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ЧАСОПИС ДРУШТВА ЗА ЕКОНОМСКА, ДРУШТВЕНА И КУЛТУРНА НАУЧНА ИСТРАЖИВАЊА – НОВИ САД

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РЕЧ УРЕДНИКА

Часопис је превасходно намењен младим истраживачима економске и сродних наука у циљу афирмације примене знања, рачунајући посебно успех у пословању, привредном систему и друштву применом савремених технологија. Савремени пословни системи и окружење довели су до значајних промена које олакшавају рад, али и омогућавају примену искуства из пословне праксе. Ефикасно пословање и привредне активности манифестују се у стратешким и тактичким интеграционим процесима, како економских, техничких и друштвених наука, а све у циљу усмеравања на моделе научних истраживања који се реализују путем теорије, тако и праксе. Један од основних постулата овог часописа је интеграција научних истраживања економске и других сродних наука усмерених на пословање, привредни и друштвени систем кроз реализацију успеха, како друштва тако и појединца.

EDITOR'S WORD

The magazine is primarily intended for young researchers of economic and related sciences with the aim of affirming the application of knowledge, counting especially success in business, the economic system and society through the application of modern technologies. Modern business systems and environment have led to significant changes that facilitate work, but also enable the application of experience from business practice. Effective business and economic activities are manifested in strategic and tactical integration processes, both economic, technical and social sciences, all with the aim of directing scientific research models that are realised through theory and practice. One of the basic postulates of this journal is the integration of scientific research in economics and other related sciences focused on business, economic and social systems through the realisation of success, both for society and for individuals.

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ZADOVOLJSTVO POTROŠAČA ZELENIM PIJACAMA U REPUBLICI SRBIJI

Nedeljko Prdić[1]

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Apstrakt

U današnje vreme razvoj tehnologije i digitalnog marketinga očigledno menja i stil života i principe poslovanja. Naime, tim se promenama moraju prilagoditi i proizvođači poljoprivrednih proizvoda u konceptu razvoja održive poljoprivrede. Upravo su potrošači na zelenim pijacama ti koji imaju odlučujuću ulogu i uticaj na poljoprivredne proizvođače i prodavce na zelenim pijacama. Stoga se prodaja na zelenim pijacama mora koncipirati na osmišljenoj strategiji marketinške komunikacije sa potrošačima kako bi poslovanje bilo uspešno. Ovaj rad prikazuje teorijski konceptualni model i tradicionalni okvir zadovoljstva potrošača proizvodima na pijacama te rezultate empirijskih istraživanja stavova potrošača. U istraživanje je uključeno 450 potrošača na zelenim pijacama u Republici Srbiji, čiji su stavovi mereni metodama statističke obrade podataka koristeći prosečne vrednosti. Anketiranjem je obuhvaćeno i 150 prodavaca voća i povrća koji prodaju na zelenim pijacama više od 10 godina. Cilj rada je utvrditi kakav uticaj imaju marketinški instrumenti komunikacije na ponašanje potrošača te koliko su potrošači spremni prihvatiti nove oblike kupovine putem e-pijaca. Rezultati istraživanja ukazuju da je prihvatanje stavova potrošača o kupovini proizvoda sa zelenih pijaca osnova očuvanja tradicionalne uloge pijaca kao mesta kupovine zdravih domaćih proizvoda i osnova razvoja održive poljoprivrede u budućnosti.

***Ključne reči*:** *potrošači, zelene pijace, digitalni marketing, e-pijace, održiva poljoprivred*

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1. Uvod

Trgovina proizvodima i poljoprivrednim proizvodima datira još iz srednjeg veka posmatrajući istorijski konteks razmene. Pijace se pojavljuju pre oko pet hiljada godina sa nastankom robne razmene. (Petrović et al., 2021., Denda, 2024). Postoje brojne veze između razvoja trgovine i pijaca. One (pijace) doprinose mnogim društvenim koristima, povećanju prihoda, jačaju društvenu komunikaciju i interakciju, razvoj društvenog bogatstva, kao i jači stepen povezanosti između potrošača i lokalne zajednice (Bonanno et al., 2017). Kako je razvoj komunikacije među ljudima rastao, tako je značaj lokalnih proizvoda i mesta prodaje doprineo konceptu ukupnog povezivanja i javnog interesa. Pijace kao tradicionalne institucije moraju prihvatiti promene i uvesti digitalne tehnologije kako bi opstale na tržištu (Adams, 2015). Proces primene digitalnih tehnologija i digitalnog marketinga je širok skup varijabli koje se koriste u definisanju identiteta pijaca, a koji je u skladu sa identitetom grada i regije, te služi kao osnova zadovoljenja interesa potrošača. Analizom poslovanja pijaca u Republici Srbiji vidimo da najveći broj pijaca kao preduzeća u nedovoljnoj meri ili veoma slabo primenjuje savremene digitalne tehnologije (Prdić, 2022, Ben, 2025). Izgradnjom identiteta za promociju lokalnih zelenih pijaca, ističe se posebnost, društveni i kulturološki aspekt, turistički i tradicionalni aspekt, pa je u domaćim uslovima neophodan trend prilagođavanja i primene u poslovanju.

U prošlosti su pijace bile mesta prodaje lokalnih poljoprivrednih proizvoda, ali su vremenom postajali lokalni centri i za prodaju mlečnih proizvoda, mesa i ribe. Činjenica je da su zelene pijace u EU i uopšte u svetu mesta prodaje poljoprivrednih proizvoda. Takođe, svuda u svetu proizvodnja poljoprivrednih proizvoda i upravljanje poljoprivrednim gazdinstvima i proizvodnjom zdrave hrane, stimulisane su, kako u pogledu očuvanja zdrave sredine, najbolje prakse, očuvanja prirodnih resursa, tako i u skladu sa potrebama savremenih potrošača. U Španiji postoji veliki broj pijaca. Svaka od njih ima svoju priču, svoju istoriju. Samo u Madridu ima ih 46, neke su pretvorene u moderne pijace, neke u gastro barove, a neke su zadržale svoj stari sjaj i pod zaštitom su države. Pravo je čudo kako su pored svih velikih trgovinskih lanaca one uspele da opstanu i krase pojedine gradove već više vekova (www.onlinekursspanskog.com).

Danas su potrošači informisani o kanalima distribucije poljoprivrednih proizvoda. Još od nastanka interneta stvaraju se različita prodajna okruženja koja uključuju konkurenciju, marketing, društvene medije,

aplikacije proširene stvarnosti i mnoge druge tehnike privlačenja potrošača. U takvom okruženju zelene pijace, moraju pratiti navike i način života potrošača, a korišćenjem interneta, svakodnevno mogu ostvarivati interese potrošača na osnovama snabdevanja zdravim proizvodima. Poseta potrošača zelenim pijacama jedan je od najvažnijih aspekata u marketinškim istraživanjima jer direktno doprinose razvoju lokalne poljoprivrede, lokalnih pijaca i prepoznatljivosti gradova. Konzumacija proizvoda sa zelenih pijaca smatra se indikatorom zdravog života i ishrane i zdravih navika u kontekstu kvaliteta proizvoda. Potrošači kvalitet proizvoda sa zelenih pijaca ocenjuju na osnovu tradicionalnog iskustva i ekonomskih parametara u vidu cena, oznake domaćeg proizvoda geografskog porekla, proizvođača, pakovanja i posebne oznake kvaliteta. Posebna obeležja koja mogu opredeliti potrošača su ukus, miris i svežina. Stavovi potrošača prema nutritivnim karakteristikama proizvoda i pravilnim prehrambenim navikama u poslednje vreme se menjaju te se potrošači sve više brinu o konzumaciji zdravih proizvoda i uopšteno vode računa o uravnoteženoj ishrani (Bandera et al., 2015).

Poznavanje ponašanja potrošača predstavlja osnovnu komponentu i imperative za uspešnu prodaju. Naime, cilj ovog istraživanja je utvrđivanje ponašanja potrošača pri kupovini i konzumiranju svežih poljoprivrednih proizvoda sa zelenih pijaca, razlozi kupovine u kontekstu kvaliteta i obeležja proizvoda. Poznavanje stavova potrošača s jedne strane opredeljuje proizvođače za proizvodnju odgovarajući na tražnju potrošača za svežim proizvodima, a s druge strane osigurava javno dostupne proizvode na javnim pijacama kojima se doprinosi zdravlju stanovništva, kao i ruralnom razvoju. Motivacija za pisanje ovog rada proističe iz nedostatka dublje analize integrisanih ekonomskih koristi pristupa zadovoljstvu potrošača u kontekstu zadovoljenja privatnog i javnog interesa. Gradska pijaca je odraz lokalne ekonomije (Vaivadaite et al., 2024).

Stoga se u zavisnosti od predmeta istraživanja koriste različite varijable uticaja na ponašanje potrošača u kupovini. U ovom istraživanju, prvi fokus je stavljen na istorijski značaj pijaca, subjektivne norme i percipirane kontrole ponašanja potrošača u kupovini (socio-ekonomske). Drugi fokus je na zadovoljstvu potrošača zelenim pijacama, komunikaciji i sopstvenom ponašanju. Treći fokus su e-pijace kao proces razumevanja proizvođača i potrošača u novom poslovnom okruženju. S obzirom na sveprisutniju konkurenciju, stavovi potrošača o kupovini na pijacama opredeljivaće aktivnosti proizvođača i prodavaca, javnih preduzeća koji upravljaju pijacama, grada i gradskih turističkih

organizacija prema potrošačima kako bi usmerili svoje aktivnosti i u kontinuitetu dobili poverenje sve većeg broja kupaca. Radi postizanja planske pozicije u poslovanju koju donosi menadžment pijaca u nekom vremenskom razdoblju, neophodno je koristiti kriterijume i pokazatelje koji će najbolje odražavati poslovne performanse pijaca (Prdić, 2022). Dobijeni rezultati će pružiti uvid u zadovoljstvo potrošača zelenim pijacama u Republici Srbiji, istovremeno poboljšavajući ekonomsku poziciju proizvođača te ukupnu korist koju zelene pijace mogu doneti gradu i društvenoj zajednici.

2. Pregled literature

2.1. Istorijski značaj zelenih pijaca za trgovinu poljoprivrednim proizvodima

Istorijski razvoj i promene u okruženju i funkcionisanju gradova uvek su vezane za pijace, odnosno promene u poslovanju tako i na promene u potrebama i željama potrošača. Podaci o istorijskom značaju pijaca, preporučuju ih kao mesta susretanja velikog broja ljudi (Prdić, 2023). Širom Evropskih istorijskih centara na glavnim trgovima bile su pijace (Zandieh et al., 2020). Na osnovu podataka sa sajtova pijaca, osvrćući se na istoriju pijaca potrebno je pomenuti i „Borough Market" u Londonu koja je najpoznatija Britanska pijaca, smeštena uz reku Temzu, a pretpostavlja se da je stara oko 1000 godina. Džinovska istorijska pijaca stara oko 800 godina je „La Boqueria" u Barseloni, na kojoj su lokalni farmer prodavali meso i povrće. Jedna od najstarijih i najpoznatijih zatvorenih pijaca u centru Moskve "Jelisejevski" poznati je turistički i istorijski simbol starih vremena i trgovine. Urbane gradske pijace su pokretači promena i socijalizacije gradova (Hiebert et al., 2015). Pijace su bile pokretači urbanog rasta i razvoja privrede. U savremenom kontekstu gradske pijace su organizovane kao urbani bazari i mesta susretanja ljudi (Marciniak, 2020). Ove istorijske pijace čine osnovu arhitekture gradova, kulturu i tradiciju podneblja, gastro i savremeni centar susretanja ljudi iz celog sveta i neizostavni događaj u turističkim ponudama. Pored tradicije i susretanja globalne trgovine koja ima lokalni karakter one su deo ozbiljnih turističkih atrakcija. Pored svetskih istorijskih veza pijaca i lokalne trgovine one imaju svoju istoriju i na domaćem tržištu.

Prva pijaca u Beogradu pod imenom „Pijaca Svetog Andreja" (u narodu poznatija kao „Velika pijaca") nastala je 1824. godine na Studentskom trgu (www.bgpijace.rs). Sa najdužom tradicijom u gradu Novom Sadu, Riblja pijaca je od mesta koje je sredinom XIX veka služilo isključivo za

snabdevanje građana svežom ribom, vremenom prerasla u klasičnu zelenu pijacu, sa bogatom ponudom svežih poljoprivrednih proizvoda, živinskog mesa, ribe i mešovite robe (www.nstrznica.co.rs). Razvojem gradova kroz istoriju, razvijao se i oblik trgovine na otvorenom prostoru, kako na unapred određenom prostoru (pijace), tako i privremeno na privremenim lokacijama (vašari). Prva ovakva trgovina je zabeležena u okviru gradskih zidina antičkog grada – utvrđenja Naissusa. Za vreme Turaka pijačna trgovina se odvijala ispred gradskih zidina tvrđave, a nešto kasnije i u centru grada sve do Prvog svetskog rata (www.trznicanis.rs). Navedeni podaci su istorijskog karaktera, ali sledeći članak u poznatom časopisu povezuje njihovu istoriju i značaj sa novim digitalnim dobom u poslovanju i komunikaciji.

Beogradska “Kalenić pijaca" svrstana je među najbolje na svetu na rang listi uglednog britanskog Fajnenšel tajmsa. Smeštena na Vračaru u srcu grada, nazvana je po Vlajku Kaleniću, koji je pre skoru jednog veka poklonio zemljište na kome je podignuta. Veliki izbor proizvoda, od domaće destilovane rakija, kajmaka, sira i voća i povrća do suhomesnatih proizvoda i začina, izložen je na tezgama gde se prodavci i kupci cenkaju, šale, pa čak i pevaju. Mnogi lokalni stanovnici mi kažu da menjaju svoje rute za pešačenje samo da bi uživali u prelepom mestu. (www.sputnikportal.rs).

Sve strane i domaće pijace kroz istoriju do danas pored arhitekture, kulture i tradicije, susretanja ljudi i trgovine, sastavni su deo ozbiljnih turističkih atrakcija i ekonomskih potencijala. Lokalna pijaca uključuje tržište, ljude i događaje (Moagi et al., 2025).

2.2. Međuzavisnost interesa proizvođača i potrošača

Pijace su zatvoreni i otvoreni prostori koji po definiciji služe za prodaju robe (Morales, 2011). Evidentno je da pijace traju uprkos činjenici rastuće tražnje i konkurencije. One omogućavaju pravednu trgovinu sa aspekta razvoja ruralnih područja i svesti koncepta lokalnog razvoja. Prodaju na pijacama karakteriše činjenica da se uglavnom nude sveži i kvalitetni proizvodi (Ostojić et al., 2013). Ovaj koncept podrazumeva procese i rezultate koji su bitni za ostvarivanje održive poljoprivrede i razvoja ruralnih sredina gde je u fokusu ključni element svež i kvalitetan proizvod. Direktan marketing poljoprivrednih proizvoda se ostvaruje preko tržišne institucije, i to pijaca na malo, ili “zelenih pijaca” što je trgovački naziv koji se često koristi. (Zarić et al., 2016). Direktan marketing i digitalni marketing imaju značajan uticaj na percepciju javnosti o prodaji na pijacama i posebno o kvalitetu, svežini i

geografskom poreklu proizvoda. Konkurentska prednost u prodaji na pijaci zavisi od jedinstvenih elemenata ponude, konkurencije i potreba potrošača (Kuzman et al., 2022). Danas se posebno shvata poslovna analiza (Čavlin., 2022). Moguće je ličnom SWOT analizom utvrdite sopstvene snage i slabosti te prilike i pretnje generisati u strategiju komunikacije sa potrošačima na pijaci i utvrditi mogućnosti stvaranja sopstvenog brenda u pijačnoj prodaji. Raste takozvana savremena poljoprivreda, zasnovana na tradiciji i pijačnoj prodaji, gde uz rast prinosa gazdinstva raste i investicija ulaganja za bolja prodajna mesta na pijacama. Tokom nekoliko prodajnih dana lokalni proizvođači gradskom stanovništvu prodaju širok asortiman poljoprivrednih proizvoda (Toftgaard, 2016). Domaće tržište zauzima značajan segment u ishrani te predstavlja jednu od osnovnih komponenti zdravog načina života. Osim toga lokalni poljoprivredni proizvodi na svetskom tržištu predstavljaju koncept ponude prilagođene potrebama potrošača. Kanalima distribucije proizvoda iz agrara, u postojećim odnosima, poseban pečat daje prisustvo pijace (Miljković et al., 2015; Puška et al., 2025). Potrošačima je najvažniji kvalitet proizvoda koje kupuju, zatim poreklo, ali i oznaka kvaliteta o poreklu proizvoda na zelenim pijacama. U okviru savremenog ekonomskog sistema, proizvođači i potrošači su tesno povezani i međusobno utiču jedni na druge (Ai et al., 2019). Tržišni segment zadovoljstva interesa potrošača u savremenom okruženju pruža proizvođačima razvoj i iskorak napred uz istovremeno ispunjavanje želja potrošača u savremenom društvu.

U društvenom smislu pijace su mesta za socijalizaciju i susretanje ljudi (Gonzales, 2020). Kako god razumeli pijace kao istorijske institucije, kao poljoprivrednu delatnost i prodaju, kao lokalni javni prostor, kao marketinški instrument distribucije one doprinose ekonomskom razvoju i susretanju ljudi. Najčešće se baca hrana poput voća, povrća, korenastog i gomoljskog povrća, koji čine oko 45% ukupno proizvedene hrane, zatim riba i morski plodovi sa 35%, te žitarice sa 30% otpada (Hermanussen et al., 2022). Ova pojava se javlja u svim fazama lanca snabdevanja, počev od početne proizvodnje pa sve do završne potrošnje u domaćinstvu (Wen et al., 2022). Tako razdvajanje proizvodnje od potrošnje je kompleksno (Gajić et al., 2024). Koncept društveno odgovornog poslovanja i održive potrošnje poljoprivrednih proizvoda u svojoj osnovi ima brigu o društvu, zdravlju i okolini. Dobro poslovanje poljoprivrednih proizvođača podrazumeva, dobar odnos prema drugim slojevima stanovništva, ukupnom konceptu proizvodnje i potrošnje, bezbednog čuvanja hrane i ponovne prerade i upotrebe. Sav taj proces operacionalizacije uspešnosti

trgovine na Veletržnici i malim pijacama, potrebno je stalno proveravati novim promenljivim veličinama (Prdić et al., 2025).

2.3. Novi oblici trgovine u funkciji zadovoljstva interesa potrošača

U savremenim uslovima poljoprivredne proizvodnje skladištenje i distribucija krajnjim potrošačima osnovni je motiv. Veletržnice su mesta za prodaju velikih količina proizvoda (Inayah et al., 2024). Zastupljenost proizvoda i koncept proizvoda u maloprodaji značajno doprinosi uvidu u prodaju i zastupljenost trgovine. Kratki lanci snabdevanja su posvećeni lokalnom ekonomskom razvoju, te održavanju odnosa proizvođača, prerađivača i potrošača (Aouinait et al., 2022). Društvene mreže postale su oblik svakodnevne privatne i/ili poslovne komunikacije. (Kostić, 2022). Težište e-trgovine u Republici Srbiji očekuje se da će kontinuirano rasti na osnovama zadovoljstva potrošača, a zdravi proizvodi mogu doprineti trendovima u online trgovini. Naučnici su dokazali važnost veleprodajnih tržišta u marketingu prehrambenih proizvoda s obzirom na značaj maloprodaje. (Boiko et al., 2019). Za uspešno funkcionisanje veleprodaje, fokus se stavlja na procese u organizaciji maloprodaje. Uspešnost lanca snabdevanja poljoprivredno prehrambenih proizvoda zavisi od jačine svake karike u lancu. (Gazdić et al., 2022). Lokalni proizvođači imaju suštinsku ulogu u maloprodaji i društvu (Bejan et al., 2025; Puska et al., 2025). (Prava procena post-prodajnog tržišta omogućava organizaciji da ostvari važnu strategiju (Miletić et al., 2022). Uloga marketinškog benčmarkinga u poslovanju pijaca je u suštini identifikovanje razlika koje postoje u odnosu na maloprodajne objekte jer se mogu uočiti i na samim prodajnim mestima (Prdić et al., 2022). Glavni cilj poređenja nije samo prodaja, nego i marketinška strategija, ali i ideja kako ostati duboko na tržištu i uspostaviti dobre odnose na tržištu. Na pokretače e-trgovine utiče kvalitet usluge e-trgovine (Rehman et al., 2022). Najveći deo e-trgovine odnosi se na online trgovinu, pa je najbolje poboljšati uslove i nivoe oglašavanja. U online kupovini, uočena korisnost znači da kupac smatra da je veb-lokacija veoma efikasna za kupovinu (Saleem et al., 2022). Istraživanje je pokazalo da sigurnost prilikom onlajn kupovine statistički značajno utiče na zainteresovanost za korišćenje aplikacije e-trgovine (Sampe et al., 2022). Što znači da je pristup ovom vidu trgovine pozitivan, ali i detalji trgovine u vidu bezbednosti i informisanosti moraju biti poznati. Veoma slična situacija za novu trgovinu je i sa pijacama (Masloch et al., 2024).

Polazeći od teorijskih problema istraživanja i utvrđenih ciljeva, kao i rezultata prethodnih istraživanja i iskustva autora, definisane su hipoteze

istraživanja koje će se potvrditi ili odbaciti istraživanjem sprovedenim u radu:

H1: Postoji značajna pozitivna povezanost između tradicionalne uloge zelenih pijaca i zadovoljstva potrošača.
H2: Postoji značajna pozitivna povezanost međusobne komunikacije prodavaca i potrošača kao elementa ponavljanja kupovine.
H3: Postoji značajna pozitivna povezanost kupovine proizvoda putem e-pijaca, ponašanja i zadovoljstva potrošača.

3. Materijal i metode

Teorijski deo rada zasnovan je na naučnoj i stručnoj literaturi domaćih i stranih autora. U radu su korišćeni sekundarni i primarni izvori podataka. U svrhu prikupljanja sekundarnih podataka sprovedeno je istraživanje za stolom, a u svrhu prikupljanja primarnih podataka terensko istraživanje. U sprovođenju sekundarnog istraživanja prikupljena je i obrađena dostupna literatura koja se odnosi uopšteno na trgovinu poljoprivrednim proizvodima, na pijace, nove oblike trgovine putem digitalnog marketinga, ponašanja potrošača i društvenog marketinga u javnom sektoru. Korišćene su i postojeće elektronske baze podataka kako bi se pratila tekuća dešavanja u svetskim razmerama na ovu temu. Primarno istraživanje je sprovedeno korišćenjem reprezentativnog uzorka uz korišćenje anketnog upitnika kao instrumenta istraživanja. U svrhu istraživanja korišćen je dubinski intervju. Prilikom kreiranja osnovnog sadržaja upitnika koristile su se teorijska saznanja o pijacama i potrošačima na pijacama, te iskustvo autora. Pitanja su bila postavljena u obliku Likerove lestvice od 1 do 5, pri čemu se ocena 1 odnosila na najmanje iskazano zadovoljstvo/slaganje/potrebu, a ocena 5 na najviše iskazano zadovoljstvo/slaganje/potrebu, različitih stavova potrošača na analiziranim pijacama. Podaci za analizirane pijace obrađeni su metodama statističke obrade podataka i prikazani putem tabela. Prilikom testiranja za obradu podataka koristiće se prosečne vrednosti svih pitanja koja se odnose na pojedinačne hipoteze. Kada je u pitanju "zadovoljstvo" podrazumeva se stepen ispunjenosti potreba u kontekstu tradicionalnog zadovoljstva na analiziranim pijacama (H1), pod pojmom "nedovoljna komunikacija" podrazumeva se nedovoljan nivo lične komunikacije prodavaca i potrošača (H2), a pod pojmom "ponašanje potrošača" podrazumeva se odnos verovatnoće prema navikama u kupovini (H3).

Prvi deo pitanja iz istraživanja koristila su se kao uvod u istraživanje. Osnovna pitanja odnosila su se na pretpostavke i hipoteze istraživanja u

vidu tradicionalnog značaja pijaca, te zadovoljstva potrošača kupovinom na pijacama i mogućnosti kupovine proizvoda putem e-pijaca. Na kraju upitnika nalazila su se pitanja koja se odnose na karakteristike ispitanika obuhvaćenih istraživanjem, kao što su socio-ekonomske i demografske karakteristike ispitanika te stepen zadovoljstva tradicionalnim pijacama, stepen ispunjavanja potreba i želja potrošača kupovinom na pijacama te mogućnosti promene navika u kupovini. Istraživanje je vršeno u periodu 01.08 do 31.08.2025. godine. Sprovođenje istraživanja je vršeno putem anketnog upitnika metodom ličnog intervjua koji je trajao u rasponu od 10 do 15 minuta. Istraživanje je vršeno na "Futoškoj pijaci" u sastavu JKP Tržnica, Novi Sad, pijaci „Tvrđava" u sastavu JKP Tržnica, Niš, i „Kalenić pijaci" u sastavu JKP Beogradske pijace, Beograd, na uzorku od po 150 slučajno izabranih potrošača. Na istim pijacama vršeno je anketiranje prodavaca koji prodaju na pijacama više od 10 godina. Svrha ovog istraživanja putem dubinskog intervjua je unakrsno preciziranje interesa kupaca i prodavaca radi iznalaženja adekvatnih zaključaka.

4. Rezultati i diskusija

U tabeli 1 prikazano je poređenje segmenata ispitanika prema polnoj strukturi na uzorku od 450 ispitanika. Segmenti su tri analizirane pijace na kojima je sprovedeno istraživanje, segment jedan ekvivalent je "Futoškoj", "Tvrđavi", "Kalenić" pijaci prvom delu po (Futoškoj) segment 1 i dalje respektivno.

Tabela 1: Poređenje ispitanika prema polnoj strukturi

	Polna struktura ispitanika	
	muškarci	žene
Segment 1	58%	42%
Segment 2	60%	40%
Segment 3	52%	48%
	χ^2 (df=2)=4,380 p=0,112>0,005	

Izvor: Istraživanje autora

U segmentu 1 58% ispitanika su muškarci, u segmentu 2 60% i u segmentu 3 52%. Dok je u segmentu 1 42% žena, segmentu 2 40% i segmentu 3 48%. Prikazani rezultati ukazuju na to da nema statistički značajne rezlike između segmenata kada je u pitanju polna struktura.

Tabela 2: Poređenje ispitanika prema starosti i obrazovanju

	Godine starosti ispitanika			**Nivo obrazovanja ispitanika**		
	od 20-40	**od 40,1-60**	**Preko 60,1**	**Osnovno i srednje obrazovanje**	**Više i visoko obrazovanje**	**Master, magistarske, doktorat**
Segment 1	34%	48%	38%	40%	34%	10%
Segment 2	52%	36%	50%	48%	40%	12%
Segment 3	24%	44%	24%	52%	44%	10%
	$c^2(2, n=150)=2,377$ p=0,307>0,05			$c^2(2, n=150)=3,794$ p=0,147>0,05		

Izvor: Istraživanje autora

Prikazani rezultati testirani primenom neparametarskog testa (Kruskal-Valisovog testa), ukazuju da nema statistički značajne razlike između segmenata (lokacije pijaca) kada su u pitanju godine starosti ispitanika niti kada se posmatra nivo obrazovanja.

Sa ciljem provere povezanosti sociodemografskih karakteristika: pol, životna dob i nivo obrazovanja s preferencijama kupovine na zelenim pijacama i supermarketima, primenjen je metod **X2** testa. Testirane su zavisne varijable: (1) pri kupovini prednost imaju domaći lokalni proizvodi; (2) preferencije kupovine proizvoda u supermarketima. Nezavisne varijable su pol, životna dob i nivo obrazovanja (tabela 3).

Tabela 3. Povezanost sociodemografskih karakteristika kupaca i sklonost kupovine na zelenim pijacama Rezultati X2 (KVADRAT)

	Zavisna varijabla	
Nezavisna varijabla	Pri kupovini prednost imaju domaći lokalni proizvodi na pijacama	Preferencije kupovine u lokalnoj trgovini
Polna struktura	1,656	10.789*
Životna dob	12,298	11.467
Obrazovanje	8,889	7,615

****p<0,05*** *Izvor: Istraživanje autora*

Rezultati pokazuju da postoji značajna statistička povezanost samo između pola i preferencije za kupovinu poljoprivrednih proizvoda u lokalnoj trgovini, i to po kriterijumu da žene više preferiraju kupovinu poljoprivrednih proizvoda u lokalnoj trgovini u odnosu na muškarce. Ostali rezultati za sve testirane varijable nisu statistički značajni, odnosno *p* je u svim slučajevima veći od 0,05 (*p>0,05.)*. Ako posmatramo ukupni uzorak istraživanja statistički testovi i merenja pokazuju da sociodemografska obeležja (životna dob i nivo obrazovanja)

ne doprinose odluci da li kupac (potrošač) preferira lokalne domaće proizvode na zelenim pijacama ili proizvode u lokalnoj trgovini. Ovaj zaključak je izveden na osnovu činjenice o vrlo visokim *p*-vrednostima u svim testovima, koje konzistentno ukazuju na nezavisnost varijabli (tabela 3).

Tabela 4. Raspodela ispitanika prema dugotrajnosti kupovine na zelenim pijacama

Koliko dugo kupujete na pijacama	Udeo ispitanika (%)
poslednjih godinu dana	8,0%
1-5 godina	27,5%
5-10 godina	33,5%
10-15 godina	18,0%
duže od 15 godina	13,0%
Ukupno	100,0%

Izvor: Istraživanje autora

Ako posmatramo dugotrajnost kupovine na zelenim pijacama (tabela 4) među anketiranim potrošačima njih 8% kupuje poslednjih godinu dana, 27,5% od 1-5 godina, 33,5% od 5-10 godina, 18% od 10-15 godina, dok njih 13% kupuje duže od 15 godina. Najveći broj ispitanika (33.5%) kupuje od 5-10 godina, pa se može izvesti zaključak da zelene pijace imaju dobru osnovu zadržavanja postojećih i projektovanu mogućnost zadržavanja postojećih i potencijalnih kupaca na osnovama ličnih marketinških komunikacija na pijacama i pridobijanju novih kupaca putem digitalnog marketinga (društvenih mreža) i e-pijaca.

Radi uspešnosti istraživanja značaja kupaca na analiziranim pijacama i preciznog merenja rezultata, kupce smo podelili na male, srednje i velike. Podaci u tabeli 5 su odgovori iz anketnog upitnika i predstavljaju deo upitnika čiji odgovori doprinose spremnosti kupaca (potrošača) da određeni nivo svojih sredstava na mesečnom nivou potroše na zelenim pijacama. Podaci su relevantni na osnovu izjava samih potrošača, ali i podataka da u periodu od 5 do 15 godina na pijacama kupuje 51,5% potrošača. Na osnovu iskustva autora i stavova ispitanika definisali smo kupce koji su posetili prodajno mesto, a možda jesu ili možda nisu kupili proizvode u srazmeri 1:3. Na osnovu njihovih stavova i kupaca koji su kupili proizvode definisali smo ukupan broj i karakteristike kupaca. Ovi podaci bitni su u kontekstu strategije prodavaca o privlačenju potencijalnih kupaca na pijačno mesto prodaje i potencijalnoj kupovini njihovih proizvoda.

Tabela 5. Karakteristike potrošača na analiziranim pijacama u kontekstu spremnosti potrošnje sredstava (N=450)

Karakteristike kupaca	Koji su kupili na prodajnom mestu	Koji su posetili prodajno mesto (možda su a možda i nisu kupili proizvode na pijaci)	Ukupno
Mali	186	558	2150
Srednji	216	648	1340
Veliki	48	144	432
Ukupno	450	1350	3922

Izvor: Rezultati ankete na pijačnim prodajnim mestima prodavaca: Proračun autora

1. Mali kupci – kupovina manja od 2500 e u prethodnoj godini (2024)
2. Srednji kupci- vrednost kupovine od 2500 e u prethodnoj godini (2024)
3. Veliki kupci – vrednost kupovini veća od 2500 e u prethodnoj godini (2024)

Kupce smo razvrstali po visini potrošenih sredstava u prethodnoj godini, a na osnovu informacija dobijenih od prodavaca. Podaci pokazuju na snažnu preferenciju potrošača za kupovinu lokalnih poljoprivrednih proizvoda među ispitanicima u kontekstu potrošnje sredstava (tabela 5). Iz navedenog zaključujemo da postoji pozitivno mišljenje o kupovini proizvoda kao i da su efekti lojalnih kupaca na uspešno poslovanje prodavaca veliki. Analiza pokazuje i da je neposredna živa reč i promocija prodaje najvažniji instrument privlačenja kupaca na pijačno prodajno mesto. Ovi podaci sastavni su deo održive strategije poslovanja pijačnih prodavaca u kontekstu ostvarivanja ekonomskih efekata i neposredne komunikacije (tabela 6).

Tabela 6. Planovi prodavaca za prodaju na pijaci na osnovu baze podataka o kupcima

Opis	Aritmetička sredina	Standardna greška
Mali kupci		
Kupovali na Vašem prodajnom mestu i na pijaci	2,54 (n=100)	0,21
Nisu kupovali kod Vas	2,69 (n=95)	0,18
Veliki kupci		
Kupovali na Vašem prodajnom mestu i na pijaci	3,14 (n=85)	0,17
Nisu kupovali kod Vas	3,00 (n=75)	0,16
Potencijalni kupci		
Kupovali na Vašem prodajnom mestu i na pijaci	2,27 (n=65)	0,20
Nisu kupovali kod Vas	2,25 (n=55)	0,22

Izvor: Rezultati ankete prodavaca na osnovu baze podataka o kupcima: Proračun autora

Anketiranje prodavaca koji prodaju više od 10 godina na pijacama vršeno je u kontekstu saznanja o planovima potencijalne kupovine i u budućnosti kada su u pitanju kupci koji posećuju pijacu i prodajno mesto, a jesu ili nisu kupovali proizvode. Cilj je bio utvrditi svesnost prodavaca o značaju i poseti njihovom prodajnom mestu od strane potencijalnih kupaca. Istraživanjem je potrebno utvrditi interesovanje potencijalnih kupaca, ali i utvrditi stepen lojalnosti postojećih kupaca. Putem Likerove skale vrednosti od 1 do 5 potrebno je izmeriti zainteresovanost i kupovne namere, gde je 1 bez planova za kupovinu (nizak interes) a 5 vrlo definisan plan za kupovinu (visok nivo kupovnih namera).

Tabela 7. Kumulativna analiza kupaca za kupovinu na pijacama na osnovu baze podataka prodavaca

Opis	Broj kupaca	Prodaja kao procenat od broja kupaca (%)	Kumulativna prodaja po kupcu
Mali kupci, posetili prodajno mesto (n = 350)	29	8,2	345
Mali kupci, nisu posetili prodajno mesto (n = 1800)	73	4,3	275
Veliki kupci, posetili prodajno mesto (n = 300)	56	28,7	650
Veliki kupci, nisu posetili prodajno	130	21,9	428

mesto (n = 1020)			
Potencijalni kupci, posetili prodajno mesto (n =1010)	25	2,8	300
Potencijalni kupci, nisu posetili prodajno mesto (n =10200)	84	0,9	196

Izvor: Rezultati ankerte prodavaca na osnovu baze podataka o kupcima: Proračun autora

Na osnovu baze podataka anketiranih prodavaca o karakteristikama kupaca u tabeli 6 i 7 vršeno je anketiranje o značaju, malih, srednjih i velikih kupaca, a u svrhu posedovanja svesti kupaca o njihovom prodajnom mestu, interesovanju i kupovini. Istraživanje je imalo za cilj i prikupljanje podataka o potencijalnim kupcima koji posećuju pijacu, da li ili ne posećuju njihovo prodajno mesto, a sve u cilju izrade poslovne strategije prodavaca radi ostvarivanja ekonomskih i komunikacionih efekata. Analizirajući ekonomske efekte na osnovu kumulativne analize prodaje moguće je izračunati stopu prinosa na investicije prodavaca. Ovaj efekat dobija se množenjem vrednosti ostvarene prodaje po posmatranim kategorijama kupaca sa prosečnom bruto profitnom stopom. Kratkoročna stopa prinosa na investicije u kupovinu u procentima predstavlja donju granicu vrednosti uloženog u privlačenje novih kupaca. Kada su u pitanju komunikacioni efekti, na kratak rok se ostvaruju putem neposredne komunikacije, živa reč, promocija prodaje, kvalitet proizvoda i drugi oblice verbalne komunikacije. Na duži rok komunikacioni efekti se ostvaruju putem društvenih mreža, odnosno digitalnog marketinga, promocijom pijace i sopstvenih proizvoda.

Tabela 8. Spremnost plaćanja više cene za kupovinu lokalnih poljoprivrednih proizvoda (voće i povrće) na zelenim pijacama (N=450)

Varijabla	N	%
Spremnost plaćanja više cene za lokalne domaće proizvode		
do 10%	204	45,3%
10-15%	164	36.6%
16-25%	80	17,7%
Više od 25%	2	0,4%

Izvor: proračun autora

Najveći broj ispitanika 45,3% (204) iskazali su mišljenje da su spremni da plate do 10% višu cenu za lokalne domaće poljoprivredne proizvode.

Na drugom mestu je grupa od 36,6% (164) ispitanika koji su spremni da plate od 10 do 15 %. Spremnost plaćanja znatno više cene od 16 do 25%, iskazala je grupa od 80 ispitanika. Samo 2 ispitanika spremna su da plate više od 25% veću cenu za lokalne domaće proizvode kupljene na zelenim pijacama. Zaključak je da visoka povećanja cena nisu prihvatljiva za većinu potrošača (tabela 8).

