

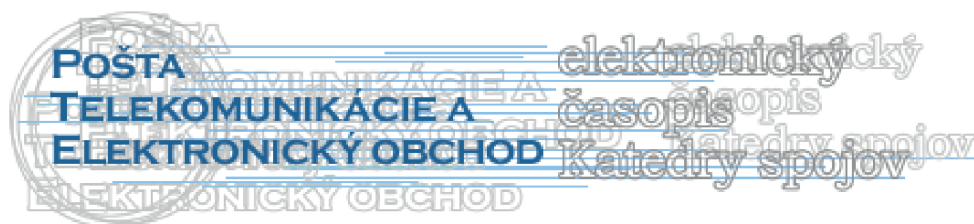
# POŠTA, TELEKOMUNIKÁCIE A ELEKTRONICKÝ OBCHOD

Elektronický vedecký časopis zameraný na problematiku poštových a telekomunikačných podnikov  
a oblasť elektronického obchodovania

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**Fakulta prevádzky a ekonomiky dopravy a spojov**  
**Katedra spojov**

## Pošta, Telekomunikácie a Elektronický obchod

Elektronický vedecký časopis profesne a obsahovo zameraný na problematiku z oblasti poštových a telekomunikačných podnikov, ako i prudko sa rozvíjajúcej oblasti elektronického obchodovania.

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## PERSPEKTÍVA VYUŽÍVANIA PLATFORMOVEJ PRÁCE AKO NOVEJ FORMY ZAMESTNANIA

Mariana Strenitzerová <sup>1</sup>

**Abstract:** The rapid rise of the platform economy is changing European labour markets. Platform work, defined as matching the demand and supply of paid work through an online platform, brings new challenges to workers. This is a new trend that is starting to develop in Europe. The aim of the article is to point out various aspects related to the platform work based on the results of primary and secondary research.

**Keywords:** new forms of employment, platform work, digital labour platforms, platform worker,

### Úvod

Spoločenský a ekonomický vývoj, ako napríklad zvýšená flexibilita na trhu práce a v podnikových politikách alebo využívanie pokrokových informačných a komunikačných technológií (digitalizácia), majú za následok vývoj nových foriem zamestnania. Líšia sa od klasických foriem, či už formou vzťahu zamestnávateľ - zamestnanec (resp. klient - samostatne zárobkovo činná osoba), alebo organizáciou práce (tzn. pracovný čas, miesto výkonu práce alebo používanie IKT). Od roku 2000 nadácia Eurofound (The European Foundation for the Improvement of Living and Working Conditions) mapuje nové trendy zamestnávania v členských štátoch EÚ, Nórsku a Spojenom kráľovstve. Na základe výsledkov z roku 2020 nadácia Eurofound zoskupila nové formy zamestnania do deviatich kategórií: *Zdieľanie zamestnancov (Employee sharing)*, *Zdieľanie práce (Job sharing)*, *Práca na základe poukážky (Voucher-based work)*, *Dočasné riadenie (Interim management)*, *Príležitostná práca (Casual work)*, *Mobilná práca založená na IKT (ICT-based mobile work)*, *Práca pre platformu (Platform work)*, *Portfóliová práca (Portfolio work)*, *Kolaboratívne zamestnanie (Collaborative employment)*. Pre relevantné formy zamestnania je charakteristické:

- *miesto výkonu práce iné ako priestory zamestnávateľa*, kde je zamestnanec mobilný a pracuje z viacerých miest, prípadne vrátane vlastnej kancelárie;
- *silná alebo prevládajúca podpora IKT* vrátane mobilných telefónov, osobných počítačov, tabletov a pod., kde táto technológia mení povahu pracovných vzťahov alebo organizáciu práce.

Nová forma zamestnania môže podliehať všeobecným pracovným zákonom alebo osobitným predpisom, môže byť regulovaná na základe kolektívnych zmlúv, alebo vôbec nie

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je regulovaná. Na obrázku 1 je uvedený všeobecný rámec pre identifikáciu nových foriem zamestnania [1].



**Obrázok 1** Všeobecný rámec pre identifikáciu nových foriem zamestnania (Zdroj: vlastné spracovanie podľa [1])

V praxi môže konkrétny pracovný pomer spadať do viac ako jednej z vyššie uvedených kategórií (napríklad platformoví pracovníci bývajú portfóliovými pracovníkmi). Mapovanie uskutočnené sieťou korešpondentov nadácie Eurofound odhalilo, že od roku 2020 väčšina analyzovaných foriem zamestnania existuje vo väčšine členských štátov EÚ, Nórsku a Spojenom kráľovstve, aj keď iba v okrajovom rozsahu.

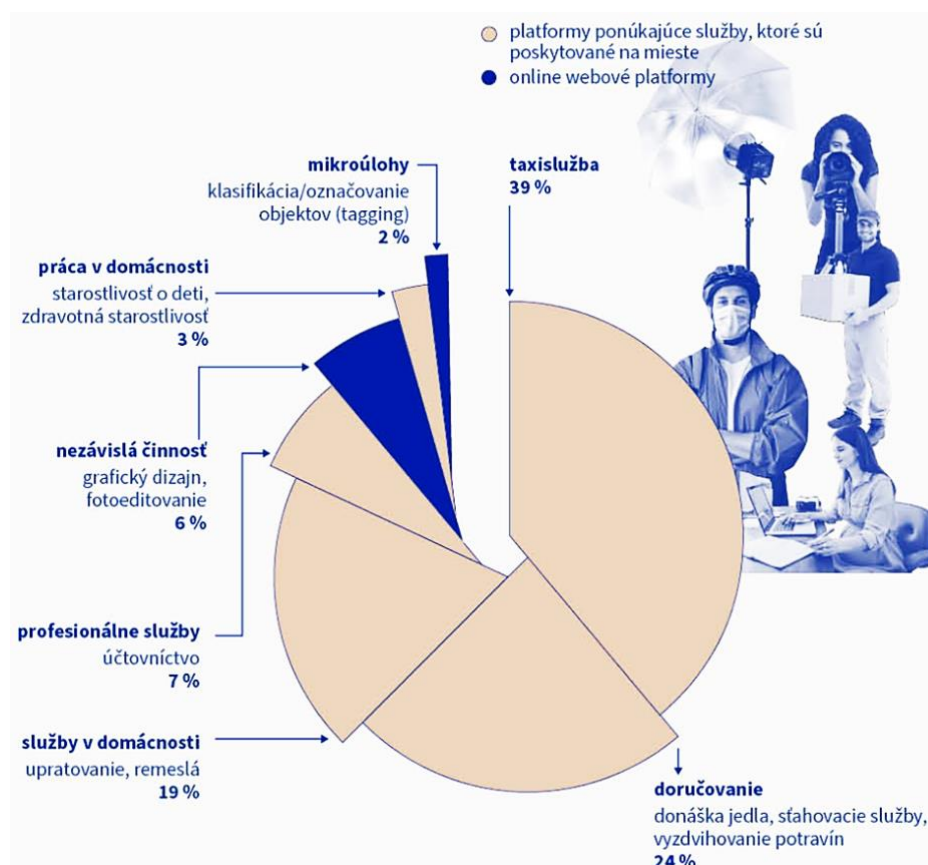
### Práca pre platformy, platformová práca

Práca pre platformy (resp. platformová práca) je novodobá forma zamestnania, kde online platforma spája organizácie a jednotlivcov s cieľom vyriešiť konkrétne problémy alebo poskytovať konkrétne služby výmenou za platbu. Do práce pre platformu sú zapojené tri strany: online platforma, klient a pracovník, pričom obchodný vzťah medzi nimi je typicky trojstranný a každá zo strán má svoju špecifickú úlohu a záujmy. Práca pre platformy má mnoho podôb a rôzny rozsah, niekedy sa nazýva aj „zákazková ekonomika“. Nadácia Eurofound identifikovala 10 typov práce pre platformy. Hlavnými rozdielmi medzi týmito typmi sú rozsah úloh, formát poskytovania služieb (či sa úlohy poskytujú lokálne alebo online), úroveň požadovaných zručností, proces, ktorým sa klienti spájajú s pracovníkmi (ponuka práce verzus konkurencia) a strana, ktorá určuje rozdelenie práce [2]. Digitálne pracovné platformy sa v súčasnosti delia na dva hlavné druhy, a to online webové platformy, v rámci ktorých sa úlohy uskutočňujú online na diaľku, a platformy založené na mieste, kde sa úlohy uskutočňujú priamo na konkrétnej fyzickej lokalite (osobne) (Obrázok 2). Online webové platformy poskytujú veľké množstvo služieb pre jednotlivých zákazníkov alebo podniky. Zahŕňajú slobodné povolania a súťaž, ako napríklad profesionálne úlohy (vývoj softvéru, grafický dizajn, či preklady textov), ďalej mikroúlohy, alebo lekárske konzultácie zabezpečujúce zákazníkovi lekárske poradenstvo priamo od lekárov prostredníctvom internetu. Platformy založené na mieste umožňujú prístup k službám ako sú taxislužby a doručovanie, ktoré sa odvíjajú od tradičného pracovného trhu. Rovnakým spôsobom sú sprostredkované aj služby a práca v domácnosti a opatrovateľské služby, kde pracovníci vykonávajú služby priamo v domácnostiach zákazníkov [3].



**Obrázok 2 Digitálne pracovné platformy** (Zdroj: vlastné spracovanie podľa [3])

Všetky služby sa poskytujú prostredníctvom platforiem založených na polohe, okrem slobodných povolání a mikrouloh, ktoré sa vykonávajú prostredníctvom online webových platforiem (Obrázok 3). Z hľadiska požadovaného stupňa zručností sa druhy platformovej činnosti rozdeľujú na činnosti vyžadujúce nízky stupeň zručností (70 %), stredne nízky až stredný stupeň zručností (20 %), vysoký stupeň zručností (6 %) a ich kombinácia (4 %). Väčšina služieb (83 %) sa poskytuje individuálnym klientom, zvyšok (17 %) sa poskytuje podnikom alebo kombinácii jednotlivcov a podnikov [4].



**Obrázok 3 Zárobky osôb pracujúcich prostredníctvom platforiem podľa typu poskytovanej služby** (Zdroj: vlastné spracovanie podľa [4])

V EÚ pôsobí približne 500 digitálnych pracovných platforiem. Digitálne pracovné platformy sú aktívne v každej krajine EÚ. Rast platformovej ekonomiky ilustruje skutočnosť,

že v rokoch 2016 až 2020 sa príjmy v platformovej ekonomike zvýšili takmer päťnásobne z odhadovaných 3 miliárd EUR na približne 14 miliárd EUR. Odhaduje sa, že najväčšie príjmy pochádzajú z odvetvia doručovacích služieb a taxislužieb.

