination within the key performance indicators (KPI), which are reported on a monthly basis within the BSC (Balanced Scorecard), a strategic management tool. Choosing the right KPIs is extremely important as it is necessary to go through existing data sets. The chosen KPIs must have formal or deliberate standardization.

As part of the investigation, it was necessary to analyse which KPIs correspond to the reporting in the BSC, since as part of the consolidation of the selected KPIs, thanks to standardization, the KPIs will be reported in the Power BI (Business Intelligence) framework. Power BI is a software product that is used to analyse and visualize data.

Power BI will then serve to visualize any data using a unified, scalable platform for self-service and company business intelligence, which is easy to use and thus helps to gain a deeper insight into the data not only for each business, but within individual deviations for the consolidated whole. In order to have uniform KPIs reporting in the company, we needed to get an overview of which company reports which KPI.

As part of the research, we found out that many indicators are not shown at all in some companies, which is why data consolidation is not possible. Subsequently, the companies

were invited by the centre of expertise to report all indicators in order to achieve maximum standardization. Furthermore, documentation was developed for individual KPIs, where the definitions of each KPI and the method of calculation were defined, which must be uniform and binding for all companies. Thanks to the standardization of KPIs, it is possible to visualize different views of the selected indicators within Power BI, which are based on the same method of calculation.

In the next step within the consolidation, it was necessary to analyse which KPIs have the greatest added value and are further evaluated from a global perspective within the consolidation. This finding was necessary in order for us to apply lean management.

Based on the KPI analysis from the point of view of consolidation and its further use, we can state that of the 37 key indicators that were evaluated as part of the consolidation:

- 13 indicators were agreed for elimination,
- 2 indicators applied the principle of simplification, as the frequency of reporting was adjusted from monthly reporting to a frequency of 2 times a year,
- 1 indicator started to be reported as part of consolidation reporting,
- other indicators were left with a clear definition of reporting or defining the formula for calculating the given indicator in order to achieve maximum standardization.

The result was a proposal of key performance indicators from the point of view of consolidation and their further use within 12 companies in which the implementation of the controlling transformation is underway.

4. CONCLUSION

The reference company in which were implemented the transformation of controlling is a large company belonging to the electrical engineering industry and its majority owner is foreign. The reference company is among the companies in which the transformation of controlling is taking place. During the implementation of controlling, lean principles were applied. We consider the elimination and standardization of controlling processes to be the greatest advantages brought by the transformation of controlling. We consider the reduction in the number of employees to be the biggest disadvantage brought about by the transformation of controlling, due to the high risk of "know-how" outflow. The quality of the controlling data was not reduced, rather the opposite. Before the transformation of controlling, each company had a specific method of calculation and analysis, the data could not be consolidated within the concern. Thanks to the transformation, we achieved a standardized approach for each business without manual adjustments, which lead to transparent consolidation. There was a reduction in the number of key performance indicators, which can be considered as a positive impact of the controlling transformation. Data consolidation was not possible in this case either. The reduction in the number of key indicators has resulted in a focus on those key indicators that have the greatest added value from the point of view of the strategy. Thanks to the transformation of controlling, the reference company has established reporting standardization. Reporting is centralized through a centre of expertise, which ensures transparent reporting without manual intervention. On the basis of the above, we assess that the transformation of controlling in the reference company resulted in the reporting being up-to-date, clear and flexible.

The transformation of controlling is more than a current topic also within the framework of "Industry 4.0. It should be remembered that this is an ongoing process and not a one-time exercise. During the transformation process, there will be various aspects that require a special approach. It is important that a business is not afraid to reassess its transformation plan if the situation calls for it. Only in this way will the company be able to develop.

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EKONOMICKÉ DOPADY AI NA TRH PRÁCE

ECONOMIC IMPACTS OF AI ON THE LABOR MARKET

Jana ŠPANKOVÁ[18]

Abstrakt: *Štúdia sa zaoberá vplyvom umelej inteligencie (AI) na zamestnanosť. Prostredníctvom systematického prehľadu literatúry, založeného na metódach PRISMA a bibliometrickej analýze z databázy Web of Science, boli identifikované hlavné otázky v tejto problematike v období rokov 2020 – 2025. Výsledky poukazujú na zmeny v štruktúre trhu práce, transformáciu požiadaviek na zručnosti a rastúci dopyt po vysoko kvalifikovanej pracovnej sile. Autori zároveň reflektujú na otázky týkajúce sa mzdových rozdieloch, nerovnosti, etických otázkach a potrebe vzdelávania. Kľúčovým zistením je, že umelá inteligencia má potenciál zvýšiť produktivitu a vytvoriť nové pracovné príležitosti, zároveň však prináša výzvy spojené s adaptáciou zamestnancov a rizikami pre niektoré profesie.*

Kľúčové slová: *umelá inteligencia, trh práce, literature review, Prisma, WOS*

Abstract: *The study examines the impact of artificial intelligence (AI) on employment. Through a systematic literature review based on PRISMA methods and a bibliometric analysis of the Web of Science database, the main issues in this field were identified for the period 2020–2025. The results highlight changes in the structure of the labour market, the transformation of skill requirements, and a growing demand for a highly skilled workforce. The authors also reflect on issues related to wage disparities, inequality, ethical concerns, and the need for education. A key finding is that artificial intelligence has the potential to increase productivity and create new employment opportunities, but it also brings challenges related to workforce adaptation and risks for certain professions..*

Key words: *artificial intelligence, labour market, literature review, Prisma, WOS*

JEL Classification: J21, J24, O33

1. ÚVOD

Rýchly rozvoj umelej inteligencie (AI) a automatizácie predtsavuje jeden z najvýznamnejších a nezvratných trendov v súčasnej spoločnosti, ktoré sa dotýkajú aj trhu práce. Tieto technológie čoraz viac formujú podobu existujúcich, ale aj budúcich pracovných miest. V tomto kontexte sa preto ako výzva javí potreba kvalifikovaných ľudských zdrojov na trhu práce. Obrovskou výhodou AI je, že dokáže automatizovať rutinné a opakujúce sa úlohy, čo ľuďom umožňuje sústrediť sa na komplexnejšiu a kreatívnejšiu prácu, zároveň môže zvýšiť produktivitu a efektivitu najmä v odvetviach, kde je čas dôležitým faktorom, napríklad výroba či logistika. Výhodou je aj možnosť zníženia nákladov na pracovnú silu automatizáciou niektorých úkonov, čím sa zníži potreba ľudskej práce. To môže byť zaujímavé pre odvetvia, kde sú vyššie mzdové náklady, napríklad zdravotníctvo a maloobchod. AI je zaujímavá aj tým, že pomôže analzovať množstvo údajov, pomáha vyvíjať nové produkty a služby, napríklad technológiou jazykového prekladu umožní mnohým spoločnostiam expandovať do nových geografických regiónov. Popri nesporných výhodách z používania umelej inteligencie existujú však aj isté obavy, najmä z ohrozenia pracovných miest. Je veľmi pravdepodobné, že pracovné miesta s nízkou kvalifikáciou alebo pracovné miesta, ktoré si vyžadujú opakujúce sa úlohy, budú postune eliminované. Avšak prispôsobenie sa pracovnému prostrediu ovplyvnenému využívaním nových technológií a vzdelávanie ľudských zdrojov bude viesť k udržateľnosti zamestnanosti na trhu práce.