Tabela 9. Podrška razvoju lokalne poljoprivredne proizvodnje (N=450)

M	Mc	Mo	SD	Min	Max
4.5	5	5	0,8	2	5

Legenda: M= prosečna vrednost; Mc= Medijan; Mo=Mod; SD= Standardna devijacija

Izvor: Proračun autora

Analiza distribucije ocena za podršku razvoja lokalne poljoprivredne proizvodnje pokazuje izuzetno pozitivne rezultate. Prosečna ocena od 4,5 jasno ukazuje na opredeljenje potrošača za lokalne proizvode, dok medijana i mod na nivou 5 dodatno potvrđuju maksimalnu podršku među anketiranima. Standardna greška je 0,8 što ukazuje na činjenicu da su odgovori koncentrisani oko visoke srednje vrednosti, s minimalnim odstupanjem.

Tabela 10. Preferencije potrošača pri kupovini lokalnih poljoprivrednih proizvoda (voće i povrće) (N= 450)

	N	%
Preferencioni oblik kupovine		
Direktno od proizvođača	45	10%
Na zelenoj pijaci	227	50.4%
Na pijaci i putem društvenih mreža (e-pijace)	178	39,6%

Izvor: Proračun autora

U tabeli 10 uočavamo da većina ispitanika (50,4%), preferira kupovinu na zelenim pijacama, što naglašava davanje prednosti tradicionalnim pijacama, svežini, kvalitetu, poznatom prodavcu i poreklu proizvoda. Značajan broj ispitanika 39,6% preferira kombinaciju tradicionalnih pijaca i društvenih mreža (e-pijaca), dakle korišćenje oba načina kupovine. Svega 10% ispitanika preferira kupovinu direktno od proizvođača. Ova distribucija pokazuje da je kupovina od proizvođača tradicionalno vezana za poslovne kupce, dok su pijace osnovni kanal snadbevanja potrošača.

Tabela 11. Prosečna dostupnost lokalnih poljoprivrednih proizvoda (N=45)

M	Mc	Mo	SD	Rang
3,01	3	3	0.789	5

Legenda: M= prosečna vrednost; Mc= Medijan; Mo=Mod; SD= Standardna devijacija

Izvor: Proračun autora

Prosečna ocena je 3,01, što nam govori da ispitanici generalno percipiraju dostupnost lokalnih poljoprivrednih proizvoda kao prosečnu. Medijana i mod su 3, što ukazuje na to da je najčešći i srednji rezultat neutralan, što nam ukazuje da tipični anketirani ispitanik percepciju dostupnosti lokalnih proizvoda ne vidi kao posebno lošu niti idealnu. Standardna greška je 0,789, što implicira umerenu varijabilnost u percepcijama dostupnosti.

Testiranje hipoteza biće vrednovano prosečnim vrednostima svih pitanja koja se odnose na pojedinačne hipoteze.

H1: Postoji značajna pozitivna povezanost između tradicionalne uloge zelenih pijaca i zadovoljstva potrošača. Gde se pod pojmom "zadovoljstva" podrazumeva nivo tradicionalne uloge zelenih pijaca u snabdevanju potrošača.

H2: Postoji značajna pozitivna povezanost međusobne komunikacije prodavaca i potrošača kao elementa ponavljanja kupovine. Gde se pod pojmom "komunikacije" podrazumeva uspešan nivo lične komunikacije prodavaca i potrošača u funkciji ponavljanja kupovine.

H3: Postoji značajna pozitivna povezanost kupovine proizvoda putem e-pijaca, „ponašanja i zadovoljstva potrošača". Gde se pod pojmom „ponašanje potrošača u kupovini" podrazumeva mogućnost novih vidova kupovnih namera u korišćenju proizvoda sa zelenih pijaca. U svrhu provere pomenutih hipoteza testiranje se vrši putem teorije o nepoznatoj aritmetičkoj sredini osnovnog skupa.

Ho:……..X = Xo

H1: ……..X # Xo

Tabela 12: Podaci o prosečnoj oceni zadovoljstva/ nedovoljan nivo ličnih komunikacija/ponašanja potrošača u kupovini/ukupnog zadovoljstvo prema lokaciji pijace

Analizirane zelene pijace	Zadovoljstvo	Nedovoljan nivo ličnih komunikacija	Ponašanje potrošača u kupovini
Futoška Market -	2,6270	4,280	4,0465
Mean	150	150	150
N	.71241	.68441	.64283
Std. Deviation	2,5688	4.4100	4,1217
Median			
	2,4110	4,3178	4,0187
Tvrđava Market -	150	150	150
Mean	.73047	.68468	.58476
N	2.4666	4,4121	4.1211
Std. Devitaion			
Median	2.8123	3.9432	4,0875
	150	150	150
Kalenić Market- Mean	.90241	.64267	.80457
N	2,5245	4,2131	4.1165
Std. Devitaion			
Median	2.5315	4.3223	3.9846
	450	450	450
Total - Mean	.76078	.66134	.63453
N	2.5100	4.5100	4.1367
Std. Devitaion			
Median			

Izvor: Istraživanje autora

Prema podacima iz istraživanja prezentovanim u (tabeli 12), ispitanici su imali mogućnost ocene sopstvenog mišljenja o ponuđenim tvrdnjama koje se odnose na pojedine hipoteze. Raspon ocena je bio od 1 do 5, gde je 1 označavao izrazito negativno mišljenje, a 5 izrazito pozitivno. Prema podacima iz (tabele 12), prosečna ocena *zadovoljstva,* u smislu ispunjenosti potreba tradicionalnih zelenih pijaca, na "Futoškoj" pijaci je 2.6270, na pijaci "Tvrđava" 2,4110, na pijaci "Kalenić" 2,8123. Prosečna ocena zadovoljstva na svim analiziranim pijacama je 2,5100. Prosečna ocena "*nedovoljnih ličnih komunikacija*", na pijaci "Futoška" je 4,280, na pijaci "Tvrđava" 4,3178, na pijaci "Kalenić" 4,0875. Prosečna ocena nedovoljnog nivoa ličnih komunikacija na svim analiziranim pijacama je 4,3223. Kada je u pitanju prosečna ocena "*Ponašanja potrošača u kupovini",* na "Futoškoj" pijaci ona iznosi 4,0465, na pijaci "Tvrđava" 4,0187, na pijaci "Kalenić" 3,9846. Dok je prosečna ocena na nivou ukupnog skupa 4,1567.

Kada je u pitanju testiranje hipoteze da distribucija ima određen oblik- **Kolmogorov-Smirnov test**

H0:…….X–N(u,o)

H1:…….X+N(u,o)

Tabela13: One-SampleKolmogorov-SmirnovTest

	Zadovoljsto	Nedovoljan nivo ličnih komunikacija	Ponašanje potrošača u kupovini
N	450	450	450
Normal/ Mean	2,5315	4,3223	3,9846
Parameters(a,b)		,66134	,63453
Std. Deviation	,76078	,66134	,63453
Most Extreme Differences			
Absolute	,098	,250	,130
Positive	,098	,164	,076
Negative	,046	-,250	-,130
Kolmogorov-Smirnov Z	,974	2,490	1,306
Asymp.Sig. (2-tailed)	,298	,000	,064

Izvor: Istraživanje autora

Putem One-Sample Kolmogorov- Smirnov (Test distribution is Normal, Calculated from data) a na osnovu rezultata ankete može se konstatovati da je kod varijable" zadovoljstvo" empirijska signifikantnost a*= 0,298=29,8%, a > 5 pa se prihvata definisana hipoteza da distribucija varijable "Zadovoljstvo" ima normalan oblik. Naime, uz signifikantnost testa od 5% zaključuje se da se zadovoljstvo potrošača tradicionalnim pijacama ima oblik normalne distribucije. Dakle prihvata se hipoteza (H1) da distribucija varijable "Zadovoljstvo" ima normalan oblik, što podrazumeva odbijanje definisane hipoteze. Kod varijable "Nedovoljan nivo ličnih komunikacija" a* = 0,000 = 0%, a < 5%, podrazumeva da se odbija definisana hipoteza (H2) da distribucija varijable" Nedovoljan nivo ličnih komunikacija" ima normalan oblik. Varijabla "Ponašanje potrošača u kupovini" ima empirijsku signifikantnost a* = 0,064 = 6,4% gde a> 5% pa je definisana hipoteza (H3) prihvaćena da distribucija varijabli " Ponašanje potrošača u kupovini" ima normalan oblik.

Dvosmerno testiranje hipoteza zadovoljstvo potrošača/nivo ličnih komunikacija/ponašanje potrošača/međuzavisnost pojedinačnog i ukupnih zadovoljstva uz graničnu signifikantnost od 5%. Hipoteze za dvosmerno testiranje imaju oblik:

Xo:.....X = Xo

X1: .....X # Xo

U toku samog intervjua i razgovora sa potrošačima na analiziranim pijacama uslov iz istraživanja je definisan u tabeli (tabela 4.) da kupuju minimum godinu dana na zelenim pijacama. Ovaj uslov je postavljen radi relevantnosti istraživanja. Ispitanici u odgovoru na pitanja iz postavljenih hipoteza bili su u mogućnosti da daju odgovor na skali od 1 do 5, gde je 1 izražavalo najmanje iskazano zadovoljstvo, a 5 izrazito pozitivno zadovoljstvo. Anketirani potrošači u odgovoru na pitanje iz hipoteze bili su u mogućnosti da daju odgovor na skali od 1 do 5, gde je 1 izražavalo najmanje iskazano zadovoljstvo, a 5 izrazito pozitivno zadovoljstvo. U narednom delu rada testirane su postavljene hipoteze.

H1: Postoji značajna pozitivna povezanost između tradicionalne uloge zelenih pijaca i zadovoljstva potrošača

Tabela 14. Podaci o prosečnoj oceni zadovoljstva potrošačana tradicionalnom ulogom pijaca (testirana vrednost = 3)

One-Sample Statistics

	N	Mean	Stan. deviation	Std. Eror Mean
Zadovoljstvo	450	2,5407	,75089	,07657

Izvor: Istraživanje autora

Tabela 15: One sample test, prosečna ocena zadovoljstva (testirana vrednost = 3). 95% Confidence interval of the Difference

One-Sample Test

	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Zadovoljstvo	-6,133	441	,000	-,46825	-,6212	-,3167

Izvor: Istraživanje autora

Prema dobijenim podacima empirijske provere signifikantnost a*<5%, što ukazuje da se prosečna vrednost (ocena zadovoljstva) razlikuje od testirane vrednosti što ukazuje da se ne može prihvatiti hipoteza da je prosečna ocena zadovoljstva u celoj populaciji 3. Ne može se prihvatiti hipoteza da je prosečna ocena zadovoljstva u celom skupu 3 budući da je u uzorku jednaka 2,54 znači manja od 3. Hipoteza H1 nije prihvaćena.

H2: Postoji značajna pozitivna povezanost međusobne komunikacije prodavaca i potrošača kao elementa ponavljanja kupovine

Tabela 16. Podaci o prosečnoj oceni povezanosti međusobne komunikacije prodavaca i potrošača kao elementa ponavljanja kupovine (testirana vrednost = 2,8)

	N	**Mean**	**Stan. deviation**	**Std. Eror Mean**
Međusobna komunikacija	450	2,5305	,75189	,07667

Izvor: Istraživanje autora

Tabela 17: One sample test, prosečna ocena međusobnih komunikacija (testirana vrednost = 2,8). 95% Confidence interval of the Difference

One-Sample Test

	t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Lower**	**Upper**
Međusobna komunikacija	-2,213	441	,029	-,8	-,3212	-,0176

Izvor:Istraživanje autora

Prema dobijenim podacima empirijska signifikantnost a*= 0,029“ 2,9%, a*<5%, što znači da se prosečna vrednost (međusobnih komunikacija) razlikuje od testirane vrednosti pa se konstatuje da se ne može prihvatiti hipoteza da je prosečna ocena međusobnih komunikacija u celom skupu 2,8. Rezultat implicira da se ne može prihvatiti hipoteza H2 da se prosečna ocena zadovoljstva međusobnih komunikacija u celom skupu 2,8 budući da je u uzorku jednaka 2,53 znači manja od 2,8.

H3: Postoji značajna pozitivna povezanost kupovine proizvoda putem e-pijaca, ponašanja i zadovoljstva potrošača

Tabela 18. Podaci o prosečnoj oceni ponašanja potrošača u kontekstu zadovoljstva i kupovine putem e-pijaca (testirana vrednost = 4)

One-Sample Statistics

	N	**Mean**	**Stan. deviation**	**Std. Eror Mean**
Ponašanje potrošača	450	3,7758	,64079	,06658

Izvor: Istraživanje autora

Tabela 19: One sample test, prosečna ocena ponašanja potrošača u kupovini (testirana vrednost = 4). 95% Confidence interval of the Difference

One-Sample Test

	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Ponašanje potrošača	-,78	441	,936	-,00514	-,1322	,1212

Izvor: Istraživanje autora

Prema dobijenim podacima empirijska signifikantnost a*= 0,936=93%, a*>5%, što znači da se prosečna vrednost (ocena ponašanja potrošača u kupovini) ne razlikuje od testirane vrednosti pa se može izvesti zaključak da se može prihvatiti hipoteza H3 da je prosečna ocena želje potrošača za promenom ponašanja u kupovini u celom skupu 4.

Test homogenosti varijansi

Tabela 20. Levene test homogenosti varijanse

	Levene Statistic	Df1	Df2	Sig.
Zadovoljstvo	,457	3	95	,714
Nedovoljan nivo ličnih komunikacija u kupovini	1,366	3	95	,253
Ponašanje potrošača u kupovini	,837	3	95	,466

Izvor: Istraživanje autora

Uslov istraživanja i obrade podataka: a*>5=>Ho

Empirijska signifikantnost: zadovoljstva je a*=0,714=71,4%, a*>5 nedovoljan nivo ličnih komunikacija u prodaji a*=0,253=25,3%, a*>5%, ponašanja potrošača u kupovini a*=0,46,6%,=46,6%, a*>5%. Prihvata se hipoteza Ho o homogenosti koja pokazuje da nema statistički značajne razlike između varijansi po pijacama te se može izvršiti test analize varijanse.

Tabela 21: Testiranje analize varijanse s jednim promenljivim faktorom, ANOVA

Anova

		Sum of Squares	df	Mean Square	F	Sig
Zadovoljstvo	Between Groups	2,126	3	,713	1,237	,300
	Within Groups	54,524	95	,566		
	Total	56,650	98			
Nedovoljan nivo li.kom.	Between Groups	1,813	3	,603	1,376	,252
	Within Groups	41,348	95	,434		
	Total	43,161	98			
Ponašanje potrošača	Between Groups	,412	3	,138	,328	,803
	Within Groups	39,366	95	,417		
	Total	39,778	98			

Izvor: Istaživanje autora

Prema dobijenim rezultatima u tabeli (tabela 21) vidi se da je empirijska vrednost F-testa za varijablu: Zadovoljstvo a*=0,300=30%, a*>5 => Ho. Iz navedenih podataka možemo zaključiti da varijansa promenljivog faktora A (lokacija pijace) nije statistički značajna, odnosno da lokacija pijace u području stanovanja kupaca po mestu stanovanja ne deluje značajno na zadovoljstvo. Kada je u pitanju nedovoljan nivo komunikacija, je a*=0,252=25,2 %, a*>5=>Ho, a kod ponašanja potrošača u kupovini a*=0,803=80,3 %, a*>5=>Ho. Naime, možemo zaključiti da varijansa promenljivog faktora A (lokacija pijace) nije statistički značajna, što znači da lokacija pijace na kojoj kupci kupuju ne deluje značajno na zadovoljstvo. Ista vrednost je i za nedovoljan nivo ličnih komunikacija je (a*=0,252=25,2 %, a*>5=>Ho), ali i za ponašanje potrošača u kupovini (a*=0,803=80,3 %, a*>5=>Ho).

Kruskal-Wallis Test

Na osnovu podataka gore navedenih u delu tabele (tabela 13), gde testirana varijabla "nedovoljan nivo ličnih komunikacija" nije normalno distribuirana, napred prikazani rezultati pa se u daljem delu rada vrši testiranje neparamerijskim testom za tu varijablu, odnosno,

Ho – ne postoji razlika u nivou ličnih komunikacija ispitanika po pijacama

H1 – postoji razlika u nivou ličnih komunikacija po pijacama

Tabela 22: Kruskal-Wallis Test za varijablu "Nedovoljan nivo ličnih komunikacija"

	Nedovoljan nivo ličnih komunikacija
Chi-Square	4,189
Df	3
Asymp. Sig.	,242

Izvor: Istraživanje autora

a) Kruskal Wallis Test

b) Grouping Variable; Rejon pijace

Prema podacima iz prethodne tabele (tabela 22) empirijska signifikantnost je a*=0,242=24,2%, a*>5 % što implicira da se prihvata Ho, odnosno početna hipoteza koja nam govori da nema statistički značajne razlike u nedovoljnom nivou ličnih komunikacija po pijacama

Tabela 23. Intervalna procena ocene zadovoljstva/ nedovoljan nivo ličnih komunikacija/ponašanja potrošača u kupovini

	Statistic
Zadovoljstvo	Mean 2,5407 95% Conf. interval Mean: Lower Bound 2,4899 Upper Bound 2,5915
Nedovoljan nivo ličnih komunikacija u kupovini	Mean 4,3407 95% Conf. interval Mean: Lower Bound 4,1890 Upper Bound 4,4555
Ponašanje potrošača	Mean 2,5407 95% Conf. interval Mean: Lower Bound 2,4899 Upper Bound 2,5915

Izvor:Istraživanje autora

Prema podacima iz prethodne tebele uviđamo da je intervalna procena aritmetičke sredine "Zadovoljstvo" ispitanika iz uzorka uz nivo pouzdanosti procene od 95%: Pr **(**2,4899<*X*<2,5915)=95%. Intervalna procena aritmetičke sredine "Nedovoljan nivo ličnih komunikacija" ispitanika iz uzorka uz nivo pouzdanosti procene od 95%: Pr(4,1890<*X*<4,4555)=95%. Kod intervala procene aritmetičke sredine "Ponašanje potrošača":Pr(2,4899<*X*<2,5915)= 95%.

Tabela 24. Prikaz koeficjenta korelacije i stepena relevantnosti među faktorima ličnih komunikacija, promena u načinu komunikacija i integrisanih marketing komunikacija koji mogu unaprediti prodaju prodavaca na osnovu stavova potrošača

	Lične komunikacije	**Živa reč IMC**		**Digitalni marketing**	**IMC Ukupno**
Lične komunikacije-Kk	1.000	.558**	.562**	.528**	.677**
Stepen relev.		.000	.000	.000	.000
N	60	60	60	60	60
Živa reč -Kk	**	1.000	.558**	.567**	.503**
Stepen. Relev.		60	.000	.000	.000
N			60	60	60
IMC -Kk	**	**	1.000	.640**	.531**
Stepen relev.			60	.000	.000
N				60	60
Digitalni marketing-Kk	**	**	**	1.000	.621**
Stepen relev.				60	.000
N					60
IMC Ukupno-Kk	**	**	**	**	1.000
Stepen. relev					
N					60

Izvor: Anketa na analiziranim pijacama: Proračun autora

N = Korelacioni koeficijent i stepen relevantnosti; ** Korelacija je relevantna pri stepenu relevantnosti 0,01 (uzajamna).

Testiranje je moguće kad postoji visoka korelacije barem jedne nezavisne varijable (Grubor et al., 2019). Iz analize korelacije (tabela 24) vidimo, da postoji pozitivna veza između faktora ličnih komunikacija, koju smo dobili s varijablom rezultata faktorske analize i stepenom integrisanih marketing komunikacija (IMC). Zbog nižeg nivoa prihvatljivosti izvedena je korelacija između pojedinih promenljivih i nivoa integracije. Za sve pojedinačne promenljive, osim za manje od 0,01). Veza između digitalnog marketinga i integrisanih marketing komunikacija je relativno snažna (r=0,531), takođe je relativno snažna i približna veza između žive reči i integrisanih marketing komunikacija (0,503), kao i ličnih komunikacija (0,677) i integrisanih marketing komunikacija. Sve su ipak statistički značajne (stepen značajnosti = 0,000),

Kategorije koje određuju integrisanost (tabela 24) analiziranih pijaca:

- **Promocija prodaje** (međusobna saradnja u prodaji, promotivne cene, postojanje lične baze podataka, društvene mreže)
- **Živa reč** (instrumenti verbalne komunikacije, posebni promotivni dani na prodajnom mestu)
- **Digitalni marketing** (prodaja putem e-pijaca, analiza marketing okruženja, plan neverbalne komunikacije, saradnje sa kupcima i potrošačima kroz program lojalnosti)
- **Strategija prodaje** (usklađivanje ponude sa tržišnim okruženjem, optimalna integrisanost instrumenata verbalne i neverbalne komunikacije i digitalnog marketinga, analiza poređenja (benčmarking) sa konkurencijom.
- **Planiranje proizvodnje i prodaje** (PEST i SWOT analiza).

5. Preporuke za buduća istraživanja

Otvorene teme za buduća istraživanja zasnivaju se na zaključku da je najvažniji aspekt istraživanja zasnovan na stavovima i percepcijama kupaca (potrošača). Na osnovu pregleda teorijskih rezultata i stručne literature, te empirijskih rezultata i iskustva autora prethodna konstatacija dobija i praktičan značaj. Teorijski koncept istraživanja u budućnosti treba zasnivati na modelu analize interesa kupaca, konkurentskog okruženja i interaktivnosti marketinga i digitalnog marketinga sa zahtevima potrošača. Na osnovu prethodnih konstatacija i projekcije novog modela zadovoljstva potrošača kupovinom na zelenim pijacama moguće je projektovati napredniji strukturalni model. Na osnovu toga otvorene su i time za buduća empirijska istraživanja. Empirijska provera i merenje rezultata zsdovoljstva potrošača pijacama u Republici Srbiji može se primeniti na veći broj pijaca i veliki broj ispitanika potrošača sa naznakom geografske zastupljenosti. Takođe je moguće vršiti istraživanja samo za pojedinačne instrumente zadovoljstva i ukupnog zadovoljstva pijacama te do bolje uporedivosti i praktično primenljivih rezultata. Posebno se naglašava državna pomoć koja može da bude pravna, ekonomska, politička, finansijska, administrativna ili socijalna (Mihajlović et al., 2022).

6. Zaključak

Cilj rada je bio utvrditi nivo zadovoljstva potrošača zelenim pijacama u Republici Srbiji kako bi se utvrdili instrumenti marketinške komunikacije. Shodno tome cilju, na osnovama teorijskih saznanja te

dosadašnjih istraživanja i praktičnih iskustava autora postavljene su i hipoteze istraživanja. Prema dobijenim podacima empirijske provere signifikantnost a*<5%, što ukazuje na to da se prosečna vrednost (ocena zadovoljstva) razlikuje od testirane vrednosti što dalje ukazuje na to da se ne može prihvatiti hipoteza da je prosečna ocena zadovoljstva u celoj populaciji 3. Ne može se prihvatiti hipoteza da je prosečna ocena zadovoljstva u celom skupu 3 budući da je u uzorku jednaka 2,54 znači manja od 3. Hipoteza H1 nije prihvaćena. Prema dobijenim podacima empirijska signifikantnost a*=0,029=2,9%, a*<5%, što znači da se prosečna vrednost (međusobnih komunikacija) razlikuje od testirane vrednosti pa se konstatuje da se ne može prihvatiti hipoteza da je prosečna ocena međusobnih komunikacija u celom skupu 2,8. Rezultat implicira da se ne može prihvatiti hipoteza H2 da se prosečna ocena zadovoljstva međusobnih komunikacija u celom skupu 2,8 budući da je u uzorku jednaka 2,53 znači manja od 2,8. Prema dobijenim podacima empirijska signifikantnost a*=0,936=93%, a*>5%, što znači da se prosečna vrednost (ocena ponašanja potrošača u kupovini) ne razlikuje od testirane vrednosti pa se može izvesti zaključak da se može prihvatiti hipoteza H3 da je prosečna ocena želje potrošača za promenom ponašanja u kupovini u celom skupu 4. Ovo istraživanje ima i određena ograničenja. Ograničenje se može pripisati veličini uzorka mada se načinom izbora analiziranih pijaca u uzorak želelo dobro ilustrovati osnovni skup. Takođe buduća ispitivanja, tokom dužeg vremenskog razdoblja bi doprinela konzistentnosti i većoj pouzdanosti rezultata. Iz sprovedenog istraživanja se može zaključiti da u određenim prethodno spomenutim aspektima integrisane marketinške komunikacije mogu doprineti većem „zadovoljstvu“, „boljim ličnim komunikacijama u kupovini“ i „ponašanju potrošača u kupovini“ i doprineti povećanju zadovoljstva i interesa svih korisnika pijaca.

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CONSUMER SATISFACTION WITH GREEN MARKETS IN THE REPUBLIC OF SERBIA

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Abstract

In the present time, the development of technology and digital marketing is evidently changing both lifestyles and business principles. Namely, these changes also require agricultural producers to adapt within the concept of sustainable agriculture development. Consumers at green markets have a decisive role and influence on agricultural producers and sellers operating at these markets. Therefore, sales at green markets must be based on a well-designed strategy of marketing communication with consumers in order to achieve successful business performance. This paper presents a theoretical conceptual model and a traditional framework of consumer satisfaction with products sold at green markets, as well as the results of empirical research on consumer attitudes. The research included 450 consumers at green markets in the Republic of Serbia, whose attitudes were measured using statistical data processing methods based on mean values. In addition, 150 fruit and vegetable vendors who have been selling at green markets for more than ten years were surveyed. The aim of the paper is to determine the influence of marketing communication instruments on consumer behaviour and to examine how willing consumers are to accept new forms of purchasing through e-markets. The research results indicate that the acceptance of consumer attitudes towards purchasing products from green markets represents the basis for preserving the traditional role of markets as places for buying healthy domestic products and the basis for the future development of sustainable agriculture.

Keywords: *consumers, green markets, digital marketing, e-markets, sustainable agriculture*

1. Introduction

Trade in products and agricultural goods dates back to the Middle Ages when observed in the historical context of exchange. Markets emerged approximately five thousand years ago with the development of

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commodity exchange (Petrović et al., 2021., Denda et al., 2024). There are numerous connections between the development of trade and markets. Green markets contribute to many social benefits, including income generation, social communication and interaction, the development of social wealth, as well as a stronger degree of connection between consumers and the local community (Bonanno et al., 2017). As the development of communication among people increased, the importance of local products and places of sale contributed to the concept of overall connectivity and public interest. As traditional institutions, markets must embrace change and introduce digital technologies in order to survive in the market (Adams, 2015). The process of implementing digital technologies and digital marketing represents a broad set of variables used in defining the identity of markets, which is aligned with the identity of the city and the region, and serves as the basis for satisfying consumer interests. An analysis of market operations in the Republic of Serbia shows that the majority of markets, as enterprises, apply modern digital technologies either insufficiently or with very low intensity (Prdić, 2022., Ben, 2025). By building an identity for the promotion of local green markets, their distinctiveness, social and cultural aspects, as well as their tourist and traditional character are emphasised; therefore, in domestic conditions, a trend of adaptation and application in business practice is necessary.

In the past, green markets were places for selling local agricultural products, but over time they also became local centres for the sale of dairy products, meat and fish. It is a fact that green markets in the European Union, and globally, are places for the sale of agricultural products. Furthermore, worldwide, the production of agricultural goods and the management of agricultural holdings and healthy food production are stimulated, both in terms of preserving a healthy environment, applying best practices, and conserving natural resources, as well as in accordance with the needs of modern consumers. In Spain there is a large number of markets, each with its own story and history. In Madrid alone there are 46 green markets; some have been transformed into modern markets, some into gastro bars, while others have preserved their old splendour and are protected by the state. It is truly remarkable that, despite the presence of large retail chains, these markets have managed to survive and adorn cities for centuries (www.onlinekursspanskog.com).

Today, consumers are informed about the distribution channels of agricultural products. Since the emergence of the internet, various sales environments have been created, including competition, marketing,

social media, augmented reality applications and many other techniques for attracting consumers. In such an environment, green markets must follow consumer habits and lifestyles, and by using the internet they can meet consumer interests on a daily basis by supplying healthy products. Consumer visits to green markets represent one of the most important aspects of marketing research, as they directly contribute to the development of local agriculture, local markets, and the recognisability of urban cities. The consumption of products from green markets is considered an indicator of a healthy lifestyle and diet, as well as healthy habits in the context of product quality. Consumers evaluate the quality of products from green markets based on traditional experience and economic parameters such as price, domestic origin labels, geographical origin, producers, packaging, and special quality marks. Specific attributes that may determine consumer choice include taste, aroma, and freshness. Consumer attitudes towards the nutritional characteristics of products and proper dietary habits have been changing recently, with consumers increasingly concerned about consuming healthy products and maintaining a balanced diet (Bandera et al., 2015).

Knowledge of consumer behaviour represents a fundamental component and an imperative for successful sales. The aim of this research is therefore to determine consumer behaviour in the purchase and consumption of fresh agricultural products from green markets, as well as the reasons for purchasing in the context of product quality and characteristics. On the one hand, understanding consumer attitudes directs producers towards production that responds to consumer demand for fresh products; on the other hand, it ensures the availability of public products at public markets, contributing to public health and rural development. The motivation for this paper arises from the lack of deeper analysis of the integrated economic benefits of the consumer satisfaction approach in the context of meeting both private and public interests. The city's green market is a reflection of the local economy (Vaivadaite et al., 2024).

Accordingly, depending on the subject of research, different variables influencing consumer purchasing behaviour are used. In this study, the first focus is placed on the historical significance of markets, subjective norms, and perceived behavioural control of consumers in purchasing (socio-economic factors). The second focus concerns consumer satisfaction with green markets, communication, and personal behaviour. The third focus is on e-markets as a process of understanding producers and consumers in a new business environment. Given the increasing competition, consumer attitudes towards purchasing at markets will

determine the activities of producers and sellers, public enterprises managing markets, the city, and municipal tourism organisations towards consumers, in order to direct their activities and continuously gain the trust of a growing number of customers. To achieve a planned business position through market management over a certain period, it is necessary to use criteria and indicators that best reflect the business performance of markets (Prdić, 2022). The obtained results will provide insight into consumer satisfaction with green markets in the Republic of Serbia, while simultaneously improving the economic position of producers and the overall benefits that green markets can bring to the city and the wider community.

2. Literature overview

2.1.. Historical significance of green markets for the trade in agricultural products

The historical development and changes in the environment and functioning of cities have always been linked to markets, that is, to changes in business operations as well as to changes in consumer needs and preferences. Data on the historical significance of markets recommend them as places where large numbers of people meet (Prdić, 2023). Across European historical centres, markets were located in the main squares (Zandieh et al., 2020). Based on data from market websites and reflecting on their history, it is necessary to mention Borough Market in London, the most famous British market, located along the River Thames and believed to be around 1,000 years old. The giant historical market La Boqueria in Barcelona, approximately 800 years old, is a place where local farmers sold meat and vegetables. One of the oldest and most famous covered markets in central Moscow, Yeliseevsky, is a well-known tourist and historical symbol of earlier times and trade. Urban city green markets are drivers of change and socialisation in cities (Hiebert et al., 2015). Green markets have been drivers of urban growth and economic development (Stobart et al., 2016). In the contemporary context, city markets are organised as urban bazaars and places for social interaction (Marciniak, 2020). These historical green markets form the foundation of urban architecture, local culture and tradition, gastronomic identity, and modern centres for people from all over the world to meet, as well as an indispensable element of tourist offerings. In addition to tradition and the encounter of global trade with a local character, they also represent important tourist attractions. Alongside their global

historical connections with local trade, markets also have their own history in the domestic context.

The first green market in Belgrade, known as **St Andrew's Market** (originally in Serbian Pijaca Svetog Andreje, commonly referred to as the *Great Market*), was established in 1824 at Studentski Trg (www.bgpijace.rs). With the longest tradition in the city of Novi Sad, the **Fish Market (Riblja pijaca)** evolved from a place that, in the mid-nineteenth century, served exclusively to supply citizens with fresh fish into a classical green market offering a wide range of fresh agricultural products, poultry, fish and mixed goods (www.nstrznica.co.rs). As cities developed throughout history, forms of open-air trade also evolved, both in designated permanent locations (markets) and temporarily in provisional locations (fairs). The earliest such trade was recorded within the city walls of the ancient fortified city of **Naissus**. During the Ottoman period, market trade took place outside the fortress walls, and somewhat later in the city centre, continuing in this form until the First World War (www.trznicanis.rs). Although these data are of a historical nature, the following article in a well-known journal links their history and significance to the new digital era of business and communication.

Belgrade's **Kalenić Market** (Kalenić(eva) pijaca) has been ranked among the best in the world on the list of the prestigious *Financial Times, a* British magazine. Located in the Vračar district in the heart of the city, it was named after Vlajko Kalenić, who donated the land on which it was built almost a century ago. A wide selection of products, ranging from locally distilled rakija, kajmak cheese, and fruit and vegetables to cured meat products and spices, is displayed on stalls where vendors and customers bargain, joke, and even sing. Many local residents say that they change their walking routes simply to enjoy this beautiful place (www.sputnikportal.rs).

All foreign and domestic green markets, from their historical origins to the present day, in addition to their architecture, culture and tradition, as well as the meeting of people and trade, represent an integral part of major tourist attractions and economic potential. The local market includes the market itself, people, and events (Moagi et al., 2025).

2.2. Interdependence of Producer and Consumer Interests

Green markets are enclosed and open spaces which, by definition, serve for the sale of goods (Morales, 2011). It is evident that markets persist

despite increasing demand and competition. They enable fair trade from the perspective of rural development and awareness of the concept of local development. Sales at green markets are characterised by the fact that mainly fresh and high-quality products are offered (Ostojić et al., 2013). This concept implies processes and outcomes that are important for achieving sustainable agriculture and the development of rural areas, where the key element is a fresh and high-quality product. Direct marketing of agricultural products is realised through market institutions, namely retail markets, or "green markets", which is a commonly used commercial term (Zarić et al., 2016). Direct marketing and digital marketing have a significant impact on public perception of market sales, particularly regarding the quality, freshness, and geographical origin of products. Competitive advantage in market sales depends on the unique elements of supply, competition, and consumer needs (Kuzman et al., 2022). Today, business analysis is particularly important (Čavlin, 2022). Through personal SWOT analysis, it is possible to identify one's own strengths and weaknesses, as well as opportunities and threats, and to incorporate them into a communication strategy with consumers at the market and to determine the possibilities for creating a personal brand in market sales. So-called modern agriculture, based on tradition and market sales, is growing, where increasing farm yields are accompanied by greater investment in better selling locations at markets. During several selling days, local producers sell a wide range of agricultural products to the urban population (Toftgaard, 2016). The domestic market occupies a significant segment of nutrition and represents one of the fundamental components of a healthy lifestyle. In addition, local agricultural products on the global market represent a concept of supply adapted to consumer needs. In existing distribution relationships for agricultural products, the presence of green markets gives a distinctive character (Miljković et al., 2015; Puška et al., 2025). For consumers, the most important factors are the quality of the products they purchase, followed by origin and quality labels indicating the provenance of products at green markets. Within the contemporary economic system, producers and consumers are closely connected and mutually influence one another (Ai et al., 2019). The market segment focused on satisfying consumer interests in a modern environment provides producers with development and progress while simultaneously fulfilling consumer needs in contemporary society.

In a social sense, markets are places for socialisation and human interaction (Gonzales, 2020). Regardless of whether markets are understood as historical institutions, agricultural activities and sales

channels, local public spaces, or marketing instruments of distribution, they contribute to economic development and social interaction. Food waste is most prevalent in fruits and vegetables, root and tuber crops, which account for about 45% of total food produced, followed by fish and seafood at 35%, and cereals with 30% waste (Hermanussen et al., 2022). This phenomenon occurs at all stages of the supply chain, from initial production to final household consumption (Wen et al., 2022). Thus, the separation between production and consumption is complex (Gajić et al., 2024). The concept of socially responsible business and sustainable consumption of agricultural products is fundamentally based on concern for society, health, and the environment. Good business practice for agricultural producers implies responsible relations towards other segments of the population, the overall concept of production and consumption, safe food storage, and the reuse and reprocessing of food. The entire process of operationalising the success of trade at wholesale markets and small markets must therefore be continuously monitored using new and changing variables (Prdić et al., 2025).

2.3. New Forms of Trade in the Function of Satisfying Consumer Interests

In contemporary conditions of agricultural production, storage and distribution to final consumers represent a fundamental motive. Wholesale markets are places for the sale of large quantities of products (Inayah et al., 2024). The presence of products and the product concept in retail significantly contribute to insights into sales and market representation. Short supply chains are dedicated to local economic development and to maintaining relationships between producers, processors and consumers (Aouinait et al., 2022). Social networks have become a form of everyday private and business communication (Kostić, 2022). The focus of e-commerce in the Republic of Serbia is expected to grow continuously on the basis of consumer satisfaction, and healthy products may contribute to trends in online trade.

Scholars have demonstrated the importance of wholesale markets in the marketing of food products, given the significance of retailing (Boiko et al., 2019). For the successful functioning of wholesale trade, the focus is placed on processes within retail organisation. The success of the agri-food supply chain depends on the strength of each link in the chain (Gazdić et al., 2022). Local producers have an essential role in retail and in society (Bejan et al., 2025). Proper assessment of the post-sales market enables an organisation to implement an important strategy (Miletić et al., 2022).