## Platformoví pracovníci

V EÚ pracovalo v roku 2022 prostredníctvom (jednej či viacerých) digitálnych pracovných platforiem viac ako 28 miliónov ľudí. Očakáva sa, že v roku 2025 tento počet dosiahne 43 miliónov [4]. Z 28,3 milióna ľudí pracujúcich pre platformy je zamestnaných 7 % (2 milióny) a 93 % (26,3 milióna) sú samostatne zárobkovo činné osoby. Spomedzi samostatne zárobkovo činných osôb je 19 % pravdepodobne nesprávne klasifikovaných (približne 5 miliónov). Najčastejšie vykonávajú prácu na platforme muži vo veku do 35 rokov, väčšina má vyššiu úroveň vzdelania nad rámec stredného vzdelania, práca pre platformu býva ich vedľajším zdrojom príjmu popri bežnom zamestnaní [4].

Z hľadiska motivácie k platformovej práci rozlišujeme päť rôznych typov platformových pracovníkov, z ktorých každý má odlišné motivačné stimuly:

1. *Hľadači*: Sú závislí od platformovej práce na finančné prežitie, ale hľadajú stabilné zamestnanie.
2. *Profesionáli*: Prijímajú platformovú prácu ako dlhodobú kariéru a využívajú platformy na kreatívne príležitosti.
3. *Krátkodobí pracovníci*: Využívajú platformovú prácu dočasne na doplnenie príjmu, bez finančnej závislosti.
4. *Dlhodobí pracovníci*: Spoliehajú sa na platformovú prácu na doplnenie neistého finančného stavu, pričom si udržiavajú iné zamestnanie.
5. *Príležitostní pracovníci*: Zapoja sa do platformovej práce príležitostne, zvyčajne z neekonomických dôvodov [5].

Pre mnohých pracovníkov je hlavnou motiváciou možnosť rozhodovať o svojom pracovnom čase a mieste práce. To poskytuje určitú mieru sebestačnosti, čo je často vnímané ako pozitívny aspekt platformovej práce. Niektorí pracovníci vykonávajú platformovú prácu, aby doplnili svoj príjem, alebo preklenuli obdobie nezamestnanosti. Pre týchto ľudí je platformová práca nevyhnutnosťou, často ju vnímajú ako dočasné riešenie, pokiaľ nenájdu stabilnejšie zamestnanie. Existujú aj takí pracovníci, ktorí platformovú prácu vnímajú ako celoživotnú kariéru a strategicky využívajú rôzne platformy na maximalizáciu svojho zárobku, najmä v oblastiach vyžadujúcich vyššie odborné znalosti, zručnosti a profesionálny prístup [5].

Platformová práca ponúka pracovníkom na digitálnych pracovných platformách mnoho výhod, ako napr. flexibilita pracovného času, autonómia, práca na diaľku, resp. rýchly prístup k pracovným príležitostiam [6-8]. Na druhej strane, platformová práca je spojená s určitými nevýhodami, napr. neisté zamestnanie, nedostatok sociálnych benefitov, tlak na plnenie úloh za nízku mzdu, nedostatočná regulácia pracovných podmienok, závislosť na algoritmoch, riziko vyhorenia, kedy vystavenie veľkému tlaku plniť úlohy v krátkom čase môže viesť k fyzickému a emocionálnemu vyčerpaniu [9-13].

Platformová práca je založená na využívaní algoritmov na riadenie ľudských zdrojov. Platformy používajú algoritmy na optimalizáciu svojej činnosti, výber a riadenie pracovníkov, určovanie cien, pridelovanie úloh, hodnotenie výkonu a pod.:

- *Pridelenie úloh*: Algoritmy používajú rôzne faktory na pridelovanie úloh pracovníkom, ako sú ich poloha, hodnotenie, rýchlosť odpovedí a dostupnosť. Napríklad, vodiči Uberu alebo Boltu dostávajú objednávky na základe svojej aktuálnej polohy a historických výkonnostných údajov.

- *Dynamické oceňovanie*: Ceny za služby na platformách sú často určované algoritmami na základe dopytu a ponuky v reálnom čase. Počas špičkových hodín, keď je dopyt vysoký, môžu byť ceny zvýšené, aby motivovali viac pracovníkov k prijatiu úloh.
- *Hodnotenie a spätná väzba*: Pracovníci sú často hodnotení zákazníkmi a tieto hodnotenia môžu ovplyvniť ich šance na získanie ďalších úloh. Algoritmy zohľadňujú tieto hodnotenia pri rozhodovaní o tom, komu pridelit' úlohy.
- *Sledovanie výkonnosti*: Algoritmy môžu monitorovať výkonnosť pracovníkov, ako sú rýchlosť, presnosť a spokojnosť zákazníkov. Tieto údaje sa používajú na optimalizáciu pridelenia úloh a niekedy aj na rozhodnutia o tom, či bude pracovník ďalej spolupracovať s platformou.

Používanie algoritmov pri platformovej práci má svoje výhody, ale aj úskalia.

Výhodami sú:

- *Efektivita a optimalizácia*: Algoritmy umožňujú platformám efektívne riadiť veľký počet pracovníkov a zákazníkov v reálnom čase. Optimalizujú pridelenie úloh, čo znižuje prestoje a zvyšuje produktivitu.
- *Flexibilita pre pracovníkov*: Automatizované systémy umožňujú pracovníkom prihlásiť sa a odhlásiť podľa ich vlastného harmonogramu. Algoritmy môžu efektívne pridelať úlohy na základe dostupnosti pracovníkov.
- *Personalizované skúsenosti pre zákazníkov*: Algoritmy môžu prispôbiť služby individuálnym preferenciám zákazníkov, čo zlepšuje ich celkovú spokojnosť.

Algoritmické riadenie však prináša nedostatok transparentnosti, závislosť na hodnotení zákazníkmi, neistotu príjmu a riziko automatizovaného ukončenia práce:

- *Nedostatok transparentnosti*: Pracovníci často nevedia, ako algoritmy rozhodujú o pridelení úloh, cenách a hodnotení. Tento nedostatok transparentnosti môže viesť k pocitu nespravodlivosti a frustrácie.
- *Závislosť na hodnotení*: Algoritmické systémy sa spoliehajú na hodnotenia zákazníkov, ktoré môžu byť subjektívne alebo neobjektívne. Negatívne hodnotenie môže mať významný dopad na možnosti pracovníka získať ďalšie úlohy.
- *Neistota príjmu*: Dynamické oceňovanie a pridelenie úloh môžu viesť k nepredvídateľným príjmom. Pracovníci nemusia mať istotu stabilného príjmu, čo môže byť problém najmä pre tých, ktorí sa spoliehajú na platformovú prácu ako na hlavný zdroj príjmu.
- *Automatizované ukončenie spolupráce*: Algoritmy môžu rozhodnúť o ukončení spolupráce s pracovníkom na základe určitých kritérií (napr. nízke hodnotenia). Tento proces je často automatizovaný a pracovníci môžu mať obmedzené možnosti na odvolanie sa alebo vysvetlenie situácie.

Celoeurópske údaje o rozsahu platformovej práce nemajú komplexný charakter vzhľadom na jej špecifickosť a chýbajúcu súhrnnú definíciu a prístup k meraniu. Väčšina výskumov naznačuje, že 1 – 2 % pracovníkov vykonáva prácu pre platformy ako svoju hlavnú pracovnú činnosť a približne 10 % pracovníkov vykonáva prácu pre platformy príležitostne. Rozsah platformovej práce sa výrazne líši v jednotlivých krajinách Európskej únie. Rozhodujúcim faktorom sa javí situácia na trhu práce a situácia v oblasti zamestnanosti danej krajiny, a naopak menej ovplyvňujúcim faktorom je úroveň využívania IKT v krajine [1, 2].

Rozsah platformovej práce na Slovensku charakterizujú tieto výsledky sekundárneho výskumu: 6,1 % populácie vykonalo prácu na platforme, 7,1 % populácie vo veku 18 – 64 rokov vyskúšalo prácu na platforme, 1,2 % sú sporadickými pracovníkmi na platforme (vyskúšali si prácu na platforme, ale nie je to významná súčasť ich pracovného života), 2,2 % tvoria pracovníci na marginálnych platformách (menej ako 10 hodín týždenne a menej ako 25 % príjmu), 1,8 % tvoria pracovníci na sekundárnych platformách (10 – 19 hodín týždenne a/alebo 25 – 50 % príjmu), 0,9 % to robí ako svoje hlavné zamestnanie (viac ako 20 hodín

týždenne a/alebo aspoň 50 % príjmu), 1,1 % to robí aspoň mesačne, 0,4 % to robí aspoň týždenne, 1 % zarobilo aspoň 50 % svojho príjmu prácou pre platformu. [1, 2].

## Ciele a metodika

V článku sú interpretované čiastkové výsledky primárneho výskumu „Analýza povedomia a záujmu ekonomicky aktívneho obyvateľstva Slovenskej republiky o platformovú prácu“. Realizácia primárneho výskumu (marec 2024 – máj 2024) smerovala k hľadaniu odpovedí na výskumné otázky týkajúce sa povedomia respondentov o tomto type práce, zisťovaním vlastných skúseností s platformovou prácou a perspektívou využívania platformovej práce v budúcnosti [14]. Metodika primárneho výskumu:

- Forma realizácie výskumu: aplikovaný empirický kvantitatívny výskum s uzatvorenými otázkami. Potrebné informácie boli získané elektronickým dopytovaním prostredníctvom dotazníka vytvoreného v Google Forms, ktorý bol následne šírený na sociálnych médiách a odoslaný e-mailom zainteresovaným účastníkom štúdie prostredníctvom databázy e-mailov na stránke [www.free-lance.sk](http://www.free-lance.sk).
- Respondenti: skupina náhodných respondentov vyhovujúcich stanoveným segmentačným kritériám v SR. Vzorka predstavuje 400 respondentov, pričom 56,5 % tvoria muži a 43,5 % ženy. Z hľadiska vekovej štruktúry respondentov najpočetnejšou skupinou boli muži vo veku 26-35 rokov (39,8 %), a ženy vo vekovej kategórii 18-25 rokov (51,1 %). Z hľadiska najvyššieho dosiahnutého vzdelania u mužov dominovalo vysokoškolské vzdelanie (59,3 %), a u žien stredoškolské vzdelanie (56,3 %). Podrobná demografická štruktúra respondentov je znázornená v tabuľke 1.