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2. LITERÁRNA REŠERS

Od konca 18. storočia bol svet svedkom nástupu niekoľko období zrýchleného technologického pokroku, ktorý v posledných rokoch nastal, stali sa známymi pod názvom „priemyselné revolúcie“. Prvá priemyselná revolúcia, ktorá sa začala vo Veľkej Británii, predstavoval vynález tzv. parného stroja, ktorý umožnil prechod na nový výrobný proces. Pri druhej priemyselnej revolúcií, známej aj pod názvom „technologická revolúcia“, ktorá sa začala takmer o storočie neskôr, v 60. rokoch 19. storočia došlo k zavedeniu elektrickej a výrobnej linky. Tretia revolúcia, nazývaná aj „digitálna revolúcia“, začala v 50-tych rokoch 20. storočia a došlo k rozšíreniu digitálnych počítačov a rýchlemu rozvoju informačných a komunikačných technológii (IKT). Termín „štvrtá priemyselná revolúcia“ bol vytvorený zakladateľom Klausom Schwabom. Je charakterizovaná rozšíreným používaním širokého súboru nových technológií: umelej inteligencie, internetu vecí, robotiky, 3-D tlače (Schwab, 2016). V roku 2011 začala nemecká vláda silne podporovať priemyselný sektor strategickou iniciatívou, ktorá prevzala názov Priemysel 4.0 (Rojko, 2017). Každá jedna priemyselná revolúcia so sebou prináša výzvy, ktorým spoločnosť musela čeliť. (Schwab, 2016) Problematika umelej inteligencie a jej vplyvu na trh práce a na spoločnosť nie je otázkou posledných rokov. V minulosti sa práve kvôli technologickému pokroku stratilo množstvo pracovných miest. Množstvo autorov sa zameriava na skúmanie vplyvu AI na nezamestnanosť (Virgili, 2024; Dall'Anese, 2020; Makridakis, 2017; Kudoh, 2025). Niektorí autori sa na problematiku zavádzania AI z toho dôvodu pozerajú pesimisticky. V roku 2019 sa Andrea Renda vo svojej publikácii „Artificial Intelligence“ venoval tejto problematike a zdôrazňoval, že AI prevezme prácu ľudí. Na druhej strane mnohí konštatujú, že využívanie AI technológií neznamená automatický nárast nezamestnanosti (Mutascu, 2021; Gries a Naudé, 2018), ale práve zmeny, ktoré prebiehajú vo veku digitalizácie, nútia pracovnú silu adaptovať sa novému pracovnému prostrediu ovplyvneného využívaním AI technológií. (Abdeldayem a Aldulaimi, 2020). Meister (2019) predpokladal, že umelá inteligencia vytvorí viac pracovných miest, ako ich odstráni.

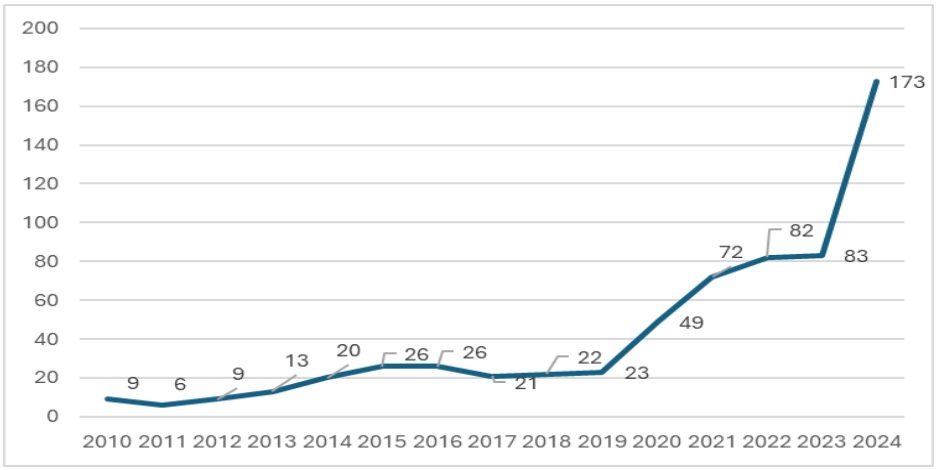
Téma umelá inteligencia sa stala predmetom diskusie v odborných kruhoch, o čom svedčí aj počet publikácii vo Wos a Scopus. Prvý príspevok v Scopus je registrovaný v roku 1966 pod názvom Artificial intelligence in automated design (Jirauch, 1966). Autor konštatuje, že v oblasti umelej inteligencie sa neustále vyvíjajú nové techniky, ktoré sú „príliš vzdialené“ na to, aby boli praktické. V databáze WoS nájdeme prvý článok, ktorý sa zaoberá AI a trhom práce v roku 1994, pričom autori zdôrazňujú využitie umelej inteligencie pri automatizácii výroby v meniacich sa výrobných prostrediach (Yazici et all, 1994).

2. CIEĽ A METODOLÓGIA

Štúdia sa zameriava na analýzu literatúry pomocou štatistickej metódy Prisma, na základe ktorej sa spracováva výber výskumov. Cieľom štúdie je identifikovať a analyzovať výskumné smery autorov, ktorých výskum obsahuje kľúčové slová súvisiace s umelou inteligenciou a trhom práce a ktorých štúdie sú dostupné na Web of Science podľa definovaných kritérií opísaných v nasledujúcej metodickej časti.