The role of marketing benchmarking in the operation of green markets essentially lies in identifying differences in relation to retail outlets, as these can also be observed at the points of sale themselves (Prdić et al., 2022). The main goal of comparison is not only sales, but also marketing strategy, as well as the idea of how to remain deeply positioned in the market and establish good market relationships. The drivers of e-commerce are influenced by the quality of e-commerce services (Rehman et al., 2022). The largest share of e-commerce relates to online trade, making it necessary to improve advertising conditions and levels. In online shopping, perceived usefulness means that the customer considers a website to be very effective for purchasing (Saleem et al., 2022). Research has shown that security in online shopping has a statistically significant impact on interest in using e-commerce applications (Sampe et al., 2022). This means that attitudes towards this form of trade are positive, but that transactional details in terms of security and information must be well understood. A very similar situation applies to new forms of trade in markets as well (Masloch et al., 2024).

Based on the theoretical framework, the research problem and defined objectives, as well as the results of previous studies and the author's experience, the following research hypotheses were formulated and will be tested in this study:

H1: *There is a significant positive relationship between the traditional role of green markets and consumer satisfaction.*

H2: *There is a significant positive relationship between seller–consumer communication and repeated purchasing.*

H3: *There is a significant positive relationship between purchasing through e-markets, consumer behaviour, and consumer satisfaction.*

3. Materials and methods

The theoretical part of the paper is based on scientific and professional literature by domestic and foreign authors. Both secondary and primary data sources were used in the study. Desk research was conducted for the collection of secondary data, while field research was conducted for the collection of primary data. In the secondary research phase, available literature relating to trade in agricultural products, markets, new forms of trade through digital marketing, consumer behaviour, and social marketing in the public sector was collected and analysed. Existing

electronic databases were also used to monitor current global developments related to this topic.

Primary research was conducted using a representative sample, with a structured questionnaire as the main research instrument. In addition, in-depth interviews were applied for research purposes. In creating the basic content of the questionnaire, theoretical knowledge about green markets and consumers at markets, as well as the author's experience, were used. The questions were formulated in the form of a Likert scale from 1 to 5, where a score of 1 represented the lowest level of expressed satisfaction, agreement, or need, and a score of 5 represented the highest level of expressed satisfaction, agreement, or need regarding different consumer attitudes at the analysed markets. Data from the analysed markets were processed using statistical methods and presented in tables. For hypothesis testing, mean values of all questions related to each individual hypothesis were used.

In this study, "satisfaction" refers to the degree of fulfilment of needs in the context of traditional satisfaction at the analysed markets (H_1); "insufficient communication" refers to an inadequate level of personal communication between sellers and consumers (H_2); and "consumer behaviour" refers to the probability-related attitudes towards purchasing habits (H_3).

The first part of the questionnaire served as an introduction to the research. The main questions were related to the research assumptions and hypotheses concerning the traditional significance of markets, consumer satisfaction with market shopping, and the possibility of purchasing products through e-markets. At the end of the questionnaire, questions were included concerning the characteristics of respondents, such as their socio-economic and demographic features, the level of satisfaction with traditional markets, the degree to which consumer needs and wishes are fulfilled through market shopping, and the possibility of changes in purchasing habits.

The research was conducted in the period from 1st of August to 31st of August 2025. Data collection was carried out through a questionnaire using the personal interview method, which lasted between 10 and 15 minutes. The research was conducted at the **Futoška Market** (Serbian: Futoška pijaca, within JKP Tržnica Novi Sad), the **Tvrđava Market** (within JKP Tržnica Niš), and the **Kalenić Market** (within JKP Beogradske Pijace, Belgrade), on a sample of 150 randomly selected consumers at each market. At the same markets, vendors who had been selling at the markets for more than ten years were also surveyed. The

purpose of this in-depth interview research was to cross-validate the interests of buyers and sellers in order to derive adequate conclusions.

4. Results and discussion

In Table 1, a comparison of respondent segments according to gender structure is presented for a sample of 450 respondents. The segments correspond to the three analysed markets where the research was conducted. Segment 1 refers to the Futoška Market, Segment 2 to the Tvrđava Market, and Segment 3 to the Kalenić Market.

Table 1: Comparison of respondents by gender structure

	respondents by gender structure	
	male	female
Segment 1	58%	42%
Segment 2	60%	40%
Segment 3	52%	48%
	χ^2 (df=2)=4.380 p=0.112>0.005	

Source: Author's research

In segment 1 - 58% respondents are men, in segment 2 - 60% and in segment 3 - 52%. At the same time, the percentage of women is as follows: in segment 1 - 42%, segment 2 - 40% and segment 3 - 48%. The presented results indicate that there is no statistically significant difference between the segments when it comes to the gender structure.

Table 2: Comparison of respondents according to age and education

	Age of respondents			**Education level of respondents**		
	20-40	**40,1-60**	**Over 60,1**	**Elementary and middle school**	**Higher education/university (Bachelor)**	**Master studies, PhD studies**
Segment 1	34%	48%	38%	40%	34%	10%
Segment 2	52%	36%	50%	48%	40%	12%
Segment 3	24%	44%	24%	52%	44%	10%
	c^2(2, n=150)=2.377 p=0.307>0.05			c^2(2, n=150)=3.794 p=0.147>0.05		

Source: Author's research

The presented results, tested using a non-parametric test (Kruskal-Wallis test), indicate that there is no statistically significant difference between the segments (market locations) when it comes to the age of the respondents or when looking at the level of education.

In order to verify the association of sociodemographic characteristics, gender, age and level of education with shopping preferences at green markets and supermarkets, the $\chi 2$-test method was applied. Dependent variables were tested: (1) domestic/local products are preferred when shopping; (2) product purchase preferences in supermarkets. The independent variables are gender, age and level of education (table 3).

Table 3. Correlation between sociodemographic characteristics of customers and propensity to shop at green markets

Results χ2 (SQUARE)

	Dependent variable	
Independent variable	**When shopping, preference is given to domestic local products in the markets**	**Shopping preferences in local stores**
Gender structure	1.656	10.789*
Age	12.298	11.467
Education	8.889	7.615

*p<0.05

Source: Author's research

The results show that there is a significant statistical association (link) only between gender and the preference for buying agricultural products in the local trade, according to the criterion that women prefer to buy more agricultural products in the local trade compared to men. The other results for all tested variables are not statistically significant, i.e. p is in all cases is greater than 0.05 (p>0.05). If we look at the total research sample, statistical tests and measurements show that sociodemographic features (age and education level) do not contribute to the decision whether the buyer (consumer) prefers local domestic products at green markets or products in local trade. This conclusion is based on the fact of very high p-values in all tests, which consistently indicate the independence of the variables (table 3).

Table 4. Distribution of respondents according to the duration of shopping at green markets

How long have you been purchasing items at the green markets?	Repondents' share (%)
For the past year	8.0%
For 1-5 years	27.5%
For 5-10 years	33.5%
For 10-15 years	18.0%
For more than 15 years	13.0%
Total	100.0%

Source: Author's research

When considering the duration of purchases at green markets (Table 4) among the surveyed consumers, 8% have been shopping for the past year, 27.5% for 1–5 years, 33.5% for 5–10 years, 18% for 10–15 years, while 13% have been purchasing for more than 15 years. The largest share of respondents (33.5%) have been shopping for 5–10 years, which suggests that green markets have a solid basis for retaining existing customers and a projected potential to maintain both current and prospective customers through personal marketing communications at the markets, as well as attracting new customers via digital marketing (social networks) and e-markets.

For the purposes of effectively assessing the significance of consumers at the analysed markets and accurately measuring results, customers were categorised as small, medium, and large. The data presented in Table 5 are responses from the survey questionnaire and represent a section of the questionnaire addressing consumers' willingness to allocate a certain level of their monthly resources to purchases at green markets. These data are relevant based on both the respondents' statements and the information that 51.5% of consumers have been shopping at these markets for a period of 5 to 15 years.

Table 5. Characteristics of consumers on the analysed green markets in the context of willingness to spend funds (N=450)

Buyers' characteristics	Buyers who purchased at the point of sale	Buyers who visited the point of sale (they may or may not have purchased products at the market)	Total
Small	186	558	2150
Medium	216	648	1340

Large	48	144	432
Total	450	1350	3922

Source: Results of a survey at market sales points of sellers - Author's calculation

1. Small customers/buyers – purchases of less than €2,500 in the previous year (2024)
2. Medium customers/buyers – purchases of €2,500 in the previous year (2024)
3. Big/large customers/buyers – purchases of more than €2,500 in the previous year (2024)

Customers were categorised according to the amount of money spent in the previous year, based on information obtained from the vendors. The data indicate a strong consumer preference for purchasing local agricultural products among the respondents in terms of expenditure (Table 5). From this, it can be concluded that there is a positive perception of purchasing products and that the impact of loyal customers on the successful operation of vendors is significant. The analysis also shows that direct, face-to-face interaction and sales promotion are the most important instruments for attracting customers to market sales points. These data form an integral part of a sustainable business strategy for market vendors in the context of achieving economic effects and direct communication (Table 6).

Table 6. Sellers' plans for selling on the green market based on the customer database

Description	Arithmetic mean	Standard error
Small buyers		
Bought at your point of sale and at the market	2.54 (n=100)	0.21
They didn't buy from you	2.69 (n=95)	0.18
Big buyers		
Bought at your point of sale and at the market	3.14 (n=85)	0.17
They didn't buy from you	3.00 (n=75)	0.16
Potential buyers		
Bought at your point of sale and at the market	2.27 (n=65)	0.20
They didn't buy from you	2.25 (n=55)	0.22

Source: Results of a survey at market sales points of sellers - Author's calculation

The survey of sellers who have been selling at the markets for more than 10 years was carried out in the context of learning about potential

purchase plans in the future when it comes to customers/buyers who visit the market and the point of sale, and did or did not buy products. The goal was to determine the sellers' awareness of the importance and visit of their sales point by potential customers/buyers. Through research, it is necessary to determine the interest of potential customers, but also to determine the degree of loyalty of existing customers. Using a Likert scale of values from 1 to 5, it is necessary to measure interest and purchase intentions, where 1 is no purchase plans (low interest) and 5 is a very defined purchase plan (high level of purchase intentions).

Table 7. Cumulative analysis of buyers for shopping at green markets based on the sellers database

Description	Number of customers/buyers	Sales as a percentage of the number of customers (%)	Cumulative sales per customer/buyer
Small buyers, visited the point of sale (n = 350)	29	8.2	345
Small buyers, did not visit the point of sale (n = 1800)	73	4.3	275
Large buyers, visited the point of sale (n = 300)	56	28.7	650
Large buyers, did not visit the point of sale (n = 1020)	130	21.9	428
Potential buyers, visited the point of sale (n = 1010)	25	2.8	300
Potential buyers, did not visit the point of sale (n = 10200)	84	0.9	196

Source: Results of a survey at market sales points of sellers - Author's calculation

Based on the database of surveyed sellers on the characteristics of customers in Tables 6 and 7, a survey was conducted on the importance of small, medium and large customers and for the purpose of having awareness of customers about their point of sale, interest and purchase. The aim of the research was also to collect data on potential customers who visit the green market, whether or not they visit their point of sale, and all with the aim of creating a business strategy for sellers in order to achieve economic and communication effects. By analysing the economic effects based on the cumulative analysis of sales, it is possible to calculate the rate of return on the sellers' investments. This effect is

obtained by multiplying the value of realised sales by observed customer categories with the average gross profit rate. The short-term rate of return on investment in purchases in percentages represents the lower limit of the value invested in attracting new customers. When it comes to communication effects, they are realised in the short term through direct communication, word-of-mouth, sales promotion, product quality and other forms of verbal communication. In the long term, communication effects are realised through social networks, especially digital marketing, promotion of the market and own products.

Table 8. Willingness to pay a higher price for the purchase of local agricultural products (fruits and vegetables) at green markets (N=450)

Variable	N	%
Willingness to pay a higher price for local domestic products		
Up to 10%	204	45.3%
10-15%	164	36.6%
16-25%	80	17.7%
More than 25%	2	0.4%

Source: Author's calculation

The largest number of respondents, 45.3% (204) expressed the opinion that they are ready to pay up to 10% higher prices for local domestic agricultural products. In second place is a group of 36.6% (164) who are ready to pay 10 to 15%. The willingness to pay a significantly higher price of 16 to 25% was expressed by a group of 80 respondents. Only 2 respondents are willing to pay more than 25% higher price for local domestic products bought at green markets. The conclusion is that high price increases are not acceptable for most consumers (table 8).

Table 9. Support for the development of local agricultural production (N=450)

M	Mc	Mo	SD	Min	Max
4.5	5	5	0.8	2	5

Legend: ***M = Mean; Mc = Median; Mo = Mode; SD = Standard Deviation***

Source: Author's calculation

The analysis of the distribution of marks for the support of the development of local agricultural production shows extremely positive results. The average score of 4.5 clearly indicates the preference of consumers for local products, while the median and mode at level 5 further confirm the maximum support among the respondents. The

standard error is 0.8, which indicates the fact that the responses are concentrated around a high mean value, with minimal deviation.

Table 10. Consumer preferences when buying local agricultural products (fruits and vegetables) (N= 450)

	N	%
Preferential form of purchase		
Directly from the manufacturer	45	10%
At the green market	227	50.4%
On the market and through social media network (e-markets)	178	39.6%

Source: Author's calculation

In Table 10, we observe that the majority of respondents (50.4) prefer shopping at green markets, which emphasises giving preference to traditional markets, freshness, quality, known seller and product origin. A significant number of respondents, 39.6%, prefer a combination of traditional markets and social networks (e-markets), thus using both ways of shopping. Only 10% of respondents prefer to buy directly from the manufacturer. This distribution shows that buying from manufacturers is traditionally related to business customers, while markets are the main supply channel for consumers.

Table 11. Average availability of local agricultural products (N=45)

M	Mc	Mo	SD	Rang
3,01	3	3	0.789	5

Legend: ***M = Mean; Mc = Median; Mo = Mode; SD = Standard Deviation***

Source: Author's calculation

The average score is 3.01, indicating that respondents generally perceive the availability of local agricultural products as moderate. Both the median and mode are 3, suggesting that the most frequent and central response is neutral. This indicates that the typical respondent does not perceive the availability of local products as particularly poor or ideal. The standard deviation is 0.789, implying a moderate variability in perceptions of availability.

Hypothesis testing will be evaluated using the mean values of all items corresponding to each individual hypothesis.

H_1: There is a significant positive relationship between the traditional role of green markets and consumer satisfaction, where "satisfaction" refers to the level of the traditional role of green markets in supplying consumers.

H_2: There is a significant positive relationship between mutual communication of vendors and consumers as an element of repeat purchase behaviour, where "communication" refers to the effective level of personal interaction between vendors and consumers in supporting repeat purchases.

H_3: There is a significant positive relationship between purchasing products via e-markets and "consumer behaviour and satisfaction," where "consumer behaviour in purchasing" refers to the potential for new forms of purchase intentions when using products from green markets.

To test these hypotheses, the analysis is conducted using the theory of an unknown arithmetic mean of the population:

H_0: …… $X = X_0$
H_1: …… $X \neq X_0$

Table 12: Data on average rating of satisfaction/insufficient level of personal communication/consumer shopping behaviour/overall satisfaction according to market location

Green markets analysed	Satisfaction	Insufficient level of personal communication	Consumer shopping behaviour
Futoška Market - Mean	2,6270	4,280	4,0465
N	150	150	150
Std. Deviation	.71241	.68441	.64283
Median	2,5688	4.4100	4,1217
Tvrđava Market - Mean	2,4110	4,3178	4,0187
N	150	150	150
Std. Devitaion	.73047	.68468	.58476
Median	2.4666	4,4121	4.1211
Kalenić Market- Mean	2.8123	3.9432	4,0875
N	150	150	150
Std. Devitaion	.90241	.64267	.80457
Median	2,5245	4,2131	4.1165
Total - Mean	2.5315	4.3223	3.9846
N	450	450	450
Std. Devitaion	.76078	.66134	.63453
Median	2.5100	4.5100	4.1367

Source: Author's calculation

According to the research data presented in Table 12, respondents were asked to evaluate their opinions on statements related to the individual hypotheses. Ratings ranged from 1 to 5, where 1 indicated a strongly negative opinion and 5 a strongly positive opinion. Based on the data in Table 12, the average satisfaction rating, in terms of meeting the needs of traditional green markets, was 2.6270 at Futoška Market, 2.4110 at Tvrđava Market, and 2.8123 at Kalenić Market. The average satisfaction rating across all analysed markets was 2.5100. The average rating for "insufficient personal communication" was 4.280 at Futoška Market, 4.3178 at Tvrđava Market, and 4.0875 at Kalenić Market. The overall average rating for insufficient personal communication across all analysed markets was 4.3223. Regarding the average rating for "consumer behaviour in purchasing," it was 4.0465 at Futoška Market, 4.0187 at Tvrđava Market, and 3.9846 at Kalenić Market. The overall mean rating across the entire sample was 4.1567.

For the hypothesis testing to determine whether the distribution follows a specific form, the Kolmogorov–Smirnov test was applied:

H_0: …… $X \sim N(\mu, \sigma)$
H_1: …… $X \neq N(\mu, \sigma)$

Table 13: One-Sample Kolmogorov-Smirnov Test

	Satisfaction	Insufficient level of personal communication	Consumer shopping behaviour
N	450	450	450
Normal/Mean	2.5315	4,3223	3.9846
Parameters (a,b)		.66134	.63453
Std. Deviation	.76078	.66134	.63453
Most Extreme Differences			
Absolute	.098	.250	.130
Positive	.098	.164	.076
Negative	.046	-.250	-.130
Kolmogorov-Smirnov Z	.974	2.490	1.306
Asymp. Sig. (2-tailed)	.298	.000	.064

Source: Author's calculation

Using the One-Sample Kolmogorov–Smirnov test (Test distribution: Normal, calculated from data), the survey results indicate that for the variable "Satisfaction", the empirical significance is $\alpha^* = 0.298$ (29.8%),

$\alpha > 5\%$, so the defined hypothesis that the distribution of the variable "Satisfaction" follows a normal distribution is accepted. Specifically, with a test significance level of 5%, it can be concluded that consumer satisfaction with traditional markets exhibits a normal distribution. Therefore, the hypothesis H_1 that the distribution of the variable "Satisfaction" is normal **is accepted.**

For the variable "Insufficient level of personal communication", $\alpha^* = 0.000$ (0%), $\alpha < 5\%$, indicating that the defined hypothesis H_2 - that the distribution of this variable is normal - is rejected.

The variable "Consumer purchasing behaviour" has an empirical significance of $\alpha^* = 0.064$ (6.4%), $\alpha > 5\%$, so the defined hypothesis H_3 - that the distribution of the variable "Consumer purchasing behaviour" is normal - is accepted.

Two-tailed hypothesis testing was performed for consumer satisfaction, level of personal communication, consumer behaviour, and the interdependence of individual and overall satisfaction, with a significance threshold of 5%. The hypotheses for two-tailed testing are defined as follows:

H_0: …… $X = X_0$
H_1: …… $X \neq X_0$

During the interviews and discussions with consumers at the analysed markets, the research condition defined in Table **4** was that respondents must have shopped at green markets for at least one year. This condition was set to ensure the relevance of the study. Respondents could rate their agreement with the statements related to the hypotheses on a scale from 1 to 5, where 1 represented the lowest level of satisfaction and 5 the highest.

In the following section, the hypotheses were tested:

H1: There is a significant positive relationship between the traditional role of green markets and consumer satisfaction.

Table 14. Data on the average rating of consumer satisfaction with the traditional role of markets (tested value = 3)

One-Sample Statistics

	N	Mean	Stan. deviation	Std. Error Mean
Satisfaction	450	2,5407	.75089	.07657

Source: Author's calculation

Table 15: One sample test, average rating of satisfaction (tested value = 3). 95% Confidence interval of the Difference

One-Sample Test

	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Satisfaction	-6.133	441	.000	-.46825	-.6212	-.3167

Source: Author's calculation

According to the results of the empirical testing, the significance level is $\alpha^* < 5\%$, indicating that the mean value (satisfaction score) differs from the tested value. This implies that the hypothesis stating that the mean satisfaction score in the entire population is 3 cannot be accepted. In the sample, the mean satisfaction score is 2.54, which is lower than 3. Therefore, **hypothesis H_1 is not accepted**.

H_2: There is a significant positive relationship between mutual communication between vendors and consumers as an element of repeat purchasing.

Table 16. Data on the average rating of the relationship between mutual communication of vendors and consumers as an element of repeat purchasing (tested value = 2.8).

	N	Mean	Stan. deviation	Std. Error Mean
Mutual communication	450	2.5305	.75189	.07667

Source: Author's calculation

Table 17: One sample test, average rating of mutual communications (tested value = 2.8). 95% Confidence interval of the Difference

One-Sample Test

	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Mutual communication	-2.213	441	.029	-.8	-.3212	-.0176

Source: Author's calculation

According to the empirical data, the significance level is α* = 0.029 (2.9%), α* < 5%, which indicates that the mean value (mutual communication) differs from the tested value. Therefore, it is concluded that the hypothesis stating that the mean rating of mutual communication in the entire population is 2.8 cannot be accepted. The result implies that **hypothesis H_2 is not accepted**, as the mean score in the sample is 2.53, which is lower than 2.8.

H_3: There is a significant positive relationship between the purchase of products via e-markets, consumer behaviour, and consumer satisfaction.

Table 18. Data on the average rating of consumer behaviour in the context of satisfaction and purchasing via e-markets (tested value = 4).

One-Sample Statistics

	N	Mean	Stan. deviation	Std. Error Mean
Customers' behaviour	450	3.7758	.64079	.06658

Source: Author's calculation

Table 19: One sample test, average rating of consumer shopping behaviour (tested value = 4). 95% Confidence interval of the Difference

One-Sample Test

	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Customers' behaviour	-.78	441	.936	-.00514	-.1322	.1212

Source: Author's calculation

According to the empirical data, the significance level is α* = 0.936 (93%), α* > 5%, which means that the mean value (consumer behaviour in purchasing) does not differ from the tested value. Therefore, it can be concluded that **hypothesis H_3 is accepted**, as the mean score of consumers' willingness to change purchasing behaviour in the entire population is 4.

Test of Homogeneity of Variances

Table 20. Levene's test for homogeneity of variance

Test of Homogeneity of Variances

	Levene's Stasistic	Df1	Df2	Sig.
Satisfaction	.457	3	95	.714
Insufficient level of personal communication in shopping	1,366	3	95	.253
Consumer buying behaviour	.837	3	95	.466

Source: Author's calculation

Table 21. One-way analysis of variance (ANOVA)

Anova

		Sum of Squares Sig	df	Mean Square	F
Satisfaction	Between Groups	2.126	3	.713	1.237
	Within Groups	.300			
	Total	54.524	95	.566	
Insufficient level of	Between Groups	56.650	98		
personal communication	Within Groups	1.813	3	.603	.376
in shopping	Total	.252			
Consumer buying	Between Groups	41.348	95	.434	
behaviour		43.161	98		
	Within Groups	.412	3	.138	.328
	Total	.803			
		39.366	95	.417	
		39.778	98		

Source: Author's calculation

Conditions for data processing and testing: $\alpha^* > 5\% \Rightarrow H_0$

The empirical significance values are as follows: for satisfaction $\alpha^* = 0.714$ (71.4%), $\alpha^* > 5\%$; for insufficient level of personal communication in sales $\alpha^* = 0.253$ (25.3%), $\alpha^* > 5\%$; and for consumer purchasing behaviour $\alpha^* = 0.466$ (46.6%), $\alpha^* > 5\%$.

Therefore, the null hypothesis (H_0) of homogeneity of variances is accepted, indicating that there are no statistically significant differences between variances across the analysed markets. This allows the application of analysis of variance (ANOVA).

According to the results presented in **Table 18**, the empirical value of the F-test for the variable **Satisfaction** is $\alpha^* = 0.300$ (30%), $\alpha^* > 5\% \Rightarrow H_0$. From these results it can be concluded that the variance of factor A (market location) is not statistically significant, meaning that the location of the market in relation to the place of residence of consumers does not

significantly affect satisfaction. For the variable **Insufficient level of communication**, $\alpha^* = 0.252$ (25.2%), $\alpha^* > 5\% \Rightarrow H_0$, and for **Consumer purchasing behaviour**, $\alpha^* = 0.803$ (80.3%), $\alpha^* > 5\% \Rightarrow H_0$. This indicates that the variance of factor A (market location) is not statistically significant for any of the analysed variables. In other words, the market where consumers shop does not significantly influence satisfaction, the perceived level of personal communication, nor consumer purchasing behaviour.

Kruskal–Wallis Test

Based on the data presented above (Table 13), the variable **"Insufficient level of personal communication"** is not normally distributed. Therefore, in the following part of the analysis, a **non-parametric test** is applied for this variable, namely the **Kruskal–Wallis test**, with the following hypotheses:

H_0 – There is no difference in the level of personal communication among respondents across markets

H_1 – There is a difference in the level of personal communication across markets

Table 22. Kruskal–Wallis test for the variable "Insufficient level of personal communication"

	Insufficient level of personal communication
Chi-Square	4,189
Df	3
Asymp. Sig.	.242

Source: Author's calculation

a) Kruskal Wallis Test
b) Grouping Variable; Green market area

According to the data from the previous table (table 22), the empirical significance is a*=0.242=24.2%, a* > 5%, which implies that H_o is accepted, i.e. the initial hypothesis which tells us that there is no statistically significant difference in the insufficient level of personal communications by market

Table 23. Interval assessment of satisfaction rating/insufficient level of personal communication/consumer shopping behaviour

	Statistic
Satisfaction	Mean 2.5407 95% Conf. interval Mean: Lower Bound

Insufficient level of personal communication in shopping	2.4899 Upper Bound 2.5915
Consumer buying behaviour	Mean 4.3407 95% Conf. interval Mean: Lower Bound 4.1890 Upper Bound 4.4555
	Mean 2.5407 95% Conf. interval Mean: Lower Bound 2.4899 Upper Bound 2.5915

Source: Author's calculation

According to the data from the previous table, we see that the interval estimate of the arithmetic mean is "Satisfaction" of the respondents from the sample with a confidence level of 95%: Pr (2.4899<X<2.5915)=95%. Interval estimation of the arithmetic mean "Insufficient level of personal communication" of respondents from the sample with a confidence level of 95%: Pr(4.1890<X<4.4555)=95%. At the arithmetic mean estimation interval "Consumer behaviour": Pr(2.4899<X<2.5915)= 95%.

Table 24. Presentation of the correlation coefficient and the degree of relevance among the factors of personal communications, changes in the way of communications and integrated marketing communications that can improve the sales of sellers based on consumer attitudes

	Personal Communications	**Word-of-mouth**	**IMC**	**Digital marketing**	**IMC Total**
Personal communications - CC **Degree of relevance N**	1.000 60	.558** .000 60	.562** .000 60	.528** .000 60	.677** .000 60
Word-of-mouth - CC **Degree of relevanc** **N**	**	1.000 60	.558** .000 60	.567** .000 60	.503** .000 60
IMC – CC **Stepen relev.** **N**	**	**	1.000 60	.640** .000 60	.531** .000 60
Digital marketing - CC	**	**	**	1.000 60	.621** .000

Degree of relevance					60
N					
IMC Total - CC	**	**	**	**	1.000
Degree of relevance					60
N					

Source: Survey on analysed markets: Author's calculation

N = Correlation coefficient and degree of relevance; ** Correlation is relevant at the 0.01 level of relevance (mutual), CC = Correlation coefficient

Testing is possible when at least one independent variable shows a sufficiently high correlation (Grubor et al., 2019). From the correlation analysis (Table 24), a positive relationship can be observed between the factor of personal communication - obtained from the factor analysis result variable - and the level of Integrated Marketing Communications (IMC). Due to a lower level of acceptability, correlations were calculated between individual variables and the level of integration. For all individual variables, the significance level was below 0.01.

The relationship between digital marketing and integrated marketing communications is relatively strong (r=0.531). A similarly strong and close relationship exists between word-of-mouth communication and IMC (r=0.503), as well as between personal communication and IMC (r=0.677). All of these relationships are statistically significant (significance level = 0.000).

The categories defining the level of integration of the analysed markets (Table 21) include:

- **Sales promotion** (mutual cooperation in sales, promotional prices, existence of a personal customer database, social media)
- **Word-of-mouth communication** (verbal communication instruments, special promotional days at the point of sale)
- **Digital marketing** (sales via e-markets, analysis of the marketing environment, non-verbal communication plans, cooperation with buyers and consumers through loyalty programs)
- **Sales strategy** (alignment of supply with the market environment, optimal integration of verbal and non-verbal communication instruments and digital marketing, benchmarking against competitors)

- **Production and sales planning** (PEST and SWOT analyses)

5. Recommendations for Future Research

Open topics for future research are based on the conclusion that the most important aspect of the study relates to the attitudes and perceptions of consumers. Based on the review of theoretical findings and professional literature, as well as empirical results and the authors' experience, the previous observation also gains practical significance. The theoretical concept for future research should be based on a model analysing consumer interests, the competitive environment, and the interactivity of marketing and digital marketing with consumer requirements. Based on previous observations and the projection of a new model of consumer satisfaction with purchases at green markets, a more advanced structural model can be developed. Consequently, these topics are open for future empirical research. Empirical verification and measurement of consumer satisfaction with markets in the Republic of Serbia could be applied to a larger number of markets and a broader sample of consumers, with attention to geographical distribution. It is also possible to conduct studies focused on individual satisfaction instruments or overall market satisfaction to achieve better comparability and practically applicable results. Particular emphasis is placed on government support, which may take legal, economic, political, financial, administrative, or social forms (Mihajlović et al., 2022).

6. Conclusion

The aim of this study was to determine the level of consumer satisfaction with green markets in the Republic of Serbia in order to identify marketing communication instruments. In line with this aim, hypotheses were formulated based on theoretical knowledge, previous research, and the practical experience of the authors. According to the empirical data, the significance level was $\alpha^* < 5\%$, indicating that the mean value (satisfaction rating) differs from the tested value. This implies that the hypothesis that the average satisfaction rating in the population is 3 cannot be accepted. The sample mean was 2.54, lower than 3; therefore, H_1 was not accepted. For H_2, the empirical significance was $\alpha^* = 0.029$ (2.9%), $\alpha^* < 5\%$, indicating that the mean value (mutual communication rating) differs from the tested value. Hence, the hypothesis that the average mutual communication rating in the population is 2.8 cannot be accepted. The sample mean was 2.53, lower than 2.8. For H_3, the empirical significance was $\alpha^* = 0.936$ (93%), $\alpha^* > 5\%$, indicating that

the mean value (consumer behaviour rating in purchasing) does not differ from the tested value. Therefore, H_3 can be accepted: the mean rating for consumers' willingness to change purchasing behaviour in the population is 4. This study has certain limitations. The sample size may be considered a limitation, although the method of selecting the analysed markets aimed to illustrate the population adequately. Furthermore, future investigations over a longer period would contribute to consistency and higher reliability of the results. From the findings of this research, it can be concluded that, in the previously mentioned aspects, integrated marketing communications can contribute to higher "satisfaction," "improved personal communication in purchasing," and "consumer behaviour in purchasing," thereby increasing overall satisfaction and interest for all market participants.

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RAZVOJ LJUDSKOG KAPITALA I INOVACIONE AKTIVNOSTI PREDUZEĆA

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Apstrakt

Razvoj ljudskog kapitala predstavlja značajnu osnovu za unapređenje inovacionih aktivnosti i prilagođavanje preduzeća savremenim poslovnim promenama. Kontinuirano ulaganje u znanje i kompetencije zaposlenih doprinosi stvaranju organizacionih uslova za razvoj i primenu novih poslovnih rešenja.

Cilj rada je da se ispita povezanost ulaganja u edukaciju zaposlenih i ulaganja u inovacione aktivnosti preduzeća u Republici Srbiji. Analizom su obuhvaćena kretanja posmatranih pokazatelja u periodu od 2017. do 2026. godine.

Rezultati ukazuju na rast ulaganja u oba analizirana područja, kao i na njihovo izraženo paralelno kretanje tokom posmatranog perioda. Nalazi ukazuju na značaj razvoja znanja i kompetencija zaposlenih za jačanje inovacionih kapaciteta i dugoročni razvoj preduzeća.

Ključne reči: *ljudski kapital, inovacije, edukacija zaposlenih, kompetencije, razvoj preduzeća.*

1. Uvod

Savremeno poslovno okruženje karakterišu intenzivne tehnološke promene, digitalizacija i potreba preduzeća za kontinuiranim prilagođavanjem tržišnim zahtevima. U takvim uslovima, znanje, veštine i kompetencije zaposlenih predstavljaju značajan razvojni resurs, dok ulaganje u ljudski kapital postaje važan činilac unapređenja

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organizacionih sposobnosti i stvaranja inovacija. Razvoj ljudskog kapitala omogućava preduzećima da efikasnije usvajaju nova znanja, primenjuju savremene tehnologije i odgovore na promene u poslovnom okruženju (Dostie, 2018; Shao et al., 2025).

Poseban značaj ima ulaganje u edukaciju zaposlenih, jer kontinuirano usavršavanje doprinosi razvoju kompetencija potrebnih za unapređenje proizvoda, usluga i poslovnih procesa. Efekti razvoja zaposlenih dodatno zavise od sposobnosti organizacije da stečena znanja prenosi, razmenjuje i primenjuje u poslovnoj praksi, čime se stvaraju pretpostavke za razvoj inovacionih sposobnosti (Boadu et al., 2018; Caloghirou et al., 2018). Istovremeno, razvoj zaposlenih, njihovo zadovoljstvo i odgovorno upravljanje raspoloživim resursima predstavljaju značajne elemente dugoročnog i održivog razvoja organizacija (Žikić et al., 2020; Bučalina Matić et al., 2024).

Polazeći od navedenog, predmet ovog rada jeste ispitivanje povezanosti ulaganja u edukaciju zaposlenih i inovacionih aktivnosti preduzeća u Republici Srbiji. Cilj istraživanja je da se sagleda dinamika ovih ulaganja i utvrdi njihova međusobna povezanost. Empirijsko istraživanje obuhvatilo je 100 preduzeća različite veličine i delatnosti, dok su analizirani pokazatelji posmatrani u periodu 2017–2026. godine. Na taj način rad doprinosi sagledavanju značaja razvoja ljudskog kapitala u kontekstu jačanja inovacionih aktivnosti savremenih preduzeća.

2. Pregled literature

Razvoj ljudskog kapitala predstavlja značajan faktor unapređenja poslovnih sposobnosti savremenih preduzeća. Znanje, veštine, iskustvo i kompetencije zaposlenih čine nematerijalne resurse koji mogu doprineti prilagođavanju promenama, unapređenju poslovnih procesa i razvoju novih rešenja. Poseban značaj ima sposobnost organizacije da postojeće znanje sistematizuje, razmenjuje i primenjuje, zbog čega upravljanje znanjem i informacijama dobija stratešku ulogu u poslovanju preduzeća (Mihajlović et al., 2024).

Jedan od osnovnih mehanizama razvoja ljudskog kapitala jeste kontinuirana edukacija zaposlenih. Ulaganja u obuku i profesionalni razvoj omogućavaju unapređenje postojećih i sticanje novih kompetencija, ali istovremeno mogu podsticati organizaciono učenje i inovativnost. Empirijska istraživanja pokazuju da ulaganja u obuku i razvoj zaposlenih mogu doprineti inovacionim rezultatima organizacije posredstvom različitih oblika organizacionog učenja (Sung & Choi, 2014). Značaj ulaganja u obuku zaposlenih za unapređenje ljudskog

kapitala i inovacionih aktivnosti potvrđuju i novija istraživanja (Ni et al., 2023; Prdić et al., 2022).

Značaj edukacije zaposlenih za razvoj inovacionih sposobnosti potvrđuju i novija empirijska istraživanja. Na osnovu podataka o 10.366 preduzeća iz zemalja Istočne Evrope i Centralne Azije utvrđena je pozitivna povezanost obuke na radnom mestu i nivoa obrazovanja zaposlenih sa različitim oblicima inovacija (Na, 2021). Slični nalazi dobijeni su i u istraživanjima koja pokazuju da ulaganje u ljudski kapital kroz obuku i razvoj zaposlenih treba posmatrati zajedno sa inovacionim kapitalom preduzeća (Kuzey et al., 2022; Trifunović et al., 2026; Damnjanović 2026; Prdić, 2025). Pored toga, razvoj ljudskog kapitala zaposlenih u istraživačko-razvojnim aktivnostima kroz obuku može unaprediti sposobnost preduzeća da postojeće tehnološko znanje koristi u procesu istraživanja i razvoja (Kim, 2022; Prdić, 2018).

Tehnološki napredak i digitalizacija dodatno povećavaju značaj kontinuiranog razvoja ljudskog kapitala. Primena novih tehnologija zahteva odgovarajuće digitalne kompetencije, dok istovremeno omogućava nove oblike obrazovanja, komunikacije i prenosa znanja. Razvoj e-obrazovanja u Srbiji pokazuje da digitalizacija menja tradicionalne modele sticanja znanja i otvara prostor za efikasnije povezivanje tehnoloških rešenja sa procesom obrazovanja i stručnog usavršavanja (Dašić et al., 2024). Sličan značaj imaju društvene mreže i digitalne platforme, koje omogućavaju brži pristup informacijama, razmenu sadržaja i nove oblike interakcije u procesu učenja (Pajić et al., 2025).

Razvoj ljudskog kapitala posebno je značajan u kontekstu inovacionih aktivnosti preduzeća. Prema međunarodno prihvaćenom okviru, inovacione aktivnosti obuhvataju razvojne, finansijske i komercijalne aktivnosti koje preduzeće preduzima sa ciljem stvaranja inovacije, dok se inovacije u poslovnom sektoru mogu odnositi na proizvode i poslovne procese (OECD/Eurostat, 2018). Takvo određenje ukazuje da inovacije ne treba svoditi isključivo na istraživanje i razvoj, već ih posmatrati kao širi proces stvaranja i primene novih ili unapređenih rešenja.