**Tabuľka 1 Demografická štruktúra respondentov**

| <b>Muži</b>                  | 18 - 25 rokov | 26 - 35 rokov | 36 - 45 rokov | 46 - 55 rokov | 55 a viac rokov | <b>Spolu:</b> |
|------------------------------|---------------|---------------|---------------|---------------|-----------------|---------------|
| Základné                     | 1             |               | 1             |               | 1               | <b>3</b>      |
| Stredoškolské - bez maturity | 1             | 3             | 3             | 5             |                 | <b>12</b>     |
| Stredoškolské - s maturitou  | 35            | 25            | 16            | 1             |                 | <b>77</b>     |
| Vysokoškolské - 1. stupeň    | 18            | 80            | 15            |               |                 | <b>113</b>    |
| Vysokoškolské - 2. stupeň    | 3             | 7             | 6             | 1             |                 | <b>17</b>     |
| Vysokoškolské - 3. stupeň    |               |               | 1             | 2             | 1               | <b>4</b>      |
| <b>Spolu:</b>                | <b>58</b>     | <b>115</b>    | <b>42</b>     | <b>9</b>      | <b>2</b>        | <b>226</b>    |
|                              |               |               |               |               |                 |               |
| <b>Ženy</b>                  | 18 - 25 rokov | 26 - 35 rokov | 36 - 45 rokov | 46 - 55 rokov | 55 a viac rokov | <b>Spolu:</b> |
| Základné                     | 1             | 2             | 1             |               |                 | <b>4</b>      |
| Stredoškolské - bez maturity |               | 2             | 2             | 1             |                 | <b>5</b>      |
| Stredoškolské - s maturitou  | 66            | 17            | 7             | 2             | 1               | <b>93</b>     |
| Vysokoškolské - 1. stupeň    | 20            | 20            | 14            |               | 1               | <b>55</b>     |
| Vysokoškolské - 2. stupeň    | 1             | 3             | 7             | 2             | 1               | <b>14</b>     |
| Vysokoškolské - 3. stupeň    | 1             |               | 1             |               | 1               | <b>3</b>      |
| <b>Spolu:</b>                | <b>89</b>     | <b>44</b>     | <b>32</b>     | <b>5</b>      | <b>4</b>        | <b>174</b>    |

Zdroj: Vlastné spracovanie

- Použité metódy: štatistické zhodnotenie výsledkov v absolútnom a pomernom vyjadrení. Metóda benchmarking bola použitá pri porovnaní výsledkov primárneho výskumu realizovaného v SR s výsledkami sekundárneho výskumu s pôsobnosťou v EÚ.

## Výsledky a diskusia

Z výsledkov primárneho výskumu vyplýva, že

- 84 % respondentov pozná, alebo sa už stretli s pojmom platformová práca;
- 62,7 % respondentov má skúsenosti s prácou pre platformu, platformová práca sa stáva bežnou súčasťou ich pracovného života;
- 66,5 % respondentov vykonávajúcich platformovú prácu má vysokoškolské vzdelanie prvého, druhého alebo tretieho stupňa;
- 64 % respondentov pracujúcich pre platformy sú muži;
- Najpočetnejšou vekovou kategóriou respondentov pracujúcich pre platformy je muž do 35 rokov (32 %);
- 44 % respondentov vykonáva platformovú prácu v online prostredí, 39 % respondentov v offline prostredí a 17 % respondentov kombinovalo oba typy práce. Podrobná štruktúra jednotlivých typov práce je znázornená na obrázku 4;
- 16,7 % respondentov vykonáva prácu pre platformy ako svoju hlavnú pracovnú činnosť;
- Zo 149 respondentov, ktorí nepracovali pre platformy, 45 % uviedlo, že nevyužívali tento druh práce, pretože o ňom nevedeli, 36,9 % respondentov malo obavy z nejasného zamestnaneckého postavenia a 27,5 % respondentov z neúplnej legislatívy v oblasti platformovej práce. Približne 26,8 % respondentov považuje za nevýhodu riziká, ktoré nesie zamestnanec sám za seba. Niektorí respondenti doplnili dôvody ako povinnosť živnosti, nestálosť platforiem alebo nedostatok príležitostí;
- 12,8 % respondentov určite plánuje využiť prácu pre platformy v budúcnosti a 38,3 % respondentov sa prikláňa k tomu, že by v budúcnosti mohli tento druh práce využiť. 48,9 % respondentov neuvažuje o využití tohto druhu práce v budúcnosti;
- Respondenti vnímajú ako hlavné výhody platformovej práce väčšiu flexibilitu (82,5 %) a možnosť pracovať kedykoľvek a kdekoľvek (64,9 %). Podčiarkujú, že tento typ práce im umožňuje pracovať podľa vlastného časového harmonogramu, preferencií a miesta. Ďalej vnímajú respondenti výhody v slobode výberu úloh a práce (57,4 %) ako aj v možnosti doplnkového alebo alternatívneho zdroja príjmu k tradičnému zamestnaniu (48,6 %). Možnosť práce z domova (44,2 %) je pre respondentov dôležitým aspektom platformovej práce. Respondenti vidia taktiež výhody v zlepšenej komunikácii a spolupráci (35,9 %) a v možnosti zvyšovania kvalifikácie (34,7 %);
- Respondenti považujú za najväčšie nevýhody platformovej práce náročné pracovné podmienky (62,2 %) a obmedzený prístup k práci a sociálnej ochrane (55,4 %). Tieto aspekty by mohli ovplyvniť celkové vnímanie platformovej práce a spôsob, akým by sa mali regulovať pracovné podmienky v tejto rýchlo sa rozvíjajúcej oblasti ekonomiky. Tretím hlavným problémom sú nízke príjmy pracovníkov a ich kolísanie (46,6 %). Ďalšie nevýhody sú spojené s nespravodlivým ukončením práce bez zrejmých dôvodov (33,5 %) a prekážkami brániacimi multi-homingu (pripojenie k viac ako 1 platforme) (22,3 %). Niektorí respondenti vnímajú ako nevýhodu konkurenciu z „lacných“ krajín [14].

Analýza vybraných aspektov výskumu:

Na základe výsledkov sekundárneho výskumu realizovaného na úrovni EÚ bolo stanovených 8 výskumných predpokladov. Tabuľka 2 ponúka porovnanie výsledkov primárneho realizovaného v SR s výsledkami sekundárneho výskumu, ktorý vychádza zo štatistík EÚ. Trend vývoja platformovej práce na Slovensku sú porovnateľný s európskym vývojom. Menší rozdiel sa týkal miesta výkonu práce, na Slovensku respondenti pracujú viac v online prostredí.



**Obrázok 4** Druhy vykonávanej platformovej práce podľa výsledkov primárneho výskumu (Zdroj: vlastné spracovanie)

**Tabuľka 2** Porovnanie výsledkov primárneho a sekundárneho výskumu

| Výsledky sekundárneho výskumu                                                                                                                                       | Výsledky primárneho výskumu                                                                                                                           | Výskumný predpoklad |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| <b>VP 1</b> Predpokladáme, že viac ako 75 % respondentov pozná alebo sa už stretli s pojmom platformová práca.                                                      | 84 % respondentov pozná, alebo sa už stretli s pojmom platformová práca                                                                               | prijatý             |
| <b>VP 2</b> Predpokladáme, že aspoň 50 % respondentov využilo túto formu práce.                                                                                     | 62,7 % respondentov má skúsenosti s prácou pre platformu, využilo túto formu práce                                                                    | prijatý             |
| <b>VP 3</b> Predpokladáme, že najväčší podiel respondentov vykonávajúcich prácu na platforme má vysokoškolské vzdelanie.                                            | 66,5 % respondentov vykonávajúcich platformovú prácu má vysokoškolské vzdelanie prvého, druhého alebo tretieho stupňa                                 | prijatý             |
| <b>VP 4</b> Predpokladáme, že viac ako 50 % respondentov pracujúcich pre platformy sú muži.                                                                         | 64 % respondentov pracujúcich pre platformy sú muži                                                                                                   | prijatý             |
| <b>VP 5</b> Predpokladáme, že najpočetnejšou vekovou kategóriou respondentov pracujúcich na platforme je muž do 35 rokov (37 % všetkých pracujúcich pre platformy). | najpočetnejšou vekovou kategóriou respondentov pracujúcich pre platformy je muž do 35 rokov (32 %);                                                   | prijatý             |
| <b>VP 6</b> Predpokladáme, že väčší podiel respondentov vykonáva platformovú prácu v offline prostredí                                                              | 44 % respondentov vykonáva platformovú prácu v online prostredí, 39 % respondentov v offline prostredí a 17 % respondentov kombinovalo oba typy práce | zamietnutý          |
| <b>VP 7</b> Predpokladáme, že pre väčšinu respondentov je platformová práca vedľajším zdrojom príjmu.                                                               | Pre 83,3 % respondentov je platformová práca vedľajším zdrojom príjmu                                                                                 | prijatý             |
| <b>VP 8</b> Predpokladáme, že 50 % respondentov plánuje v budúcnosti využiť prácu pre platformy                                                                     | 51,1 % respondentov plánuje v budúcnosti využiť prácu pre platformy                                                                                   | prijatý             |

Zdroj: Vlastné spracovanie

## Záver

Platformová práca má výrazný vplyv na prepojenie pracovného a osobného života, a to najmä pre pracovníkov, ktorí sú na nej finančne závislí. Pracovníci na platformách sú často nútení pracovať dlhé hodiny, vrátane večerov, víkendov a sviatkov, aby dosiahli potrebný príjem a udržali si dobré hodnotenia. Tento tlak vedie k vyššej intenzite práce a často k nevyváženosti medzi pracovným a súkromným životom. Jedným z hlavných dôsledkov je tzv. "work-home spillover", kde sa pracovné povinnosti prelínajú so súkromným časom. Neustála dostupnosť a potreba byť aktívnym v čase, keď je dopyt najvyšší, narúša možnosti odpočinku, rodinného života a oddychu, čím negatívne ovplyvňuje osobnú pohodu a rovnováhu medzi prácou a súkromím.

Európska únia si uvedomuje rastúci vplyv digitálnych pracovných platforiem na pracovný trh a právne postavenie pracovníkov, ktorí tieto platformy využívajú. Vzhľadom na tento vývoj prijala EÚ niekoľko opatrení zameraných na reguláciu podmienok práce v tomto novom digitálnom prostredí a zabezpečenie spravodlivých pracovných podmienok (napr. Smernica o transparentných a predvídateľných pracovných podmienkach, Iniciatíva pre lepšie pracovné podmienky na digitálnych platformách, Európsky pilier sociálnych práv, Boj proti nelegálnej práci a nedeklarovaným formám zamestnania). Tieto opatrenia majú za cieľ zlepšiť právne postavenie pracovníkov na digitálnych platformách, chrániť ich pred zneužívaním a vytvoriť rámec, ktorý zabezpečí spravodlivé a transparentné podmienky práce v rýchlo sa rozvíjajúcej digitálnej ekonomike. V decembri 2021 Európsky parlament a Rada predstavili návrh smernice o zlepšení pracovných podmienok v oblasti práce pre platformy. Tento návrh je reakciou na rastúci trend digitalizácie a flexibilných pracovných foriem, kde pracovníci často čelia neistote ohľadom svojho právneho postavenia a pracovných práv. Cieľom smernice je zlepšiť pracovné podmienky a ochranu osobných údajov v oblasti práce pre platformy prostredníctvom: zavedenia opatrení na uľahčenie správneho určenia postavenia v zamestnaní v prípade osôb pracujúcich pre platformy; podpory transparentnosti, spravodlivosti, ľudského dohľadu, bezpečnosti a zodpovednosti pri algoritmickej riadení v oblasti práce pre platformy; zlepšenia transparentnosti v oblasti práce pre platformy, a to aj v cezhraničných situáciách. Návrh smernice je dôležitým krokom v snahách EÚ o reguláciu digitálnej ekonomiky, najmä v oblasti pracovných podmienok na digitálnych pracovných platformách. Hoci do dnešného dňa návrh smernice nebol schválený, mohol by výrazne zlepšiť postavenie pracovníkov na platformách a zaručiť im väčšiu ochranu v celej EÚ.