Na výber relevantnej literatúry sme si zvolili databázu Web of Science a ohraničili ju rokmi 2020 – 2024, nakoľko práve v tomto období zaznamenávame fázu intenzívneho rozvoja technológií v rôznych sektoroch, vrátane pracovného trhu, čo z neho robí relevantný časový rámec na analýzu aktuálnych trendov a dopadov. Na obrázku 1 ilustrujeme počet článkov, v ktorých sa nachádza kľúčové slovo “AI” a “trh práce”.

Obrázok 1: Použitie kľúčových slov "AI" a "trh práce v databáze Wos v rokoch 2010 - 2024

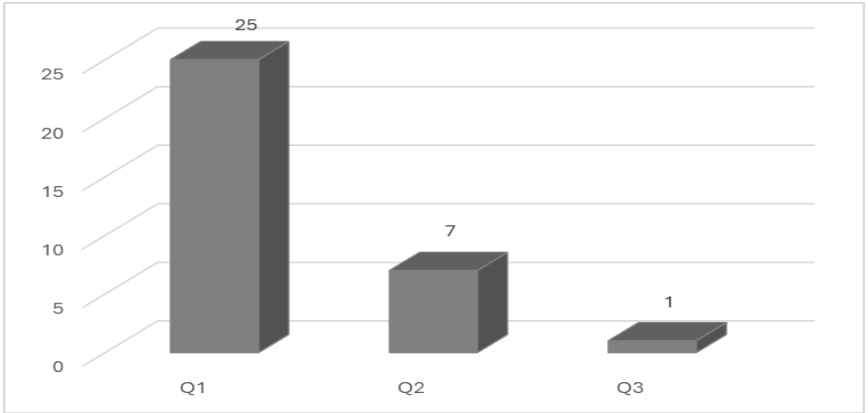


Zdroj: vlastné spracovanie

Vyhľadávací reťazec s kľúčovými slovami "AI" a „trh práce" sa používal v počiatočnom výbere relevantných štúdií (celkový počet n= 735). Ďalej sme filtrovali dokument typu – článok (562), Web of Science index SSCI (227), Web of Science kategórie – Ekonomika a Manažment (102 výsledkov). Ďalej sme vytriedili len články publikované v časopisoch v rokoch 2020 – 2025, nakoľko práve v týchto rokoch je téma aktuálna (93 výsledkov). Dostupných článkov, ktoré môžu byť použité v kontexte tejto štúdie je 48.

Použitím Journal citation reports (JCR), sme vytriedili 33 časopisov, ktoré splnili predchádzajúce kritériá. K 1Q 2025 bola problematika riešená najmä v časopisoch Q1 (25 časopisov), Q2 (7 časopisov) a Q3 (1 časopis).

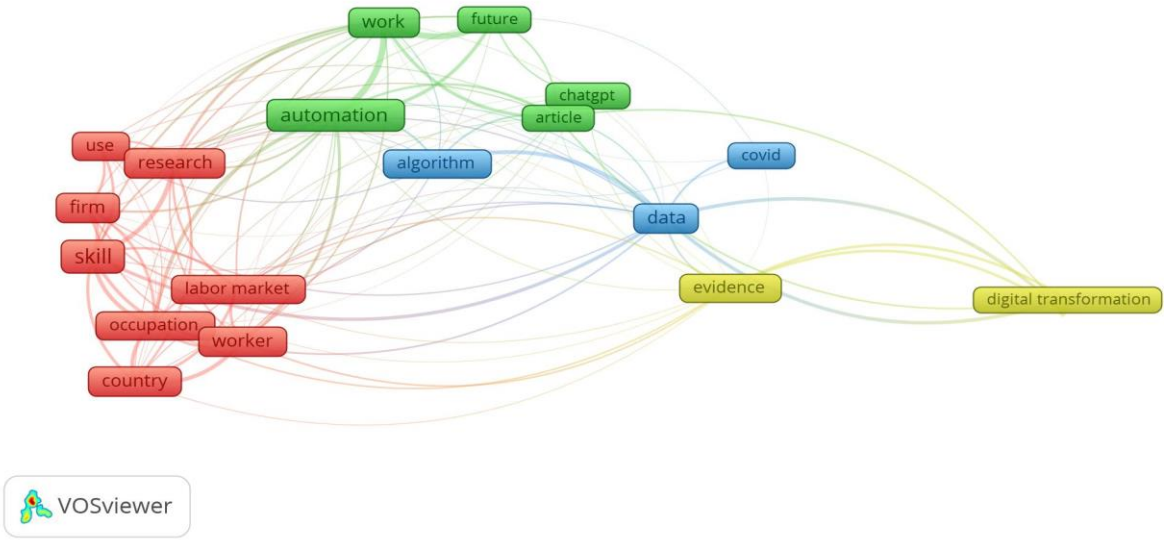
Obrázok 2: Počet štúdií publikovaných počas roku 2020 – 2025



Zdroj: vlastné spracovanie

Nasledujúca ilustrácia vizualizuje prepojenosť kľúčových slov použitých v článkoch Wos v kontexte výskumu umelej inteligencie. Medzi najpoužívanejšie slová patrili: digitálna transformácia, podnikové ESG stratégie, automatizácia, zručnosti, práca, trh práce.