Znanje zaposlenih predstavlja važnu osnovu tog procesa, jer razvoj i primena novih ideja zahtevaju sposobnost prepoznavanja problema, usvajanja novih informacija i njihove praktične primene. Zbog toga se ulaganja u edukaciju mogu posmatrati kao jedan od načina povećanja kapaciteta preduzeća za inovacije. Pored formalnog obrazovanja, značaj imaju stručno usavršavanje, iskustvo, razmena znanja i organizaciono učenje. Savremeni pristupi inovacijama posebno naglašavaju značaj tokova znanja unutar organizacije i između preduzeća i njegovog okruženja (OECD/Eurostat, 2018).

Značaj razmene i primene znanja potvrđuju i istraživanja otvorenih inovacija, prema kojima ljudski kapital može doprineti inovacionim aktivnostima neposredno, ali i posredstvom razmene znanja i povezivanja zaposlenih kroz savremene komunikacione kanale (Latifah et al., 2022). Time se dodatno naglašava da efekti ulaganja u ljudski kapital ne zavise samo od nivoa znanja zaposlenih, već i od organizacionih mogućnosti za njegovo prenošenje i praktičnu primenu (Latifah et al., 2022; Sheehan et al., 2025; Ahmetagić et al., 2022).

Inovacione aktivnosti imaju poseban značaj za mala i srednja preduzeća, koja se često suočavaju sa ograničenim finansijskim i materijalnim resursima. U takvim uslovima znanje, sposobnosti zaposlenih i prilagodljivost organizacije mogu imati važnu ulogu u razvoju konkurentske pozicije Razvoj malih i srednjih preduzeća u Srbiji povezan je sa potrebom unapređenja njihovih razvojnih i inovacionih kapaciteta, zbog čega inovacije predstavljaju važan element njihovog dugoročnog poslovnog razvoja (Pavlović et al., 2021; Chabbouh & Boujelbene, 2020).

Savremena digitalna transformacija dodatno menja prirodu inovacionih aktivnosti. Veštačka inteligencija, automatizacija i napredna obrada podataka stvaraju mogućnosti za razvoj novih proizvoda, usluga i poslovnih modela, ali istovremeno zahtevaju nova znanja i kompetencije zaposlenih. Primena veštačke inteligencije u finansijskim sistemima pokazuje njen sve izraženiji značaj kao pokretača inovacija i digitalne transformacije, uz istovremeno povećanje značaja investicija u tehnološki razvoj (Joksimović et al., 2026).

Odnos ljudskog kapitala i inovacija, međutim, nije zasnovan samo na raspoloživom nivou znanja. Važna je i sposobnost preduzeća da znanje prepozna, usvoji, poveže sa postojećim resursima i primeni u poslovanju. Iz tog razloga ulaganje u edukaciju zaposlenih dobija puni značaj kada organizacija stvara uslove za praktičnu primenu stečenih znanja. Inovacioni proces je, prema tome, rezultat međusobnog delovanja ljudskih, tehnoloških, organizacionih i finansijskih resursa.

Na osnovu analizirane literature može se uočiti da razvoj ljudskog kapitala i inovacione aktivnosti predstavljaju međusobno povezane dimenzije razvoja preduzeća. Kontinuirano ulaganje u znanje i kompetencije zaposlenih povećava sposobnost organizacije da prati tehnološke promene, koristi nove informacije i učestvuje u razvoju novih poslovnih rešenja (Chang & Nguyen-Van, 2021; Prdić, 2019). Istovremeno, inovacione aktivnosti stvaraju nove zahteve u pogledu znanja zaposlenih, zbog čega se edukacija i inovacije mogu posmatrati kao komplementarni procesi.

3. Metodologija

Predmet empirijskog istraživanja odnosi se na ispitivanje povezanosti ulaganja u edukaciju zaposlenih i ulaganja u inovacione aktivnosti preduzeća u Republici Srbiji. Polazište istraživanja zasniva se na pretpostavci da razvoj znanja i kompetencija zaposlenih predstavlja značajnu organizacionu pretpostavku za razvoj i primenu inovativnih rešenja.

U istraživanju je primenjen kvantitativni metodološki pristup. Primarni podaci prikupljeni su metodom anketiranja, korišćenjem strukturisanog upitnika distribuiranog elektronskim putem. Upitnikom su obuhvaćena pitanja koja se odnose na osnovne karakteristike preduzeća, ulaganja u razvoj i edukaciju zaposlenih, kao i ulaganja u inovacione aktivnosti.

Istraživački uzorak činilo je 100 preduzeća sa teritorije Republike Srbije. Istraživanjem su obuhvaćena preduzeća različite veličine i delatnosti, sa ciljem sagledavanja analiziranih pojava u različitim organizacionim kontekstima. Učešće u istraživanju bilo je dobrovoljno, uz obezbeđenu anonimnost i poverljivost prikupljenih podataka.

U okviru empirijske analize posmatrana su dva ključna pokazatelja: ulaganje u edukaciju zaposlenih i ulaganje u inovacije. Pokazatelji su izraženi kao udeo preduzeća koja su iskazala ulaganja u navedene oblasti, a njihovo kretanje analizirano je za period od 2017. do 2026. godine.

Obrada podataka zasnovana je na deskriptivnoj i uporednoj statističkoj analizi. Analizirane su godišnje vrednosti posmatranih pokazatelja, njihove promene tokom vremena, razlike izražene u procentnim poenima, kao i sličnosti u pravcu i dinamici njihovog kretanja. Posebna pažnja posvećena je promenama nakon 2020. godine i odnosu između dinamike ulaganja u edukaciju zaposlenih i ulaganja u inovacije. Ovakav pristup omogućava identifikovanje obrazaca povezanosti posmatranih pokazatelja, bez izvođenja zaključaka o direktnom uzročno-posledičnom odnosu.

U skladu sa predmetom i ciljem istraživanja postavljena je sledeća istraživačka hipoteza:

H1: Postoji pozitivna povezanost između ulaganja u edukaciju zaposlenih i ulaganja u inovacije u analiziranim preduzećima.

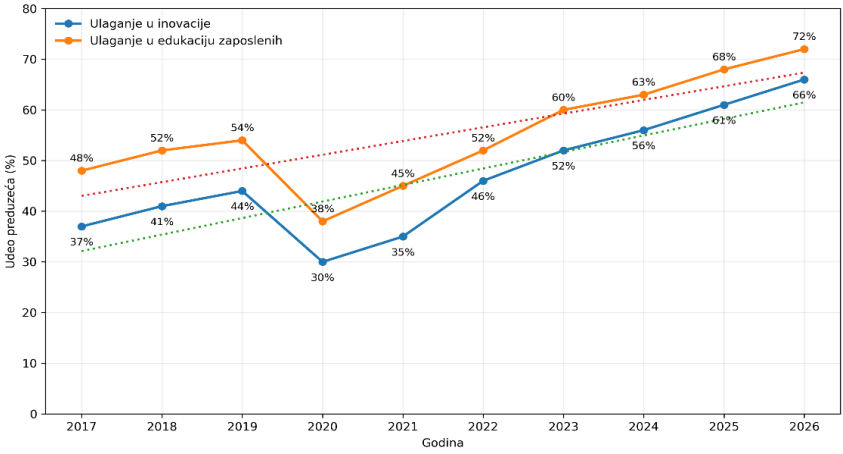
4. Rezultati

Analiza kretanja posmatranih pokazatelja u desetogodišnjem periodu 2017–2026. godine ukazuje na rast ulaganja u inovacije i ulaganja u edukaciju zaposlenih, uz izraženije odstupanje tokom 2020. godine.

Udeo preduzeća koja su iskazala ulaganje u inovacije iznosio je 37% u 2017. godini, nakon čega je povećan na 41% u 2018. i 44% u 2019. godini. U 2020. godini zabeleženo je smanjenje na 30%. Nakon ovog pada dolazi do promene trenda, pa pokazatelj raste na 35% u 2021, 46% u 2022. i 52% u 2023. godini. Tendencija rasta nastavljena je i u poslednjem delu analiziranog perioda, sa 56% u 2024. na 61% u 2025. i 66% u 2026. godini.

Kod ulaganja u edukaciju zaposlenih uočeno je slično kretanje. Udeo preduzeća koja ulažu u ovaj segment iznosio je 48% u 2017, 52% u 2018. i 54% u 2019. godini. Nakon pada na 38% u 2020. godini, pokazatelj raste na 45% u 2021, 52% u 2022. i 60% u 2023. godini. Rast je nastavljen na 63% u 2024, 68% u 2025. i 72% u 2026. godini.

Posmatrano na nivou celog perioda, ulaganje u inovacije povećano je sa 37% na 66%, odnosno za 29 procentnih poena, dok je ulaganje u edukaciju zaposlenih povećano sa 48% na 72%, odnosno za 24 procentna poena. Istovremeno kretanje dva pokazatelja predstavlja osnov za njihovu dalju uporednu analizu i sagledavanje obrazaca međusobne povezanosti.



Slika 1. Kretanje ulaganja u inovacije i ulaganja u edukaciju zaposlenih u periodu 2017–2026. godine

Izvor: Istraživanje autora

Radi detaljnijeg sagledavanja dinamike posmatranih pokazatelja, izvršeno je poređenje ulaganja u inovacije i ulaganja u edukaciju zaposlenih tokom analiziranog desetogodišnjeg perioda. Rezultati pokazuju da je tokom svih posmatranih godina udeo preduzeća koja ulažu u edukaciju zaposlenih bio viši od udela preduzeća koja ulažu u

inovacije. Razlika između dva pokazatelja, međutim, nije bila konstantna, što ukazuje na različitu dinamiku njihovog kretanja.

Tabela 1. Kretanje ulaganja u inovacije i edukaciju zaposlenih u periodu 2017–2026. godine

Godina	Ulaganje u inovacije (%)	Ulaganje u edukaciju zaposlenih (%)	Razlika (p.p.)
2017.	37	48	11
2018.	41	52	11
2019.	44	54	10
2020.	30	38	8
2021.	35	45	10
2022.	46	52	6
2023.	52	60	8
2024.	56	63	7
2025.	61	68	7
2026.	66	72	6

Izvor: Istraživanje autora

Podaci prikazani u Tabeli 1 pokazuju da se razlika između posmatranih pokazatelja tokom analiziranog perioda postepeno smanjuje. Dok je 2017. i 2018. godine iznosila 11 procentnih poena, u 2026. godini iznosila je 6 procentnih poena. Ovakvo kretanje pokazuje da je rast ulaganja u inovacije u drugom delu analiziranog perioda bio izraženiji, čime se nivo ovog pokazatelja približavao nivou ulaganja u edukaciju zaposlenih.

Posebno odstupanje uočava se 2020. godine, kada je kod oba pokazatelja evidentirano smanjenje. Ulaganje u inovacije smanjeno je sa 44% u 2019. na 30% u 2020. godini, odnosno za 14 procentnih poena, dok je ulaganje u edukaciju zaposlenih smanjeno sa 54% na 38%, odnosno za 16 procentnih poena. Već od 2021. godine dolazi do oporavka oba pokazatelja, a od 2022. godine njihov rast postaje izraženiji.

U periodu od 2020. do 2026. godine udeo preduzeća koja ulažu u inovacije povećan je sa 30% na 66%, odnosno za 36 procentnih poena. Istovremeno, udeo preduzeća koja ulažu u edukaciju zaposlenih povećan je sa 38% na 72%, odnosno za 34 procentna poena. Rezultati stoga ukazuju na paralelno kretanje posmatranih pokazatelja, naročito u periodu nakon 2020. godine.

Uporedna analiza pokazuje da promene ulaganja u edukaciju zaposlenih i ulaganja u inovacije tokom posmatranog perioda imaju sličan smer. Periodi povećanja ulaganja u edukaciju zaposlenih uglavnom su praćeni povećanjem ulaganja u inovacije, dok je tokom 2020. godine kod oba pokazatelja evidentiran pad.

Ovakav obrazac kretanja podržava istraživačku hipotezu H1 o pozitivnoj povezanosti ulaganja u edukaciju zaposlenih i ulaganja u inovacije. Uočenu povezanost potrebno je tumačiti u okviru sprovedene deskriptivne i uporedne analize, bez izvođenja zaključaka o direktnom uzročno-posledičnom odnosu između posmatranih pojava.

Sa teorijskog stanovišta, dobijeni rezultati mogu se posmatrati kroz komplementarnost razvoja ljudskih resursa i inovacionih aktivnosti. Ulaganje u edukaciju doprinosi razvoju znanja i stručnih kompetencija zaposlenih, dok inovacione aktivnosti zahtevaju sposobnost organizacije da postojeća i nova znanja primeni u unapređenju proizvoda, usluga i poslovnih procesa. Rezultati ovog istraživanja pokazuju da se rast ova dva pokazatelja u analiziranom periodu odvijao paralelno, što opravdava njihovo zajedničko razmatranje u kontekstu razvoja savremenih preduzeća.

Na osnovu sprovedene analize mogu se izdvojiti tri značajna nalaza. Prvo, tokom perioda 2017–2026. godine evidentan je dugoročni rast oba analizirana pokazatelja. Drugo, ulaganje u edukaciju zaposlenih tokom čitavog perioda ostaje zastupljenije od ulaganja u inovacije, ali se razlika između njih smanjuje sa 11 procentnih poena na početku na 6 procentnih poena na kraju analiziranog perioda. Treće, nakon pada 2020. godine dolazi do relativno kontinuiranog rasta oba pokazatelja, pri čemu su njihove najviše vrednosti zabeležene 2026. godine.

Dobijeni nalazi ukazuju na značaj istovremenog posmatranja ulaganja u ljudske resurse i inovacione aktivnosti. Međutim, imajući u vidu karakteristike uzorka i način prikupljanja podataka, rezultate je potrebno tumačiti u okviru analiziranih 100 preduzeća, bez automatskog generalizovanja zaključaka na sva preduzeća u Republici Srbiji.

5. Diskusija

Rezultati sprovedenog istraživanja ukazuju na izraženu tendenciju rasta ulaganja u inovacije i edukaciju zaposlenih u analiziranim preduzećima u Republici Srbiji. Posmatrano u periodu od 2017. do 2026. godine, oba pokazatelja beleže dugoročno povećanje, uz odstupanje tokom 2020. godine. Dobijeni nalazi ukazuju na to da razvoj ljudskih resursa i inovacione aktivnosti zauzimaju sve značajnije mesto u poslovnim praksama preduzeća obuhvaćenih istraživanjem.

Udeo preduzeća koja ulažu u inovacije povećan je sa 37% u 2017. na 66% u 2026. godini, što predstavlja povećanje od 29 procentnih poena. Istovremeno, ulaganje u edukaciju zaposlenih povećano je sa 48% na 72%, odnosno za 24 procentna poena. Pored rasta pojedinačnih pokazatelja, značajan nalaz predstavlja njihovo relativno usklađeno kretanje tokom analiziranog perioda. Takav obrazac ukazuje na povezanost razvoja kompetencija zaposlenih sa intenziviranjem inovacionih aktivnosti, što je u skladu sa shvatanjem znanja kao jednog od važnih resursa organizacionog razvoja (Trifunović & Tankosić, 2013).

Ulaganje u edukaciju zaposlenih tokom čitavog posmatranog perioda bilo je zastupljenije od ulaganja u inovacije. Ipak, razlika između pokazatelja smanjena je sa 11 procentnih poena u 2017. na 6 procentnih poena u 2026. godini. Smanjivanje ovog jaza ukazuje na intenzivniji rast inovacionih aktivnosti u završnom delu posmatranog perioda. Ovakav rezultat je značajan jer pokazuje da se rast ulaganja u razvoj znanja i kompetencija zaposlenih odvija paralelno sa sve većom zastupljenošću inovacionih aktivnosti.

Dobijeni nalazi mogu se sagledati u kontekstu savremenog pristupa upravljanju ljudskim resursima, prema kojem znanje zaposlenih predstavlja važan element sposobnosti organizacije da odgovori na promene u poslovnom okruženju. Edukacija omogućava unapređivanje stručnih i profesionalnih kompetencija, ali i stvaranje osnove za usvajanje novih tehnologija, unapređenje poslovnih procesa i razvoj novih proizvoda i usluga. Prenos i reprodukcija znanja imaju poseban značaj za razvoj organizacionih sposobnosti i povezivanje poslovnog sektora sa izvorima novih znanja (Trifunović & Tankosić, 2013).

Posebno odstupanje od opšteg trenda registrovano je 2020. godine. U odnosu na prethodnu godinu, ulaganje u inovacije smanjeno je sa 44% na 30%, dok je ulaganje u edukaciju zaposlenih smanjeno sa 54% na 38%. Činjenica da je pad istovremeno prisutan kod oba pokazatelja ukazuje na njihovu osetljivost na promene poslovnih uslova. Međutim,

već od 2021. godine beleži se oporavak, nakon čega oba pokazatelja ostvaruju kontinuirani rast do kraja analiziranog perioda.

Naročito je izražena dinamika u periodu 2020–2026. godine. Ulaganje u inovacije u ovom periodu povećano je za 36 procentnih poena, dok je ulaganje u edukaciju zaposlenih povećano za 34 procentna poena. Ovakvo kretanje pokazuje da se nakon perioda pada razvojne aktivnosti analiziranih preduzeća intenziviraju u oba posmatrana segmenta. Istovremeno povećavanje ulaganja u ljudske resurse i inovacione aktivnosti ukazuje na njihovu komplementarnost u procesu organizacionog razvoja.

Rezultati se mogu posmatrati i iz perspektive kontinuiranog unapređenja kvaliteta poslovnih procesa. Sposobnost organizacije da unapređuje kvalitet povezana je sa razvojem internih kapaciteta, korišćenjem znanja i sistemskim pristupom organizacionim promenama (Živaljević et al., 2016). U tom smislu, edukacija zaposlenih može imati širi organizacioni značaj, jer razvoj kompetencija stvara pretpostavke za kvalitetnije obavljanje postojećih aktivnosti, ali i za identifikovanje mogućnosti njihovog unapređenja.

Paralelno kretanje analiziranih pokazatelja podržava polaznu pretpostavku o pozitivnoj povezanosti ulaganja u edukaciju zaposlenih i ulaganja u inovacije. Ipak, ovakav nalaz potrebno je interpretirati kao povezanost, a ne kao dokaz direktnog uzročno-posledičnog odnosa. Na inovacionu aktivnost preduzeća, pored znanja i kompetencija zaposlenih, mogu uticati brojni organizacioni i eksterni faktori, uključujući raspoložive finansijske resurse, tehnološke kapacitete, karakteristike tržišta i institucionalno okruženje. Značaj institucionalnih uslova za razvojne procese potvrđuje potrebu da se ponašanje organizacija posmatra u okviru šireg ekonomskog okruženja (Lalić & Trifunović, 2026).

Sa stanovišta upravljanja preduzećem, dobijeni rezultati naglašavaju značaj usklađenog razvoja ljudskog i inovacionog potencijala. Ulaganje u edukaciju omogućava zaposlenima da unapređuju postojeća i stiču nova znanja, dok inovacione aktivnosti predstavljaju jedan od načina njihove praktične primene. Zbog toga razvoj kompetencija zaposlenih dobija puni organizacioni značaj kada postoji mogućnost da se stečeno znanje primeni u unapređenju proizvoda, usluga, procesa i načina organizovanja poslovnih aktivnosti.

Rezultati istraživanja istovremeno pokazuju da rast ulaganja u edukaciju ne treba posmatrati izolovano od drugih elemenata upravljanja ljudskim

resursima. Motivacija zaposlenih, zadovoljstvo poslom, mogućnosti profesionalnog razvoja i organizacioni uslovi u kojima zaposleni primenjuju stečena znanja predstavljaju značajne elemente održivog upravljanja ljudskim potencijalima. Time se razvoj zaposlenih povezuje sa širim konceptom organizacione održivosti i dugoročnog razvoja.

Na osnovu ukupnih rezultata može se zaključiti da analizirani desetogodišnji period karakteriše približavanje dinamike ulaganja u inovacije dinamici ulaganja u edukaciju zaposlenih. Posebno je značajno smanjenje razlike između ova dva pokazatelja, kao i njihov kontinuirani rast nakon 2020. godine. Nalazi time ukazuju na značaj istovremenog posmatranja razvoja ljudskih resursa i inovacionih aktivnosti kao međusobno povezanih dimenzija razvoja preduzeća. U kontekstu analiziranih 100 preduzeća, rezultati pružaju empirijsku osnovu za zaključak da ulaganje u znanje zaposlenih i intenziviranje inovacionih aktivnosti predstavljaju povezane elemente savremenog organizacionog razvoja.

6. Zaključak

Rezultati istraživanja sprovedenog na uzorku od 100 preduzeća u Republici Srbiji ukazuju na rast značaja ulaganja u edukaciju zaposlenih i inovacione aktivnosti tokom perioda 2017–2026. godine. Udeo preduzeća koja ulažu u inovacije povećan je sa 37% na 66%, dok je udeo preduzeća koja ulažu u edukaciju zaposlenih povećan sa 48% na 72%. Paralelno kretanje analiziranih pokazatelja ukazuje na značaj razvoja znanja i kompetencija zaposlenih za stvaranje organizacionih pretpostavki za inovativno poslovanje. Ovakvo stanovište podržavaju i istraživanja koja ukazuju na povezanost obuke zaposlenih, razvoja ljudskog kapitala i inovacionih performansi preduzeća (Manresa et al., 2019; Ma et al., 2019).

Dobijeni nalazi ukazuju na značaj posmatranja ulaganja u ljudske resurse i inovacije kao povezanih dimenzija razvoja preduzeća. Znanje i kontinuirano usavršavanje zaposlenih predstavljaju važnu osnovu za usvajanje i primenu novih ideja, tehnologija i poslovnih procesa, pri čemu efekti edukacije zavise i od sposobnosti organizacije da stečena znanja primeni u praksi (Manresa et al., 2019). Ovakav odnos potvrđuju i nalazi prema kojima ulaganja u obuku i razvoj zaposlenih mogu doprineti organizacionom učenju i inovacionim rezultatima (Sung & Choi, 2014), dok kontinuirano unapređenje znanja i veština zaposlenih može imati značajnu ulogu u razvoju različitih oblika inovacija (Dostie, 2018).

Rezultati istraživanja dodatno pokazuju da je ulaganje u edukaciju zaposlenih tokom celog posmatranog perioda bilo zastupljenije od ulaganja u inovacije, ali da se razlika između ova dva pokazatelja postepeno smanjivala. Razlika je sa 11 procentnih poena na početku posmatranog perioda smanjena na 6 procentnih poena u 2026. godini, što ukazuje na intenzivniji rast inovacionih aktivnosti u njegovom završnom delu. Takvo kretanje može se povezati sa značajem znanja zaposlenih za razvoj inovacionih kapaciteta preduzeća, pri čemu efekti ljudskog kapitala zavise i od njegove strukture, raspoloživih kompetencija i mogućnosti njihove primene u organizaciji (Shao et al., 2025).

Poseban značaj ima činjenica da savremeni inovacioni procesi zahtevaju povezivanje ljudskih i tehnoloških resursa. Digitalizacija, razvoj novih tehnologija i primena veštačke inteligencije stvaraju nove mogućnosti za unapređenje poslovnih procesa, ali istovremeno povećavaju zahteve u pogledu znanja i kompetencija zaposlenih. U tom kontekstu, upravljanje znanjem i informacijama dobija strateški značaj za poslovanje preduzeća (Mihajlović et al., 2024), dok tehnološki napredak i digitalizacija dodatno naglašavaju potrebu za kontinuiranim obrazovanjem i stručnim usavršavanjem (Dašić et al., 2024). Razvoj veštačke inteligencije dodatno potvrđuje povezanost tehnoloških inovacija sa potrebom razvoja odgovarajućih organizacionih i ljudskih kapaciteta (Joksimović et al., 2026).

Na osnovu sprovedene analize može se zaključiti da razvoj kompetencija zaposlenih predstavlja važan element inovacione orijentacije analiziranih preduzeća. Istovremeno, rezultate treba tumačiti u okviru karakteristika posmatranog uzorka i primenjenog deskriptivnog i uporednog istraživačkog pristupa, bez izvođenja direktnih uzročno-posledičnih zaključaka i bez njihovog automatskog generalizovanja na sva preduzeća u Republici Srbiji. Istraživanje time doprinosi boljem razumevanju odnosa ulaganja u ljudski kapital i inovacionih aktivnosti u domaćem poslovnom okruženju i ukazuje na značaj njihovog usklađenog razvoja za dugoročno unapređenje organizacionih kapaciteta preduzeća

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HUMAN CAPITAL DEVELOPMENT AND INNOVATION ACTIVITIES OF ENTERPRISES

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Abstract

Human capital development represents an important foundation for enhancing innovation activities and enabling enterprises to adapt to contemporary changes in the business environment. Continuous investment in employees' knowledge and competencies contributes to creating organizational conditions conducive to the development and implementation of new business solutions.

The aim of this paper is to examine the relationship between investment in employee training and investment in the innovation activities of enterprises in the Republic of Serbia. The analysis covers trends in the observed indicators over the period from 2017 to 2026.

The results indicate an increase in investment in both areas analyzed, as well as a pronounced parallel trend throughout the observed period. The findings highlight the importance of developing employees' knowledge and competencies for strengthening innovation capacities and supporting the long-term development of enterprises.

Keywords: *human capital, innovation, employee training, competencies, enterprise development.*

1. Introduction

The contemporary business environment is characterized by rapid technological change, digitalization, and the need for enterprises to continuously adapt to market requirements. Under such conditions, employees' knowledge, skills, and competencies represent an important development resource, while investment in human capital has become an important factor in enhancing organizational capabilities and fostering innovation. Human capital development enables enterprises to acquire new knowledge more effectively, adopt modern technologies, and

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respond to changes in the business environment (Dostie, 2018; Shao et al., 2025).

Investment in employee training is particularly important, as continuous professional development contributes to building the competencies required to improve products, services, and business processes. The effects of employee development also depend on an organization's ability to transfer, share, and apply acquired knowledge in business practice, thereby creating the conditions necessary for the development of innovation capabilities (Boadu et al., 2018; Caloghirou et al., 2018). At the same time, employee development, job satisfaction, and the responsible management of available resources represent important elements of the long-term and sustainable development of organizations (Žikić et al., 2020; Bučalina Matić et al., 2024).

Against this background, this paper examines the relationship between investment in employee training and the innovation activities of enterprises in the Republic of Serbia. The aim of the research is to analyze the dynamics of these investments and determine the relationship between them. The empirical study included 100 enterprises of different sizes and operating in different sectors, while the indicators analyzed were observed over the period from 2017 to 2026. In this way, the paper contributes to a better understanding of the importance of human capital development in the context of strengthening the innovation activities of contemporary enterprises.

2. Literature Review

Human capital development represents an important factor in enhancing the business capabilities of contemporary enterprises. Employees' knowledge, skills, experience, and competencies constitute intangible resources that can contribute to adaptation to change, improvement of business processes, and development of new solutions. Of particular importance is an organization's ability to systematize, share, and apply existing knowledge, which gives knowledge and information management a strategic role in enterprise operations (Mihajlović et al., 2024).

One of the fundamental mechanisms of human capital development is continuous employee training. Investment in training and professional development enables employees to enhance existing competencies and acquire new ones, while also fostering organizational learning and innovation. Empirical research indicates that investment in employee training and development can contribute to organizational innovation

outcomes through different forms of organizational learning (Sung & Choi, 2014). More recent studies also confirm the importance of investment in employee training for enhancing human capital and innovation activities (Ni et al., 2023; Prdić, 22).

The importance of employee training for the development of innovation capabilities is also supported by recent empirical research. Based on data from 10,366 enterprises in Eastern Europe and Central Asia, a positive relationship was identified between on-the-job training and employees' educational attainment, on the one hand, and different forms of innovation, on the other (Na, 2021). Similar findings have been reported in studies indicating that investment in human capital through employee training and development should be considered alongside an enterprise's innovation capital (Kuzey et al., 2022; Trifunović et al., 2026; Damnjanović, 2026; Prdić, 2025; Prdić, 2018). In addition, developing the human capital of employees engaged in research and development through training can enhance an enterprise's ability to utilize existing technological knowledge in the R&D process (Kim, 2022).

Technological progress and digitalization further increase the importance of continuous human capital development. The adoption of new technologies requires appropriate digital competencies, while at the same time enabling new forms of education, communication, and knowledge transfer. The development of e-education in Serbia demonstrates that digitalization is transforming traditional models of knowledge acquisition and creating opportunities for more effective integration of technological solutions into education and professional development (Dašić et al., 2024). Social networks and digital platforms play a similar role by facilitating faster access to information, content sharing, and new forms of interaction in the learning process (Pajić et al., 2025).

Human capital development is particularly important in the context of enterprise innovation activities. According to the internationally accepted framework, innovation activities include developmental, financial, and commercial activities undertaken by an enterprise with the aim of creating innovation, while business-sector innovations may relate to products and business processes (OECD/Eurostat, 2018). This definition indicates that innovation should not be limited exclusively to research and development but should instead be viewed as a broader process involving the creation and implementation of new or improved solutions.

Employees' knowledge represents an important foundation for this process, as the development and implementation of new ideas require the ability to identify problems, acquire new information, and apply it in

practice. Investment in employee training can therefore be regarded as one means of increasing an enterprise's capacity for innovation. In addition to formal education, professional development, experience, knowledge sharing, and organizational learning are also important. Contemporary approaches to innovation particularly emphasize the importance of knowledge flows within organizations and between enterprises and their external environment (OECD/Eurostat, 2018).

The importance of knowledge sharing and application is also supported by research on open innovation, according to which human capital can contribute to innovation activities both directly and indirectly through knowledge sharing and employee networking via contemporary communication channels (Latifah et al., 2022). This further emphasizes that the effects of investment in human capital depend not only on employees' level of knowledge but also on organizational opportunities for its transfer and practical application (Latifah et al., 2022; Sheehan et al., 2025; Ahmetagić et al., 2022).

Innovation activities are particularly important for small and medium-sized enterprises, which often face limited financial and material resources. Under such conditions, employees' knowledge and capabilities, as well as organizational adaptability, can play an important role in strengthening the competitive position of enterprises. The development of small and medium-sized enterprises in Serbia is associated with the need to enhance their development and innovation capacities, making innovation an important element of their long-term business development (Pavlović et al., 2021; Chabbouh & Boujelbene, 2020).

Contemporary digital transformation is further changing the nature of innovation activities. Artificial intelligence, automation, and advanced data processing create opportunities for the development of new products, services, and business models, while simultaneously requiring new knowledge and competencies from employees. The application of artificial intelligence in financial systems demonstrates its increasingly prominent role as a driver of innovation and digital transformation, while also increasing the importance of investment in technological development (Joksimović et al., 2026).

The relationship between human capital and innovation, however, is not based solely on the existing level of knowledge. An enterprise's ability to identify, acquire, integrate, and apply knowledge in its operations is also important. For this reason, investment in employee training achieves its full value when an organization creates conditions for the practical

application of acquired knowledge. The innovation process is therefore the result of the interaction between human, technological, organizational, and financial resources.

Based on the literature reviewed, human capital development and innovation activities can be regarded as interconnected dimensions of enterprise development. Continuous investment in employees' knowledge and competencies enhances an organization's ability to respond to technological change, utilize new information, and participate in the development of new business solutions (Chang & Nguyen-Van, 2021; Prdić, 2019). At the same time, innovation activities generate new requirements regarding employees' knowledge, which means that training and innovation can be viewed as complementary processes.

3. Methodology

The empirical research focuses on examining the relationship between investment in employee training and investment in the innovation activities of enterprises in the Republic of Serbia. The research is based on the assumption that the development of employees' knowledge and competencies represents an important organizational prerequisite for the development and implementation of innovative solutions.

A quantitative methodological approach was applied in the study. Primary data were collected through a survey using a structured questionnaire distributed electronically. The questionnaire included questions concerning the basic characteristics of the enterprises, investment in employee development and training, and investment in innovation activities.

The research sample consisted of 100 enterprises operating in the Republic of Serbia. Enterprises of different sizes and from different sectors were included in order to examine the phenomena under study across different organizational contexts. Participation in the research was voluntary, and the anonymity and confidentiality of the collected data were ensured.

Two key indicators were considered in the empirical analysis: investment in employee training and investment in innovation. The indicators were expressed as the proportion of enterprises reporting investment in the respective areas, and their trends were analyzed over the period from 2017 to 2026.

Data processing was based on descriptive and comparative statistical analysis. The annual values of the observed indicators, their changes

over time, differences expressed in percentage points, and similarities in the direction and dynamics of their trends were analyzed. Particular attention was paid to changes after 2020 and to the relationship between the dynamics of investment in employee training and investment in innovation. This approach enables the identification of patterns of association between the observed indicators without drawing conclusions regarding a direct cause-and-effect relationship.

In accordance with the subject and aim of the research, the following research hypothesis was formulated:

H1: There is a positive relationship between investment in employee training and investment in innovation among the enterprises analyzed.

4. Results

The analysis of trends in the observed indicators over the ten-year period from 2017 to 2026 indicates an increase in both investment in innovation and investment in employee training, with a more pronounced deviation occurring in 2020.

The proportion of enterprises reporting investment in innovation was 37% in 2017, increasing to 41% in 2018 and 44% in 2019. In 2020, it declined to 30%. Following this decline, the trend reversed, with the indicator increasing to 35% in 2021, 46% in 2022, and 52% in 2023. The upward trend continued in the final part of the period, rising from 56% in 2024 to 61% in 2025 and 66% in 2026.

A similar pattern was observed for investment in employee training. The proportion of enterprises investing in this area was 48% in 2017, 52% in 2018, and 54% in 2019. After declining to 38% in 2020, the indicator increased to 45% in 2021, 52% in 2022, and 60% in 2023. Growth continued to 63% in 2024, 68% in 2025, and 72% in 2026.

Over the entire period, investment in innovation increased from 37% to 66%, representing an increase of 29 percentage points, while investment in employee training increased from 48% to 72%, representing an increase of 24 percentage points. The parallel movement of the two indicators provides a basis for further comparative analysis and for examining patterns of association between them.

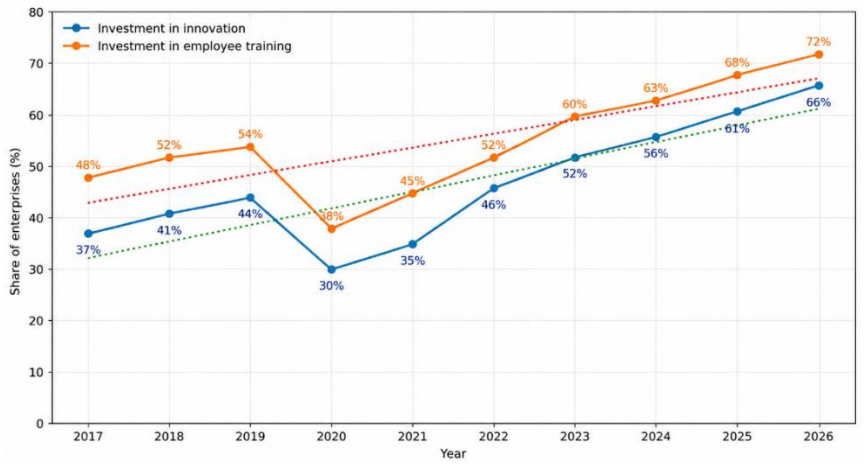

Figure 1. Trends in Investment in Innovation and Employee Training, 2017–2026

Source: Authors' research

To examine the dynamics of the observed indicators in greater detail, investment in innovation and investment in employee training were compared over the ten-year period analyzed. The results show that, in every year observed, the proportion of enterprises investing in employee training was higher than the proportion investing in innovation. However, the difference between the two indicators was not constant, indicating differences in the dynamics of their respective trends.

Table 1. Trends in Investment in Innovation and Employee Training, 2017–2026

Year	Investment in innovation (%)	Investment in employee training (%)	Difference (p.p.)
2017.	37	48	11
2018.	41	52	11
2019.	44	54	10
2020.	30	38	8
2021.	35	45	10
2022.	46	52	6

Year	Investment in innovation (%)	Investment in employee training (%)	Difference (p.p.)
2023.	52	60	8
2024.	56	63	7
2025.	61	68	7
2026.	66	72	6

Source: Authors' research

The data presented in Table 1 show that the difference between the observed indicators gradually decreased over the period analyzed. While the difference amounted to 11 percentage points in both 2017 and 2018, it declined to six percentage points in 2026. This pattern indicates that growth in investment in innovation was more pronounced in the latter part of the period, bringing this indicator closer to the level of investment in employee training.

A notable deviation occurred in 2020, when both indicators declined. Investment in innovation decreased from 44% in 2019 to 30% in 2020, representing a decline of 14 percentage points, while investment in employee training decreased from 54% to 38%, representing a decline of 16 percentage points. Both indicators began to recover in 2021, with growth becoming more pronounced from 2022 onward.

Between 2020 and 2026, the proportion of enterprises investing in innovation increased from 30% to 66%, representing an increase of 36 percentage points. At the same time, the proportion of enterprises investing in employee training increased from 38% to 72%, representing an increase of 34 percentage points. The results therefore indicate a parallel movement of the observed indicators, particularly in the period after 2020.

The comparative analysis shows that changes in investment in employee training and investment in innovation followed a similar direction over the period observed. Periods of increased investment in employee training were generally accompanied by increases in investment in innovation, while both indicators declined in 2020.

This pattern supports research hypothesis H1 regarding a positive relationship between investment in employee training and investment in innovation. The observed relationship should be interpreted within the

framework of the descriptive and comparative analysis conducted, without drawing conclusions regarding a direct cause-and-effect relationship between the phenomena under study.

From a theoretical perspective, the results can be viewed in terms of the complementarity between human resource development and innovation activities. Investment in employee training contributes to the development of employees' knowledge and professional competencies, while innovation activities require organizations to apply both existing and newly acquired knowledge to the improvement of products, services, and business processes. The results of this study show that the two indicators increased in parallel over the period analyzed, which supports their joint consideration in the context of the development of contemporary enterprises.