Platformová práca prináša veľké možnosti, ale aj výzvy. Aby bola platformová ekonomika udržateľná a spravodlivá, je dôležité nájsť rovnováhu medzi technologickými inováciami, potrebami trhu a ochranou práv pracovníkov. Z hľadiska regulácie je potrebné, aby boli vyvinuté nové právne rámce a regulácie, ktoré budú lepšie chrániť práva pracovníkov na platformách a zabezpečovať spravodlivé používanie algoritmov. Platformy budú musieť investovať do vývoja sofistikovanejších algoritmov, ktoré budú schopné lepšie vyvažovať potreby zákazníkov a pracovníkov, budú transparentné, spravodlivé a zodpovedné. Zároveň sa očakáva väčší dôraz na etické aspekty algoritmickeho rozhodovania. Kombinácia tradičných pracovných modelov a platformovej práce by mohla viesť k hybridným modelom, kde pracovníci majú istú mieru stability, ale zároveň môžu využívať flexibilitu, ktorú ponúkajú platformy.

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## THE IMPACT OF BLACK FRIDAY ON SLOVAK RETAIL AND CONSUMER BEHAVIOUR

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**Abstract:** The article analyses the impact of Black Friday on retail, consumer behaviour, and the development of e-commerce, with a focus on the specifics of the Slovak market. The article examines psychological factors such as the sense of urgency and fear of missing out, cultural differences, and economic determinants. The findings indicate that Slovak consumers prefer affordable products, particularly in categories such as electronics and cosmetics, and are increasingly relying on online platforms for shopping. Unlike Western Europe, where sustainability plays a significant role, the Slovak market remains primarily price driven. The implementation of new legislative measures to enhance price transparency and consumer protection underscores the importance of Black Friday in advancing retail development in Slovakia and aligning it with global trends.

**Keywords:** Black Friday, E-commerce, Shopping Holiday, Consumer Behaviour, Retail Trends.

### Introduction

In recent decades, shopping holidays have become one of the most important phenomena influencing the global economy, retail and consumer behaviour. These special shopping periods, often associated with cultural or seasonal events, not only stimulate economic activity, but also redefine consumer behaviour patterns and determine new marketing approaches [1]. Shopping holidays such as Black Friday are not limited to one-off events, but have a lasting impact on year-round economic trends and retail developments, due to their ability to boost seasonal consumption and expand market potential. [2]. The importance of these holidays can be illustrated by the Christmas shopping season, which in some countries accounts for up to 30% of retailers' total annual sales [3]. From this perspective, Black Friday is not only an economic event, but also a social event that amplifies the tradition of giving and social bonding. Moreover, with the development of technology and globalization, these holidays are becoming more and more established in different regions of the world, including countries that do not have a tradition of similar shopping events [2].

Since its inception in the 1950s in Philadelphia, Black Friday has transformed into a global sales holiday. The day, originally described as a time of traffic jams and mass movement of people, now symbolizes the economic turnaround of retailers from loss to profit, thus gaining significant economic significance [4]. Its impact is not limited to traditional retail channels, but with the advent of e-commerce, it has spread to online platforms, fundamentally changing consumer shopping habits. Today, Black Friday represents a significant boost not only to pre-

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Christmas sales, but also to the overall growth of e-commerce and the modernisation of retail infrastructure.

This article focuses on the analysis of Black Friday in a global, European and Slovak context, highlighting the psychological, cultural and economic factors that contribute to its development and enduring popularity. It aims to identify the key trends and challenges associated with this shopping holiday, with an emphasis on its impact on consumer behaviour and the development of e-commerce in Slovakia.

### **Theoretical background**

Black Friday has become one of the most important global shopping holidays. The term "Black Friday" first appeared in the second half of the 20th century in Philadelphia, where it was used by local police to describe the traffic chaos that ensued the day after Thanksgiving. This day was traditionally associated with big shopping as it signalled the beginning of the Christmas shopping season. [4] Gradually, however, the term took on a more positive meaning in the context of the economy. In accounting, the colour black is used to denote profit, while red signifies loss. Therefore, retailers began to use this day as a symbol of the transition from loss to profit, giving the term Black Friday a new economic meaning [5]. In the 1960s and 1970s, Black Friday began to establish itself as a major shopping day in the United States. Retailers began to organize targeted sales promotions in order to attract as many customers as possible. Significant discounts on electronics, clothing, and other popular categories of goods became common practice. In the 1980s, this phenomenon spread throughout the United States. Chain stores invested in massive advertising campaigns that promoted Black Friday as the best discount day of the year. This strategy greatly increased the popularity of the day among consumers [6]. At the same time, retailers began using psychological tactics such as limited-time offers or limited-quantity goods to create a sense of urgency among customers. [4] A breakthrough in the development of Black Friday occurred at the turn of the millennium, when online shopping began to emerge. The online store Amazon and other e-commerce pioneers created a new space for Black Friday sales. Significant discounts were suddenly available not only in brick-and-mortar stores but also online, which significantly changed consumer behaviour [5]. In 2005, a new concept was born - Cyber Monday. This day was introduced to encourage online sales after the weekend associated with Black Friday. Cyber Monday quickly became popular and is now one of the most important days for e-commerce worldwide [2].

Initially, Black Friday was a one-day event, but it has gradually expanded to a longer period and crossed the borders of the USA [4]. In the first decade of the 21st century, Black Friday spread outside the United States and grew in popularity in Canada, Mexico, Europe, Asia, and Australia, where it was adapted to local conditions. Consumers in Western Europe, for example, emphasize green values and sustainability, which forces retailers to offer products that match these trends [3]. In Central and Eastern Europe, including Slovakia, Black Friday focuses mainly on electronics and consumer goods. Slovak consumers perceive this day as an opportunity to buy products at bargain prices, which contributes to the growth of e-commerce [7]. It is now a global phenomenon that significantly influences the retail sector and consumer behaviour worldwide. Its popularity is mainly due to the significant discounts offered by merchants, often reaching 50% to 70% off the regular price [8].

Based on the analysis of scientific articles, trade publications and available data, it is possible to identify the key aspects that have contributed substantially to the development and growing popularity of Black Friday. This consumer culture holiday is not just a question of the discounts offered and sales strategies, but also a complex interaction of psychological, cultural and economic factors that together shape consumer behaviour and their relationship with retail in a dynamically changing global marketplace.

## Psychological factors

Psychology plays a significant role in consumer behaviour during Black Friday. In the scholarly article "A Review on the Cause of Black Friday Consumerism," the authors discuss several psychological factors that influence shopping behaviour. Among these is the aforementioned mental model of scarcity, which increases the perceived value of limited offers and creates a sense of urgency [5]. This phenomenon is known as FOMO (Fear of Missing Out), which is the fear of a consumer missing out on a bargain. Studies show that this psychological aspect motivates consumers to make impulse purchases even though the product may not be essential for them [9]. In addition, the importance of social comparisons is also highlighted. In the current social media era, consumers are constantly exposed to other people's lifestyles and possessions, which creates pressure to conform to social norms and status symbols [5]. In this way, Black Friday provides a platform for expressing social status through shopping, increasing the motivation to participate in this shopping holiday. Consumer psychology plays a significant role in Black Friday shopping decisions. Discounts and promotions create a sense of urgency and Fear of Missing Out (FOMO), which motivates consumers to make impulse purchases. Many shoppers create wish lists before the promotions begin to maximize their savings [10].

## Cultural factors

Cultural factors also play an important role in the context of Black Friday. Black Friday has become a cultural phenomenon in societies with high levels of materialism [5]. The day is associated with a tradition of giving and celebrating material wealth, which reinforces the idea that shopping is a way of expressing love and care for loved ones. In many cultures, Black Friday is strategically positioned as part of the Christmas shopping season, making it an integral part of the cultural discourse on giving [11]. The cultural context of Black Friday thus reflects broader expectations about spending and consumption. The day is not just a commercial event, but has become a ritual that involves collective behaviour and shared experiences among consumers [5]. In this way, Black Friday personifies cultural values associated with wealth and success. According to Huang's analysis (2024), Black Friday is strongly rooted in a culture of materialism and consumerism. Consumers are motivated not only by the need for products, but also by the desire for social recognition through the possession of luxury or desirable items. This aspect is particularly significant during the holiday season, when the giving and sharing of material goods takes on greater importance [5,11].

## Economic factors

Economic factors are another important aspect influencing consumer behaviour during Black Friday. The economic environment has a major impact on consumers' decision making and their willingness to spend money during the discount period [12]. During economic downturns, consumers are more susceptible to tempting offers and discounts, leading to increased participation in promotions such as Black Friday [13]. Income elasticity of demand, which determines how responsive consumers are to changes in their income, also plays a role during the shopping holidays [14]. Products with low demand elasticities remain stable during economic downturns, while luxury goods may experience a more pronounced decline in sales. These economic factors create dynamics that affect the overall level of spending during Black Friday. The dynamic between economic conditions and consumer behaviour is fundamental to understanding the success of Black Friday as a sales phenomenon. Consumers are more responsive to marketers' marketing tactics during periods of economic uncertainty. Marketers use sales psychology to maximize sales during this critical period [13,14].

## Methodology

This article aims to examine Black Friday and its impact on retail, e-commerce and consumer behaviour, with a particular focus on the situation in Slovakia. Based on the available data, the research objective can be classified as descriptive and explanatory, as the study not

only describes the Black Friday phenomenon but also identifies key factors that influence its development. A combination of quantitative and qualitative methods was used. These methods provide a comprehensive view of Black Friday, taking into account economic, social and technological factors.

- Quantitative analysis – the quantitative analysis focused on the collection and processing of statistical data from available secondary sources. The sources used included reputable databases such as Statista, Euronews, Kantar and PR Newswire. The analysis included data on average consumer spending, average product prices and total sales during Black Friday. This data was then compared between countries, with a particular focus on Slovakia.
- Qualitative analysis – this analysis included an assessment of perceptions of discounts, purchase planning, and use of online outlets. The research also included an evaluation of the Slovak Republic's legislative measures governing price transparency and consumer protection.
- Comparative analysis – this part of the research allowed to identify regional differences in consumer preferences and their approach to the shopping holiday.

Research is limited to secondary sources, which may affect the accuracy and timeliness of the data. In addition, differences in regional trends and consumer behaviour may reduce the generalisability of the results. These limitations are compensated by the wide range of sources used and the methodological triangulation that ensures the reliability of the results.

## Results

Black Friday has become a major global shopping phenomenon, with its impact on retail and online sales increasing year on year. In 2024, global Black Friday sales reached \$74.4 billion, which translates to approximately 67 billion € (at an exchange rate of \$1 = 0.90 €). This figure represents a year-on-year increase of around 5%, underlining the growing importance of this shopping holiday in global retail. [7] According to the October 2024 survey, awareness of Black Friday was high in most countries. In the US, up to 97% of respondents said they were familiar with the phenomenon. On the other hand, Australia showed the lowest awareness rate of the countries surveyed, suggesting different marketing strategies and local approaches to sales events [15].