Obrázok 3: Mapa kľúčových slov



Zdroj: vlastné spracovanie

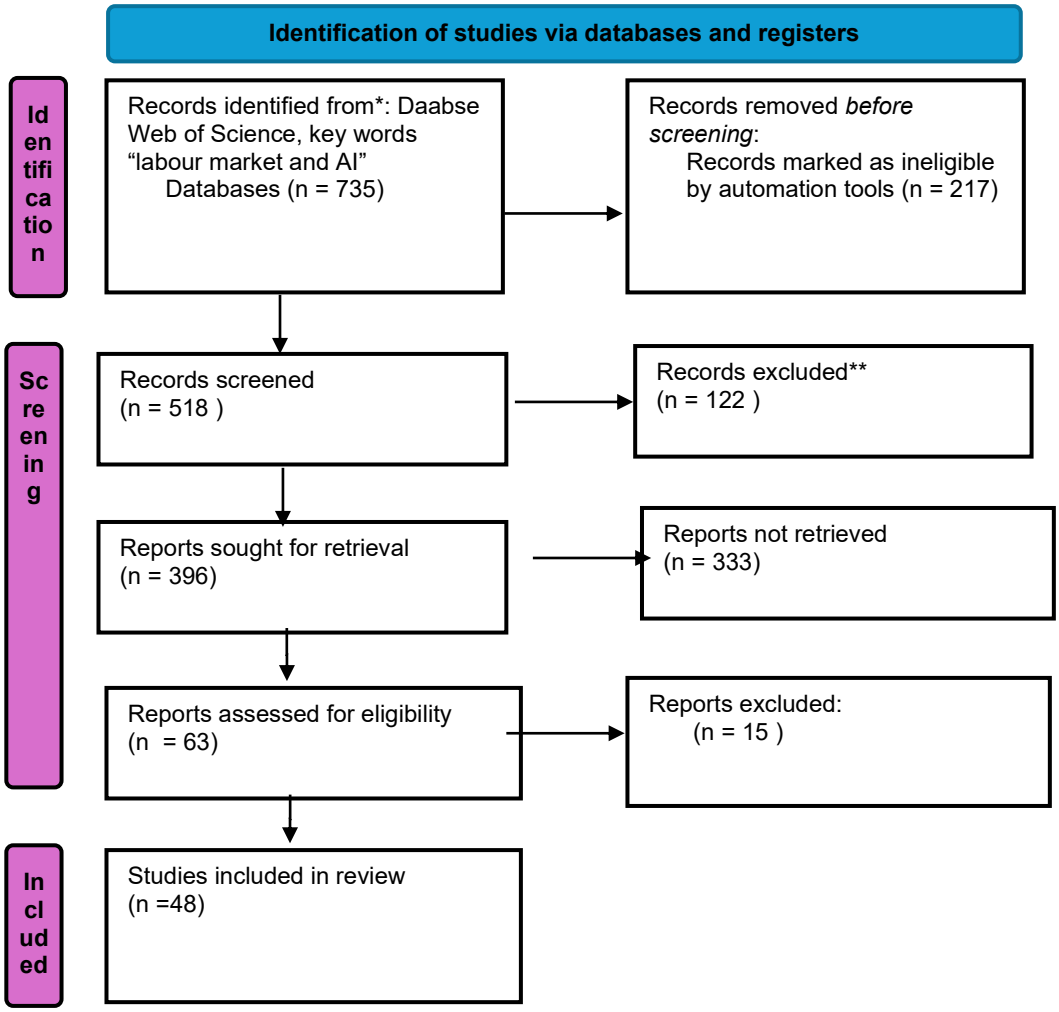
Na základe mapy môžeme definovať štyri tematické oblasti. V prvom rade je to automatizácia a budúcnosť práce, kde sa štúdie zameriavajú na vplyv automatizácie na charakter práce. Ďalšia oblasť je trh práce a zručnosti, teda aké zručnosti budú potrebné v budúcnosti, ako sa menia existujúce povolaniapod vplyvom AI. Treťou obasťou sú štúdie zaoberajúce sa využitím AI počas pandémie COVID-19 aa poslednou je digitálna transformácia, ktorá poukazuje na širší kontext, vývoj a implementáciu AI.

Medzi najcitovanejších autorov patrí Acemoglu a kol. (2022) s najväčším počtom citácii (149) s článkom, v ktorom skúma vplyv umelej inteligencie na trhy práce v Spojených štátoch od roku 2010. Ďalším najcitovanejším autorom je Alekseeva a kol (2021) s 86 citáciami. V článku sa zameriava na požiadavky na zručnosti v online voľných pracovných miestach. Prüfer and Prüfer (2020) s 68 citáciami v článku popisuje najvýznamnejšie metódy vedy o údajoch vplavu AI, poskytuje odkazy na literatúru a internetové zdroje, dospel k záveru, že ďalšie štúdium podnikateľských zručností vo všeobecnej populácii – mimo sféry podnikateľov – je vďačným predmetom budúceho výskumu.

Postup, ktorým sme prišli ku konečnému počtu článkov uvádzame na obrázku 4 PRISMA modely (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). Tento model bol navrhnutý tak, aby transparentne a systematicky informoval o postupe report a spracovania prehľadov literatúry. Bol vytvorený na základe metodiky načrtnutej v iných publikáciách (Page a kol., 2021; Moher, 2009).

Prvý výber výskumných článkov bol založený na podmienke výberu relevantných zdrojov, ktorá je popísaná v úvodnej časti metodiky. Štúdium musí byť z kategórie ekonómia alebo manažment, článok typu dokumentu, index Web of Science (SSCI) a otvorený prístup. Podmienkou boli aj články, ktoré boli uverejnené v rokoch 2020 – 2025, nakoľko v tom období sa o AI začalo publikovať najviac.

Obrázok 4: PRISMA diagram



Zdroj: vlastné spracovanie

Cieľom článku je analyzovať existujúce štúdie a publikácie týkajúce sa vplyvu umelej inteligencie na trh práce. Zameriavame sa na identifikáciu hlavných trendov, výziev a príležitostí, ktoré umelá inteligencia prináša do oblasti zamestnanosti a pracovných miest. Primárne sme čerpali z databázy Web of Science (WoS) a Scopus, ktoré poskytujú prístup k širokému spektru vedeckých článkov a štúdií. Zároveň sme študovali realizované výskumy v tejto oblasti. Analyzujeme viacero faktorov, ktoré môžu ovplyvniť trh práce a identifikujeme ich relatívnu dôležitosť.

3. VÝSLEDKY A DISKUSIA

Umelá inteligencia (AI) sa objavuje ako transformačná inovácia s potenciálom viesť k výraznému ekonomickému rastu a zvýšeniu productivity (Damioli, 2025). Mnohí autori, ale aj prax poukazujú na dôležitosť zmeny vo vzdelávaní. Pre pracovníkov je dôležité, aby boli ochotní neustále sa zlepšovať v svojich zručnostiach (Lloyd and Payne, 2019). V kontexte článkov môžeme konštatovať, že sa zameriavajú na viaceré oblasti. Najviac autorov sa zameriava na vplyv umelej inteligencie na štruktúru trhu práce a zručnosti. Analýza štúdii niektorých autorov (Marinas et al., 2024; Holm a Lorenz, 2022; Istudor et al., 2024; Hui, 2024; Popa, 2024) naznačuje, že umelá inteligencia mení požiadavky na zručnosti, najmä v náročnejších pozíciách, pričom by mala mať pozitívny vplyv na zamestnanosť vysokoškolsky