Three key findings can be identified based on the analysis. First, both indicators exhibited long-term growth over the 2017–2026 period. Second, investment in employee training remained more prevalent than investment in innovation throughout the entire period, although the difference between them decreased from 11 percentage points at the beginning of the period to six percentage points at the end. Third, following the decline in 2020, both indicators exhibited relatively continuous growth, reaching their highest values in 2026.

The findings highlight the importance of considering investment in human resources and innovation activities simultaneously. However, given the characteristics of the sample and the data collection method, the results should be interpreted within the context of the 100 enterprises analyzed and should not be automatically generalized to all enterprises in the Republic of Serbia.

5. Discussion

The results of the study indicate a pronounced upward trend in investment in innovation and employee training among the enterprises analyzed in the Republic of Serbia. Over the period from 2017 to 2026, both indicators showed long-term growth, with a deviation occurring in 2020. The findings indicate that human resource development and innovation activities are playing an increasingly important role in the business practices of the enterprises included in the study.

The proportion of enterprises investing in innovation increased from 37% in 2017 to 66% in 2026, representing an increase of 29 percentage points. At the same time, investment in employee training increased from 48% to 72%, representing an increase of 24 percentage points. In addition to the growth of

the individual indicators, an important finding is their relatively consistent movement throughout the period analyzed. This pattern indicates an association between the development of employees' competencies and the intensification of innovation activities, which is consistent with the understanding of knowledge as an important resource for organizational development (Trifunović & Tankosić, 2013).

Investment in employee training was more prevalent than investment in innovation throughout the entire period observed. Nevertheless, the difference between the indicators decreased from 11 percentage points in 2017 to six percentage points in 2026. The narrowing of this gap indicates more pronounced growth in innovation activities toward the end of the period. This finding is significant because it shows that increased investment in the development of employees' knowledge and competencies occurred in parallel with the growing prevalence of innovation activities.

The findings can be considered within the context of contemporary human resource management approaches, according to which employees' knowledge represents an important element of an organization's ability to respond to changes in the business environment. Training enables the development of professional competencies while also providing a foundation for the adoption of new technologies, improvement of business processes, and development of new products and services. The transfer and reproduction of knowledge are particularly important for developing organizational capabilities and connecting the business sector with sources of new knowledge (Trifunović & Tankosić, 2013).

A notable deviation from the overall trend was recorded in 2020. Compared with the previous year, investment in innovation decreased from 44% to 30%, while investment in employee training declined from 54% to 38%. The simultaneous decline in both indicators indicates their sensitivity to changes in business conditions. However, a recovery was already evident in 2021, after which both indicators continued to increase until the end of the period analyzed.

The dynamics were particularly pronounced during the 2020–2026 period. Investment in innovation increased by 36 percentage points during this period, while investment in employee training increased by 34 percentage points. This pattern shows that, following the period of decline, the development activities of the enterprises analyzed intensified in both areas. The simultaneous increase in investment in human resources and innovation activities indicates their complementarity in the process of organizational development.

The results can also be considered from the perspective of continuous improvement in the quality of business processes. An organization's ability to improve quality is associated with the development of internal capacities, the utilization of knowledge, and a systematic approach to organizational change (Živaljević et al., 2016). In this respect, employee training may have broader organizational significance, as competency development creates the conditions for improving the quality of existing activities and identifying opportunities for their further improvement.

The parallel movement of the indicators analyzed supports the initial assumption of a positive relationship between investment in employee training and investment in innovation. However, this finding should be interpreted as an association rather than evidence of a direct cause-and-effect relationship. In addition to employees' knowledge and competencies, enterprise innovation activity may be influenced by numerous organizational and external factors, including available financial resources, technological capacities, market characteristics, and the institutional environment. The importance of institutional conditions for development processes highlights the need to consider organizational behavior within the broader economic environment (Lalić & Trifunović, 2026).

From an enterprise management perspective, the results emphasize the importance of the coordinated development of human and innovation potential. Investment in training enables employees to enhance their existing knowledge and acquire new knowledge, while innovation activities provide one avenue for its practical application. Consequently, employee competency development acquires its full organizational significance when opportunities exist to apply acquired knowledge to improving products, services, processes, and the organization of business activities.

At the same time, the research results indicate that increased investment in employee training should not be considered in isolation from other elements of human resource management. Employee motivation, job satisfaction, opportunities for professional development, and the organizational conditions in which employees apply their acquired knowledge represent important elements of sustainable human resource management. Employee development is thus linked to the broader concept of organizational sustainability and long-term development.

Based on the overall results, it can be concluded that the ten-year period analyzed was characterized by a convergence between the dynamics of investment in innovation and those of investment in employee training. Particularly noteworthy are the narrowing gap between the two indicators and their continuous growth after 2020. The findings therefore highlight the

importance of considering human resource development and innovation activities simultaneously as interconnected dimensions of enterprise development. In the context of the 100 enterprises analyzed, the results provide an empirical basis for concluding that investment in employees' knowledge and the intensification of innovation activities represent interconnected elements of contemporary organizational development.

6. Conclusion

The results of the study conducted on a sample of 100 enterprises in the Republic of Serbia indicate the growing importance of investment in employee training and innovation activities over the period from 2017 to 2026. The proportion of enterprises investing in innovation increased from 37% to 66%, while the proportion of enterprises investing in employee training increased from 48% to 72%. The parallel movement of the analyzed indicators highlights the importance of developing employees' knowledge and competencies in creating the organizational conditions necessary for innovative business practices. This perspective is also supported by studies indicating a relationship between employee training, human capital development, and enterprise innovation performance (Manresa et al., 2019; Ma et al., 2019).

The findings highlight the importance of considering investment in human resources and innovation as interconnected dimensions of enterprise development. Employees' knowledge and continuous professional development provide an important foundation for the adoption and implementation of new ideas, technologies, and business processes, while the effects of training also depend on an organization's ability to apply acquired knowledge in practice (Manresa et al., 2019). This relationship is also supported by findings indicating that investment in employee training and development can contribute to organizational learning and innovation outcomes (Sung & Choi, 2014), while the continuous enhancement of employees' knowledge and skills can play an important role in the development of different forms of innovation (Dostie, 2018).

The results further show that investment in employee training was more prevalent than investment in innovation throughout the entire period observed, although the gap between the two indicators gradually narrowed. The difference decreased from 11 percentage points at the beginning of the period to six percentage points in 2026, indicating more pronounced growth in innovation activities toward the end of the period. This trend can be associated with the importance of employees' knowledge for the development of enterprise innovation capacities, while the effects of human

capital also depend on its structure, the competencies available, and the opportunities for their application within the organization (Shao et al., 2025).

Of particular importance is the fact that contemporary innovation processes require the integration of human and technological resources. Digitalization, the development of new technologies, and the application of artificial intelligence create new opportunities for improving business processes, while simultaneously increasing the requirements regarding employees' knowledge and competencies. In this context, knowledge and information management assumes strategic importance for enterprise operations (Mihajlović et al., 2024), while technological progress and digitalization further emphasize the need for continuous education and professional development (Dašić et al., 2024). The development of artificial intelligence further demonstrates the relationship between technological innovation and the need to develop appropriate organizational and human capacities (Joksimović et al., 2026).

Based on the analysis conducted, it can be concluded that employee competency development represents an important element of the innovation orientation of the enterprises analyzed. At the same time, the results should be interpreted within the context of the characteristics of the sample and the descriptive and comparative research approach applied, without drawing direct cause-and-effect conclusions or automatically generalizing the findings to all enterprises in the Republic of Serbia. The study thus contributes to a better understanding of the relationship between investment in human capital and innovation activities in the Serbian business environment and highlights the importance of their coordinated development for the long-term enhancement of enterprises' organizational capacities.

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UPRAVLJANJE PROJEKTOM MULTIDISCIPLINARNOG INŽENJERSKOG RAZVOJA: RETROSPEKTIVNA STUDIJA SLUČAJA ROBOTSKE RUKE

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Apstrakt

Ovaj rad predstavlja retrospektivnu analizu upravljanja projektom razvoja robotske ruke povezane na internet, koja je prvobitno projektovana kao inženjerski prototip. Sistem je integrisao hardver, upravljanje zasnovano na Raspberry Pi platformi, mrežnu komunikaciju, veb servis i klijentski softver za daljinsko upravljanje. Budući da prvobitni razvoj nije sproveden primenom formalno dokumentovane metodologije upravljanja projektima, dokumentovane aktivnosti, tehničke odluke i ograničenja retrospektivno su organizovani primenom koncepata upravljanja projektima. Razvijena je struktura raščlanjivanja poslova (Work Breakdown Structure – WBS), dok su analizirani zavisnosti sistema, novonastali zahtevi, rizici i potencijalne promene obima projekta. Rezultati pokazuju da su pojedini zahtevi i rizici postali očigledni tek tokom implementacije, integracije i testiranja. Zavisnost od interneta, odsustvo autentifikacije i potpune povratne komunikacije, ograničenja klijentske platforme i Bluetooth komunikacija ilustruju kako odluke donete na nivou prototipa mogu uticati na kasniji obim i planiranje projekta. Studija pokazuje kako retrospektivna analiza može transformisati dokumentovano inženjersko iskustvo u naučene lekcije koje mogu podržati upravljanje sličnim multidisciplinarnim projektima razvoja tehnologije.

Ključne reči: *upravljanje projektima; inženjerski projekat; upravljanje rizicima; obim projekta; integracija sistema*

1. Uvod

Razvoj savremenih robotskih sistema i sistema interneta stvari (*IoT*) sve više zahteva integraciju heterogenih hardverskih, softverskih,

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komunikacionih i komponenti zasnovanih na oblaku. Iako su tehničke performanse ovih komponenti od suštinskog značaja, uspešan razvoj takvih sistema takođe zavisi od efikasne koordinacije zahteva, razvojnih aktivnosti, resursa, rizika i promena tokom životnog ciklusa projekta. Inženjerski razvojni projekti stoga predstavljaju ne samo tehničke izazove već i izazove upravljanja projektima, posebno kada je potrebno projektovati, implementirati i integrisati više međusobno zavisnih podsistema u funkcionalno rešenje (Efrati & Reich, 2023; Ding et al., 2022; Sharon et al., 2011). Upravljanje projektima pruža strukturirani okvir za definisanje ciljeva i obima projekta, raščlanjivanje složenih razvojnih aktivnosti na zadatke kojima se može upravljati, koordinaciju implementacije, identifikovanje rizika i praćenje napretka. U tom kontekstu, potrebe i percepcije relevantnih zainteresovanih strana takođe mogu pružiti značajne ulazne informacije za definisanje razvojnih prioriteta i podršku odlukama u vezi sa projektom (Prdić et al., 2023).

Ovi aspekti su posebno značajni u projektima razvoja tehnologije, gde neizvesnost može proisteći iz ograničenja hardvera, zavisnosti softvera, komunikacionih tehnologija i integracije sistema. Efikasno upravljanje rizicima u razvoju proizvoda zasnovanih na tehnologiji zahteva da se rizici povezani sa komponentama sistema i njihovim međuzavisnostima identifikuju i da se njima upravlja tokom celokupnog životnog ciklusa projekta (Efrati & Reich, 2023; Yasinetskyi & Fesenko, 2025). Sistemi zasnovani na IoT-u pružaju odgovarajući kontekst za razmatranje ovih pitanja, jer njihov razvoj kombinuje fizičke uređaje, softver, komunikacionu infrastrukturu i mrežne servise. Zavisnosti između ovih komponenti znače da ograničenje ili projektantska odluka u jednom podsistemu mogu uticati na druge delove projekta. Ova studija razmatra razvoj robotske ruke povezane na internet iz perspektive upravljanja projektom. Inženjerski razvoj obuhvatao je robotsku ruku, upravljačku jedinicu zasnovanu na *Raspberry Pi* platformi, mrežnu komunikaciju, veb servis i klijentske aplikacije za daljinsko upravljanje. Umesto da se prvenstveno fokusira na tehničku implementaciju pojedinačnih komponenti, ova analiza razmatra razvojni proces kao inženjerski projekat i ispituje kako su ciljevi projekta, raščlanjivanje poslova, integracija sistema, rizici i promene uticali na njegovu implementaciju. Posebna pažnja posvećena je problemima koji su postali očigledni tokom razvoja i testiranja, ali nisu bili u potpunosti predviđeni u početnoj fazi projektovanja. Oni uključuju ograničenja povezana sa povratnom komunikacijom, autentifikacijom i zavisnošću od interneta. Retrospektivnom analizom ovih pitanja u okviru upravljanja projektom,

studija ima za cilj da identifikuje naučene lekcije koje mogu podržati planiranje i upravljanje sličnim multidisciplinarnim inženjerskim razvojnim projektima. Retrospektivna analiza je posebno značajna u ovom kontekstu, jer završeni inženjerski razvoj pruža empirijske dokaze o zavisnostima, ograničenjima i zahtevima koji možda nisu bili u potpunosti vidljivi tokom početnog planiranja. Sistematsko tumačenje takvih dokaza iz perspektive upravljanja projektom stoga može podržati informisanije definisanje obima, identifikaciju rizika i upravljanje zahtevima u budućim projektima razvoja tehnologije. Doprinos studije ogleda se u uspostavljanju sledive veze između dokumentovanih inženjerskih dokaza i njihove retrospektivne interpretacije u pogledu obima projekta, zavisnosti, rizika i novonastalih zahteva, bez pretpostavke o primeni praksi upravljanja projektima koje prvobitno nisu bile dokumentovane.

U skladu sa tim, studija razmatra sledeća istraživačka pitanja:

RQ1: Kako se razvoj robotskog sistema povezanog na internet može strukturirati i analizirati primenom principa upravljanja projektima?

RQ2: Koji su se tehnički rizici i rizici povezani sa integracijom pojavili tokom implementacije i kako su uticali na prvobitne zahteve i obim projekta?

RQ3: Koje se lekcije iz oblasti upravljanja projektima mogu izvesti iz procesa razvoja i testiranja za slične multidisciplinarne inženjerske projekte?

2. Okvir upravljanja projektom

Proces razvoja je retrospektivno analiziran iz perspektive upravljanja projektom, pri čemu su dokumentovane aktivnosti, tehničke odluke i ograničenja korišćeni kao primarna osnova za analizu. Analiza nije imala za cilj da rekonstruiše formalni proces upravljanja projektom koji prvobitno nije bio dokumentovan. Umesto toga, raspoloživi dokazi klasifikovani su prema obimu projekta, raščlanjivanju poslova, zavisnostima sistema, rizicima i novonastalim zahtevima, a zatim su razmotrene njihove potencijalne implikacije na dodatne razvojne aktivnosti, obim i zahteve. Dobijena zapažanja potom su korišćena za izvođenje lekcija za slične multidisciplinarne inženjerske projekte.

Prvobitni razvoj sastojao se od nekoliko blisko povezanih tehničkih zadataka koji su obuhvatali robotsku ruku, upravljanje zasnovano na *Raspberry Pi* platformi, mrežnu komunikaciju, veb servis i klijentske

aplikacije za daljinsko upravljanje. Za potrebe retrospektivne analize, dokumentovane aktivnosti organizovane su u šest glavnih oblasti rada: hardver robotske ruke, upravljanje zasnovano na *Raspberry Pi* platformi, mrežna komunikacija, razvoj veb servisa, razvoj klijentske aplikacije i integracija i testiranje sistema. Ovo raščlanjivanje odražava stvarnu tehničku strukturu razvijenog rešenja, a ne formalno dokumentovanu strukturu raščlanjivanja poslova (*Work Breakdown Structure*) korišćenu tokom prvobitnog razvoja. Ono pruža praktičnu osnovu za razmatranje raspodele i međusobnih odnosa izvršenih poslova (*Project Management Institute*, 2021).

Šest oblasti rada nisu posmatrane kao nezavisni elementi. Funkcionalnost kompletnog sistema zavisila je od uspešne interakcije hardvera robotske ruke, upravljačke jedinice, komunikacione infrastrukture, veb servisa i klijentskog softvera. Zavisnosti između elemenata sistema mogu predstavljati značajne izvore projektne neizvesnosti, jer ograničenja ili promene u jednoj komponenti mogu uticati na implementaciju i funkcionisanje drugih (Efrati & Reich, 2023; Browning, 2001). Retrospektivno raščlanjivanje je stoga korišćeno ne samo za predstavljanje izvršenih poslova već i za identifikovanje interfejsa i zavisnosti relevantnih za naknadnu analizu rizika i promena.

Analiza rizika zasnivala se na problemima i ograničenjima dokumentovanim tokom razvoja i testiranja, a ne na hipotetičkim rizicima rekonstruisanim retrospektivno. Ova pitanja analizirana su u pogledu njihovog izvora, potencijalnih efekata i dodatnih razvojnih aktivnosti potrebnih nakon faze prototipa (Efrati & Reich, 2023; Yasinetskyi & Fesenko, 2025; ISO, 2018). Isti pristup zasnovan na dokazima primenjen je na zahteve i potencijalne promene obima projekta, pri čemu je napravljena razlika između funkcija uključenih u prvobitni razvoj i potreba koje su se pojavile tokom implementacije ili integracije. Identifikovano ograničenje je stoga klasifikovano prema tome da li je uticalo na implementirano rešenje, predstavljalo novonastali zahtev ili zahtevalo dodatni rad izvan prvobitnog obima projekta (International Organization for Standardization et al., 2018).

Klasifikacija je potkrepljena originalnom inženjerskom dokumentacijom. Autentifikacija je izostavljena iz prototipa jer su korišćeni jedan robot i servis koji nije bio javno dostupan, dok je nepotpuna povratna komunikacija identifikovana kao ograničenje za potencijalnu industrijsku primenu. Implementacija klijentske aplikacije bila je ograničena na uređaje zasnovane na *Windows* platformi, iako je prepoznata mogućnost

prilagođavanja dodatnim platformama. Direktna *Bluetooth* komunikacija bila je eksplicitno izvan prvobitnog obima projekta, ali je naknadno identifikovana kao potencijalno korisna u slučajevima kada je internet konekcija ograničena ili nedostupna.

Rezultujući analitički proces može se stoga sažeti kao niz koji polazi od dokumentovanih inženjerskih dokaza, preko identifikacije i klasifikacije sa stanovišta upravljanja projektom, do procene implikacija na nivou projekta i izvođenja naučenih lekcija. Ovaj postupak održava sledljivost između prvobitnog inženjerskog iskustva i retrospektivne interpretacije, istovremeno izbegavajući pripisivanje formalnih praksi upravljanja projektima koje nisu bile sprovedene ili dokumentovane tokom prvobitnog razvoja.

Na osnovu ovog okvira, studija slučaja analizirana je u četiri oblasti:

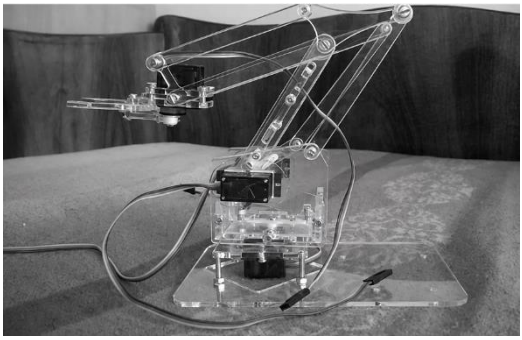
- ciljevi i obim projekta;
- raščlanjivanje poslova i zavisnosti sistema;
- identifikacija i procena rizika;
- analiza zahteva i promena.

Ove oblasti predstavljaju strukturu retrospektivne analize prikazane u narednim odeljcima.

3. Studija slučaja i arhitektura sistema

Studija slučaja zasniva se na razvoju robotske ruke povezane na internet, projektovane za daljinsko upravljanje. Sistem je objedinjavao mehaničke komponente, ugrađeno upravljanje, mrežnu komunikaciju, serverske servise i klijentski softver. Takve kombinacije fizičkih uređaja, komunikacione infrastrukture i softverskih servisa karakteristične su za sistemske arhitekture orijentisane na *IoT* (Gubbi et al., 2013; Miorandi et al., 2012).

Robotska ruka predstavljala je fizički deo sistema. Njeno kretanje ostvarivano je pomoću servo motora kojima se upravljalo preko *Raspberry Pi* platforme. *Raspberry Pi* je imao ulogu centralne upravljačke jedinice, primao je komande putem mreže i pretvarao ih u signale potrebne za upravljanje servo motorima. Ugrađene računarske platforme pružaju praktičan način integracije upravljačkih i komunikacionih funkcija u robotskim sistemima (Bräunl, 2008).



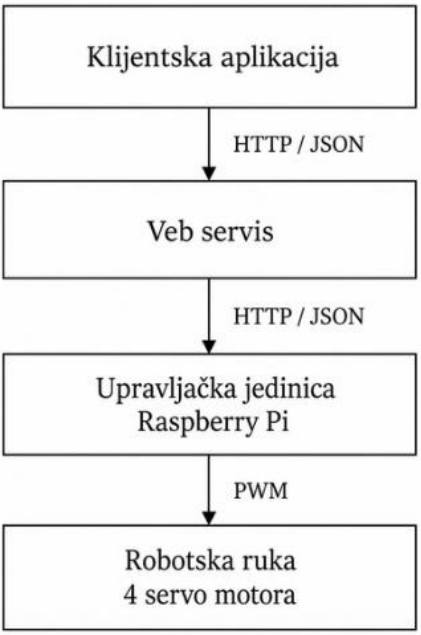
Slika 1. Sklopljena robotska ruka sa vidljivim ožičenjem

Daljinsko upravljanje zahtevalo je dodatni komunikacioni sloj. Veb servis je korišćen za prenos komandi između klijentske aplikacije i upravljačke jedinice zasnovane na *Raspberry Pi* platformi (Vujović et al., 2013). Servis je stoga imao ulogu posrednika između softvera namenjenog korisniku i fizičkog uređaja. Ova arhitektura omogućila je slanje upravljačkih komandi putem internet veze bez potrebe da klijentska aplikacija direktno komunicira sa hardverom robotske ruke. Mrežna komunikacija između distribuiranih uređaja i servisa predstavlja važan element *IoT* arhitektura i omogućava fizičkim uređajima interakciju sa udaljenim aplikacijama i drugim mrežnim resursima (Gubbi et al., 2013; Miorandi et al., 2012).

Klijentska aplikacija obezbeđivala je korisnički interfejs za upravljanje robotskom rukom. Korisničke komande prenošene su putem veb servisa, a zatim ih je obrađivao *Raspberry Pi*. Kao rezultat toga, kompletan upravljački lanac obuhvatao je nekoliko uzastopnih komponenti: korisnički interfejs → veb servis → mrežna komunikacija → *Raspberry Pi* → upravljanje servo motorima → robotska ruka. Funkcionisanje kompletnog sistema stoga je zavisilo od uspešne interakcije svih ovih elemenata, a ne od izolovanih performansi bilo koje pojedinačne komponente.

Za potrebe ove retrospektivne analize projekta, arhitektura je organizovana prema oblastima rada uvedenim u Odeljku 2: hardver robotske ruke, upravljanje zasnovano na *Raspberry Pi* platformi, mrežna komunikacija, razvoj veb servisa, razvoj klijentske aplikacije i integracija i testiranje sistema. Ovo raščlanjivanje prati stvarnu tehničku strukturu razvijenog rešenja i pruža praktičnu osnovu za razmatranje odnosa između razvojnih aktivnosti. Iz perspektive projekta, zavisnosti između ovih oblasti posebno su značajne jer poteškoće u jednom

podsistemu mogu uticati na implementaciju i integraciju drugih komponenti (Efrati & Reich, 2023).



Slika 2. Arhitektura sistema robotske ruke povezane na internet

Arhitektura takođe ilustruje značaj integracije sistema: daljinsko upravljanje zavisilo je od uspešne interakcije robotske ruke, upravljačke jedinice, mrežne komunikacije, veb servisa i klijentske aplikacije. Iz perspektive projekta, ove međuzavisnosti su značajne jer rizici ili ograničenja u jednoj komponenti mogu uticati na druge delove razvoja (Efrati & Reich, 2023).

Dokumentovana arhitektura sistema uspostavlja vezu između originalnih inženjerskih dokaza i retrospektivne analize upravljanja projektom. Ona omogućava da se pojedinačne razvojne aktivnosti, tehničke odluke i uočena ograničenja povežu sa određenim komponentama i interfejsima sistema, pružajući osnovu za naknadnu analizu obima, zavisnosti, rizika i novonastalih zahteva.

4. Planiranje i implementacija projekta

4.1. Ciljevi i obim projekta

Primarni cilj inženjerskog razvoja bio je kreiranje robotskog sistema povezanog na internet za daljinsko upravljanje. U okviru prvobitnog razvoja razmatrane su i potencijalne primene u građevinarstvu i automobilskoj proizvodnji, uključujući daljinski upravljane dizalice i robotske ruke koje se koriste u proizvodnji vozila.

Iz perspektive ove retrospektivne analize, ovi ciljevi definišu osnovni obim projekta. Obim je uključivao kako fizički sistem, tako i softverske i komunikacione komponente potrebne za daljinsko upravljanje. Istovremeno, neke funkcije koje su mogle povećati primenljivost sistema nisu bile uključene u početni razvoj. Razlikovanje između prvobitnog obima i zahteva identifikovanih kasnije tokom implementacije važno je jer definisanje obima utvrđuje granice poslova koje treba izvršiti i pruža osnovu za procenu naknadnih promena (Project Management Institute, 2021; Cerezo-Narváez et al., 2020).

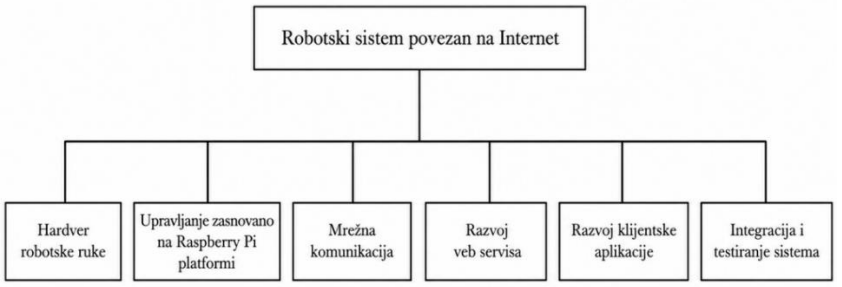
Jedan primer postao je posebno značajan tokom razvoja. Direktno upravljanje putem *Bluetooth* komunikacije nije bilo deo prvobitnog obima, jer je sistem prvenstveno bio projektovan za upravljanje putem interneta. Međutim, tokom implementacije postalo je očigledno da se dostupnost internet veze ne može pretpostaviti u svim potencijalnim radnim okruženjima. *Bluetooth* komunikacija se stoga pojavila kao moguće proširenje, a ne kao prvobitno planirani zahtev projekta. Ova razlika se kasnije koristi u studiji kako bi se razmotrilo na koji način praktično iskustvo tokom implementacije može otkriti zahteve koji nisu bili očigledni na početku projekta razvoja tehnologije.

4.2.. Raščlanjivanje poslova

U prvobitnom razvoju primenjeno je raščlanjivanje zadataka podelom funkcija na podzadatke kojima se može upravljati, dok je mogućnost ponovne upotrebe takođe predstavljala eksplicitno razvojno razmatranje. Za potrebe ove analize, ove dokumentovane aktivnosti retrospektivno su organizovane u pojednostavljenu strukturu raščlanjivanja poslova (*Work Breakdown Structure – WBS*).

Njena svrha nije da sugeriše da je formalna *WBS* korišćena tokom prvobitnog razvoja, već da pruži projektno orijentisan prikaz poslova koji su zaista izvršeni. *WBS* predstavlja hijerarhijsko raščlanjivanje

projektnih poslova na postepeno manje elemente kojima se lakše može upravljati i može povezati ciljeve projekta sa aktivnostima i resursima (Project Management Institute, 2021; Cerezo-Narváez et al., 2020; Tausworthe, 1984). Izbor i organizacija WBS-a takođe mogu uticati na planiranje aktivnosti, izradu vremenskog plana i prikaz odnosa između projektnih aktivnosti (Odedairo, 2024).



Slika 3. Retrospektivna struktura raščlanjivanja poslova razvoja robotskog sistema

Na prvom nivou, *WBS* predstavlja kompletan robotski sistem povezan na internet. Drugi nivo sastoji se od šest prethodno identifikovanih razvojnih oblasti. Tamo gde je to prikladno, ove oblasti mogu se dalje raščlaniti na pojedinačne tehničke aktivnosti. Na primer, upravljanje zasnovano na *Raspberry Pi* platformi uključuje upravljanje servo motorima i obradu komandi, dok oblast komunikacije uključuje prenos komandi između klijenta, veb servisa i upravljačke jedinice. Dobijena struktura odražava stvarni inženjerski rad, istovremeno pružajući jasniji prikaz načina na koji su pojedinačne razvojne aktivnosti doprinele ukupnom cilju projekta.

4.3.. Implementacija i integracija sistema

Implementacija je pratila modularnu strukturu sistema, pri čemu su hardverske i softverske komponente razvijane u skladu sa svojim specifičnim funkcijama, a zatim integrisane u kompletan upravljački lanac. *Raspberry Pi* je povezivao fizičku robotsku ruku sa mrežnim delom rešenja, dok je veb servis omogućavao da komande iz klijentske aplikacije stignu do upravljačke jedinice.

Tokom prvobitnog razvoja, *Azure IoT Hub* je razmatran kao dostupno rešenje zasnovano na oblaku, ali je na kraju izabran i implementiran prilagođeni servis zasnovan na *Web API*-ju. Ova dokumentovana projektantska odluka rezultirala je jednostavnom klijent–server

arhitekturom u kojoj je klijent slao upravljačke zahteve servisu, a *Raspberry Pi* preuzimao informacije potrebne za upravljanje robotskom rukom. *JSON* je korišćen za predstavljanje podataka, pružajući zajednički format koji su mogli da obrađuju klijent, server i softver na upravljačkoj strani. Upotreba jednostavnih formata podataka i komunikacije zasnovane na vebu u skladu je sa utvrđenim pristupima povezivanju heterogenih uređaja i servisa u *IoT* okruženjima (Gubbi et al., 2013; Miorandi et al., 2012; Atzori et al., 2010).

Integracija je bila posebno značajna jer je uspešno funkcionisanje zavisilo od kompletnog komunikacionog lanca, a ne od izolovane funkcionalnosti pojedinačnih komponenti. Iz perspektive upravljanja projektom, ovi interfejsi i zavisnosti predstavljaju potencijalne izvore tehničke neizvesnosti i projektnog rizika (Efrati & Reich, 2023).

Implementacija je takođe odražavala naglasak na ponovnoj upotrebljivosti utvrđen tokom prvobitnog razvoja. Upravljačke funkcije projektovane su tako da nisu bile ograničene na fiksni broj zglobova, dok je veb servis bio namenjen podršci različitim konfiguracijama uređaja i strukturama podataka. Time je smanjena zavisnost softverske arhitekture od jedne fizičke konfiguracije i obezbeđena osnova za moguća kasnija proširenja sistema.

4.4. Testiranje i identifikacija razvojnih problema

Testiranje integrisanog sistema potvrdilo je da se glavni cilj daljinskog upravljanja robotskom rukom može ostvariti, istovremeno otkrivajući ograničenja relevantna za projektne rizike, dodatne zahteve i potencijalne buduće promene.

Jedno ograničenje odnosilo se na povratnu komunikaciju. Implementirani komunikacioni proces prvenstveno je prenosio komande ka robotskoj ruci, dok potpuni mehanizam povratne komunikacije od uređaja ka korisniku nije bio uključen. U jednostavnoj eksperimentalnoj konfiguraciji to nije sprečavalo funkcionisanje, ali bi u zahtevnijoj primeni odsustvo pouzdane povratne informacije otežalo potvrđivanje stvarnog stanja robota. Ovo pitanje stoga predstavlja ne samo tehničko ograničenje već i operativni rizik koji bi morao biti rešen pre primene u industrijskom okruženju.

Autentifikacija je predstavljala drugo pitanje. Pošto je eksperimentalni sistem uključivao samo jednog robota, a adresa servisa nije bila javno dostupna, autentifikacija je izostavljena iz implementiranog veb servisa.

To je pojednostavilo prototip, ali ne bi bilo odgovarajuće za sistem koji funkcioniše u manje kontrolisanom okruženju. Iz perspektive projekta, ovo ilustruje kako pretpostavke koje su prihvatljive u početnom razvojnom kontekstu mogu postati dodatni zahtevi kada se promeni očekivano radno okruženje.

Zavisnost od interneta predstavljala je još jedno ograničenje identifikovano kroz praktično razmatranje mogućih scenarija upotrebe. Daljinsko upravljanje putem veb servisa zahtevalo je internet vezu, koja se ne može garantovati u svim industrijskim ili građevinskim okruženjima. Kao što je razmotreno u Odeljku 4.1, direktna *Bluetooth* komunikacija je naknadno prepoznata kao korisna alternativa, iako nije bila deo prvobitnog obima projekta. Ovaj primer pokazuje kako testiranje i razmatranje stvarnih radnih uslova mogu dovesti do identifikacije dodatnih zahteva i potencijalnih promena obima projekta.

Ovi nalazi predstavljaju osnovu za naknadnu analizu projektnih rizika, novonastalih zahteva i potencijalnih promena obima projekta.

5. Upravljanje rizicima i promenama

Retrospektivna analiza identifikovala je četiri glavna problema relevantna za rizike projekta i potencijalne promene: nedostatak povratne komunikacije, nedostatak autentifikacije, zavisnost od internet konekcije i zavisnost od klijentske platforme. Svaki problem analiziran je u pogledu njegovog izvora, potencijalnog uticaja na projekat i dodatnih razvojnih aktivnosti potrebnih izvan prvobitnog konteksta prototipa.

Upravljanje rizicima je posebno značajno u projektima razvoja tehnologije jer neizvesnost može proisteći ne samo iz pojedinačnih tehničkih komponenti već i iz zavisnosti i interfejsa između njih (Efrati & Reich, 2023; Yasinetskyi & Fesenko, 2025; Raz et al., 2002). Strukturirani proces upravljanja rizicima podržava identifikaciju, analizu i tretman neizvesnosti i pruža osnovu za donošenje informisanih odluka (ISO, 2018). Na nivou projekta, rizici identifikovani tokom implementacije mogu takođe uticati na zahteve, obim projekta i naknadne razvojne aktivnosti (Project Management Institute, 2021; Cerezo-Narváez et al., 2020). U ovoj analizi, svaki dokumentovani problem je stoga razmatran na dva nivoa: prvo kao tehničko ograničenje implementiranog sistema, a zatim u pogledu njegovih potencijalnih implikacija na obim projekta, zahteve i dalji razvoj.

Tabela 1. Rizici i razvojni problemi identifikovani tokom implementacije

Rizik/problem	Izvor	Potencijalni uticaj na projekat	Potencijalni razvojni odgovor
Nedostatak povratne komunikacije	Arhitektura sistema	Ograničene informacije o stvarnom stanju robota	Uvesti dvosmernu povratnu komunikaciju
Nedostatak autentifikacije	Veb servis	Bezbednosna ograničenja u manje kontrolisanim okruženjima	Implementirati autentifikaciju i kontrolu pristupa
Zavisnost od interneta	Komunikaciona arhitektura	Gubitak mogućnosti daljinskog upravljanja kada pristup internetu nije dostupan ili je ograničen	Obezbediti alternativni metod lokalne komunikacije
Zavisnost od platforme	Klijentski softver	Ograničena dostupnost na različitim klijentskim platformama	Proširiti podršku na dodatne platforme

Odsustvo potpune povratne komunikacije bilo je prihvatljivo za rad prototipa, ali predstavlja značajniji operativni rizik u širim primenama u kojima je potrebna potvrda stanja robota ili izvršenja komande.

Autentifikacija je izostavljena iz prototipa jer je sistem radio sa jednim robotom u kontrolisanom okruženju. Međutim, šira mrežna ili industrijska primena uvela bi dodatne zahteve u pogledu bezbednosti i kontrole pristupa (Sicari et al., 2015; Roman et al., 2013; Boyes et al., 2018; Alaba et al., 2017).

Zavisnost od interneta predstavlja najjasniji primer odnosa između rizika i promene obima projekta. Početni koncept zasnivao se na daljinskom upravljanju putem interneta, ali je tokom razvoja utvrđeno da internet konekcija u nekim radnim okruženjima može biti ograničena ili nedostupna. Direktna *Bluetooth* komunikacija je stoga identifikovana kao moguća alternativa. Pošto je ova funkcionalnost bila izvan prvobitnog obima projekta, njena identifikacija predstavlja potencijalno proširenje obima nastalo kao rezultat novonastalog operativnog zahteva (Project Management Institute, 2021; Cerezo-Narváez et al., 2020; Jarratt et al., 2011).

Zavisnost od platforme nije uticala na rad prototipa, ali je ograničila njegovu širu primenljivost jer je klijentska aplikacija razvijena za uređaje zasnovane na *Windows* platformi. Podrška za dodatne platforme zahtevala bi dalji razvoj i stoga bi je trebalo tretirati kao dodatni zahtev koji utiče na budući obim projekta i resurse.

Ovi slučajevi zajedno pokazuju kako se dokumentovana tehnička ograničenja mogu pretvoriti u projektne rizike, novonastale zahteve i potencijalne promene obima projekta. Njihove implikacije zavise od potrebnih dodatnih razvojnih aktivnosti i predviđenog konteksta primene, bez pretpostavke da je tokom prvobitnog razvoja sproveden formalni proces upravljanja rizicima.