In terms of purchase planning, 64% of Generation Z consumers and millennials in the US said they would be taking part in Black Friday sales. These groups also dominated other sales events such as Amazon Prime Day and Cyber Monday. This trend demonstrates the powerful influence of social media and technological innovation on the behaviour of younger generations [16]. An important factor in this growth is the rise of online shopping, which has become the dominant way for consumers to shop. In 2024, more than 70% of total sales on Black Friday came from online sales. The categories that accounted for the largest share of these sales were electronics, fashion and homewares, which are traditionally popular with consumers around the world [7].

In Europe, Black Friday has cemented its position as one of the most important retail holidays in recent years. Europe saw high interest in Black Friday, with consumers from Germany having the highest average shopping budget of 317 €. In Italy, the average Black Friday shopping budget was around 264 €, a slight increase on the previous year. Electronics and home appliances were the most popular categories, followed by fashion products, which were preferred by 37% of Italian consumers [17]. In France, more than 20% of consumers planned to consider sustainability in their purchasing decisions during Black Friday. This trend is less pronounced in Spain and Italy, where only around 10% of consumers reported similar values. This information indicates the growing importance of environmental aspects in purchasing behaviour in parts of Europe [18].

In 2024, online sales within the European Union grew by 1.4% during the day. Countries such as Germany, France and Austria saw sales increase by up to 175% compared to the average of other days, with electronics, clothing and cosmetics seeing the highest sales. An interesting phenomenon is the gradual adaptation of Black Friday to the specificities of individual countries. In Western Europe, for example, there is a strong emphasis on environmental sustainability, which is forcing retailers to adapt their offers. At the same time, in Central and Eastern Europe, including Slovakia, the demand for traditionally high-discount products such as mobile phones, computers and household appliances dominates [3]

### **Black Friday in Slovakia**

In Slovakia, Black Friday is growing in popularity, with online sales during the period reaching approximately 14.5 million € in 2024, which is over 2 million € more than in 2023, representing a year-on-year increase of 5-10%, confirming the trend that Slovak consumers are willing to adapt their shopping behaviour to international practices [9]. Top-selling categories included electronics, clothing, perfumes and cosmetics, reflecting similar preferences to other European countries [19]. The most expensive and sought-after products during Black Friday in Slovakia were laptops, with an average price of 654 €. This was followed by televisions with an average price of 535 € and refrigerators with a price of 526 € [20]. These data point to the dominance of electronics as the main category of interest for Slovak consumers, which is consistent with trends observed in other European countries [3].

During Black Friday in Slovakia, customer activity is characterised by significant time differences, with the highest level of shopping activity observed in the morning and evening hours. In the morning, activity starts to increase as early as 6:00 and reaches its first peak between 9:00 and 11:00, indicating that customers start the day by actively searching for and making bargain purchases. This increase may be linked to the fact that many people are taking advantage of the early hours to secure the best deals before stocks run out. After the morning peak, there is a slight decrease in activity during the midday and early afternoon hours, between 12:00 and 18:00. This decrease may be due to customers shifting their attention to other daily duties. However, activity increases again in the evening, with a second peak between 19:00 and 21:00. This evening surge may be the result of the availability of free time after the workday or the goal of completing purchases that customers had planned during the day [21].

There was an interesting difference in planned expenditure between men and women. Men had an average planned spending of 154 € on Black Friday, while women planned to spend 129 €. This difference may be a reflection of different preferences in product categories, with men more likely to invest in more expensive technology products [22].

Black Friday is an opportunity for Slovak consumers to buy Christmas gifts at cheaper prices. This incentive is particularly important in a period of rising inflation, which affects household purchasing power and spending. In addition to the actual increase in sales, Black Friday in Slovakia is also changing consumer purchasing behaviour. In November, the total turnover of Slovak e-shops rose to 52 million €, which is almost 8 million € more than in the previous year, 2023. The trend of extending Black Friday deals in Slovakia continues, with promotions increasingly being extended not only to the Black Friday day itself, but to the whole weekend or even the whole week. This trend has also contributed to the natural linking of Black Friday with the Cyber Monday sales, which has significantly boosted the increase in e-commerce activity. During November, Slovak online platforms processed more than 700 thousand orders. According to this data, consumers are increasingly using online platforms to compare prices and make purchases, making online sales a more important channel for retailers [23].

This trend supports the development of e-commerce infrastructure in Slovakia, including investments in logistics and distribution. Global and European statistics highlight several key trends. The growth of online sales and technological advances, such as the use of

artificial intelligence to personalise offers, are contributing to making Black Friday more effective and attractive to consumers [24]. On the other hand, ethical and transparency issues remain challenges to Black Friday, especially practices such as artificially inflating prices ahead of promotions, which negatively affect consumer trust in retailers. As of 1 July 2024, a Consumer Protection Act (108/2024 Coll.) came into force in Slovakia, which regulates the introduction of false discounts and other aspects of consumer rights protection. According to this law, the trader is obliged to indicate discounts calculated on the lowest price at which the goods were sold during the last 30 days prior to the discount. This legislative step is intended to prevent price manipulation, where prices are artificially increased just before promotions and then offered as heavily discounted. The aim of these legislative changes is to ensure that consumers are aware in advance of the conditions under which they are buying and that their commercial behaviour is not influenced by deceptive practices. It is crucial for retailers to interpret the new rules on discount communication correctly and implement them in practice. This not only strengthens consumer protection but also contributes to a fair business environment. These measures are in line with broader initiatives within the European Union to ensure transparency in commercial practices and the protection of consumer rights [25].

## Conclusion

Based on the analysis conducted, it can be concluded that Black Friday has become not only a significant economic phenomenon, but also a cultural and social event that influences consumer behaviour, retail strategies and the development of e-commerce around the world. Its global popularity is the result of a combination of psychological, cultural and economic factors that increase its attractiveness not only in the United States of America, but also in foreign markets, including Slovakia. The results of qualitative and quantitative analysis highlight that Black Friday presents consumers with an opportunity for bargain shopping, while gradually adapting to local preferences and cultural specificities in each region.

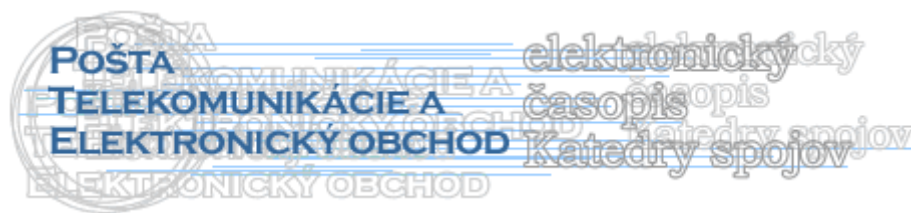
A comparison of Slovak consumers with foreign consumers revealed some interesting differences and similarities. In Slovakia, as in many other European countries, interest in electronics, clothing and cosmetics dominates. However, the average spending of Slovak consumers during Black Friday is lower compared to consumers from countries such as Germany or France. While the average Slovak consumer spends an average of 141 €, German consumers are willing to spend up to 317 €. This difference may be due to lower purchasing power and different spending patterns in Central and Western Europe. On the other hand, Slovak shoppers are increasingly relying on online platforms, with more than 700 thousand orders placed during November 2024 showing the fast-growing importance of e-commerce in this country. More and more Slovak customers are engaging in this shopping holiday, often seeing it as an opportunity to buy Christmas gifts at bargain prices. In Western Europe, particularly in France, eco-values are playing a more prominent role, leading to a growing interest in sustainable products. In Slovakia, however, these values are not yet a priority, with price factors and product availability retaining a dominant position.

Global trends such as the rise of technology, personalisation of offers through artificial intelligence and the linking of Black Friday with Cyber Monday show that Slovakia is actively adapting to these changes. Although the Slovak market remains smaller compared to Western countries, its dynamism, the growing popularity of Black Friday and the increase in online sales suggest strong potential for future development. At the same time, however, it appears that there are still challenges related to price transparency and consumer protection in Slovakia. The new legislative measures adopted in 2024 represent a positive step towards strengthening consumer confidence and ensuring a fair-trading environment.

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## EXPLORING THE IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN B2B

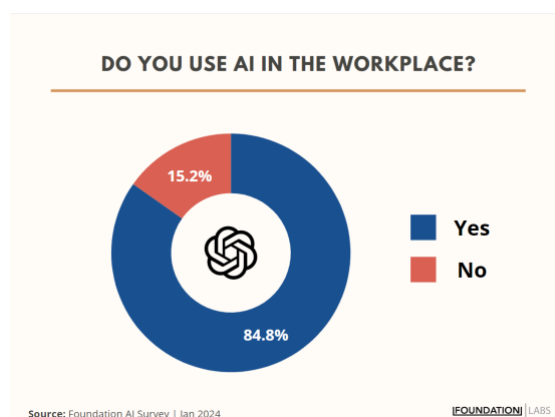
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**Abstract:** This article examines the implementation of artificial intelligence in the B2B sector through an analysis of existing scientific literature and industry reports. Based on the review of scholarly studies, it highlights key technologies and methods that are transforming sales and marketing processes. The research reveals that artificial intelligence facilitates the automation of routine tasks, the analysis of large datasets, and the personalization of offerings, leading to increased customer satisfaction and more efficient sales strategies. The discussion addresses the impacts of artificial intelligence on efficiency, innovation, and the adaptation of business models, while also considering ethical and regulatory challenges associated with this transformation.

**Keywords:** artificial intelligence, B2B, machine learning, implementation, innovation.

### 1 Introduction

Artificial intelligence is a whirlwind of innovation that is transforming business operations and consumer experiences. From streamlining sales and marketing to revolutionizing healthcare and entertainment, the impact of AI extends across various industries. According to research conducted by Foundation, nearly 85% of marketing professionals utilize artificial intelligence in their work environments. However, it is emphasized that not all practitioners use AI in the same way, and there remains significant ambiguity and room for learning about new technologies, as well as for improving AI itself [1].



**Figure 1.** Illustration of Generative AI Applications in B2B Marketing and Workplace Integration. **Source:** [1]

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Recent empirical studies indicate that organizations integrating advanced technologies within their marketing channels, operational models, and corporate culture exhibit a significantly enhanced potential to unlock substantial value. According to McKinsey & Company, B2B firms operating in the top quartile achieve 3.5% higher revenue growth and are 15% more profitable compared to their industry counterparts [2]. Furthermore, the report highlights an untapped revenue growth potential ranging from \$74 billion to \$298 billion, which could be realized through the strategic adoption of technological innovations in sales processes. The transformative role of technology in improving sales performance is predominantly observed in the development of novel customer experiences, the enhancement of pricing strategies, and the optimization of sales operations. The academic corpus provides a comprehensive exploration of artificial intelligence applications in the B2B sector, offering insights into both operational improvements and adaptive strategies to meet customer requirements [3]. These investigations extend to the analysis of prevalent technologies, methodologies, and techniques utilized in this domain. Numerous scientific inquiries underscore AI's transformative capacity in the B2B ecosystem, particularly through intelligent process automation, predictive analytics, and personalized customer engagement. The automation of repetitive tasks via AI technologies not only augments efficiency but also substantially reduces operational costs. Machine learning-driven analysis of historical data enables firms to forecast future trends and predict customer behavior patterns, thereby informing strategic decision-making. Moreover, the integration of applications such as chatbots and intelligent agents significantly enhances customer interaction while delivering tailored services [5].