vzdelaných pracovníkov. Štúdia zo Slovenska (Valaskova et al., 2024) upozorňuje na pomalšiu adaptáciu na Industry 4.0 v dôsledku nedostatočného vzdelávacieho systému a štátnej podpory, čo môže ovplyvniť schopnosť pracovníkov prispôsobiť sa zmenám. Preto je nevyhnutná adaptácia vzdelávacieho systému a zvýšenie digitálnej gramotnosti. Autori sa zhodujú v tom, že AI má potenciál zásadne zmeniť ekonomiku a spoločnosť, pričom trh práce je jednou z najvýznamnejšie ovplyvnených oblastí. Znalosti o AI zvyšujú aj mzdy zamestnancov. Pracovníci na AI projektoch dostávajú o 3,0%-3,2% vyššie mzdy ako pracovníci na non-AI projektoch na skúmanom online trhu práce. To naznačuje existenciu mzdovej prémie spojenej s prácou na AI projektoch. (Duch-Brown et al. (2022). Pracovné ponuky, ktoré vyžadujú AI zručnosti v USA v rokoch 2010-2019 ponúkali o 11% vyšší plat v rámci rovnakej firmy a o 5% vyšší plat v rámci rovnakej pracovnej pozície v porovnaní s pozíciami bez požiadavky na AI zručnosti. (Alekseeva et al. (2021; Maer Matei, 2023). Autori v publikáciách sa zaoberajú nielen mzdovými výhodami, ale zároveň upozorňujú aj na príjmovú nerovnosť a nerovnosť na trhu práce. (Lazaroiu et al. (2024); Acemoglu et al. (2022) Holm a Lorenz (2022, Corrocher, 2024; Dawid, a Neugart 2023; Stephany, 2024)

Ďalšia skupina autorov sa zameriava aj na výzvy a riziká spojené s AI na trhu práce (Otoiu, 2022). Existujú obavy z prepúšťania pracovníkov v niektorých sektoroch, z prehĺbenia ekonomickej nerovnosti, znižovania dopytu po nízko kvalifikovanej práci (starší pracovníci, nízko kvalifikovaní a niektoré marginalizované skupiny sú označovaní za najviac ohrozených) a rastu potreby vysoko kvalifikovaných pracovníkov (Badea et al., 2024; Lazaroiu et al., 2024). Zároveň však použitie AI môže zvýšiť produktivitu a demokratizovať prístup k znalostiam a odbornosti (Komp-Leukkunen, 2024). Li (2024) konštatuje, že technológia AI má pozitívny vplyv na zamestnanosť spoločností tým, že zvyšuje tržby z predaja a zmierňuje finančné obmedzenia (Gans, 2023; Hammer a Karmakar, 2021). Rovnako aj Carbonero (2023) upozorňuje, že dopady digitalizácie a technológií umelej inteligencie na trhy práce sú mnohostranné.. Pracovníkom vykonávajúcim prevažne pracovné činnosti, ktoré sa dajú automatizovať (napríklad Chat GPT – Bolos,2024), hrozí, že ich digitálne stroje vytlačia. Povolania, ktoré kombinujú činnosti, ktoré sa nedajú automatizovať, s tými, ktoré sa dajú, sa však pravdepodobne zmenia. Pracovníci v týchto povolaniach môžu mať prospech z úzkej spolupráce s novými digitálnymi technológiami, a nie z ich vytláčania strojmi.

Potreba vzdelávania sa očakáva aj od softvérových odborníkov, rovnako ako od iných pracovníkov, pretože tiež budú čeliť voľbe medzi zvyšovaním kvalifikácie alebo stratou časti svojej zamestnateľnosti, hoci v oveľa menšej miere (Komp-Leukkunen, 2024). Podľa výskumu Cretu a kol. (2025) mladí ľudia s technickými (tvrdými), ale aj prierezovými (mäkkými) zručnosťami majú oveľa vyššiu mieru zamestnanosti v troch hlavných smeroch: „Manažér služieb“ (správca služieb), ktorého úloha sa využíva na prepojenie IT a podnikania. životné prostredie; obchodný analytik, vývojár a tester – obchodný analytik, vývojár softvéru a ten, kto testuje a overuje vytvorené riešenie; a používanie vytvorených softvérových botov podnikateľským prostredím (koncovými používateľmi). Rovnako aj výskum Albaness a kol. (2025) sa venoval prepojeniu medzi vývojom na trhu práce a novými technológiami, ako je umelá inteligencia (AI) v období rokov 2011–2019. V záveroch konštatuje, že v priemere sa zvýšil podiel zamestnanosti v povolaniach, ktoré sú viac vystavené AI. Platí to najmä pre povolania s relatívne vyšším podielom mladších a kvalifikovaných pracovníkov.

Zároveň je témou článkov aj etické využívanie AI. Nová vlna digitalizácie a UI prináša potrebu aktualizácie politík trhu práce a riešenia otázok ako ochrana údajov, etické využívanie UI a politika hospodárskej súťaže (Dolado et al., 2021; Jones, 2023; Qin, 2024; Abrardi, 2024).

V diskusiách sa začína polemizovať o tom, ako je digitálna transformácia prospešná pre optimalizáciu štruktúry ľudského kapitálu, zrýchlenie zelených technologických inovácií a zlepšenie efektívnosti riadenia, čím sa zlepší výkonnosť podnikového ESG.(You, 2024)

Digitálna transformácia v každom prípade zvyšuje výkonnosť podnikového ESG prostredníctvom modernizácie ľudského kapitálu.

Vplyv AI na trh práce je komplexný a mnohostranný. Zatiaľ čo existuje potenciál pre zvýšenie productivity (Kljčnikov2023), hospodárskeho rastu (Batabyal, 2024)a vytvorenia nových pracovných miest, zároveň nemôžeme nevidieť aj existujúce riziká spojené so substitúciou práce, prehĺbením nerovností a potrebou adaptácie zručností. Dôležitú úlohu zohrávajú politiky trhu práce, vzdelávací system, schopnosť spoločností a jednotlivcov prispôsobiť sa týmto zmenám.

4. ZÁVER

Rozmachom umelej inteligencie očakávame transformáciu priemyselných odvetví, predstavuje novú výzvy pre tvorcov finančných rozhodnutí zapojených do environmentálnej (Biggi, 2025), sociálnej a verejnej správy (ESG). Algoritmy AI sa stali jedným z najsľubnejších nástrojov na riešenie výziev ESG spojením obrovského množstva generovaných údajov a pokročilých metód spracovania s cieľom získať cenné poznatky a robiť optimálne rozhodnutia v každodennom živote (Burnaev, 2023). Zároveň sa zaujímavou diskusiou javí aj riadenie outsourcingu AI z pohľadu dodávateľov, vzťah medzi klientom a dodávateľom, zmluva o outsourcingu a súvisiace dokumenty, ako je úroveň služieb a správy o audite (Beulen, 2022). Problematika je veľmi široká a v budúcnosti očakávame presnejšie výsledky, resp. aj ekonomické prepočty. Tým sa otvára ďalší priestor na výskum v tejto oblasti.