6. Rezultati i naučene lekcije

Retrospektivna analiza je rezultirala sa četiri glavna nalaza koji se odnose na strukturu projekta i zavisnosti (RQ1), rizike i promene zahteva i obima projekta (RQ2), kao i na lekcije za slične multidisciplinarne inženjerske projekte (RQ3). Iako je prvobitni inženjerski cilj ostvaren na nivou prototipa, analiza je pokazala da uspešan rad prototipa ne podrazumeva spremnost za širu ili industrijsku primenu.

Prvi nalaz odnosi se na zavisnosti između šest oblasti rada identifikovanih retrospektivnim raščlanjivanjem: hardvera robotske ruke, upravljanja zasnovanog na *Raspberry Pi* platformi, mrežne komunikacije, razvoja veb servisa, razvoja klijentske aplikacije i integracije i testiranja. Iako su ove oblasti predstavljale različite tehničke aktivnosti, dokumentovana arhitektura sistema pokazala je da uspešno funkcionisanje zavisi od njihovih interfejsa i koordinisanog rada. Ograničenje ili promena koja utiče na jednu oblast rada stoga može imati posledice i na druge delove razvoja. Iz perspektive upravljanja projektom, ovo pokazuje zašto prilikom planiranja i procene projektnih rizika, pored samih aktivnosti, treba razmotriti i zavisnosti između tehničkih oblasti rada. Zavisnosti i interakcije između komponenti sistema mogu uvesti dodatnu neizvesnost i otežati dekompoziciju i integraciju sistema (Efrati & Reich, 2023; Browning, 2001).

Drugi nalaz odnosi se na trenutak identifikovanja zahteva. *Bluetooth* povezivanje, koje je bilo izvan prvobitnog obima projekta, pojavilo se tokom implementacije kao potencijalni zahtev za okruženja sa ograničenim ili nedostupnim pristupom internetu. Ovo pokazuje da iskustvo stečeno tokom implementacije može otkriti zahteve koji nisu identifikovani prilikom početnog definisanja obima projekta. Takve zahteve treba proceniti kao potencijalne promene obima projekta koje imaju implikacije na dodatne aktivnosti i resurse (Nuseibeh & Easterbrook, 2000; Nurmuliani et al., 2004).

Treći nalaz je da uspešan rad prototipa treba razlikovati od operativne spremnosti. Autentifikacija i potpuna povratna komunikacija nisu bile

neophodne za demonstraciju osnovne funkcionalnosti prototipa, ali bi postale važni zahtevi u kontekstu šire primene. Ova razlika je značajna za upravljanje projektom jer promene u predviđenom radnom okruženju mogu dovesti do dodatnih zahteva i razvojnih aktivnosti čak i nakon što je prvobitni tehnički cilj ostvaren (Héder, 2017; Olechowski et al., 2015; Mankins, 2009).

Četvrti nalaz odnosi se na vezu između arhitekture sistema i budućeg obima projekta. Dokumentovani naglasak na modularnosti i funkcijama koje se mogu ponovo koristiti obezbedio je tehničku osnovu za proširenje pojedinačnih delova sistema bez potrebe za ponovnim projektovanjem kompletnog rešenja. Međutim, takva proširenja bi i dalje zahtevala dodatne aktivnosti implementacije, integracije i testiranja. Alternativne metode komunikacije, dodatne klijentske platforme, autentifikaciju i dvosmernu povratnu komunikaciju stoga treba tretirati kao dodatne projektne aktivnosti sa implikacijama na obim i resurse, a ne kao mogućnosti koje postojeći prototip implicitno obezbeđuje. Ovo tumačenje je u skladu sa ulogom arhitekture sistema u određivanju načina na koji naknadne izmene utiču na međusobno povezane komponente sistema (Ulrich, 1995).

Posmatrana zajedno, četiri nalaza ukazuju na to da uspešan završetak prototipa ne treba automatski tumačiti kao ispunjenje svih zahteva za praktičnu primenu. U multidisciplinarnim inženjerskim projektima, implementacija, integracija i testiranje mogu pružiti informacije relevantne ne samo za tehničku verifikaciju već i za naknadne projektne odluke. Tehnička ograničenja i dodatne potrebe identifikovane tokom ovih aktivnosti mogu otkriti prethodno neprepoznate rizike, pretpostavke i zahteve i mogu uticati na obim i planiranje narednih faza razvoja (Browning, 2001; Nuseibeh & Easterbrook, 2000; Nurmuliani et al., 2004; Héder, 2017). U ovom slučaju, integracija i testiranje sistema stoga su predstavljali ključnu tačku u kojoj su tehnička ograničenja postala vidljiva kao projektni rizici i novonastali zahtevi, sa direktnim implikacijama na naknadne odluke o obimu projekta.

Glavne lekcije izvedene iz retrospektivne analize sažete su u Tabeli 2.

Tabela 2. Glavni nalazi i implikacije retrospektivne analize na upravljanje projektom

Glavni nalaz	Dokumentovani dokazi iz razvoja	Implikacija na upravljanje projektom
Zavisnosti između oblasti rada	Daljinsko upravljanje zahtevalo je koordinisano funkcionisanje hardvera robotske ruke, upravljanja zasnovanog na *Raspberry Pi* platformi, mrežne komunikacije, veb servisa i klijentskog softvera.	Zavisnosti i interfejse između tehničkih oblasti rada treba eksplicitno razmotriti tokom planiranja projekta i analize rizika.
Zahtevi koji se pojavljuju tokom implementacije	*Bluetooth* komunikacija bila je izvan prvobitnog obima projekta, ali je naknadno prepoznata kao potencijalno korisna alternativa kada je pristup internetu ograničen ili nedostupan.	Zahteve identifikovane tokom implementacije treba proceniti kao potencijalne promene obima projekta sa implikacijama na dodatne aktivnosti i resurse.
Uspeh prototipa naspram operativne spremnosti	Autentifikacija i potpuna povratna komunikacija nisu bile potrebne za demonstraciju osnovne funkcionalnosti prototipa, ali postaju važne u kontekstu šire primene.	Ostvarenje početnog tehničkog cilja ne znači nužno da su ispunjeni svi zahtevi za operativnu primenu.
Arhitektura i budući obim projekta	Modularne funkcije i funkcije koje se mogu ponovo koristiti omogućile su potencijalno proširenje komunikacionih metoda, klijentskih platformi i drugih mogućnosti sistema.	Fleksibilnost arhitekture može olakšati naknadne promene, ali proširenja i dalje treba planirati i njima upravljati kao dodatnim projektnim aktivnostima.

Tabela 2 uspostavlja sledljivost između dokumentovanih inženjerskih dokaza i njihove retrospektivne interpretacije iz perspektive upravljanja projektom, bez pretpostavke da je prvobitni razvoj sledio formalnu metodologiju upravljanja projektima. Ona pokazuje kako konkretna zapažanja iz procesa razvoja mogu pružiti strukturirane informacije za naknadno planiranje i upravljanje projektom.

7. Diskusija

Nalazi ukazuju na to da značaj upravljanja projektom u multidisciplinarnom inženjerskom razvoju prevazilazi formalnu primenu metoda upravljanja projektima. Zavisnosti, novonastali zahtevi i odluke o arhitekturi ugrađeni su u sam inženjerski razvoj i mogu uticati na naknadne projektne odluke. Ovo podržava sistemski orijentisano tumačenje prema kojem se tehničke komponente i projektne aktivnosti ne mogu razmatrati nezavisno (Browning, 2001; Ulrich, 1995; Baccarini, 1996). Ova studija slučaja pokazuje kako se ovi odnosi mogu

retrospektivno identifikovati na osnovu dokumentovanih inženjerskih dokaza i prevesti u implikacije za upravljanje projektom.

Nalaz da su se dodatni zahtevi pojavili tokom implementacije u skladu je sa shvatanjem inženjerstva zahteva kao iterativnog procesa. Kako se razvija znanje o sistemu i njegovom radnom okruženju, zahtevi mogu zahtevati preciziranje ili proširenje (Nuseibeh & Easterbrook, 2000; Nurmuliani et al., 2004; McGee & Greer, 2009; Ferreira et al., 2009). U ovom slučaju, *Bluetooth* povezivanje pojavilo se izvan početnog obima projekta. Iz perspektive upravljanja projektom, takvi novonastali zahtevi mogu uticati na obim projekta, resurse, aktivnosti integracije i naknadne razvojne odluke.

Pojavu dodatnih zahteva ne treba nužno tumačiti kao dokaz neadekvatnog početnog planiranja. U projektima razvoja tehnologije, potpuno poznavanje ponašanja sistema, tehničkih ograničenja i radnih uslova možda nije dostupno na početku projekta, a neizvesnost se može postepeno smanjivati kroz razvoj i testiranje (Ward & Chapman, 2003; Perminova et al., 2008). Novonastali zahtevi stoga mogu predstavljati znanje stečeno tokom razvoja. Izazov upravljanja projektom je proceniti da li su takvi zahtevi opravdani i kako utiču na obim projekta, resurse, rizike i naknadne aktivnosti (Project Management Institute, 2021; ISO, 2018; Cerezo-Narváez et al., 2020).

Razlikovanje uspeha prototipa od operativne spremnosti ima šire implikacije za projekte razvoja tehnologije. Ostvarenje početnog tehničkog cilja pokazuje izvodljivost u uslovima prototipa, ali ne potvrđuje spremnost za primenu u drugačijim operativnim uslovima. U ovom slučaju, identifikovana ograničenja pokazuju da se zahtevi projekta mogu menjati kako se širi predviđeni kontekst upotrebe. Ovo je u skladu sa konceptima tehnološke spremnosti, koji razlikuju tehničku izvodljivost od validacije i rada u sve realističnijim uslovima (Héder, 2017; Olechowski et al., 2015; Mankins, 2009).

Bezbednost predstavlja posebno ilustrativan primer. Autentifikacija nije bila potrebna za demonstraciju glavne funkcionalnosti u kontrolisanom okruženju prototipa, ali bi postala važan zahtev u širim mrežno povezanim ili industrijskim primenama (Sicari et al., 2015; Roman et al., 2013; Boyes et al., 2018; Alaba et al., 2017). Prema tome, prihvatljivo pojednostavljenje tokom razvoja prototipa može postati značajan zahtev kada se kontekst primene proširi.

Analiza dalje ukazuje na to da arhitektura sistema može uticati na obim potrebnog rada povezanog sa naknadnim promenama projekta. Prvobitni naglasak na modularnosti i funkcijama koje se mogu ponovo koristiti olakšao je moguća proširenja bez potrebe za potpunim redizajniranjem sistema. Međutim, promene koje utiču na međusobno povezane komponente i dalje mogu zahtevati značajan napor u integraciji (Browning, 2001; Ulrich, 1995). Takva proširenja stoga treba posmatrati kao zasebne projektne aktivnosti sa odgovarajućim implikacijama na obim projekta i resurse.

Šira implikacija studije slučaja jeste da integracija i testiranje, pored svoje uobičajene uloge u verifikaciji, mogu doprineti i učenju u okviru projekta (Schindler & Eppler, 2003; Williams, 2008). U ovom slučaju, nekoliko ograničenja postalo je očigledno tek nakon integracije komponenti ili razmatranja kompletnog sistema u mogućim radnim okruženjima. Informacije dobijene tokom implementacije i testiranja stoga treba da doprinesu naknadnoj proceni rizika, analizi zahteva, odlukama o obimu projekta i planiranju razvoja (Project Management Institute, 2021; ISO, 2018; Nuseibeh & Easterbrook, 2000; Nurmuliani et al., 2004).

Retrospektivni pristup primenjen u ovoj studiji takođe ima ograničenja. Prvobitni projekat nije sproveden prema formalno dokumentovanoj metodologiji upravljanja projektima, a dokumentacija kao što su formalni registar rizika, osnovni vremenski plan, plan resursa ili sistematski dnevnik promena nije bila dostupna. Analiza se stoga fokusira na dokumentovane tehničke odluke, ograničenja sistema i zahteve, umesto na rekonstrukciju kvantitativnih pokazatelja projekta koji nisu bili evidentirani. Pored toga, budući da se analiza zasniva na jednoj retrospektivnoj studiji slučaja, nalaze treba tumačiti kao analitičke uvide specifične za ovaj slučaj, a ne kao statistički generalizabilne rezultate.

Uprkos ovim ograničenjima, studija slučaja pruža praktičan primer kako se iskustvo stečeno tokom inženjerskog razvoja može transformisati u znanje iz oblasti upravljanja projektima. Retrospektivna *WBS*, klasifikacija rizika i analiza novonastalih zahteva čine vidljivim odnose koji su bili manje eksplicitni u prvobitnom tehničkom opisu. U sličnim multidisciplinarnim projektima razvoja tehnologije, menadžeri bi trebalo eksplicitno da prate zavisnosti između tehničkih oblasti rada i ponovo procenjuju zahteve i rizike kako nove informacije postaju dostupne tokom integracije i testiranja. Dokumentovanje takvih informacija može

podržati upravljanje rizicima, kontrolu promena i planiranje narednih faza razvoja (Schindler & Eppler, 2003; Williams, 2008; Kotnour, 2000).

8. Zaključci

Ova studija predstavlja retrospektivnu analizu upravljanja projektom razvoja robotske ruke povezane na internet. Prvobitni inženjerski rad bio je prvenstveno usmeren na tehničku implementaciju sistema, dok je u ovoj analizi isti razvoj razmatran iz perspektive obima projekta, raščlanjivanja poslova, zavisnosti sistema, upravljanja rizicima i promenama i naučenih lekcija.

Retrospektivna struktura raščlanjivanja poslova pokazala je da se razvoj može organizovati u šest međusobno povezanih oblasti rada: hardver robotske ruke, upravljanje zasnovano na *Raspberry Pi* platformi, mrežna komunikacija, razvoj veb servisa, razvoj klijentske aplikacije i integracija i testiranje sistema. Iako su ove oblasti predstavljale različite tehničke aktivnosti, uspešno funkcionisanje sistema zavisilo je od njihove integracije. Ovo naglašava značaj razmatranja zavisnosti i interfejsa između oblasti rada prilikom planiranja multidisciplinarnih inženjerskih projekata.

Analiza je takođe identifikovala razliku između zahteva definisanih na početku razvoja i onih koji su postali očigledni tokom implementacije. *Bluetooth* komunikacija predstavlja jasan primer: nije bila uključena u prvobitni obim projekta, ali je naknadno prepoznata kao potencijalno korisna alternativa u okruženjima u kojima internet konekcija nije dostupna ili je ograničena. Autentifikacija, povratna komunikacija i šira podrška za klijentske platforme na sličan način ilustruju kako razvoj prototipa može otkriti dodatne zahteve koji postaju značajniji kada se razmatra šira primena sistema.

Posmatrani zajedno, ovi nalazi daju odgovore na istraživačka pitanja pokazujući kako se razvoj može strukturirati iz perspektive projekta, kako rizici povezani sa implementacijom mogu dovesti do dodatnih zahteva i potencijalnih promena obima projekta i koje se lekcije mogu izvesti za planiranje sličnih multidisciplinarnih inženjerskih projekata.

Iz perspektive upravljanja projektom, ovi nalazi pokazuju da implementacija i testiranje mogu pružiti informacije koje utiču ne samo na tehničko projektovanje već i na obim projekta, procenu rizika i naknadno planiranje. Zahteve i rizike stoga ne treba smatrati potpuno fiksiranim na početku projekta. U projektima razvoja tehnologije, znanje

stečeno tokom implementacije može podržati donošenje informisanijih odluka u vezi sa promenama i budućim razvojnim aktivnostima.

Studija takođe pokazuje vrednost retrospektivne analize u slučajevima kada tokom prvobitnog inženjerskog rada nije izrađena formalna dokumentacija upravljanja projektom. Retrospektivna *WBS* i strukturirano razmatranje dokumentovanih tehničkih odluka mogu otkriti odnose između razvojnih aktivnosti, novonastalih zahteva i projektnih rizika bez pretpostavke da su formalne prakse upravljanja projektima prvobitno bile primenjene. Istovremeno, odsustvo projektne dokumentacije nastale tokom samog razvoja ograničava kvantitativnu procenu vremenskog plana, resursa, troškova i izloženosti rizicima.

Rezultati se zasnivaju na jednom projektu inženjerskog razvoja i stoga ih ne treba tumačiti kao opšte primenljive kvantitativne dokaze. Buduća istraživanja mogla bi primeniti isti retrospektivni okvir na dodatne multidisciplinarne inženjerske projekte i uporediti dobijene obrasce zavisnosti, novonastalih zahteva i promena obima projekta. U sličnim budućim projektima, evidentiranje rizika, promena zahteva i problema povezanih sa integracijom tokom implementacije takođe bi omogućilo detaljniju procenu njihovog uticaja na performanse projekta.

U celini, studija slučaja ukazuje na to da su uspešan razvoj tehničkog prototipa i upravljanje projektom koji vodi do tog prototipa blisko povezane, ali različite perspektive. Kombinovanje inženjerskog iskustva sa sistematskom analizom upravljanja projektom može omogućiti jasnije razumevanje načina na koji tehničke odluke, zavisnosti sistema i novonastali zahtevi utiču na proces razvoja i može podržati planiranje narednih faza projekta.

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PROJECT MANAGEMENT OF MULTIDISCIPLINARY ENGINEERING DEVELOPMENT: A RETROSPECTIVE ROBOTIC ARM CASE STUDY

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Abstract

This study presents a retrospective project management analysis of the development of an Internet-connected robotic arm originally designed as an engineering prototype. The system integrated hardware, Raspberry Pi-based control, network communication, a web service and client software for remote operation. Since the original development was not conducted using a formally documented project management methodology, documented activities, technical decisions and limitations were retrospectively organised using project management concepts. A Work Breakdown Structure was developed, while system dependencies, emerging requirements, risks and potential scope changes were analysed. The results show that several requirements and risks became apparent only during implementation, integration and testing. Internet dependency, the absence of authentication and complete communication feedback, client-platform limitations and Bluetooth communication illustrate how prototype-level decisions may influence subsequent project scope and planning. The study demonstrates how retrospective analysis can transform documented engineering experience into lessons supporting the management of similar multidisciplinary technology-development projects.

Keywords: *project management; engineering project; risk management; project scope; system integration*

1. Introduction

The development of modern robotic and Internet of Things (IoT) systems increasingly requires the integration of heterogeneous hardware, software, communication and cloud-based components. Although the technical performance of these components is essential, the successful development of such systems also depends on the effective coordination of requirements, development activities, resources, risks and changes throughout the project life cycle. Engineering development projects

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therefore represent not only technical challenges but also project management challenges, particularly when several interdependent subsystems must be designed, implemented and integrated into a functional solution (Efrati & Reich, 2023; Ding et al., 2022; Sharon et al., 2011). Project management provides a structured framework for defining project objectives and scope, decomposing complex development activities into manageable tasks, coordinating implementation, identifying risks and monitoring progress. In this context, the needs and perceptions of relevant stakeholders can also provide important input for defining development priorities and supporting project-related decisions (Prdić et al., 2023). These aspects are particularly relevant in technology-development projects, where uncertainty may arise from hardware limitations, software dependencies, communication technologies and system integration. Effective risk management in technology-based product development requires risks associated with system components and their interdependencies to be identified and managed throughout the project life cycle (Efrati & Reich, 2023; Yasinetskyi & Fesenko, 2025). IoT-based systems provide an appropriate context for examining these issues because their development combines physical devices, software, communication infrastructure and network-based services. The dependencies between these components mean that a limitation or design decision in one subsystem may influence other parts of the project. The present study examines the development of an Internet-connected robotic arm from a project management perspective. The engineering development comprised the robotic arm, a Raspberry Pi-based control unit, network communication, a web service and client applications for remote operation. Rather than focusing primarily on the technical implementation of individual components, the present analysis considers the development process as an engineering project and examines how project objectives, work decomposition, system integration, risks and changes influenced its implementation. Particular attention is given to problems that became apparent during development and testing but were not fully anticipated during the initial design stage. These include limitations related to communication feedback, authentication and Internet dependency. By analysing these issues retrospectively within a project management framework, the study aims to identify lessons that can support the planning and management of similar multidisciplinary engineering development projects. Retrospective analysis is particularly relevant in this context because completed engineering development provides empirical evidence of dependencies, limitations and

requirements that may not have been fully visible during initial planning. Systematically interpreting such evidence from a project management perspective can therefore support more informed scope definition, risk identification and requirements management in future technology-development projects. The contribution of the study lies in establishing a traceable link between documented engineering evidence and its retrospective interpretation in terms of project scope, dependencies, risks and emerging requirements, without assuming project management practices that were not originally documented. Accordingly, the study addresses the following research questions:

RQ1: How can the development of an Internet-connected robotic system be structured and analysed using project management principles?

RQ2: Which technical and integration-related risks emerged during implementation, and how did they affect the original project requirements and scope?

RQ3: What project management lessons can be derived from the development and testing process for similar multidisciplinary engineering projects?

2. Project Management Framework

The development process was examined retrospectively from a project management perspective using documented activities, technical decisions and limitations as the primary evidence base. The analysis did not attempt to reconstruct a formal project management process that had not originally been documented. Instead, the available evidence was classified according to project scope, work decomposition, system dependencies, risks and emerging requirements, and its potential implications for additional development work, scope and requirements were examined. The resulting observations were then used to derive lessons for similar multidisciplinary engineering projects.

The original development consisted of several closely related technical tasks involving the robotic arm, Raspberry Pi-based control, network communication, a web service and client applications for remote operation. For the retrospective analysis, the documented activities were organised into six main work areas: robotic hardware, Raspberry Pi-based control, network communication, web-service development, client application development, and system integration and testing. This decomposition reflects the actual technical structure of the developed

solution rather than a formally documented Work Breakdown Structure used during the original development. It provides a practical basis for examining the distribution and relationships of the work performed (Project Management Institute, 2021).

The six work areas were not treated as independent elements. The functionality of the complete system depended on the successful interaction of the robotic hardware, controller, communication infrastructure, web service and client software. Dependencies between system elements can represent important sources of project uncertainty because limitations or changes in one component may affect the implementation and operation of others (Efrati & Reich, 2023; Browning, 2001). The retrospective decomposition was therefore used not only to represent the work performed but also to identify interfaces and dependencies relevant to subsequent risk and change analysis.

Risk analysis was based on problems and limitations documented during development and testing rather than on hypothetical risks reconstructed retrospectively. These issues were examined in terms of their source, potential effects and the additional development response required beyond the prototype stage (Efrati & Reich, 2023; Yasinetskyi & Fesenko, 2025; ISO, 2018). The same evidence-based approach was applied to requirements and potential scope changes by distinguishing between functions included in the original development and needs that emerged during implementation or integration. An identified limitation was therefore classified according to whether it affected the implemented solution, represented an emerging requirement, or required additional work beyond the original project scope (International Organization for Standardization et al., 2018).

The classification is supported by the original engineering documentation. Authentication was omitted from the prototype because a single robot and a non-public service were used, while incomplete communication feedback was identified as a limitation for potential industrial use. The client implementation was limited to Windows-based devices, although adaptation to additional platforms was recognised. Direct Bluetooth communication was explicitly outside the original project scope but was subsequently identified as potentially useful where Internet connectivity was restricted or unavailable.

The resulting analytical process can therefore be summarised as a sequence from documented engineering evidence, through identification and project management classification, to the assessment of project-level

implications and the derivation of lessons learned. This procedure maintains traceability between the original engineering experience and the retrospective interpretation while avoiding the attribution of formal project management practices that were not performed or documented during the original development.

Based on this framework, the case study was analysed in four areas:

- project objectives and scope;
- work decomposition and system dependencies;
- risk identification and assessment;
- requirements and change analysis.

These areas provide the structure for the retrospective analysis presented in the following sections.

3. Case Study and System Architecture

The case study is based on the development of an Internet-connected robotic arm designed for remote operation. The system combined mechanical components, embedded control, network communication, server-side services and client software. Such combinations of physical devices, communication infrastructure and software services are characteristic of IoT-oriented system architectures (Gubbi et al., 2013; Miorandi et al., 2012).

The robotic arm formed the physical part of the system. Its movements were produced by servo motors controlled through a Raspberry Pi. The Raspberry Pi acted as the central control unit, receiving commands through the network and translating them into signals required to operate the servos. Embedded computing platforms provide a practical means of integrating control and communication functions in robotic systems (Bräunl, 2008).

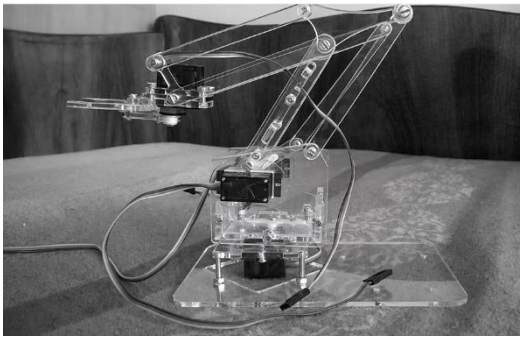

Figure 1. The assembled robotic arm with the wiring visible

Remote operation required an additional communication layer. A web service was used to transfer commands between the client application and the Raspberry Pi-based controller (Vujović et al., 2013). The service therefore acted as an intermediary between the user-facing software and the physical device. This architecture made it possible to send control commands over an Internet connection without requiring the client application to communicate directly with the robotic hardware. Network-based communication between distributed devices and services is an important element of IoT architectures and enables physical devices to interact with remote applications and other network resources (Gubbi et al., 2013; Miorandi et al., 2012).

The client application provided the user interface for operating the robotic arm. User commands were transmitted through the web service and subsequently processed by the Raspberry Pi. As a result, the complete control chain involved several successive components: user interface → web service → network communication → Raspberry Pi → servo control → robotic arm. The operation of the complete system therefore depended on successful interaction between all these elements rather than on the isolated performance of any single component.

For the present retrospective project analysis, the architecture was organised into the work areas introduced in Section 2: robotic hardware, Raspberry Pi-based control, network communication, web-service development, client application development, and system integration and testing. This decomposition follows the actual technical structure of the developed solution and provides a practical basis for examining the relationships between development activities. From a project perspective, the dependencies between these areas are particularly relevant because difficulties in one subsystem can influence the

implementation and integration of other components (Efrati & Reich, 2023).

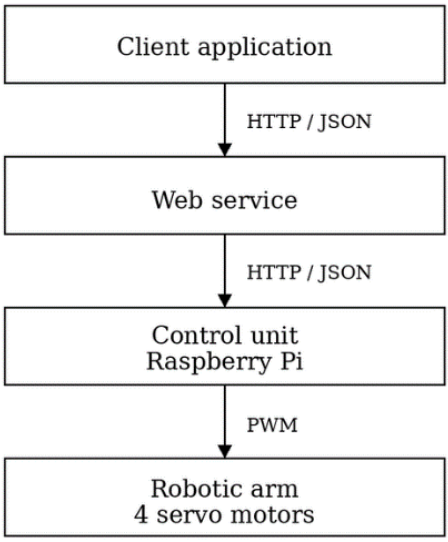

Figure 2. System architecture of the Internet-connected robotic arm

The architecture also illustrates the importance of system integration: remote operation depended on the successful interaction of the robotic arm, controller, network communication, web service and client application. From a project perspective, these interdependencies are relevant because risks or limitations in one component may affect other parts of the development (Efrati & Reich, 2023).

The documented system architecture establishes the link between the original engineering evidence and the retrospective project management analysis. It enables individual development activities, technical decisions and observed limitations to be traced to specific system components and interfaces, providing a basis for the subsequent analysis of scope, dependencies, risks and emerging requirements.

4. Project Planning and Implementation

4.1. Project Objectives and Scope

The primary objective of the engineering development was to create an Internet-connected robotic system for remote operation. The original development also considered potential applications in construction and

automotive manufacturing, including remotely operated cranes and robotic arms used in vehicle production.

From the perspective of the present retrospective analysis, these objectives define the core project scope. The scope included both the physical system and the software and communication components required for remote operation. At the same time, some functions that could have increased the applicability of the system were not included in the initial development. Distinguishing between the original scope and requirements identified later during implementation is important because scope definition establishes the boundaries of the work to be performed and provides a basis for evaluating subsequent changes (Project Management Institute, 2021; Cerezo-Narváez et al., 2020).

One example became particularly relevant during development. Direct Bluetooth control was not part of the original scope, since the system was designed primarily for Internet-based operation. During implementation, however, it became apparent that Internet connectivity could not be assumed in all potential operating environments. Bluetooth communication therefore emerged as a possible extension rather than as an initially planned project requirement. This distinction is used later in the study to examine how practical experience during implementation can reveal requirements that were not apparent at the beginning of a technology-development project.

4.2. Work Decomposition

The original development applied task decomposition by dividing functions into manageable subtasks, while reusability was also an explicit development consideration. For the present analysis, these documented activities were retrospectively organised as a simplified Work Breakdown Structure (WBS).

Its purpose is not to suggest that a formal WBS was used during the original development, but to provide a project-oriented representation of the work that was actually performed. The WBS provides a hierarchical decomposition of project work into progressively smaller and more manageable elements and can connect project objectives with activities and resources (Project Management Institute, 2021; Cerezo-Narváez et al., 2020; Tausworthe, 1984). The choice and organisation of a WBS can also influence activity planning, scheduling and the representation of relationships between project activities (Odedairo, 2024).

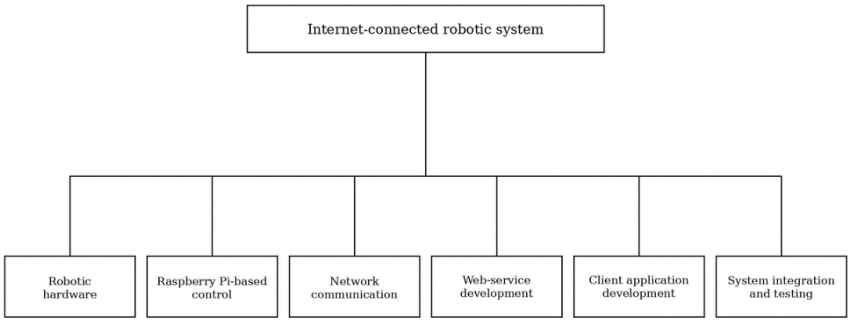

Figure 3. Retrospective Work Breakdown Structure of the robotic system development

At the first level, the WBS represents the complete Internet-connected robotic system. The second level consists of the six development areas identified above. Where appropriate, these areas can be further decomposed into individual technical activities. For example, Raspberry Pi-based control includes servo control and processing of commands, whereas the communication area includes transmission of commands between the client, web service and control unit. The resulting structure reflects the actual engineering work while providing a clearer view of how individual development activities contributed to the overall project objective.

4.3. Implementation and System Integration

Implementation followed the modular structure of the system, with hardware and software components developed around their specific functions and subsequently integrated into the complete control chain. The Raspberry Pi linked the physical robotic arm to the network-based part of the solution, while the web service enabled commands from the client application to reach the control unit.

During the original development, Azure IoT Hub was considered as an available cloud-based solution, but a custom Web API-based service was ultimately selected and implemented. This documented design decision resulted in a simple client–server architecture in which the client transmitted control requests to the service and the Raspberry Pi retrieved the information required to operate the robotic arm. JSON was used for data representation, providing a common format that could be handled by the client, server and control-side software. The use of lightweight data formats and web-based communication is consistent with

established approaches to connecting heterogeneous devices and services in IoT environments (Gubbi et al., 2013; Miorandi et al., 2012; Atzori et al., 2010).

Integration was particularly important because successful operation depended on the complete communication chain rather than on the isolated functionality of individual components. From a project management perspective, these interfaces and dependencies represent potential sources of technical uncertainty and project risk (Efrati & Reich, 2023).

The implementation also reflected the emphasis on reusability established during the original development. Control functions were designed so that they were not restricted to a fixed number of joints, while the web service was intended to support different device configurations and data structures. This reduced the dependence of the software architecture on a single physical configuration and provided a basis for possible later extensions of the system.

4.4. Testing and Identification of Development Issues

Testing of the integrated system confirmed that the main objective of remote robotic-arm control could be achieved, while also revealing limitations relevant to project risks, additional requirements and potential future changes.

One limitation concerned communication feedback. The implemented communication process primarily transferred commands towards the robotic arm, while a complete feedback mechanism from the device to the user was not included. In a simple experimental configuration this did not prevent operation, but in a more demanding application the absence of reliable feedback would make it difficult to confirm the actual state of the robot. The issue therefore represents not only a technical limitation but also an operational risk that would have to be addressed before deployment in an industrial environment.

Authentication represented a second issue. Because the experimental system involved only one robot and the service address was not publicly exposed, authentication was omitted from the implemented web service. This simplified the prototype but would not be appropriate for a system operating in a less controlled environment. From the project perspective, this illustrates how assumptions that are acceptable within the initial

development context may become additional requirements when the expected operating environment changes.

Internet dependency was another limitation identified through practical consideration of possible use scenarios. Remote control through the web service required Internet connectivity, which cannot be guaranteed in all industrial or construction environments. As discussed in Section 4.1, direct Bluetooth communication was subsequently recognised as a useful alternative even though it had not been part of the original project scope. The example demonstrates how testing and consideration of real operating conditions can lead to the identification of additional requirements and potential scope changes.

These findings provide the basis for the subsequent analysis of project risks, emerging requirements and potential scope changes.

5. Risk and Change Management

The retrospective risk analysis focused on four documented development issues with project-level implications: communication feedback, authentication, dependence on Internet connectivity and client-platform dependency. Each issue was examined in terms of its source, potential project impact and the additional development response required beyond the original prototype context.

Risk management is particularly important in technology-development projects because uncertainty may originate not only from individual technical components but also from dependencies and interfaces between them (Efrati & Reich, 2023; Yasinetskyi & Fesenko, 2025; Raz et al., 2002). A structured risk management process supports the identification, analysis and treatment of uncertainty and provides a basis for informed decision making (ISO, 2018). At project level, risks identified during implementation may also affect requirements, scope and subsequent development activities (Project Management Institute, 2021; Cerezo-Narváez et al., 2020). In the present analysis, each documented issue was therefore examined at two levels: first as a technical limitation of the implemented system, and second in terms of its potential implications for project scope, requirements and further development.

Table 1 summarises the identified issues and their project implications.

Table 1. Risks and development issues identified during implementation

Risk/issue	Source	Potential project impact	Potential development response
Missing communication feedback	System architecture	Limited information about the actual state of the robot	Introduce bidirectional feedback
Missing authentication	Web service	Security limitations in less controlled environments	Implement authentication and access control
Internet dependency	Communication architecture	Loss of remote-control capability where Internet access is unavailable or restricted	Provide an alternative local communication method
Platform dependency	Client software	Restricted availability on different client platforms	Extend support to additional platforms

The absence of complete communication feedback was acceptable for prototype operation but represents a more significant operational risk in broader applications where confirmation of robot state or command execution is required.

Authentication was omitted from the prototype because it operated with a single robot in a controlled setting. However, broader network or industrial deployment would introduce additional security and access-control requirements (Sicari et al., 2015; Roman et al., 2013; Boyes et al., 2018; Alaba et al., 2017).

Internet dependency provides the clearest example of the relationship between risk and scope change. The initial concept relied on Internet-based remote control, but development revealed that connectivity might be restricted or unavailable in some operating environments. Direct Bluetooth communication was therefore identified as a possible alternative. Since this functionality was outside the original project scope, its identification represents a potential scope extension generated by an emerging operational requirement (Project Management Institute, 2021; Cerezo-Narváez et al., 2020; Jarratt et al., 2011).

Platform dependency did not affect prototype operation but limited wider applicability because the client application was developed for Windows-based devices. Support for additional platforms would require further development and should therefore be treated as an additional requirement affecting future project scope and resources.

Together, these cases show how documented technical limitations can translate into project risks, emerging requirements and potential scope changes. Their implications depend on the additional development work required and the intended deployment context, without implying that a formal risk management process was conducted during the original development.

6. Results and Lessons Learned

The retrospective analysis produced four main findings addressing project structure and dependencies (RQ1), risks and changes in requirements and scope (RQ2), and lessons for similar multidisciplinary engineering projects (RQ3). Although the original engineering objective was achieved at prototype level, the analysis showed that successful prototype operation did not imply readiness for broader or industrial deployment.

The first finding concerns the dependencies between the six work areas identified through the retrospective decomposition: robotic hardware, Raspberry Pi-based control, network communication, web-service development, client application development, and integration and testing. Although these areas represented distinct technical activities, the documented system architecture showed that successful operation depended on their interfaces and coordinated functioning. A limitation or change affecting one work area could therefore have implications for other parts of the development. From a project management perspective, this illustrates why dependencies between technical work areas should be considered together with the activities themselves when planning and assessing project risks. Dependencies and interactions between system components can introduce additional uncertainty and complicate system decomposition and integration (Efrati & Reich, 2023; Browning, 2001).

The second finding concerns the timing of requirement identification. Bluetooth connectivity, which was outside the original project scope, emerged during implementation as a potential requirement for environments with restricted or unavailable Internet access. This demonstrates that implementation experience can reveal requirements not identified during initial scope definition. Such requirements should be evaluated as potential scope changes with implications for additional work and resources (Nuseibeh & Easterbrook, 2000; Nurmuliani et al., 2004).

The third finding is that successful prototype operation should be distinguished from operational readiness. Authentication and complete communication feedback were not necessary to demonstrate the basic prototype functionality but would become important requirements in broader deployment contexts. This distinction is relevant to project management because changes in the intended operating context may generate additional requirements and development activities even after the original technical objective has been achieved (Héder, 2017; Olechowski et al., 2015; Mankins, 2009).

The fourth finding concerns the relationship between system architecture and future project scope. The documented emphasis on modularity and reusable functions provided a technical basis for extending individual parts of the system without redesigning the complete solution. However, such extensions would still require additional implementation, integration and testing activities. Alternative communication methods, additional client platforms, authentication and bidirectional feedback should therefore be treated as additional project work with implications for scope and resources rather than as capabilities implicitly provided by the existing prototype. This interpretation is consistent with the role of system architecture in determining how subsequent modifications affect interconnected system components (Ulrich, 1995).