In the evolving paradigm of B2B commerce, artificial intelligence and machine learning have emerged as pivotal enablers of transformation [6,7,8]. These advanced technological tools not only bolster operational efficacy but also facilitate data-driven strategic decision-making, providing organizations with unprecedented analytical insights. In the face of competitive market dynamics, the adoption of AI and ML technologies has become indispensable for B2B entities, enabling accurate demand forecasting, streamlined sales processes, and scalable personalization in marketing efforts. As traditional sales models, predominantly reliant on intuition and retrospective analysis, give way to data-centric approaches, AI technologies are increasingly utilized to process vast, real-time datasets [7,9,10]. This shift empowers sales teams to identify latent patterns and trends, resulting in refined sales forecasts and precision-targeted strategies. For example, predictive analytics powered by AI enables sales teams to prioritize prospects with higher conversion probabilities, thereby enhancing sales process efficiency and effectiveness [11,12].

However, despite the evident advantages, the implementation of AI in the B2B sector presents notable risks. Over-reliance on AI systems may expose firms to vulnerabilities in dynamic market environments, where adaptability and contextual understanding are paramount. Additionally, concerns regarding data privacy and the opacity of algorithmic decision-making remain critical issues. A further challenge is the scarcity of qualified professionals equipped to implement and manage sophisticated AI technologies effectively [11,12].

Artificial intelligence has emerged as a central driver of transformation within business processes and marketing strategies, offering a spectrum of opportunities alongside inherent challenges. Research highlights the potential of AI to significantly enhance operational efficiency in B2B contexts. For instance, 57% of B2B marketers currently employ chatbots for demand generation, facilitating a deeper understanding of customer preferences and requirements [13]. Additionally, 73% of marketing managers within the B2B sector report the adoption of AI tools, with 31% planning future implementations [14]. These technologies

enable the automation of routine tasks and support predictive analytics, fostering more informed decision-making and enabling highly personalized service delivery.

In the B2B context, it is imperative to acknowledge that the efficacy of AI implementation extends beyond technological considerations to encompass cultural and organizational dimensions. Organizations must cultivate an innovation-centric environment that supports experimentation and cross-disciplinary collaboration. Such an approach necessitates continuous employee training in emerging technologies and the integration of interdisciplinary teams that combine technical expertise with business acumen [11,12,14].

Moreover, the formulation of a robust and forward-looking AI strategy is critical. Firms must evaluate the ethical dimensions of AI deployment, including data protection and algorithmic equity, while maintaining transparency in how customer data is utilized and how AI-driven decisions are made. Such transparency is instrumental in fostering trust and reinforcing a positive brand reputation [12,13].

## **2 Methodology**

The aim of this study is to conduct secondary empirical research based on the analysis of existing literature on the applications of artificial intelligence in the B2B sector. The secondary research focuses on processing and analysing data from available scientific articles, professional publications, and studies that address topics such as AI implementation, its benefits, challenges, and strategic implications.

The primary data sources were scientific databases such as Web of Science, Scopus, and Google Scholar, with publications from the period 2018 to 2024 included in the analysis. The literature selection was aimed at identifying articles that deal with AI applications in B2B sales, marketing, predictive analytics, and process optimization. The inclusion criterion focused on specific technologies and techniques such as machine learning, neural networks, chatbots, decision support systems, and other tools related to AI. This secondary analysis allowed for an exploration of how companies apply AI in their sales and marketing processes, what results they achieve, and what challenges they face.

The results of this analysis are presented in the form of a synthesis of empirical knowledge that provides a comprehensive view of current AI applications in the B2B sector. Secondary research enables the identification not only of opportunities associated with AI implementation but also of risks and limitations that organizations must overcome on their path to digital transformation.

## **3 Results and Discussion**

In the dynamic and rapidly changing business environment, the role of advanced technology in enhancing sales performance within B2B organizations is becoming increasingly pivotal. The ongoing wave of digital transformation has prompted companies to explore the potential of technology to optimize their sales processes and drive sustainable revenue growth [15].

The value derived from the integration of AI varies significantly across distinct business models and organizational contexts. B2B enterprises targeting small and medium-sized businesses often prioritize customer acquisition and the expansion of their client base due to the continuous emergence of new entities. Conversely, organizations catering to larger corporations emphasize relationship maintenance and expansion. Meanwhile, firms focused on personalization and loyalty enhancement strive to meet the growing demand for consumer-like experiences, which are increasingly centered on brand identity and product offerings. The

strategic identification of customer-centric opportunities has emerged as a critical success factor in this context [15].

Recent research highlights the transformative potential of AI in refining organizational operations [16]. A growing number of organizations are deploying AI-driven initiatives to automate or augment critical business processes, with the ultimate aim of securing a competitive advantage [17]. Scholars have positioned AI as a frontier for innovation in competition and productivity, while some contend it represents a revolutionary force poised to reshape traditional business paradigms [18,19]. The proliferation of data has also catalysed significant advancements in technologies and methodologies for its storage and analysis [11,12,20].

A systematic review of literature in the domain of B2B digital marketing underscores several emerging themes. These include advancements in digital marketing communication and sales management, while areas such as decision support systems, critical success factors, and e-marketing adoption remain underexplored. The concept of cultivating “digital relationships” with customers has gained prominence. Empirical studies have revealed a substantial shift toward mobile commerce, with mobile device sales now accounting for 22% to 27% of total online transactions. This trend underscores the imperative for B2B firms to adapt to evolving digital interaction paradigms and integrate technological advancements into their sales processes [4].

In a structured literature review, Harald Konnerth, in “The Potential of AI in B2B E-Commerce,” analysed over 50 scientific articles and synthesized findings into a comprehensive summary of frequently discussed technologies, techniques, and methods (Table 1). This work provides an essential framework for understanding the trends and practical applications of AI in B2B e-commerce, offering valuable insights for researchers and practitioners in this domain [21].

**Table 1. Frequently mentioned technologies, techniques, or methods**

| <i>Frequently mentioned technologies, techniques, or methods</i> |                             |
|------------------------------------------------------------------|-----------------------------|
| Augmented Reality                                                | Image Recognition           |
| Automatic Reasoning                                              | Internet of Things          |
| Big Data Analytics                                               | Language Generation         |
| Blockchain                                                       | Logistic Regression         |
| Chatbots                                                         | Natural Language Processing |
| Clustering                                                       | Neural Networks             |
| Computer Vision                                                  | Predictive Analytics        |
| Convolutional Neural Networks                                    | Predictice Modelling        |
| Data Analysis                                                    | Recommender Systems         |
| Data Mining                                                      | Robotics Process Automation |
| Decision Support System                                          | Smart contracts             |
| Decision tree methods                                            | Speech Recognition          |
| Deep Learning                                                    | Support Vector Machines     |
| Fuzzy Logic                                                      | Text Analytics              |

Source:[21]

The main areas of AI application include chatbots, customer experience, data analysis and mining, decision support, efficiency and automation, fraud and intrusion detection, as well as sales predictions and forecasting. Many other AI methods remain relatively unknown [21].

In work, “How Generative AI Can Help B2B Sales Become More Effective,” Steve Reis identifies critical challenges associated with the adoption and scaling of generative AI technologies. One key insight pertains to the inherent difficulty in transitioning from conceptualization to widespread implementation, particularly when it necessitates behavioral

changes among large groups of individuals. Building trust in new capabilities and facilitating the adaptation of work processes represent significant hurdles. Moreover, Reis observes the rapid improvement in the quality of generative AI outputs, with notable reductions in inaccuracies. Distinguishing between AI-generated and human-created outputs is becoming increasingly complex [15].

### **3.1 The use of artificial intelligence in e-commerce**

In the article by Devi [22], four main benefits of using artificial intelligence in e-commerce are identified. The author emphasizes that AI and machine learning technologies can analyze and predict consumer behavior based on their browsing and purchasing history. This enables the development of more targeted and effective marketing and sales strategies. Furthermore, it is noted that AI can be integrated into customer support systems through chatbots, which handle a significant portion of customer inquiries, thereby improving the overall customer experience and reducing the burden on support teams [4,21].

Rosas [23] highlights how AI and machine learning are transforming business processes and information analysis, allowing companies to make better decisions. These technologies mimic "human" thinking, facilitating professional business analytics and adapting to business patterns, thus altering processes according to specific needs. Zong et al. [24] describe the advantages of AI in e-commerce and decision support systems. AI systems, such as decision support systems, efficiently gather and process large amounts of data, which is beneficial for managing operations and business planning. In e-commerce, AI analyzes customer data, offering more comprehensive insights than traditional systems.

Pan and Zhou [25] discuss the use of convolutional neural networks in e-commerce, particularly in data mining. CNNs automatically extract effective features from raw data, enhancing the accuracy of sales predictions. Chatbots and conversational AI are transforming customer interactions in the B2B sector [6,26,27,28]. These tools process inquiries, provide product information, and assist in the sales process without human intervention. By automating routine tasks, chatbots allow sales teams to focus on more complex issues, increasing efficiency and customer satisfaction. Advanced conversational AI, such as GPT-4, can engage in sophisticated interactions, provide personalized responses, and understand customer inquiries, thereby enhancing the overall customer experience [4,21,27].

Additionally, the literature review acknowledges that while technology can improve sales performance in B2B companies, it does not replace the importance of human interaction in building strong customer relationships. In a study on technology and sales teams, researchers found that technology plays a significant role in enabling salespeople to successfully close deals. One key area where technology can enhance sales performance in B2B firms is during the pre-sales phase. Digital marketing can provide valuable support at this stage by helping companies engage potential customers and generate leads. Through various digital marketing tools and techniques such as search engine optimization, content marketing, social media advertising, and email marketing, B2B firms can reach a broader audience and attract potential customers [4].

These digital marketing strategies allow companies to showcase their products and services, provide valuable information and resources, and build brand awareness. Moreover, digital marketing enables personalized and targeted communication, allowing B2B firms to tailor their messages and approaches based on the specific needs and interests of individual potential customers. This personalized approach can significantly enhance the effectiveness of pre-sales activities and increase the likelihood of converting leads into customers [4,21].

In addition to supporting pre-sales activities, technology can also improve the sales process itself. By leveraging technology, B2B firms can streamline their sales processes and enhance efficiency. This can be achieved through customer relationship management systems, sales

automation software, and other sales support tools. These technologies help sales teams track and manage customer interactions, automate repetitive tasks, and provide real-time analytics tools for better understanding customer behavior and preferences. This enables sales teams to make more informed decisions, effectively prioritize their efforts, and deliver a personalized and tailored sales experience to each customer [4].