Dodatok

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TRENDS IN HUMAN TECHNOLOGY INTERACTION AND WORK TRANSFORMATION - BIBLIOMETRIC STUDY

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Abstract: *The implementation of new technologies presents challenges not only for the management of companies adopting these innovations but also impacts employees, who face the task of learning how to work with them. The introduction of new technologies is a key driver in the transformation of occupations, fundamentally altering traditional work processes. Given the significance of new technologies for both work and employees, it is essential to explore the interaction between people and technology. The presented article offers insights into trends in researchers' interest in human-technology interaction and the areas investigated within this field. The findings reveal that the interaction between people and technology is closely linked to adaptation, decision-making, and learning. The results further highlight that areas such as simulation, skill development, and the transformation of physical workplaces into virtual ones are integral to understanding how people interact with technologies.*

Key words: *digital skills, human-technology interaction, virtual workplace, work transformation*

JEL Classification: *J24, D33, D83, L86, O33*

1. INTRODUCTION

Industrial engineering is focused on managing systems integrating people, materials, information, finance, equipment, energy. It is also focused on the development of these systems for streamlining the processes taking place in companies (Badiru, 2005; Kádárová et al., 2014). Manufacturing companies applying industrial engineering methods also increase their efficiency by adding new, digital and data-oriented methods and tools in various areas of industrial engineering (Deuse, 2022; Pivnička et al., 2022).

The implementation of new technologies is often associated with automation. Optimization of processes is aimed at identifying inefficient activities and their electronicization. It is often used to make manual or administrative work more efficient. Efforts to save costs are also promoted, which leads to the optimization of traditional professional work. Rather than introducing better manual systems, most current rationalizations within professions involve the introduction of technology. Automation uses technology to support their current ways of working. A large part of automation focuses on routine work, on laborious work, so it allows professionals to do their traditional work with the support of a more efficient machine. However, automation can also be transformative (Susskind and Susskind, 2015). In addition to possible benefits, the transition from human labor to technology can also present certain risks for the company and its employees. Machines can replace the performance of simple tasks, which can cause job losses for some groups of workers, especially those without technical skills (Schroeder et al., 2024). The future of work is affected by the substitution of

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human labour by machines, which harms workers, but also brings the so-called add-ons - additional tasks related to the advent of automation that are covered by human labour. The first version of the transformation of professions consists in simply a more efficient version of work, when various professionals use technologies mostly to make their traditional ways of working more efficient and optimized. The second version is that increasingly capable systems and machines, either operating independently or controlled by humans, are gradually taking over more of the tasks associated with these traditional experts. New technologies are "replacing" professionals in these activities (Susskind and Susskind, 2017). The transformation of work due to technology can also concern administrative work. The ultimate goal of work transformation is to break away from the traditional definition of work and move forward into a more flexible environment that strengthens employee responsibility. The transformation of work is based on facilities management, human resources and information technology working together to develop more creative ways of handling space in terms of the "real" office and the rapidly growing "virtual" office (Robertson, 2000).

Technology in the workplace is more important than ever. These technologies began as instrumental aids to support the office work of individuals, but have since become the basis for social interactions and community building in organizations, and more recently are able to perform managerial tasks using advanced AI capabilities. Emerging technologies can have different layers in the workplace. The digital work of technology in the workplace is intended to fulfil increasingly sophisticated functions in organizations: from instrumental to collaborative to intelligent extension. Individual layers of evolving technologies in the workplace can have both superficial and deeper effects on all types of workers, work patterns, and the deep structure of organizations. These effects include the emergence of increasingly complex configurations of digital technologies and the new work of people to manage these configurations (Baptista et al., 2020). The impact of digitization and automation on the work of employees is very significant in industrial enterprises. New technologies such as collaborative robots provide new possibilities for interaction, but require strategies to support adoption. Small and medium enterprises often lack coherent strategies to identify barriers and promote acceptance (Baumgartner et al., 2022). The digital transformation of industrial enterprises leads to the emergence of new technologies, processes and personnel requirements. The HR strategy must adapt to these changes so that the company's employees have the necessary qualifications and skills. Digital technologies make it possible to automate and optimize business processes, therefore the HR strategy must reflect these changes and take into account new roles and requirements for personnel. As technologies and processes change, there is a need to continuously educate and develop staff. Part of the HR strategy should be educational and development programs aimed at increasing digital skills. Studying the conceptual foundations of personnel strategy development in the conditions of digitization will help companies to effectively adapt to current challenges and ensure their competitiveness (Voronkova et al., 2024). The introduction of new technologies also enables faster communication and develops people's ability to work effectively in the information society (Bolek et al., 2018). The relationship between the interpretation of a new technology and users can make the difference between the success and failure of organizational change. Employees form interpretations of technology usefulness based on their interactions and experiences with technology, which supports their willingness to use new technologies in the future (Leonardi, 2009). Knowing the prerequisites and conditions of cooperation and also the investigation of the human factor in the interactions of people with machines and people with technologies is essential for increasing the performance of processes and organizations. Therefore, the main aim of presented article is to explore the evolution of interest in human technology interaction (HTI) and work transformation and related areas based on published research and studies. The relationship between technology, labour transformation and the human factor is illustrated in Figure 1.

Figure 1: The relationship between technology, labour transformation and the human factor

Source: (own elaboration, 2024)

The Figure 1 illustrates that the introduction of new technologies transforms work, which has a direct impact on people. Conversely, the way in which people perform their work affects the effectiveness of the technologies used.

Developing research findings on work transformation in the context of human-technology interaction involves understanding technology user acceptance and use of technology and digital technologies (Pintádo et al., 2023). Intelligent human-computer interaction technologies such as speech recognition and natural language processing are designed for complex work environments (Tegtmeier et al., 2023). The impact of intelligent machines such as robo-advisors on employees in the financial sector highlights the need for future workforce skills. Together, these studies highlight the importance of integrating technology with human-centred approaches to support digital transformation in diverse organizations (Altrock, 2023).

2. MAIN AIM AND METHODOLOGY

The main aim of the article is to present the results of an analysis aimed at investigating trends in the interaction between people, technology and work transformation.