Taken together, the four findings indicate that successful prototype completion should not automatically be interpreted as completion of all requirements for practical deployment. In multidisciplinary engineering projects, implementation, integration and testing can provide information relevant not only to technical verification but also to subsequent project decisions. Technical limitations and additional needs identified during these activities may reveal previously unrecognised risks, assumptions and requirements and may influence the scope and planning of subsequent development phases (Browning, 2001; Nuseibeh & Easterbrook, 2000; Nurmuliani et al., 2004; Héder, 2017). In this case, system integration and testing therefore acted as a key point at which technical limitations became visible as project risks and emerging requirements, with direct implications for subsequent scope decisions.

The main lessons derived from the retrospective analysis are summarised in Table 2.

Table 2. Main findings and project management implications of the retrospective analysis

Main finding	Documented evidence from the development	Project management implication
Dependencies between work areas	Remote operation required the coordinated functioning of robotic hardware, Raspberry Pi-based control, network communication, the web service and client software.	Dependencies and interfaces between technical work areas should be considered explicitly during project planning and risk analysis.
Requirements emerging during implementation	Bluetooth communication was outside the original project scope but was subsequently recognised as a potentially useful alternative where Internet access was restricted or unavailable.	Requirements identified during implementation should be evaluated as potential scope changes with implications for additional work and resources.
Prototype success versus operational readiness	Authentication and complete communication feedback were not required to demonstrate the basic prototype functionality but become important in broader deployment contexts.	Achievement of the initial technical objective does not necessarily imply that all requirements for operational deployment have been satisfied.
Architecture and future project scope	Modular and reusable functions supported possible extension of communication methods, client platforms and other system capabilities.	Architectural flexibility can facilitate subsequent changes, but extensions should still be planned and managed as additional project work.

Table 2 establishes traceability between documented engineering evidence and its retrospective project management interpretation without implying that the original development followed a formal project management methodology. It shows how specific development observations can provide structured information for subsequent project planning and management.

7. Discussion

The findings indicate that the project management relevance of multidisciplinary engineering development extends beyond the formal application of project management methods. Dependencies, emerging requirements and architectural decisions are embedded in the engineering development itself and may influence subsequent project decisions. This supports a systems-oriented interpretation in which technical components and project activities cannot be considered independently (Browning, 2001; Ulrich, 1995; Baccarini, 1996). The

present case shows how these relationships can be identified retrospectively from documented engineering evidence and translated into project management implications.

The finding that additional requirements emerged during implementation is consistent with the view of requirements engineering as an iterative process. As knowledge of the system and its operating environment develops, requirements may need to be refined or extended (Nuseibeh & Easterbrook, 2000; Nurmuliani et al., 2004; McGee & Greer, 2009; Ferreira et al., 2009). In the present case, Bluetooth connectivity emerged outside the initial project scope. From a project management perspective, such emerging requirements may affect scope, resources, integration activities and subsequent development decisions.

The emergence of additional requirements should not necessarily be interpreted as evidence of inadequate initial planning. In technology-development projects, complete knowledge of system behaviour, technical constraints and operating conditions may not be available at project initiation, and uncertainty can be reduced progressively through development and testing (Ward & Chapman, 2003; Perminova et al., 2008). Emerging requirements may therefore represent knowledge generated during development. The project management challenge is to evaluate whether such requirements are justified and how they affect project scope, resources, risks and subsequent activities (Project Management Institute, 2021; ISO, 2018; Cerezo-Narváez et al., 2020).

The distinction between prototype success and operational readiness has broader implications for technology-development projects. Achievement of the initial technical objective demonstrates feasibility under prototype conditions but does not establish readiness for deployment under different operational conditions. In the present case, the identified limitations show that project requirements may change as the intended context of use expands. This is consistent with technology-readiness concepts, which distinguish technical feasibility from validation and operation under increasingly realistic conditions (Héder, 2017; Olechowski et al., 2015; Mankins, 2009).

Security provides a particularly illustrative example. Authentication was unnecessary for demonstrating the main functionality in the controlled prototype environment but would become an important requirement in broader network-connected or industrial applications (Sicari et al., 2015; Roman et al., 2013; Boyes et al., 2018; Alaba et al., 2017). Thus, an

acceptable simplification during prototype development may become a significant requirement when the deployment context expands.

The analysis further indicates that system architecture can influence the effort associated with subsequent project changes. The original emphasis on modularity and reusable functions facilitated possible extensions without requiring complete system redesign. However, changes affecting interconnected components may still generate substantial integration effort (Browning, 2001; Ulrich, 1995). Such extensions should therefore be considered separate project activities with corresponding implications for scope and resources.

A broader implication of the case study is that integration and testing can contribute to project learning in addition to their conventional verification role (Schindler & Eppler, 2003; Williams, 2008). In this case, several limitations became apparent only after components had been integrated or the complete system was considered in possible operating environments. Information obtained during implementation and testing should therefore contribute to subsequent risk assessment, requirements analysis, scope decisions and development planning (Project Management Institute, 2021; ISO, 2018; Nuseibeh & Easterbrook, 2000; Nurmuliani et al., 2004).

The retrospective approach used in this study also has limitations. The original project was not conducted according to a formally documented project management methodology, and records such as a formal risk register, baseline schedule, resource plan or systematic change log were not available. The analysis therefore focuses on documented technical decisions, system limitations and requirements rather than reconstructing quantitative project indicators that were not recorded. In addition, because the analysis is based on a single retrospective case, the findings should be interpreted as case-specific analytical insights rather than statistically generalisable results.

Despite these limitations, the case provides a practical example of how engineering-development experience can be transformed into project management knowledge. The retrospective WBS, risk classification and analysis of emerging requirements make relationships visible that were less explicit in the original technical description. In similar multidisciplinary technology-development projects, managers should explicitly track dependencies between technical work areas and reassess requirements and risks as information emerges during integration and testing. Documenting such information can support risk management,

change control and planning of subsequent development phases (Schindler & Eppler, 2003; Williams, 2008; Kotnour, 2000).

8. Conclusions

This study presented a retrospective project management analysis of the development of an Internet-connected robotic arm. The original engineering work focused primarily on the technical implementation of the system, while the present analysis examined the same development from the perspective of project scope, work decomposition, system dependencies, risk and change management, and lessons learned.

The retrospective Work Breakdown Structure showed that the development could be organised into six interconnected work areas: robotic hardware, Raspberry Pi-based control, network communication, web-service development, client application development, and system integration and testing. Although these areas represented distinct technical activities, the successful operation of the system depended on their integration. This highlights the importance of considering dependencies and interfaces between work areas when planning multidisciplinary engineering projects.

The analysis also identified a distinction between requirements defined at the beginning of the development and those that became apparent during implementation. Bluetooth communication provides a clear example: it was not included in the original project scope but was subsequently recognised as a potentially useful alternative in environments where Internet connectivity was unavailable or restricted. Authentication, communication feedback and broader client-platform support similarly illustrate how prototype development can reveal additional requirements that become more important when a system is considered for wider deployment.

Taken together, these findings address the research questions by showing how the development can be structured in project terms, how implementation-related risks can generate additional requirements and potential scope changes, and what lessons can be derived for the planning of similar multidisciplinary engineering projects. From a project management perspective, these findings show that implementation and testing can provide information that affects not only technical design but also project scope, risk assessment and subsequent planning. Requirements and risks should therefore not be regarded as completely fixed at project initiation. In technology-development

projects, knowledge gained during implementation can support more informed decisions concerning changes and future development activities.

The study also demonstrates the value of retrospective analysis when formal project management documentation was not created during the original engineering work. A retrospective WBS and structured examination of documented technical decisions can reveal relationships between development activities, emerging requirements and project risks without assuming that formal project management practices were originally applied. At the same time, the absence of contemporaneous project records limits quantitative evaluation of schedule, resources, costs and risk exposure.

The results are based on a single engineering development project and should therefore not be interpreted as generally applicable quantitative evidence. Future work could apply the same retrospective framework to additional multidisciplinary engineering projects and compare the resulting patterns of dependencies, emerging requirements and scope changes. For similar future developments, recording risks, requirements changes and integration-related issues during implementation would also enable more detailed evaluation of their effects on project performance.

Overall, the case study indicates that the successful development of a technical prototype and the management of the project leading to that prototype are closely related but distinct perspectives. Combining engineering experience with systematic project management analysis can provide a clearer understanding of how technical decisions, system dependencies and emerging requirements influence the development process and can support the planning of subsequent project phases.

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ORGANIZACIONO PONAŠANJE ZAPOSLENIH KAO DETERMINANTA KVALITETA USLUGA

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Apstrakt

Cilj rada je da se ispita značaj ponašanja zaposlenih u formiranju percepcije korisnika o kvalitetu bankarskih usluga i utvrdi da li pojedini aspekti ponašanja zaposlenih predstavljaju značajan faktor procene kvaliteta. Istraživanje je sprovedeno na uzorku od 606 korisnika bankarskih usluga u Srbiji. Ponašanje zaposlenih operacionalizovano je kroz osam aspekata odnosa sa zaposlenima, a kvalitet usluge procenjen je kroz odnos kvaliteta i cene. Rezultati pokazuju da korisnici najpovoljnije ocenjuju ljubaznost zaposlenih, koja je u punom regresionom modelu imala statistički značajan pozitivan doprinos proceni kvaliteta usluge. Nalazi ukazuju da ponašanje zaposlenih ima značaj, ali da se kvalitet bankarske usluge formira kroz međusobno delovanje više elemenata uslužnog procesa.

Ključne reči: *ponašanje zaposlenih; kvalitet bankarskih usluga; percepcija korisnika; bankarske usluge; korisničko iskustvo*

1. Uvod

Kvalitet bankarskih usluga predstavlja važan element konkurentske sposobnosti bankarskih organizacija, jer korisnik kvalitet ne procenjuje samo na osnovu karakteristika proizvoda, već i na osnovu ukupnog iskustva tokom korišćenja usluge (Grönroos, 2000). U uslužnim organizacijama deo tog iskustva nastaje u neposrednom kontaktu zaposlenih sa korisnicima. Zaposleni su često prva i najvidljivija tačka

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kontakta korisnika sa bankom, zbog čega način komunikacije, dostupnost, ljubaznost i spremnost da se korisniku pruži pomoć mogu oblikovati njegovu percepciju banke.

Poseban značaj ima činjenica da korisnik uslugu procenjuje iz sopstvene perspektive. Ista procedura ili proizvod mogu biti ocenjeni različito u zavisnosti od toga kako je usluga pružena i kako je korisnik doživeo interakciju sa zaposlenim. U tom smislu, ponašanje zaposlenih predstavlja jedan od elemenata preko kojih se organizacioni kvalitet usluge neposredno prenosi u korisničko iskustvo, što je u literaturi o menadžmentu odnosa sa potrošačima prepoznato kao ljudski faktor CRM strategije (Greenberg & Baron, 2000).

Značaj ovog pitanja dodatno potvrđuju istraživanja koja povezuju kvalitet usluge, satisfakciju i lojalnost potrošača sa profitabilnošću uslužnih organizacija (Heskett et al., 1994; Hallowell, 1996). U bankarskom sektoru, gde su proizvodi u velikoj meri standardizovani i teško diferencirani sami po sebi, upravo se u ponašanju zaposlenih otvara prostor za diferenciranje kvaliteta usluge u odnosu na konkurenciju (Babić-Hodović, 2002).

Cilj rada je da se ispita značaj ponašanja zaposlenih u formiranju percepcije korisnika o kvalitetu bankarskih usluga, kao i da se utvrdi da li pojedini aspekti ponašanja zaposlenih predstavljaju značajan faktor procene kvaliteta usluge. Predmet analize nije samoprocena zaposlenih, već percepcija korisnika o njihovom ponašanju u neposrednom kontaktu sa bankom.

2. Ponašanje zaposlenih u uslužnim organizacijama

Zaposleni u uslužnim organizacijama imaju specifičnu ulogu jer učestvuju u procesu stvaranja i isporuke vrednosti za korisnika. U bankarskom sektoru ova uloga je posebno izražena u situacijama u kojima korisnik ostvaruje neposredan kontakt sa službenikom radi dobijanja informacija, izbora proizvoda, rešavanja problema ili obavljanja određene usluge. Ponašanje zaposlenog tada postaje deo same usluge iz perspektive korisnika.

Ponašanje zaposlenih ne obuhvata samo formalno izvršavanje zadatka. Ono uključuje način ophođenja prema korisniku, spremnost na komunikaciju, dostupnost, brzinu reagovanja, jasnoću informacija i sposobnost da se korisniku pomogne u rešavanju konkretnog problema. U bankarskom okruženju važni su i stručnost i sposobnost zaposlenog da

složene informacije o proizvodima i uslugama predstavi na razumljiv način.

Percepcija korisnika ima poseban značaj jer se ponašanje zaposlenog ne vrednuje prema nameri zaposlenog, već prema iskustvu i utisku koji nastaje kod korisnika (Greenberg & Baron, 2000). Zbog toga organizacije mogu unapređivati kvalitet usluge ne samo kroz tehničke i procesne promene, već i kroz razvoj komunikacionih i interpersonalnih kompetencija zaposlenih.

2.1. Ljudski faktor i motivacija zaposlenih u bankarskom poslovanju

Ljudski faktor predstavlja jedan od nosećih elemenata upravljanja odnosima sa potrošačima, jer se veći deo interakcije sa korisnikom bankarskih usluga ostvaruje posredstvom zaposlenog, a ne posredstvom samog proizvoda. Osoblje banke prenosi korisniku informacije o proizvodima i uslugama, ali istovremeno svojim ponašanjem gradi i utisak o pouzdanosti, profesionalizmu i pristupačnosti institucije. Determinante koje se u literaturi najčešće vezuju za kvalitet osoblja obuhvataju pouzdanost, profesionalizam, lakoću pristupa uslugama, kredibilitet i otvorenost zaposlenih, ljubaznost, kao i sposobnost razumevanja potreba korisnika (Jovin, 2011).

Stepen motivacije zaposlenih neposredno se odražava na kvalitet pružene usluge. Motivisani zaposleni ulažu više napora u obavljanje poverenih zadataka, dok nedovoljna motivacija dovodi do pada produktivnosti, opadanja pažnje prema korisniku i, posledično, do niže procene kvaliteta usluge (Boshoff & Mels, 1995). Menadžment banke stoga treba da prepozna razlike u individualnim vrednostima, osobinama i percepciji zaposlenih i da u skladu s tim prilagodi pristup njihovoj motivaciji, obuci i pripremi za rad sa korisnicima.

Konstantno investiranje u razvoj interpersonalnih i komunikacionih kompetencija osoblja predstavlja jedan od retkih elemenata kvaliteta usluge kojim banka može ostvariti diferencijaciju u odnosu na konkurenciju, s obzirom na to da su bankarski proizvodi u velikoj meri standardizovani i lako se kopiraju.

3. Ponašanje zaposlenih i kvalitet bankarskih usluga

Kvalitet bankarske usluge predstavlja složen konstrukt koji se formira kroz više elemenata (Parasuraman, Zeithaml & Berry, 1988). U neposrednoj interakciji sa zaposlenima korisnik procenjuje ne samo ishod usluge već i način na koji je do tog ishoda došao. Ljubaznost,

dostupnost i spremnost zaposlenog da posveti vreme korisniku mogu doprineti pozitivnom iskustvu, dok nejasne informacije, nedovoljna pažnja ili neadekvatna komunikacija mogu umanjiti ukupnu procenu.

U istraživačkom okviru rada ponašanje zaposlenih posmatra se kao jedan od elemenata ukupnog kvaliteta usluge. Ovakav pristup je u skladu sa činjenicom da se u bankarskim uslugama različite dimenzije kvaliteta prepliću. Korisnik može istovremeno vrednovati interpersonalni odnos, stručnost zaposlenog, efikasnost procesa, dostupnost informacija i funkcionalnost drugih kanala pružanja usluge.

3.1. Modeli kvaliteta usluga i mesto ponašanja zaposlenih

Teorijski okvir za razumevanje uloge ponašanja zaposlenih u proceni kvaliteta bankarske usluge nude modeli kvaliteta razvijeni u literaturi o marketingu usluga. Prema Grönroosovom modelu, kvalitet usluge čine tehnička dimenzija, koja se odnosi na to šta korisnik dobija kao ishod usluge, i funkcionalna dimenzija, koja se odnosi na to kako je usluga pružena (Grönroos, 1984). Ponašanje zaposlenih, uključujući brzinu, ljubaznost, sigurnost i transparentnost u komunikaciji, u ovom modelu pripada funkcionalnoj dimenziji kvaliteta i neposredno oblikuje ukupnu percepciju korisnika, nezavisno od tehničke ispravnosti same usluge.

Slično tome, SERVQUAL model Parasuramana, Zeithaml i Berryja (1985, 1988) definiše kvalitet usluge kroz pet dimenzija: pouzdanost, odgovornost, sigurnost, empatiju i opipljivost. Od navedenih dimenzija, odgovornost, sigurnost i empatija u najvećoj meri zavise od ponašanja zaposlenih, odnosno njihove spremnosti da pomognu korisniku, stručnosti i sposobnosti da grade poverenje, kao i individualizovane pažnje prema potrebama korisnika. Ove dimenzije su u velikoj meri saglasne sa aspektima ponašanja zaposlenih koji su operacionalizovani u istraživačkom delu ovog rada.

U kontekstu bankarskog sektora, empirijska istraživanja potvrđuju da ponašanje osoblja predstavlja jedan od ključnih prediktora percepcije kvaliteta i satisfakcije korisnika bankarskih usluga (Nel, Boshoff & Mels, 1992; Kang & James, 2005; Radojević & Marjanović, 2011). Kotler i Keller (2006) kvalitet definišu kao sposobnost proizvoda ili usluge da ispuni ili nadmaši očekivanja korisnika, čime se naglašava da je kvalitet u osnovi subjektivna, percepcijska kategorija, što opravdava fokus ovog istraživanja na percepciju korisnika, a ne na samoprocenu zaposlenih.

Noviji radovi potvrđuju da ponašanje zaposlenih zadržava značaj i u savremenom, sve više digitalizovanom bankarskom okruženju. Istraživanje sprovedeno na uzorku korisnika e-bankarstva pokazuje da ponašanje osoblja, uz fizičko okruženje i tehnološku dimenziju usluge, značajno utiče na percipirani rizik i vrednost usluge iz perspektive korisnika (Kim, Jindabot, Yeo & Wichianrat, 2025). Slično, istraživanje sprovedeno u tradicionalnom bankarskom poslovanju potvrđuje da ljubaznost, brzina odgovora i stručnost osoblja predstavljaju značajne prediktore satisfakcije i lojalnosti korisnika (Piyinchu, 2025).

4. Metodologija istraživanja

Predmet istraživanja je percepcija korisnika o ponašanju zaposlenih u bankarskim organizacijama i njen odnos prema proceni kvaliteta bankarskih usluga. Istraživanje je sprovedeno na uzorku od 606 korisnika bankarskih usluga u Srbiji. Podaci su prikupljani neposredno i elektronskim putem, korišćenjem *Google Forms* upitnika i distribucijom putem elektronske pošte. Upitnik je bio strukturiran, pretežno zatvorenog tipa, uz nekoliko otvorenih pitanja. Većina stavova merena je sedmostepenom Likertovom skalom, od 1 – „uopšte nisam zadovoljan" do 7 – „potpuno sam zadovoljan".

Ponašanje zaposlenih operacionalizovano je kroz osam aspekata odnosa korisnika sa zaposlenima banke: VARP1 – ljubaznost zaposlenih; VARP2 – vreme koje su im posvetili zaposleni; VARP3 – brzina i efikasnost obavljanja posla od strane zaposlenih; VARP4 – stručno znanje o ponuđenim bankarskim proizvodima i uslugama; VARP5 – jasnoća i preciznost informacija koje dobijaju; VARP6 – sposobnost predlaganja odgovarajućih rešenja za potrebe potrošača; VARP7 – lakoća komuniciranja i pristupačnost osoblja banke; VARP8 – pozitivan stav osoblja prema poslu koji obavljaju.

Kao osnovna mera kvaliteta bankarske usluge korišćena je tvrdnja P25 – „Kvalitet usluge je u skladu sa cenom proizvoda". Dodatno su posmatrane P26 – „Usluge koje se nude uz proizvode i usluge su transparentne i jasne" i P28 – „Usluge ispunjavaju vaša očekivanja", pri čemu P28 predstavlja meru zadovoljstva korisnika.

5. Rezultati istraživanja

5.1. Deskriptivni rezultati

Deskriptivni rezultati pokazuju da su svi posmatrani aspekti odnosa sa zaposlenima ocenjeni relativno povoljno. Najvišu prosečnu ocenu ima

ljubaznost zaposlenih (M=5,5231; SD=1,36617), zatim lakoća komuniciranja i pristupačnost osoblja (M=5,4175; SD=1,41502) i vreme koje su zaposleni posvetili korisnicima (M=5,4076; SD=1,38010). Najniže prosečne ocene zabeležene su za pozitivan stav osoblja prema poslu koji obavljaju (M=4,9604; SD=1,79303) i sposobnost predlaganja odgovarajućih rešenja (M=4,9802; SD=1,56921).

Tabela 1. Deskriptivni pokazatelji aspekata ponašanja zaposlenih / Table 1. Descriptive statistics of employee behavior aspects

Aspekt	M	SD
Ljubaznost zaposlenih	5,5231	1,36617
Vreme posvećeno korisniku	5,4076	1,38010
Brzina i efikasnost	5,2310	1,39281
Stručno znanje	5,2162	1,39698
Jasnoća i preciznost	5,1353	1,45279
Predlaganje rešenja	4,9802	1,56921
Komunikacija i pristupačnost	5,4175	1,41502
Pozitivan stav prema poslu	4,9604	1,79303

Izvor: Obrada podataka iz istraživanja.

5.2. Analiza razlika u procenama korisnika

Testiranje u odnosu na referentnu srednju vrednost 5,23 pokazalo je statistički značajne razlike kod ljubaznosti zaposlenih ($t=5,281$; $p<0,001$), vremena koje su zaposleni posvetili korisnicima ($t=3,168$; $p=0,002$), sposobnosti predlaganja odgovarajućih rešenja ($t=-3,919$; $p<0,001$), lakoće komunikacije i pristupačnosti osoblja ($t=3,262$; $p=0,001$) i pozitivnog stava prema poslu ($t=-3,701$; $p<0,001$). Za brzinu i efikasnost, stručno znanje i jasnoću i preciznost informacija nisu utvrđene statistički značajne razlike u odnosu na referentnu vrednost.

5.3. Faktorska struktura

Faktorska analiza pokazala je dvokomponentnu strukturu koja objašnjava ukupno 61,22667% varijanse. Prvi faktor ima karakterističnu vrednost 9,994711 i objašnjava 52,60374% varijanse, dok drugi faktor ima karakterističnu vrednost 1,638355 i objašnjava 8,62292% varijanse.

5.4. Regresiona analiza kvaliteta bankarske usluge

Regresioni model sa zavisnom varijablom P25 statistički je značajan ($F=61,10978$; $p<0,001$). Koeficijent višestruke korelacije iznosi $R=0,847880$, $R^2=0,718900$, a prilagođeni $R^2=0,707136$. Model objašnjava 71,89% varijabiliteta procene kvaliteta bankarske usluge.

Od analiziranih aspekata odnosa sa zaposlenima, ljubaznost zaposlenih pokazala je statistički značajan pozitivan doprinos proceni kvaliteta usluge ($B=0,145499$; $\beta=0,115967$; $t=2,58572$; $p=0,010028$). Za vreme posvećeno korisnicima ($p=0,709330$), brzinu i efikasnost ($p=0,161961$), stručno znanje ($p=0,581493$), jasnoću i preciznost informacija ($p=0,191610$), sposobnost predlaganja rešenja ($p=0,243623$) i lakoću komunikacije i pristupačnost ($p=0,950310$) nisu utvrđeni statistički značajni pojedinačni doprinosi. VARP8 nije uključen u dostupnu regresionu tabelu i zato se za njega ne izvodi zaključak o regresionom efektu.

5.5. *Stepwise* regresiona analiza

U završnom *stepwise* modelu nijedan od analiziranih aspekata odnosa sa zaposlenima nije zadržan kao samostalan prediktor. U završnom modelu zadržane su druge varijable, među kojima P26d, P12e, P14e i P19a, sa statistički značajnim Valdovim (*Wald)* testovima.

6. Diskusija

Rezultati istraživanja ukazuju na to da ponašanje zaposlenih predstavlja relevantan element korisničkog doživljaja bankarske usluge, ali da njegov značaj nije moguće posmatrati izolovano od drugih elemenata uslužnog procesa. Zaposleni predstavljaju neposrednu tačku kontakta između banke i korisnika, zbog čega način na koji komuniciraju, postupaju i odgovaraju na potrebe korisnika može uticati na ukupnu procenu usluge.

Najviša prosečna ocena zabeležena je za ljubaznost zaposlenih, zatim za lakoću komuniciranja i pristupačnost osoblja i vreme koje zaposleni posvećuju korisnicima. Ovi nalazi ukazuju da korisnici naročito vrednuju interpersonalni aspekt bankarske usluge. Nasuprot tome, nešto niže ocene odnose se na pozitivan stav osoblja prema poslu i sposobnost predlaganja odgovarajućih rešenja. To ne znači izrazito nezadovoljstvo, već relativno slabiju procenu ovih aspekata.

Posebno je značajan rezultat regresione analize. Model objašnjava 71,89% varijabiliteta procene kvaliteta usluge. Od osam posmatranih

aspekata odnosa sa zaposlenima, u punom regresionom modelu statistički značajan pozitivan doprinos imala je ljubaznost zaposlenih. To znači da, uz kontrolu ostalih uključenih varijabli, viša procena ljubaznosti prati višu procenu kvaliteta bankarske usluge.

Za ostale analizirane aspekte nije potvrđen statistički značajan pojedinačni doprinos. To ne znači da oni nisu važni korisnicima. Njihove relativno visoke prosečne ocene pokazuju da ih korisnici vrednuju, ali kada se posmatraju istovremeno sa drugim faktorima, njihov samostalni doprinos proceni kvaliteta nije statistički potvrđen.

Ovi nalazi u velikoj meri odgovaraju teorijskom razlikovanju tehničke i funkcionalne dimenzije kvaliteta usluge: ponašanje zaposlenih pripada funkcionalnoj, interpersonalnoj dimenziji, dok se osnovna mera kvaliteta korišćena u ovom istraživanju (odnos kvaliteta i cene) u većoj meri oslanja na tehničku dimenziju usluge (Grönroos, 1984). *Stepwise* regresiona analiza dodatno pokazuje da nijedan od aspekata odnosa sa zaposlenima nije ostao kao samostalan prediktor u završnom modelu. Ovaj nalaz pokazuje da ponašanje zaposlenih ne treba predstavljati kao jedini niti dominantni faktor kvaliteta bankarske usluge. Njegova uloga se ostvaruje u neposrednoj interakciji sa korisnikom, dok se konačna procena kvaliteta formira kroz kombinaciju više elemenata usluge, u skladu sa nalazima da se lanac satisfakcija–lojalnost–profitabilnost u uslužnim organizacijama gradi kroz kombinovano delovanje više faktora (Heskett et al., 1994; Hallowell, 1996). Ovakvo tumačenje podupiru i noviji radovi u multikanalnom bankarstvu, prema kojima kvalitet usluge na lojalnost korisnika deluje pretežno posredno, preko satisfakcije, a ne direktno i izolovano od drugih elemenata korisničkog iskustva (Mugova, Kiliswa & Mashizha, 2025; Chikazhe, Makanyeza & Chigunhah, 2021).

Za bankarsku praksu rezultati ukazuju da ulaganje u stručnost zaposlenih i efikasnost procesa jeste potrebno, ali da tehnička kompetentnost sama po sebi nije dovoljna za stvaranje pozitivnog korisničkog iskustva. Obuka zaposlenih trebalo bi da obuhvati i interpersonalne veštine, komunikaciju i način reagovanja u različitim situacijama. Nešto niža procena sposobnosti predlaganja odgovarajućih rešenja ukazuje i na prostor za unapređenje savetodavne uloge zaposlenih.

U celini, istraživanje pokazuje da korisnici bankarskih usluga ponašanje zaposlenih uglavnom ocenjuju pozitivno, ali da se pojedini aspekti razlikuju po intenzitetu i po njihovom doprinosu ukupnoj proceni kvaliteta. Najizraženija je pozitivna percepcija ljubaznosti zaposlenih, a upravo je ovaj aspekt pokazao i statistički značajan pozitivan doprinos kvalitetu bankarske usluge u punom regresionom modelu. Istovremeno,

izostanak aspekata ponašanja zaposlenih iz završnog stepwise modela pokazuje da kvalitet bankarske usluge predstavlja složen konstrukt.

7. Zaključak

Istraživanje potvrđuje da korisnici bankarskih usluga u Srbiji relativno povoljno ocenjuju ponašanje zaposlenih. Najbolje je ocenjena ljubaznost zaposlenih, dok su nešto niže ocenjeni pozitivan stav prema poslu i sposobnost predlaganja odgovarajućih rešenja. Regresiona analiza pokazala je da ljubaznost zaposlenih ima statistički značajan pozitivan doprinos proceni kvaliteta bankarske usluge, dok ostali analizirani aspekti nisu pokazali samostalan statistički značajan doprinos u punom modelu.

Istovremeno, *stepwise* analiza ukazuje da nijedan od aspekata odnosa sa zaposlenima nije zadržan u završnom modelu. Zbog toga se može zaključiti da ponašanje zaposlenih jeste važan deo korisničkog iskustva, ali da kvalitet bankarske usluge nije moguće objasniti samo ponašanjem zaposlenih. Za praksu banaka to znači da unapređenje kvaliteta treba da obuhvati istovremeno razvoj zaposlenih, unapređenje komunikacije, procesa, informacija i drugih elemenata usluge.

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ORGANIZATIONAL BEHAVIOR OF EMPLOYEES AS A DETERMINANT OF SERVICE QUALITY

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Abstract

The aim of this paper is to examine the importance of employee behavior in shaping customers' perceptions of banking service quality and to determine whether particular aspects of employee behavior represent significant factors in service-quality assessment. The research was conducted on a sample of 606 banking-service users in Serbia. Employee behavior was operationalized through eight aspects of customer relationships with bank employees, while service quality was assessed through the relationship between service quality and product price. The results show that customers rated employee friendliness most favorably, and friendliness had a statistically significant positive contribution to perceived service quality in the full regression model. The findings indicate that employee behavior matters, but banking service quality is formed through the interaction of several service-process elements.

Keywords: *employee behavior; banking service quality; customer perception; banking services; customer experience*

1. Introduction

Banking service quality represents an important element of banks' competitive capacity, since customers do not evaluate quality solely on the basis of product characteristics, but also on the basis of their overall experience while using the service (Grönroos, 2000). In service organizations, part of this experience arises from direct contact between employees and customers. Employees are often the first and most visible point of contact between the customer and the bank, which is why the way they communicate, their availability, courtesy, and willingness to help can shape the customer's perception of the bank.

Of particular importance is the fact that the customer evaluates the service from his or her own perspective. The same procedure or product

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may be rated differently depending on how the service was delivered and how the customer experienced the interaction with the employee. In this sense, employee behavior represents one of the elements through which organizational service quality is directly translated into customer experience, which in the customer relationship management literature is recognized as the human factor of the CRM strategy (Greenberg & Baron, 2000).

The importance of this issue is further confirmed by research linking service quality, customer satisfaction, and loyalty to the profitability of service organizations (Heskett et al., 1994; Hallowell, 1996). In the banking sector, where products are largely standardized and difficult to differentiate in themselves, it is precisely in employee behavior that room opens up for differentiating service quality from competitors (Babić-Hodović, 2002).

The aim of the paper is to examine the importance of employee behavior in shaping customers' perceptions of banking service quality, as well as to determine whether particular aspects of employee behavior represent a significant factor in the assessment of service quality. The subject of the analysis is not employees' self-assessment, but rather customers' perception of their behavior in direct contact with the bank.

2. Employee Behavior in Service Organizations

Employees in service organizations have a specific role because they participate in the process of creating and delivering value for the customer. In the banking sector this role is particularly pronounced in situations where the customer has direct contact with a bank officer in order to obtain information, choose a product, resolve a problem, or complete a particular service. The employee's behavior then becomes part of the service itself, from the customer's perspective.

Employee behavior does not consist merely of the formal execution of tasks. It includes the manner of treating the customer, willingness to communicate, availability, speed of response, clarity of information, and the ability to help the customer resolve a specific problem. In the banking environment, the employee's expertise and ability to present complex information about products and services in an understandable way are also important.

Customer perception is of particular importance because employee behavior is not evaluated according to the employee's intention, but according to the experience and impression it creates in the customer

(Greenberg & Baron, 2000). For this reason, organizations can improve service quality not only through technical and process changes, but also through the development of employees' communication and interpersonal competencies.

2.1. Human Factor and Employee Motivation in Banking

The human factor represents one of the pillars of customer relationship management, since most of the interaction with the banking service user takes place through the employee rather than through the product itself. Bank staff convey information about products and services to the customer, but at the same time, through their behavior, they build an impression of the institution's reliability, professionalism, and accessibility. The determinants most frequently associated with staff quality in the literature include reliability, professionalism, ease of access to services, staff credibility and openness, courtesy, and the ability to understand customer needs (Jovin, 2011).

The degree of employee motivation is directly reflected in the quality of the service provided. Motivated employees invest more effort in performing their assigned tasks, while insufficient motivation leads to a decline in productivity, reduced attention to the customer, and consequently a lower assessment of service quality (Boshoff & Mels, 1995). Bank management should therefore recognize differences in employees' individual values, traits, and perceptions, and adjust its approach to their motivation, training, and preparation for customer-facing work accordingly.

Continuous investment in developing staff's interpersonal and communication competencies represents one of the few elements of service quality through which a bank can achieve differentiation from its competitors, given that banking products are largely standardized and easily replicated.

3. Employee Behavior and Banking Service Quality

Banking service quality represents a complex construct formed through multiple elements (Parasuraman, Zeithaml & Berry, 1988). In direct interaction with employees, the customer evaluates not only the outcome of the service but also the manner in which that outcome was reached. Courtesy, availability, and the employee's willingness to devote time to the customer can contribute to a positive experience, whereas unclear information, insufficient attention, or inadequate communication can diminish the overall assessment.

Within the research framework of this paper, employee behavior is treated as one of the elements of overall service quality. This approach is consistent with the fact that different dimensions of quality intertwine in banking services. The customer may simultaneously evaluate the interpersonal relationship, the employee's expertise, process efficiency, the availability of information, and the functionality of other service delivery channels.

3.1. Service Quality Models and the Role of Employee Behavior

The theoretical framework for understanding the role of employee behavior in the assessment of banking service quality is offered by quality models developed in the services marketing literature. According to Grönroos's model, service quality consists of a technical dimension, referring to what the customer receives as the outcome of the service, and a functional dimension, referring to how the service is delivered (Grönroos, 1984). Employee behavior, including speed, courtesy, security, and transparency in communication, belongs in this model to the functional dimension of quality and directly shapes the customer's overall perception, independent of the technical correctness of the service itself.

Similarly, the SERVQUAL model of Parasuraman, Zeithaml, and Berry (1985, 1988) defines service quality through five dimensions: reliability, responsiveness, assurance, empathy, and tangibles. Of these dimensions, responsiveness, assurance, and empathy depend to the greatest extent on employee behavior — that is, on employees' willingness to help the customer, their competence and ability to build trust, and their individualized attention to customer needs. These dimensions largely correspond to the aspects of employee behavior operationalized in the empirical part of this paper.

In the context of the banking sector, empirical research confirms that staff behavior represents one of the key predictors of perceived quality and customer satisfaction with banking services (Nel, Boshoff & Mels, 1992; Kang & James, 2005; Radojević & Marjanović, 2011). Kotler and Keller (2006) define quality as the ability of a product or service to meet or exceed customer expectations, thereby emphasizing that quality is fundamentally a subjective, perceptual category — which justifies this study's focus on customer perception rather than on employees' self-assessment.

Recent studies confirm that employee behavior retains its importance even in today's increasingly digitalized banking environment. Research

conducted among e-banking users shows that staff behavior, together with the physical environment and the technological dimension of the service, significantly affects perceived risk and perceived value from the customer's perspective (Kim, Jindabot, Yeo & Wichianrat, 2025). Similarly, research conducted in traditional banking confirms that staff courtesy, response speed, and expertise are significant predictors of customer satisfaction and loyalty (Piyinchu, 2025).

4. Research Methodology

The subject of the research is customer perception of employee behavior in banking organizations and its relationship to the assessment of banking service quality. The study was conducted on a sample of 606 banking service users in Serbia. Data were collected both directly and electronically, using a Google Forms questionnaire distributed by e-mail. The questionnaire was structured, predominantly of the closed-ended type, with a few open-ended questions. Most items were measured on a seven-point Likert scale, ranging from 1 – "not at all satisfied" to 7 – "completely satisfied."

Employee behavior was operationalized through eight aspects of the customer's relationship with bank employees: VARP1 – employee courtesy; VARP2 – time devoted to the customer by employees; VARP3 – speed and efficiency of task performance by employees; VARP4 – expert knowledge of the banking products and services offered; VARP5 – clarity and precision of the information received; VARP6 – ability to propose appropriate solutions to customer needs; VARP7 – ease of communication and accessibility of bank staff; VARP8 – staff's positive attitude toward their work.

As the basic measure of banking service quality, the statement P25 – "The quality of the service is in line with the price of the product" was used. Additionally, P26 – "The services offered together with the products are transparent and clear" and P28 – "The services meet your expectations" were examined, with P28 representing the measure of customer satisfaction.