### 3.2 Applications of Artificial Intelligence in B2B environments

Goyal et al. [29] describe the significance of AI in B2B e-commerce, focusing on process automation, sales enhancement, and supply chain maintenance. AI reduces information search costs and increases operational efficiency. The document "RATAN: A Smart Business to Business Communicator" by Das et al. [30] illustrates how AI automates the search, planning, and scheduling of business meetings. This approach simplifies processes in B2B communication and enhances interaction efficiency between businesses.

Nguyen [31] emphasizes the role of AI and machine learning in analysing complex sales data and uncovering reasons for customer rejection of sales offers. This approach aids companies in better understanding the factors that influence the success of sales strategies. Han et al. [32] demonstrate that AI enables personalized services for customers and improves sales forecasts, thereby increasing customer satisfaction in B2B marketing. Their research highlights the importance of personalization in customer interactions.

Buyanova et al. [33] discuss the benefits of AI in developing digital marketplaces, logistics solutions, and supply chain efficiency. Their research indicates a synergistic effect between AI technology and the optimization of logistics processes. Rustholkar et al. [35] identify four key managerial activities supported by AI in B2B: analysis, design, engagement, and customer journey leadership. These activities are crucial for successful customer relationship management.

Predictive analytics and forecasting are essential for strategic planning in B2B sales and marketing [7,8,32]. AI and ML models analyse historical data to predict future trends, customer behavior, and market conditions. These insights help companies make informed decisions regarding resource allocation, product development, and marketing strategies. Predictive analytics can also identify patterns and anomalies that indicate emerging opportunities or risks. Platforms like IBM Watson and SAS Analytics offer advanced predictive analytics capabilities, helping companies maintain competitiveness [4].

AI- and ML-powered sales intelligence tools analyse vast amounts of data to identify potential customers and assess their likelihood of conversion [32]. These tools gather data from sources such as social media, company websites, and industry reports to provide a comprehensive view of potential clients. AI-driven lead scoring helps sales teams focus on high-value prospects, improving conversion rates and sales efficiency. Companies like Inside View and Zoom Info provide AI-based sales intelligence solutions to identify and target the right potential customers [4,33].

Technology also facilitates collaboration and communication within sales teams, enabling better coordination and information sharing. For instance, cloud-based collaboration platforms and communication tools like video conferencing and instant messaging allow sales teams to work together seamlessly even when geographically dispersed. Additionally, technology can significantly enhance the transaction phase in B2B sales processes. Through e-commerce platforms, online ordering systems, and electronic payments, B2B companies can streamline the purchasing process, making it more convenient [4].

### 3.3 Artificial intelligence technologies in data analysis

Alabi and David [33] introduced a new AI application in their research titled "Framework for Detection of Fraud at Point of Sale on Electronic Commerce sites using Logistic

Regression." In this article, logistic regression and artificial immune systems are used to identify fraudulent transactions on e-commerce websites. Moradi & Dass [34] highlight the benefits of AI in email analysis and real-time sales training. The authors argue that chatbots can be more effective than new hires in outbound sales, contributing to increased productivity of sales teams.

AI is transforming social media marketing in the B2B sector [6,8,9,10]. AI-powered tools analyse social media data to identify trends, track brand sentiment, and monitor competitor activities. These insights help companies create effective social media strategies, engage with their audience, and build brand awareness. AI-driven platforms like Sprout Social and Hootsuite use machine learning algorithms to optimize posting times, recommend content, and analyse engagement metrics, maximizing the impact of their social media efforts.

Until now, attention has focused on how generative AI can facilitate certain tasks for people by automating communication and saving time. The conversation is now shifting towards improving customer experience and seeking opportunities where human involvement may not be necessary, such as utilizing a chatbot with an AI agent in customer service. In the next phase, as a commercial organization fully embraces generative AI, marketing, sales, and pricing could converge. This would create opportunities for individuals to develop more personalized experiences, helping customers derive real value across multiple channels [4,15].

It is important to stay focused on what matters to customers and what drives them to purchase. For every dollar a company spends on technology, it must allocate an equal or greater amount to its people. This means not only modernizing capabilities but also reevaluating processes and resource allocation. If companies are clear about how generative AI will benefit customers, they can then focus on what their employees need to derive full value from it [4,15].

#### **4 Conclusion**

Currently, AI and machine learning are becoming key factors in transforming B2B sales practices. This article demonstrates that AI technologies have the potential to significantly improve sales efficiency, optimize processes, and provide valuable insights that support strategic decision-making. With the rapid development of technologies and their integration into business models, B2B companies must adapt to new trends to gain a competitive advantage. Literature analysis indicates that AI and machine learning enable sales teams to identify patterns in customer behavior, personalize marketing strategies, and automate repetitive tasks, leading to increased customer satisfaction and sales efficiency. The integration of CRM with technological tools enhances collaboration and data sharing, thereby supporting successful management of customer interactions.

Despite many benefits, there are also risks associated with AI implementation, such as a lack of qualified professionals and concerns about data privacy. Therefore, it is crucial for companies to develop a clear strategy for implementing these technologies that includes employee training and ensuring transparency with customers.

Overall, this article provides an overview of the current state of research on artificial intelligence in the B2B sector and emphasizes the need for a balanced approach between leveraging opportunities and managing threats associated with this technology. Given the rapid development of AI, it is essential for businesses to strategically consider its impact on their operations and prepare for the transformation that this technology brings. Sustainable growth in the era of artificial intelligence requires a proactive approach to adapting new technologies and continuous education for employees across all areas of the organization.

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## TRANSPORTATION AND LOCATION-ALLOCATION PROBLEMS

Peter Malacký<sup>1</sup>

**Abstract:** This article provides a comprehensive overview of transportation and location allocation problems within transportation and logistics systems theory, with emphasis on their mathematical formulations. Recent research developments, including optimization approaches and real-world applications, are discussed. Two case studies from the Slovak automotive sector highlight practical implementations, specifically plant location and inbound logistics optimization.

**Keywords:** transportation problem, location-allocation problems mathematical modeling

### Introduction

Transportation and logistics systems theory provides the basis for planning how goods are moved and where facilities are located in supply chains. These decisions are particularly critical in regions with high levels of logistics activity. For example, Slovakia's central location in Europe makes it an ideal regional hub for transportation and logistics networks [1]. The country has developed a strong automotive cluster with four major car assembly plants (Volkswagen in Bratislava, Stellantis-PSA in Trnava, Kia in Žilina, and Jaguar Land Rover in Nitra) [2]. The automotive sector accounts for almost half of Slovakia's industrial production and exports [2]. In 2019, the country produced over 1.1 million vehicles - approximately 202 cars per 1,000 people - the highest per capita automotive production in the world [2][3]. Efficient transportation and facility location strategies are therefore paramount to maintaining this competitive advantage.

In this context, the theory of transportation and logistics systems focuses on optimization problems that ensure the cost-effective and timely delivery of goods. Two fundamental classes of problems in this theory are transportation problems (optimizing shipment flows between supply and demand points) and location allocation problems (choosing optimal locations for facilities and assigning customers to them). This article provides an overview of these problems. In the introduction, the importance of such problems in the real world is outlined. Next, an overview of the current state of research is given, highlighting recent developments. Finally, the theoretical foundations of transport and location assignment problems are discussed, including mathematical formulations and examples illustrating their application in the Slovak automotive logistics sector.

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## Overview of current research

**Transportation problems:** The transportation problem is a classic optimization model in logistics. It was originally formulated in the 1940s (also known as the Hitchcock problem) and has since become a standard example of linear programming in supply chain optimization [4]. Because it can be solved efficiently by linear programming methods, the transportation problem is considered essentially "solved" from an algorithmic point of view. Research in this area today often focuses on extending the basic model to more complex scenarios or integrating it with other decision problems. For example, recent studies consider multimodal transportation (e.g., combining road and rail) and real-time routing, reflecting industry trends toward flexible and sustainable logistics. In Slovakia, where about 50% of finished vehicles are transported by rail in multimodal networks [1], researchers and practitioners are interested in models that incorporate such modalities and constraints (e.g., schedules, capacities) into transportation optimization. Another active area of research is the location-transportation problem, which combines facility location decisions with flow decisions. This integrated approach recognizes that the optimal transportation plan may depend on facility locations and vice versa. Uncertainty and robustness are also studied: for example, robust transportation models account for demand fluctuations or disruptions, and aim to find solutions that minimize costs while meeting service level objectives under different scenarios.

**Location-Allocation Problems:** Location-Allocation (L-A) problems remain a vibrant area of research due to their complexity and impact on strategic logistics planning. These problems are generally NP-hard, meaning that exact solutions become computationally infeasible for large instances [5]. As a result, there is a rich literature on advanced algorithms for solving L-A problems. Researchers have developed both exact optimization methods (e.g., branch-and-bound, cutting planes) for moderately large instances and heuristic or metaheuristic approaches (genetic algorithms, tabu search, etc.) for large-scale or real-time applications. There are four main classical models in the area of location assignment: the p-Median, the Simple Plant Location Problem (also known as the Uncapacitated Plant Location Problem), the p-Center, and Covering models. Each addresses a different objective—for example, the p-median model minimizes the total distance or cost to all customers, while the p-center model minimizes the maximum distance each customer must travel to the nearest facility. Recent research has extended these models to address new objectives and constraints. One prominent trend is the incorporation of sustainability and resilience into location decisions. For example, "green" location models include carbon emissions in the objective function or constrain the environmental impact of logistics networks. In practice, this is consistent with efforts by automotive companies to reduce their carbon footprint by designing networks that minimize total transportation distance or favor lower-emission modes. Another current focus is on dynamic and stochastic location problems - where location decisions can be adjusted over time or must be robust to uncertain demand.

The rise of e-commerce and new delivery technologies has also spurred specialized L-A research, such as the optimal placement of urban distribution hubs or drone delivery stations. Overall, the field is moving toward more integrated and realistic models, solved with increasingly sophisticated algorithms and often aided by geographic information systems (GIS) and big data analytics for calibration [4].

In Slovakia, academic and industrial researchers are following these global trends. For example, Kádárová et al. (2021) propose optimization models for automotive supplier networks that balance risk and just-in-time performance [2]. Other studies focus on optimizing logistics infrastructure to support the growth of the country's automotive sector, such as evaluating potential locations for new logistics parks or improving the capacity of intermodal terminals in

response to growing rail traffic. These efforts illustrate how current research in transportation and logistics systems is being directly applied to support real-world logistics challenges in the Slovak automotive industry.

## Theoretical Foundations

### Transportation Problem

The transportation problem is a fundamental model in logistics and operations research that deals with the optimal distribution of goods from multiple supply points to multiple demand points. In the basic scenario, we have a set of supply nodes (e.g., factories or warehouses) with given supply quantities and a set of demand nodes (e.g., customer locations or regional distribution centers) with desired demand quantities. Shipping costs are defined for moving a unit of product from each supply node to each demand node. The objective is to determine how much to ship along each route (supply node to demand node) so that all demands are satisfied without exceeding supply at minimum total cost.