To achieve the main aim of the article, an analysis of the scientific databases Web of Sciences (WoS) and Scopus was carried out. As part of the analysis, the search filter was used: Article title, Abstract and Keywords. The specified search allows you to find the largest possible range of results. The main reason for choosing the search filter is the fact that both databases include abstracts. Subsequently, we entered the key term Human – Technology Interaction. The same procedure was chosen for both scientific databases.

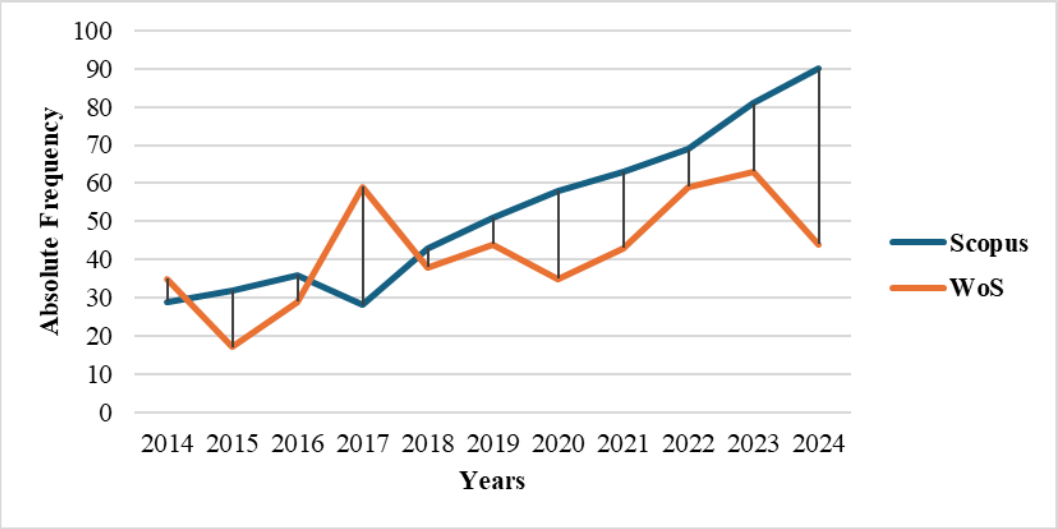
Several scientific methods and tools were used in the analysis. Among the used scientific methods (thought operations), which were used in the research, we can include: analysis, deduction, induction, synthesis, generalization and categorization, which were used in all parts of the article. Furthermore, the basic tools of statistical analysis (descriptive statistics) were used in the data analysis: tables of absolute and relative frequencies, histograms and line diagrams for data interpretation. An important tool used in the analysis was the VOSviewer software. The VOSviewer software is a powerful tool specially developed for the visualization and analysis of bibliometric networks, focusing on various aspects of scientific data such as co-authorship, citation networks, keywords or thematic similarities. Created by researchers at Leiden University in the Netherlands, this software is highly effective at mapping and graphically representing relationships within large data sets such as those from the Web of Science or Scopus (van Eck and Waltman, 2010). The created data files from the WOS and Scopus databases were processed as part of the quantitative analysis using the VOSviewer software. A qualitative analysis of selected literary sources was used as part of

the processing of theoretical starting points. The last analytical tool used by the authors was the Web of Science Research Assistant. The Web of Science (WoS) Research Assistant is a generative artificial intelligence tool from Clarivate that helps researchers efficiently navigate and process the scientific literature. One of the main functions of the WoS Research Assistant is support in the preparation of a literature review. The tool searches for relevant articles and key publications, allowing users to understand the evolution of certain scientific concepts and identify influential works in the field. WoS Research Assistant also provides personalized information about the main researchers, institutions and developments occurring in a given topic (Clarivate, 2024).

3. RESULTS AND DISCUSSION

The mentioned part of the performed analysis contains a quantitative analysis, which includes analyzes of the scientific databases Scopus and WoS. The analysis of the key term Human – Technology Interaction brought the finding that a total of 585 publications on the given topic are registered in the WoS database and a total of 764 publications are registered in the Scopus database. Subsequently, the All Open Access filter was applied, which narrowed the number of publications to: WoS contains 212 publications and Scopus contains 240 publications after applying the filter. As part of the analysis, the interval from 2014 to 2024 was determined in order to find out the trend in occurrence in both analyzed databases. We can see the results in Figure 2.

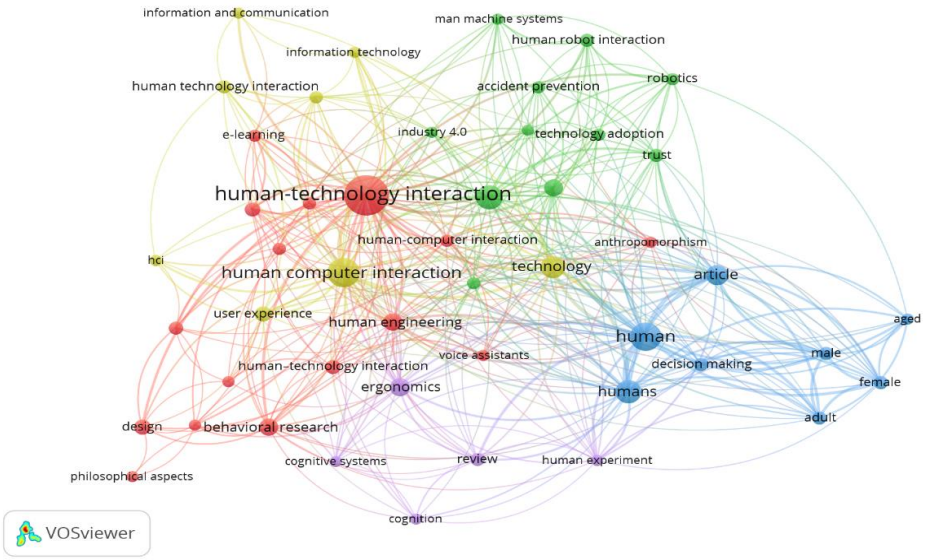
Figure 2: The trend of the occurrence of publications in the WoS and Scopus database



Source: (own elaboration, 2024)

It follows from Figure 2 that within the analysis of the observed period in the Scopus database, there is an increasing trend in the occurrence of publications on the topic of Human technology interaction, on the contrary, the trend is not linear in the WoS database. The decrease in 2024 is due to the fact that the analysis was not carried out after the registration of all publications was completed. In 2017, the number of publications was the second highest (59). The authors created data files that were compared to each other to exclude duplicates and proceeded to the analysis with the help of VOSviewer software. Subsequently, the type of analysis: Co-occurrence and Unit of analysis: All keywords were selected. The results can be seen in Figure 3.