Mathematically, the classical transportation problem can be formulated as a linear program. Let  $I$  be the index set of supply nodes and  $J$  the index set of demand nodes. Let  $a_i$  be the supply available at source  $i \in I$ ,  $b_j$  the demand required at destination  $j \in J$ ,  $c_{ij}$  the unit transportation cost from  $i$  to  $j$ . The decision variable  $x_{ij}$  represents the quantity transported from  $i$  to  $j$ . The formulation of the linear programming is:

$$\begin{aligned} \min_{x_{ij}} \quad & \sum_{i \in I} \sum_{j \in J} c_{ij} x_{ij} \\ \sum_{j \in J} x_{ij} = a_i, \quad & \forall i \in I \text{ (supply constraints),} \\ \sum_{i \in I} x_{ij} = b_j, \quad & \forall j \in J \text{ (demand constraints),} \\ x_{ij} \geq 0, \quad & \forall i, j. \end{aligned}$$

In essence, the first set of constraints ensures each supply node sends out no more than it produces, and the second set ensures each demand node receives exactly the amount it needs. If total supply equals total demand (a *balanced* transportation problem), all constraints can be satisfied exactly; if not, a dummy supply or demand node can be introduced to balance the equation.

The transportation problem is a special case of a minimum-cost network flow problem on a bipartite network (sources connected directly to destinations). This structure allows very efficient solution. The simplex algorithm can solve even large transportation problems relatively quickly, and specialized algorithms (such as the *transportation simplex* or the *stepping-stone method*) exploit the network structure for faster computations. In fact, the constraint matrix of this linear program is totally unimodular, which guarantees that an optimal basic solution will be integer-valued (so shipments can be treated as indivisible units without needing a separate integer programming solver).

**Example (Automotive Inbound Logistics):** In Slovakia's automotive industry, the transportation problem framework is used to optimize inbound logistics. A car assembly plant sources thousands of parts from various suppliers. This scenario can be modeled with suppliers as the "sources" and the assembly plant as a single "sink" (demand point) that needs specific quantities of each part. Logistics providers (third-party integrators) often consolidate shipments from multiple suppliers by setting up a network of collection points (cross-docks). For instance,

an integrator might operate a cross-dock near Žilina where suppliers from around the region deliver their components; these are then consolidated into full truckloads bound for the Kia Motors assembly plant. By solving a transportation problem, the integrator can determine the cost-minimizing allocation of each supplier's shipments to different trucks or routes, while ensuring the plant's demand for each part is met. Furthermore, they employ strategies like milk-run deliveries – a single truck picking up from multiple suppliers in sequence – which is essentially a routing optimization built on top of the transportation plan. The milk-run ensures high vehicle utilization (trucks never run empty on their circuit) [8], reducing the total transportation cost per unit. The use of such methods helped Slovak automakers maintain efficient operations; even during the COVID-19 disruptions, flexible transport planning was crucial to handle supply interruptions [2].

### Location-Allocation Problems

Location-allocation problems address the question of where to establish facilities (location decisions) and how to assign demand points to those facilities (allocation decisions) in order to optimize one or more objectives. These objectives can include minimizing transportation costs, maximizing coverage of clients, minimizing response time, or balancing workloads among facilities, depending on the context. Typical facilities considered in these problems include warehouses, distribution centers, factories, retail outlets, or service centers (like hospitals or fire stations), and demand points are usually customer locations or markets. Several classical models fall under the location-allocation umbrella [5]:

- **p-Median Problem:** Select  $p$  facility sites out of a given set such that the total distance or transportation cost from each demand point to its nearest open facility is minimized. This model tends to locate facilities in a way that reduces the average distance customers travel.
- **Uncapacitated Facility Location Problem (UFLP):** Decide which facility sites to open (from a set of candidates) and assign each demand point to an open facility. The objective is to minimize the sum of fixed facility opening costs and transportation costs for serving all demands. This model (also called the simple plant location problem) generalizes the  $p$ -median by including facility fixed costs and not fixing the number of facilities in advance.
- **p-Center Problem:** Choose  $p$  facilities to minimize the maximum distance any demand point must travel to a facility. This “minimax” model is critical for emergency services, where the worst-case response time needs to be as small as possible.
- **Covering Problems:** Ensure that all demand points are within a certain distance or time threshold of a facility. Variants include maximizing the number of demands covered by  $p$  facilities (maximal covering) or minimizing the number of facilities needed to cover all demand (set covering).

Most location-allocation models can be formulated as mixed-integer programming problems. As an example, consider the uncapacitated facility location problem described above. Let  $J$  be the set of potential facility locations and  $I$  the set of demand points. For each location  $j \in J$ , there is a fixed cost  $f_j$  to open a facility there. For each demand point  $i \in I$ , if it is served by facility  $j$ , a transportation cost  $c_{ij}$  is incurred (e.g. proportional to the distance or shipping cost from facility  $j$  to client  $i$ ). We introduce a binary decision variable  $y_j$  which is 1 if a facility is opened at site  $j$ , and 0 otherwise. We also have binary decision variables  $a_{ij}$  which equal 1 if demand point  $i$  is assigned to facility  $j$ , and 0 otherwise. One formulation is:

$$\begin{aligned}
& \min \sum_{j \in J} f_j y_j + \sum_{i \in I} \sum_{j \in J} c_{ij} a_{ij} \\
& \text{s. t.} \quad \sum_{j \in J} a_{ij} = 1, \quad \forall i \in I, \\
& \quad a_{ij} \leq y_j, \quad \forall i \in I, \quad \forall j \in J, \\
& \quad y_j \in \{0,1\}, \quad a_{ij} \in \{0,1\}, \quad \forall i \in I, \quad \forall j \in J.
\end{aligned}$$

Here, the first constraint means every demand point  $i$  is assigned to exactly one facility (no customer is left unserved and no customer is served by two facilities). The second constraint ensures that a demand point can only be assigned to facility  $j$  if that facility is open ( $y_j = 1$ ). The objective function combines the total fixed costs of opened facilities with the total transportation (service) costs for all assignments. This formulation assumes facilities have unlimited capacity; in a capacitated version, one would add constraints to limit the total demand assigned to each facility.

Location-allocation problems are generally NP-hard (except in special cases), so they are challenging to solve exactly for large-scale instances. However, modern integer programming solvers can handle moderately sized instances (on the order of tens of potential facilities and hundreds of demand points) to optimality. For larger instances or more complex variants, heuristic and metaheuristic algorithms are widely used in practice. Techniques such as greedy add/drop heuristics, genetic algorithms, and simulated annealing have been successfully applied to large L-A problems, including those arising in logistics network design.

**Example 1 (Automotive Distribution Center Location):** A real-world illustration of a facility location decision in the Slovak automotive sector is the establishment of BMW Group's regional distribution center for spare parts near Bratislava. Although BMW does not produce cars in Slovakia, in 2016 it opened a 25,000 m<sup>2</sup> logistics hub at Prologis Park Bratislava to serve Central and Eastern Europe. The choice of location was driven by proximity to core transport corridors and markets – the site lies on the Pan-European Corridor IV highway, which was a key factor in BMW's decision [7]. By situating this parts warehouse in western Slovakia, BMW can quickly dispatch parts to 12 surrounding countries within its Central European service region [7]. This location-allocation solution minimizes transit times to dealerships and cuts costs by centralizing inventory in a logistically advantageous spot. In terms of our model, the “facility” (the warehouse) was chosen among candidate locations for its minimal total distribution cost to the region's demand points. The success of this hub underscores the importance of rigorous location analysis: it provides a high service-level network for aftersales logistics while keeping transportation expenses in check.

**Example 2 (Automotive Plant Location Decision):** Another example highlighting location-allocation considerations is Jaguar Land Rover's decision to build a new manufacturing plant in Nitra, Slovakia. In 2015, after examining various sites worldwide, JLR selected Nitra as the preferred location for its €1.4 billion factory. A major reason cited was the strong existing supplier base and logistics infrastructure in Western Slovakia [6]. In terms of location theory, JLR essentially solved a complex location-allocation problem: it chose an optimal site that would allow it to *allocate* its incoming supply chain efficiently (many of JLR's key suppliers are within easy reach of Nitra, reducing inbound transport costs) and to distribute finished vehicles efficiently to important markets. This was facilitated by Slovakia's well-integrated road and rail network, with a robust transportation infrastructure to handle exports (approximately half of Slovakia's exported cars are moved by rail) [1]. The Nitra plant began production in 2018, and its performance has validated the location choice – the facility is well-served by highways and rail, and it leverages the country's dense cluster of automotive

suppliers. This example demonstrates how strategic factory location is intertwined with transportation considerations: the goal was to minimize overall logistics costs (including both the inbound shipment of parts and the outbound distribution of vehicles) while maintaining high service levels. In effect, JLR's investment decision was guided by the same principles that underpin formal location-allocation models, balancing fixed facility costs with transportation efficiencies across its supply chain network.

### **Integrating Transportation and Location Decisions**

In practice, transportation and location-allocation decisions are often interdependent. Businesses must frequently make facility location choices (where to site a plant, warehouse, or distribution hub) in tandem with transportation planning (how to route deliveries or shipments), as part of an overall supply chain *network design*. Solving this combined problem optimally is complex, but even partial integration can yield significant benefits. For example, a company might decide to open a slightly more expensive warehouse in a central location if it substantially lowers transport costs to customers, resulting in a net gain. Advanced optimization models and software now allow companies to tackle such integrated network design problems using a combination of exact methods and heuristics.

The theoretical frameworks outlined above – from the linear programming solution of the transportation problem to the integer programming formulations of facility location – provide essential decision-support tools. In Slovakia's automotive industry, these tools underpin decisions such as designing milk-run collection circuits, locating regional logistics centers, and expanding supplier parks near assembly plants. As the industry evolves (e.g. with the shift to electric vehicles and new distribution models), transport and logistics systems theory will remain indispensable. Companies and researchers will continue to refine these models to incorporate new factors (like carbon emissions or risk mitigation) and to solve ever-larger instances with modern computational techniques. The end result is a more efficient and resilient logistics network, which is crucial for competitiveness in today's fast-changing market.

### **Conclusion**

Efficient transport and logistics systems are the backbone of supply chain competitiveness. The transportation and location-allocation problems discussed in this article form the theoretical core for optimizing these systems. The transportation problem offers a powerful yet tractable model for minimizing distribution costs between fixed supply and demand nodes, whereas location-allocation models guide strategic placement of facilities to balance cost, service level, and other criteria. The current research landscape shows a maturing of solution techniques for these problems, with an emphasis on integration (combining multiple decision layers), handling uncertainty, and addressing sustainability considerations. Real-world examples from Slovakia's automotive logistics sector illustrate the tangible impact of these theoretical models: from daily operations like inbound parts delivery to high-level investments like new factories and distribution hubs, optimization principles drive better outcomes. By applying the theory of transport and logistics systems, organizations can achieve significant cost savings, service improvements, and greater resilience – outcomes that are vitally important in a global supply chain environment characterized by demand volatility and constant pressure for efficiency.

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## **Pošta, Telekomunikácie a Elektronický obchod**

Elektronický vedecký časopis zameraný na problematiku poštových a telekomunikačných podnikov a oblasť elektronického obchodovania.

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