Figure 3: Co-occurrence analysis on the topic of Human Technology Interaction



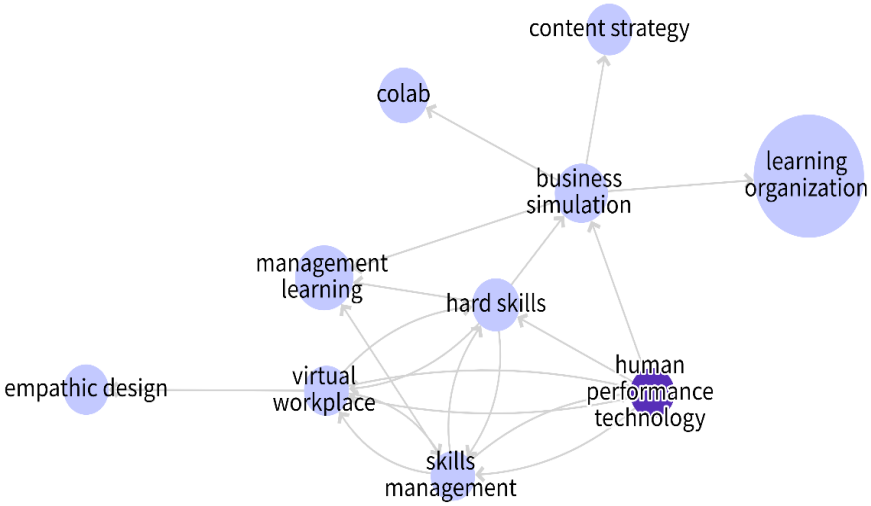
Source: (own elaboration, 2024)

Based on the Co-occurrence – All Keywords analysis performed in VOSviewer, the graphic map (Figure 3) is divided into five color clusters that represent related research areas and their key concepts in the context of human-technology interaction:

- **Red cluster (human-technology interaction):** This cluster includes terms related to HTI and user experience, such as “design,” “behavioural research,” “user experience,” and “human engineering.” This cluster indicates a focus on aspects of design and user experience, as well as philosophical and behavioural research related to human interaction with technology.
- **Green cluster (technological adoption and robotics):** Included in this cluster are key terms such as “robotics,” “technology adoption,” “human robot interaction,” “accident prevention,” and “trust.” This cluster highlights aspects of technology, particularly robotics, and technology adoption in industries such as Industry 4.0. Also represented are issues of trust and human-robot interaction, which may inform research on public acceptance of robots and their safety.
- **Blue cluster (demographic aspects and decision-making):** This cluster includes terms such as "human," "male," "female," "aged," "decision making," and "article." The terms indicate demographic and psychological aspects of research focused on differences in decision-making processes and interactions between people of different ages. groups and genders.
- **Yellow cluster (technology and e-learning):** It includes terms such as "information and communication," "information technology," "e-learning," and "human technology interaction." This cluster focuses on topics related to the use of information and communication technologies in education and human-technology interaction, putting emphasis on information technology in the context of online education.
- **Purple cluster (ergonomics and cognitive systems):** This cluster includes key terms such as "ergonomics," "cognitive systems," "cognition," and "human experiment." Topics in this cluster focus on ergonomics and the cognitive aspects of human interaction with technology, which includes cognitive systems research and systems design, which are adapted to the cognitive abilities and physical needs of the users.

Furthermore, the issue of HTI was analysed with the help of the Web of Science Research Assistant. The result of the performed analysis can be seen in Figure 4.

Figure 4: WoS Research Assistant - Human Technology Interaction



Source: (own elaboration, 2024)

Figure 4 shows the results of a Human Technology Interaction key term analysis created using the Web of Science Research Assistant. This map shows the interrelationships between topics, which are represented by individual nodes and the links between them. The size of the nodes and the thickness of the lines indicate the frequency of occurrence and the strength of the connection between the concepts. The analysis of the mentioned relationships shows the following thematic concepts:

- **Business Simulation:** This central node is associated with several terms such as "learning organization", "content strategy", "colab" and "management learning". This suggests that business simulations are a key aspect in developing knowledge and skills within organizations and related to content sharing and collaboration strategies.
- **Learning Organization:** The term is linked to "business simulation" and "content strategy", which may indicate a focus on organizations that support continuous learning and adaptation to technological change. The association with "content strategy" suggests that organizations use strategies to effectively disseminate knowledge and support learning.
- **Human Performance Technology:** This node is linked to "skills management" and "virtual workplace" suggesting that improving people's performance in the work environment involves managing skills and using technology in a virtual environment. This topic can be related to the effort to improve the efficiency and productivity of employees using technological solutions.
- **Virtual Workplace:** This term is closely related to concepts such as "skills management" and "hard skills" suggesting that virtual work environments require specific management and development of professional skills. The mentioned area can be crucial in the context of the growing need for remote work and adaptation to new forms of work processes.

The map suggests that key themes in human technology interaction research are focused on skill development, organizational learning, collaboration, and user-centered design. Together, these concepts paint a comprehensive picture of how technology affects the work environment, learning and performance in modern organizations.

4. CONCLUSIONS

The results of the presented research provided an overview of the key trends in the interaction between people and technology and their impact on the transformation of the working environment. These findings are consistent with the theories at the beginning of the article describing how new technologies are radically changing workplace needs and requiring new skills. One of the dominant trends is the rise of automation and robotization, which confirms the theories of the "Fourth industrial revolution". The deployment of robots and automated systems reduces the need for manual tasks, but at the same time puts pressure on employees to acquire advanced technical and digital skills. Another significant trend is the growing importance of artificial intelligence, which transforms jobs and enables process optimization, which corresponds to theoretical assumptions about digital transformation and data analytics as a basis for decision-making. The research presented also highlights the change in the work environment with the transition to a hybrid work model that combines remote work with office work. Our findings provide an overview of the current trends in research, which subsequently reaches industrial practice.

Limitations of the research include the limited range of available data and methodological challenges associated with bibliometric analysis, such as the selection of databases and the possible bias of research papers in selected databases. These factors may have affected the results because they cannot fully cover all approaches and geographic differences within the field of human-technology interaction research.

In the future, research should focus on in-depth investigation of specific aspects, such as the psychological impact of technological changes on employees, analysis of educational systems in the adaptation of the workforce to new technological requirements. At the same time, the authors of the article plan to use the questionnaire method in the future, which will investigate the opinions of employees of industrial organizations in Slovakia.

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