5. Research Results

5.1. Descriptive Results

Descriptive results show that all observed aspects of the relationship with employees were rated relatively favorably. The highest average rating was given to employee courtesy (M=5.5231; SD=1.36617),

followed by ease of communication and staff accessibility (M=5.4175; SD=1.41502) and time devoted to customers by employees (M=5.4076; SD=1.38010). The lowest average ratings were recorded for staff's positive attitude toward their work (M=4.9604; SD=1.79303) and the ability to propose appropriate solutions (M=4.9802; SD=1.56921).

Table 1. Descriptive statistics of employee behavior aspects

Aspect	M	SD
Employee courtesy	5.5231	1.36617
Time devoted to customer	5.4076	1.38010
Speed and efficiency	5.2310	1.39281
Expert knowledge	5.2162	1.39698
Clarity and precision	5.1353	1.45279
Proposing solutions	4.9802	1.56921
Communication and accessibility	5.4175	1.41502
Positive attitude toward work	4.9604	1.79303

Source: research data processing.

5.2.. Analysis of Differences in Customer Ratings

Testing against the reference mean value of 5.23 showed statistically significant differences for employee courtesy ($t=5.281$; $p<0.001$), time devoted to customers by employees ($t=3.168$; $p=0.002$), the ability to propose appropriate solutions ($t=-3.919$; $p<0.001$), ease of communication and staff accessibility ($t=3.262$; $p=0.001$), and positive attitude toward work ($t=-3.701$; $p<0.001$). No statistically significant differences from the reference value were found for speed and efficiency, expert knowledge, or clarity and precision of information.

5.3. Factor Structure

Factor analysis revealed a two-component structure explaining a total of 61.22667% of variance. The first factor has an eigenvalue of 9.994711 and explains 52.60374% of variance, while the second factor has an eigenvalue of 1.638355 and explains 8.62292% of variance.

5.4. Regression Analysis of Banking Service Quality

The regression model with P25 as the dependent variable was statistically significant ($F=61.10978$; $p<0.001$). The multiple correlation coefficient is $R=0.847880$, $R^2=0.718900$, and the adjusted $R^2=0.707136$. The model explains 71.89% of the variance in the assessment of banking service quality.

Among the analyzed aspects of employee relationships, employee courtesy showed a statistically significant positive contribution to the assessment of service quality ($B=0.145499$; $\beta=0.115967$; $t=2.58572$; $p=0.010028$). No statistically significant individual contributions were found for time devoted to customers ($p=0.709330$), speed and efficiency ($p=0.161961$), expert knowledge ($p=0.581493$), clarity and precision of information ($p=0.191610$), the ability to propose solutions ($p=0.243623$), or ease of communication and accessibility ($p=0.950310$). VARP8 was not included in the available regression table, and therefore no conclusion regarding its regression effect can be drawn.

5.5. Stepwise Regression Analysis

In the final stepwise model, none of the analyzed aspects of the employee relationship was retained as an independent predictor. Other variables were retained in the final model, including P26d, P12e, P14e, and P19a, with statistically significant Wald tests.

6. Discussion

The research results indicate that employee behavior represents a relevant element of the customer's experience of the banking service, although its importance cannot be observed in isolation from other elements of the service process. Employees represent the direct point of contact between the bank and the customer, which is why the manner in which they communicate, act, and respond to customer needs can influence the overall assessment of the service.

The highest average rating was recorded for employee courtesy, followed by ease of communication and staff accessibility, and the time employees devote to customers. These findings indicate that customers particularly value the interpersonal aspect of the banking service. In contrast, somewhat lower ratings relate to staff's positive attitude toward their work and their ability to propose appropriate solutions. This does not indicate pronounced dissatisfaction, but rather a relatively weaker assessment of these aspects.

The result of the regression analysis is particularly significant. The model explains 71.89% of the variability in the assessment of service quality. Among the eight observed aspects of employee relationships, employee courtesy was the only one to show a statistically significant positive contribution in the full regression model. This means that, controlling for the other variables included, a higher rating of courtesy is associated with a higher rating of banking service quality.

For the other analyzed aspects, no statistically significant individual contribution was confirmed. This does not mean that they are unimportant to customers. Their relatively high average ratings show that customers value them, but when considered simultaneously with other factors, their independent contribution to the assessment of quality is not statistically confirmed.

These findings largely correspond to the theoretical distinction between the technical and functional dimensions of service quality: employee behavior belongs to the functional, interpersonal dimension, while the basic measure of quality used in this study (the quality–price relationship) relies to a greater extent on the technical dimension of the service (Grönroos, 1984). The stepwise regression analysis further shows that none of the aspects of the employee relationship remained as an independent predictor in the final model. This finding shows that employee behavior should not be presented as the sole or dominant factor of banking service quality. Its role is realized in direct interaction with the customer, while the final assessment of quality is formed through a combination of several service elements, consistent with findings that the satisfaction–loyalty–profitability chain in service organizations is built through the combined action of multiple factors (Heskett et al., 1994; Hallowell, 1996). This interpretation is further supported by recent studies in multi-channel banking, according to which service quality affects customer loyalty predominantly indirectly, through satisfaction, rather than directly and in isolation from other elements of the customer experience (Mugova, Kiliswa & Mashizha, 2025; Chikazhe, Makanyeza & Chigunhah, 2021).

For banking practice, the results indicate that investment in employee expertise and process efficiency is necessary, but that technical competence alone is not sufficient to create a positive customer experience. Employee training should also encompass interpersonal skills, communication, and the manner of responding in various situations. The somewhat lower assessment of the ability to propose

appropriate solutions also points to room for improving employees' advisory role.

Overall, the research shows that banking service users generally rate employee behavior positively, although individual aspects differ in intensity and in their contribution to the overall assessment of quality. The most pronounced positive perception concerns employee courtesy, and it is precisely this aspect that showed a statistically significant positive contribution to banking service quality in the full regression model. At the same time, the absence of employee behavior aspects from the final stepwise model shows that banking service quality represents a complex construct.

7. Conclusion

The research confirms that banking service users in Serbia rate employee behavior relatively favorably. Employee courtesy received the highest rating, while a somewhat lower rating was given to staff's positive attitude toward their work and their ability to propose appropriate solutions. Regression analysis showed that employee courtesy has a statistically significant positive contribution to the assessment of banking service quality, while the other analyzed aspects did not show an independent statistically significant contribution in the full model.

At the same time, the stepwise analysis indicates that none of the aspects of the employee relationship was retained in the final model. It can therefore be concluded that employee behavior is an important part of the customer experience, but that banking service quality cannot be explained by employee behavior alone. For banking practice, this means that improving quality should simultaneously encompass employee development, and the improvement of communication, processes, information, and other service elements.

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INOVACIJE NASTAVNIKA, VEŠTAČKA INTELIGENCIJA I ODRŽIVI RAZVOJ U SREDNJEM OBRAZOVANJU

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Apstrakt

Digitalna transformacija postala je ključna komponenta savremenog obrazovanja, utičući na kvalitet nastave i ostvarivanje Ciljeva održivog razvoja (COR). Nastavnici imaju centralnu ulogu u integrisanju digitalnih tehnologija i veštačke inteligencije (VI) u nastavne prakse i prakse ocenjivanja. Međutim, empirijski dokazi o spremnosti nastavnika da prihvate VI u srednjem obrazovanju i dalje su ograničeni.

Ova studija ispituje stavove nastavnika srednjih škola prema digitalnim tehnologijama, upotrebi VI u obrazovanju, digitalnim kompetencijama i percepcijama digitalizacije u odnosu na održivi razvoj. Kvantitativno istraživanje sprovedeno je na 31 nastavniku srednje škole.

Rezultati pokazuju visok nivo prihvatanja digitalnih tehnologija u nastavnoj praksi i generalno pozitivne stavove prema njihovoj obrazovnoj vrednosti. Međutim, postoji jasan jaz između široke upotrebe digitalnih alata i ograničene primene VI u učionici. Nastavnici prepoznaju potencijal VI za poboljšanje ishoda učenja, ali je njena primena i dalje niska. Ispitanici takođe snažno percipiraju digitalizaciju kao mehanizam za unapređenje kvaliteta, efikasnosti i dostupnosti obrazovanja, naročito u odnosu na COR 4 – Kvalitetno obrazovanje.

Ovi nalazi pružaju uvide za obrazovnu politiku i stručno usavršavanje nastavnika usmereno na digitalne kompetencije i kompetencije u oblasti VI.

Ključne reči: *digitalna transformacija, veštačka inteligencija, nastavnici, digitalne kompetencije, srednje obrazovanje, COR 4*

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1. Uvod

Digitalna transformacija obrazovanja predstavlja jedan od ključnih pravaca savremenih obrazovnih reformi, sa ciljem unapređenja kvaliteta nastave, povećanja pristupa obrazovanju i usklađivanja obrazovnih sistema sa zahtevima digitalnog društva. U okviru ovog procesa, digitalne tehnologije i alati zasnovani na veštačkoj inteligenciji (VI) sve više se integrišu u obrazovnu praksu, menjajući tradicionalne pristupe nastavi i učenju.

Savremena istraživanja ukazuju da integracija digitalnih tehnologija u nastavu doprinosi razvoju kompetencija učenika, povećava efikasnost nastave i unapređuje procese ocenjivanja (Stošić & Mikhailova, 2023). Prethodne studije pokazale su da veštačka inteligencija omogućava personalizovano učenje, automatizuje administrativne zadatke i podržava nastavnike u donošenju pedagoških odluka (Holmes et al., 2019; Zawacki-Richter et al., 2019). Novija istraživanja ističu da generativni alati VI dodatno proširuju mogućnosti nastavnika olakšavajući izradu nastavnih materijala, adaptivno planiranje časova i unapređenje procesa ocenjivanja učenika (Tlili A. et al., 2023).

U ovom kontekstu, nastavnici zauzimaju centralnu ulogu u digitalnoj transformaciji obrazovanja. Njihove digitalne kompetencije, stavovi prema tehnologiji i spremnost za prihvatanje inovacija direktno utiču na kvalitet i uspešnu primenu digitalnih alata u obrazovnoj praksi. Kontinuirano stručno usavršavanje se stoga smatra neophodnim, jer razvoj digitalnih kompetencija predstavlja preduslov za efikasnu upotrebu savremenih tehnologija, uključujući sisteme zasnovane na VI (Mandić et al., 2025; Gajić et al., 2024).

Pored pedagoškog značaja, digitalna transformacija obrazovanja ima šire društvene i razvojne implikacije. Ona je usko povezana sa ostvarivanjem Cilja održivog razvoja 4 (COR 4 – Kvalitetno obrazovanje), koji promoviše inkluzivno, pravedno i kvalitetno obrazovanje za sve. Digitalne inovacije doprinose većoj dostupnosti obrazovanja, efikasnijem korišćenju resursa i boljim ishodima učenja, čime dodatno potvrđuju svoj strateški značaj u savremenim obrazovnim politikama (UNESCO, 2023).

Poslednjih godina, naročito sa pojavom generativne veštačke inteligencije zasnovane na velikim jezičkim modelima, otvorena su nova pitanja u vezi sa ulogom nastavnika, etičkom upotrebom VI u obrazovanju i potrebom razvoja pismenosti u oblasti VI. Istraživanja ukazuju na to da nastavnici uglavnom prepoznaju potencijal alata VI da

unaprede nastavu i učenje; međutim, izražavaju i zabrinutost u vezi sa njihovom pouzdanošću, etičkom primenom i mogućim uticajem na pedagošku interakciju (Kasneci, E. et al., 2023; Trifunović et al., 2026; Damnjanović, 2026).

Uprkos sve većoj dostupnosti digitalnih alata, spremnost nastavnika da ih primenjuju i dalje se znatno razlikuje, što ukazuje na potrebu za sistematskim pristupom razvoju digitalnih kompetencija u obrazovnim sistemima. Poseban izazov predstavlja razumevanje i integrisanje veštačke inteligencije u svakodnevnu nastavnu praksu uz očuvanje kvaliteta obrazovanja i pedagoške autonomije nastavnika. U Republici Srbiji, proces digitalne transformacije u obrazovanju intenziviran je uvođenjem nacionalnih digitalnih platformi, elektronskih udžbenika i različitih programa stručnog usavršavanja nastavnika (Dašić et al., 2024; Kostić, 2023; Budimir, 2024; Babić, et al., 2024; Savić et al., 2025). Ipak, primena savremenih alata VI još uvek nije sistematski regulisana, što dovodi do značajnih razlika među nastavnicima u pogledu digitalnih kompetencija, spremnosti za korišćenje generativne veštačke inteligencije i percepcije njenog doprinosa nastavnom procesu. Shodno tome, postoji jasna potreba za empirijskim istraživanjima koja ispituju stavove nastavnika prema primeni digitalnih inovacija i tehnologija VI u srednjem obrazovanju.

Na osnovu navedenog, ova studija ispituje stavove nastavnika srednjih škola u Srbiji prema primeni digitalnih inovacija, upotrebi veštačke inteligencije u obrazovanju i njihovoj ulozi u ostvarivanju Ciljeva održivog razvoja, sa posebnim naglaskom na COR 4.

Cilj ove studije je da ispita stavove nastavnika srednjih škola prema upotrebi digitalnih tehnologija i alata zasnovanih na veštačkoj inteligenciji u nastavnom procesu, kao i da proceni njihov doprinos unapređenju kvaliteta obrazovanja i ostvarivanju Cilja održivog razvoja 4 (COR 4).

Na osnovu definisanog cilja istraživanja, formulisana je sledeća hipoteza:

H1: Nastavnici srednjih škola imaju pozitivne stavove prema upotrebi digitalnih tehnologija i smatraju da one doprinose unapređenju kvaliteta nastave i ostvarivanju Ciljeva održivog razvoja, dok praktična primena alata VI u nastavi ostaje ograničena.

2. Metodologija istraživanja

U ovoj studiji primenjen je kvantitativni istraživački pristup radi ispitivanja stavova nastavnika srednjih škola prema digitalnoj transformaciji obrazovanja, upotrebi veštačke inteligencije u nastavi i doprinosu digitalnih tehnologija ostvarivanju Ciljeva održivog razvoja (COR). Kvantitativni pristup izabran je zato što omogućava sistematsko merenje stavova i percepcija ispitanika, kao i utvrđivanje opštih obrazaca u njihovim odgovorima (Creswell & Creswell, 2018).

Istraživanje je sprovedeno na uzorku od 31 nastavnika srednjih škola zaposlenih u Srbiji. Uzorak je obuhvatio nastavnike različitih starosnih grupa i različitog nivoa profesionalnog iskustva, pružajući uvid u potencijalne razlike u stavovima povezanim sa nastavnim iskustvom i izloženošću digitalnim tehnologijama.

Podaci su prikupljeni pomoću strukturisanog upitnika izrađenog u *Google Forms*-u. Učešće je bilo dobrovoljno i anonimno, a svi ispitanici bili su obavešteni o svrsi istraživanja i isključivoj upotrebi prikupljenih podataka u naučnoistraživačke svrhe. Istraživački instrument razvijen je na osnovu prethodnih studija koje se bave digitalnim kompetencijama nastavnika i integracijom tehnologije u obrazovanje (Redecker, 2017; Lucas et al., 2021).

Upitnik se sastojao iz dva dela. U prvom delu prikupljani su demografski podaci, uključujući starost ispitanika i godine nastavnog iskustva. Drugi deo bio je usmeren na stavove nastavnika prema upotrebi digitalnih tehnologija, platformi za učenje i veštačke inteligencije u obrazovanju, kao i na njihove percepcije doprinosa ovih tehnologija kvalitetu nastave i održivom razvoju. Ispitanici su označavali nivo slaganja sa svakom tvrdnjom koristeći Likertovu skalu od pet stepeni, gde je 1 označavalo „uopšte se ne slažem“, a 5 „u potpunosti se slažem“. Stavke upitnika osmišljene su na osnovu modela prihvatanja tehnologije, koji naglašavaju percipiranu korisnost i percipiranu lakoću upotrebe kao ključne odrednice prihvatanja tehnologije (Davis, 1989).

Upitnik je sadržao tvrdnje koje se odnose na učestalost korišćenja digitalnih alata u nastavi, percepcije nastavnika o njihovom uticaju na kvalitet nastave, upotrebu sistema za upravljanje učenjem kao što su *Google Classroom* i *Moodle*, doprinos digitalnih nastavnih materijala poboljšanju pristupa učenika obrazovnim resursima, angažovanje učenika pri korišćenju digitalnih tehnologija i upotrebu alata veštačke inteligencije, uključujući *ChatGPT*, *Gemini* i *Copilot*, u pripremi nastavnih materijala.

Pored toga, studija je ispitala percepcije nastavnika o uticaju digitalnih kompetencija na njihov profesionalni razvoj, kao i njihove stavove o doprinosu digitalnih tehnologija dostupnosti i inkluzivnosti obrazovanja. Upitnik je takođe sadržao tvrdnju kojom su procenjivane percepcije ispitanika o nivou digitalne transformacije u školama u kojima su zaposleni.

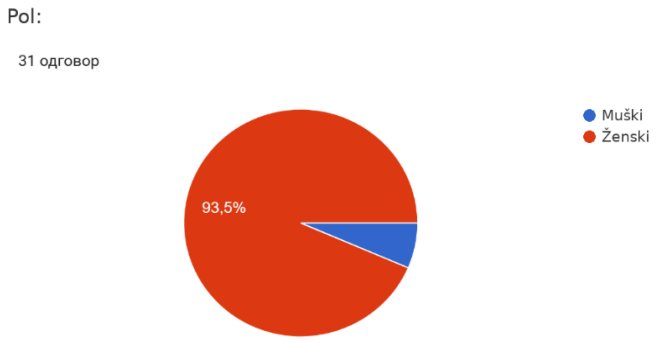
Teorijski okvir studije zasniva se na konceptu digitalnih kompetencija nastavnika, naglašavajući njihovu ključnu ulogu u savremenom obrazovanju i značaj kontinuiranog stručnog usavršavanja (Redecker, 2017). Pored toga, istraživanje je usklađeno sa okvirom Ciljeva održivog razvoja Ujedinjenih nacija, naročito sa COR 4 (Kvalitetno obrazovanje), koji zagovara inkluzivno, pravedno i visokokvalitetno obrazovanje za sve (UNESCO, 2023).

Prikupljeni podaci analizirani su primenom deskriptivnih statističkih metoda. Izračunate su frekvencije i procenti radi sažimanja odgovora ispitanika, dok su nalazi grafički prikazani u narednom odeljku kako bi se pružio jasan pregled raspodele stavova nastavnika.

3. Rezultati istraživanja

Ovaj odeljak prikazuje rezultate deskriptivne statističke analize zasnovane na odgovorima 31 nastavnika zaposlenog u Ekonomskoj školi „Nada Dimić“ u Zemunu, Srbija. Nalazi su predstavljeni kroz grafičke prikaze praćene tekstualnim tumačenjem kako bi se pružio jasan pregled strukture uzorka i ključnih demografskih karakteristika ispitanika.

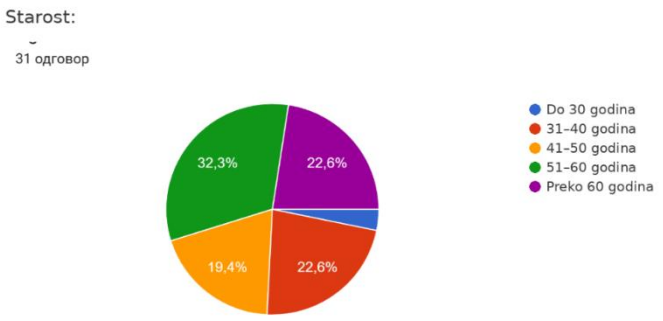
Slika 1. Polna struktura



Izvor: Pripremila autorka na osnovu podataka iz ankete

Slika 1 prikazuje polnu strukturu ispitanika. Većinu učesnika činile su žene, odnosno 29 nastavnica (93,5%), dok su samo 2 ispitanika (6,5%) bila muškarci. Ovi nalazi ukazuju na izraženu zastupljenost žena među nastavnicima u uzorku, što je u skladu sa opštom polnom strukturom nastavničke profesije, u kojoj su žene znatno zastupljenije od muškaraca.

Slika 2. Starosna struktura

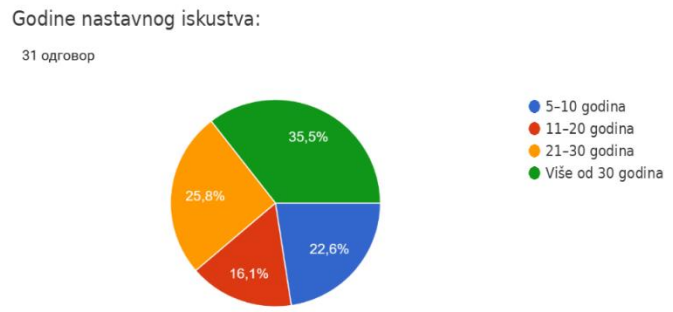


Izvor: Pripremila autorka na osnovu podataka iz ankete

Slika 2 prikazuje starosnu strukturu ispitanika. Analiza ukazuje da je uzorak heterogen u pogledu starosti. Najveći udeo ispitanika pripadao je starosnoj grupi od 51 do 60 godina (10 nastavnika, 32,3%). Dve starosne grupe bile su podjednako zastupljene: nastavnici stariji od 60 godina (7 ispitanika, 22,6%) i oni između 31 i 40 godina (7 ispitanika, 22,6%). Starosna grupa od 41 do 50 godina obuhvatila je 6 ispitanika (19,4%), dok je grupa mlađih od 30 godina bila najmanje zastupljena, sa samo jednim ispitanikom (3,2%).

Ovakva starosna struktura ukazuje da je uzorak pretežno bio sastavljen od nastavnika srednjih i starijih godina, što je naročito relevantno za tumačenje nalaza u odnosu na digitalne kompetencije i spremnost nastavnika da prihvate i primenjuju savremene obrazovne tehnologije.

Slika 3. Godine iskustva nastavnika



Izvor: Pripremila autorka na osnovu podataka iz ankete

U trećem segmentu rezultata prikazana je struktura ispitanika prema godinama nastavnog iskustva. Analiza ukazuje na to da su ispitanici raspoređeni u četiri kategorije iskustva, pri čemu najzastupljeniju grupu čine nastavnici sa više od 30 godina profesionalnog iskustva, ukupno 11 ispitanika (35,5%). Ova kategorija odražava značajan udeo nastavnika sa dugogodišnjim profesionalnim iskustvom, što može značajno uticati na njihove stavove prema digitalnoj transformaciji i primeni savremenih tehnologija u obrazovanju. Nastavnici sa 21 do 30 godina iskustva predstavljaju drugu najveću grupu, sa 8 ispitanika (25,8%). Slede nastavnici sa 5 do 10 godina iskustva, ukupno 7 ispitanika (22,6%), dok najmanje zastupljenu grupu čine nastavnici sa 11 do 20 godina iskustva, sa 5 ispitanika (16,1%).

Takva struktura uzorka ukazuje da studija obuhvata nastavnike sa različitim nivoima profesionalnog iskustva, uz dominaciju onih koji su u obrazovnom sistemu angažovani više od 20 godina. Ova raspodela je posebno važna za tumačenje rezultata, jer godine profesionalnog iskustva mogu uticati na nivo prihvatanja digitalnih alata, spremnost za primenu veštačke inteligencije u nastavi, kao i na percepciju značaja digitalnih kompetencija u savremenom obrazovanju.

Slika 4. Učestalost korišćenja digitalnih alata

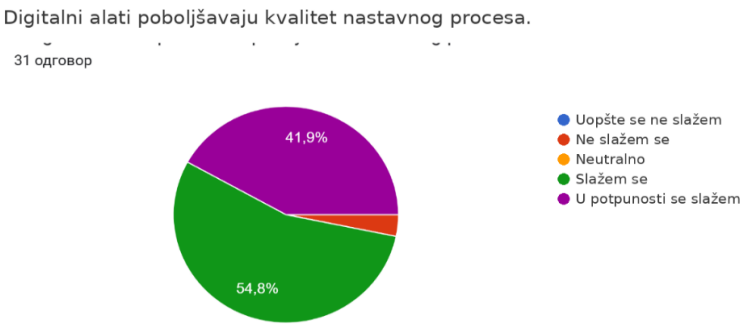


Izvor: Pripremila autorka na osnovu podataka iz ankete

Slika 4 prikazuje raspodelu odgovora na tvrdnju „Redovno koristim digitalne alate u svojim nastavnim aktivnostima“, koja se odnosi na učestalost korišćenja digitalnih alata u nastavnoj praksi. Rezultati ukazuju na izrazito pozitivan stav nastavnika prema upotrebi digitalnih tehnologija u obrazovanju. Od ukupno 31 ispitanika, 8 nastavnika (25,8%) izabralo je „u potpunosti se slažem“, dok je 20 ispitanika (64,5%) navelo da se „slaže“ sa tvrdnjom. Samo 3 ispitanika (9,7%) navela su da se „ne slažu“, dok nijedan ispitanik nije izabrao „uopšte se ne slažem“.

Ovi nalazi ukazuju na to da velika većina nastavnika redovno koristi digitalne alate u svojoj nastavnoj praksi, potvrđujući visok nivo prihvatanja digitalnih tehnologija u obrazovnom procesu. Istovremeno, mali udeo negativnih odgovora može ukazivati na postojanje određenih ograničenja, kao što su nedovoljna obuka, tehnička ograničenja ili individualne razlike u digitalnim kompetencijama. Sveukupno, rezultati ukazuju da su digitalni alati postali sastavni deo svakodnevne nastavne prakse, a ne samo povremena podrška tradicionalnim nastavnim metodama.

Slika 5. Kvalitet korišćenja digitalnih alata

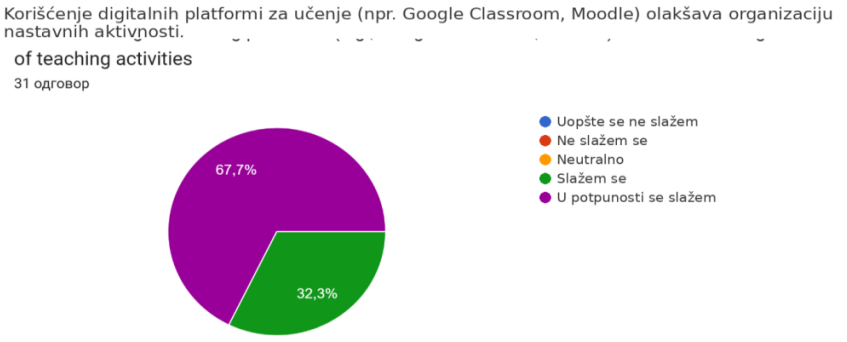


Izvor: Pripremila autorka na osnovu podataka iz ankete

Ovaj odeljak analizira tvrdnju „Digitalni alati poboljšavaju kvalitet nastavnog procesa“, koja se odnosi na percepcije nastavnika o uticaju digitalnih tehnologija na kvalitet nastave. Rezultati ukazuju na veoma pozitivan stav ispitanika prema ulozi digitalnih alata u unapređenju kvaliteta nastave. Od ukupno 31 ispitanika, 14 nastavnika (45,2%) izabralo je „u potpunosti se slažem“, dok je 16 ispitanika (51,6%) navelo da se „slaže“ sa tvrdnjom. Samo jedan ispitanik (3,2%) naveo je „ne slažem se“, dok nijedan ispitanik nije izabrao „uopšte se ne slažem“.

Dobijeni rezultati ukazuju na veoma visok nivo slaganja među nastavnicima u pogledu pozitivnog uticaja digitalnih alata na kvalitet nastavnog procesa. Dominacija pozitivnih odgovora ukazuje na to da nastavnici prepoznaju digitalne tehnologije kao važan faktor u unapređenju efikasnosti nastave, boljoj organizaciji časova i omogućavanju boljeg pristupa obrazovnim sadržajima. Istovremeno, minimalan udeo negativnih odgovora može ukazivati na individualne prepreke u primeni digitalnih alata ili različite nivoe digitalnih kompetencija među nastavnicima.

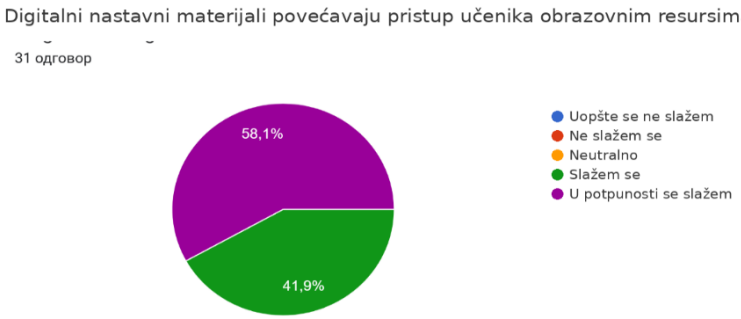
Slika 6. Organizacija uz digitalne platforme



Izvor: Pripremila autorka na osnovu podataka iz ankete

Od ukupno 31 ispitanika, 21 nastavnik (67,7%) izabrao je „u potpunosti se slažem“, dok je 10 ispitanika (32,3%) navelo da se „slaže“ sa tvrdnjom. Nijedan ispitanik nije izabrao nijedan oblik neslaganja. Ovi rezultati ukazuju na gotovo jednoglasnu percepciju nastavnika da digitalne platforme kao što su *Google Classroom* i *Moodle* značajno doprinose boljoj organizaciji nastavnih aktivnosti. Visok nivo potpunog slaganja ukazuje da su ove tehnologije postale ključni alati u savremenoj nastavnoj praksi, naročito u kontekstu planiranja časova, distribucije materijala i komunikacije sa učenicima.

Slika 7. Pristup resursima

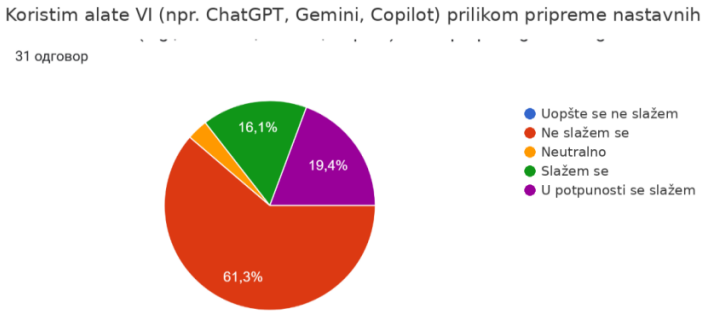


Izvor: Pripremila autorka na osnovu podataka iz ankete

Ovaj segment analizira tvrdnju „Digitalni nastavni materijali povećavaju pristup učenika obrazovnim resursima“, koja se odnosi na percepcije nastavnika o uticaju digitalnih nastavnih materijala na dostupnost obrazovnih resursa učenicima. Rezultati ukazuju na veoma visok nivo

slaganja među ispitanicima. Većina nastavnika, 18 ispitanika (58,1%), izabrala je „u potpunosti se slažem“, dok je 13 ispitanika (41,9%) navelo da se „slaže“ sa tvrdnjom. Nijedan ispitanik nije izrazio neslaganje. Dobijeni rezultati pokazuju gotovo jednoglasno uverenje nastavnika da digitalni nastavni materijali značajno doprinose povećanju pristupa obrazovnim resursima. Takvi nalazi ukazuju na percepciju da digitalizacija obrazovanja omogućava učenicima lakši pristup sadržajima, veću fleksibilnost u učenju i širu dostupnost obrazovnih materijala izvan tradicionalnog učioničkog okruženja.

Slika 8. Korišćenje alata za pripremu nastave



Izvor: Pripremila autorka na osnovu podataka iz ankete

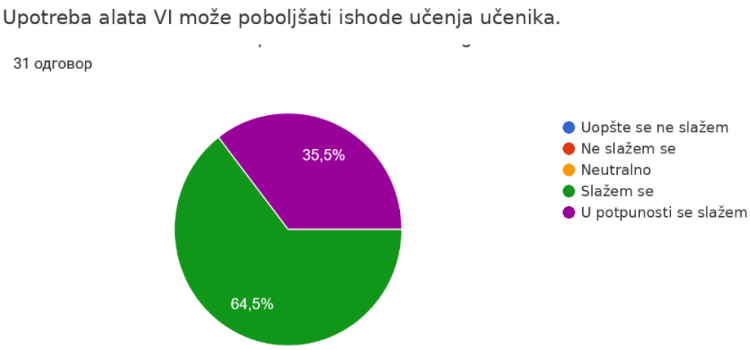
Ovaj segment analizira tvrdnju „Koristim alate VI (npr. *ChatGPT*, *Gemini*, *Copilot*) prilikom pripreme nastavnih materijala“, koja se odnosi na meru u kojoj nastavnici koriste alate veštačke inteligencije u pripremi nastavnih materijala. Rezultati otkrivaju značajne razlike u odgovorima ispitanika, pri čemu negativni odgovori jasno preovlađuju. Od ukupno 31 ispitanika, 6 nastavnika (19,4%) izabralo je „u potpunosti se slažem“, dok je 5 ispitanika (16,1%) navelo da se „slaže“ sa tvrdnjom. Jedan ispitanik (3,2%) izabrao je neutralnu opciju, dok je 19 ispitanika (61,3%) navelo da se „ne slaže“. Nijedan ispitanik nije izabrao „uopšte se ne slažem“; umesto toga, neslaganje je izraženo isključivo kroz kategoriju „ne slažem se“.

Ovi nalazi ukazuju na to da, iako je manjina nastavnika već uključila alate veštačke inteligencije u pripremu nastavnih materijala, većina ispitanika još uvek nije usvojila ove tehnologije u svojoj nastavnoj praksi. Ovaj obrazac ukazuje na to da je integracija alata VI u obrazovanje još uvek u ranoj fazi i da može biti ograničena faktorima kao što su nedovoljno stručno usavršavanje, ograničena upoznatost sa

mogućnostima tehnologija VI ili zabrinutost u vezi sa njihovom pedagoškom primenom.

Istovremeno, rezultati ukazuju na značajne mogućnosti za proširenje stručnog usavršavanja nastavnika u oblasti korišćenja generativne veštačke inteligencije, naročito za izradu nastavnih materijala, planiranje časova i formativno ocenjivanje.

Slika 9. Poboljšanje ishoda učenja

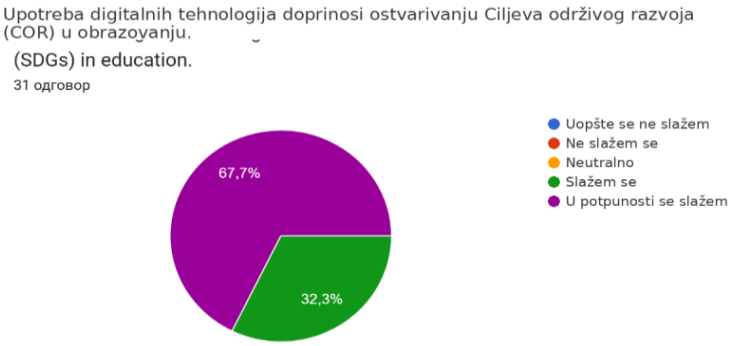


Izvor: Pripremila autorka na osnovu podataka iz ankete

Slika 9 prikazuje raspodelu odgovora na tvrdnju koja se odnosi na potencijal veštačke inteligencije da poboljša ishode učenja. Od ukupno 31 ispitanika, 11 nastavnika (35,5%) izabralo je „u potpunosti se slažem“, dok je 18 ispitanika (58,1%) navelo da se „slaže“ sa tvrdnjom. Dva ispitanika (6,5%) izabrala su „ne slažem se“, dok nijedan ispitanik nije izrazio neutralno mišljenje niti izabrao „uopšte se ne slažem“.

Rezultati ukazuju na visok nivo poverenja nastavnika u potencijal veštačke inteligencije da unapredi ishode učenja. Dominacija pozitivnih odgovora ukazuje da ispitanici percipiraju VI kao vredan alat za poboljšanje razumevanja nastavnih sadržaja kod učenika, podršku personalizovanom učenju i povećanje ukupne efikasnosti obrazovnog procesa. Istovremeno, mali udeo negativnih odgovora ukazuje da ograničen broj nastavnika i dalje izražava određene rezerve u vezi sa integracijom VI u obrazovnu praksu.

Slika 10. Ciljevi održivog razvoja i obrazovanje – korelacija



Izvor: Pripremila autorka na osnovu podataka iz ankete

Dobijeni rezultati ukazuju na gotovo jednoglasnu percepciju nastavnika da digitalne tehnologije imaju značajnu ulogu u ostvarivanju Ciljeva održivog razvoja (COR) u obrazovanju. Ispitanici su posebno naglasili doprinos COR 4 – Kvalitetno obrazovanje, prepoznajući digitalizaciju kao ključni faktor u unapređenju dostupnosti, inkluzivnosti i ukupnog kvaliteta obrazovnog procesa. Ovi nalazi ukazuju da nastavnici digitalne tehnologije ne doživljavaju samo kao nastavne alate, već i kao šire instrumente razvoja obrazovanja sa važnim društvenim implikacijama.

Rezultati pokazuju visok nivo prihvatanja digitalnih tehnologija u nastavnoj praksi, naročito u pogledu njihovog doprinosa unapređenju kvaliteta nastave, boljoj organizaciji nastavnog procesa i povećanju pristupa obrazovnim resursima. Međutim, usvajanje veštačke inteligencije ostaje relativno ograničeno, što ukazuje da je njena integracija u obrazovni sistem još uvek u ranoj fazi. Ovi rezultati naglašavaju potrebu za dodatnim mogućnostima stručnog usavršavanja i institucionalnom podrškom kako bi se olakšala efikasna i pedagoški smislena primena tehnologija VI u obrazovanju.

4. Diskusija

Nalazi ove studije pokazuju da su digitalne tehnologije postale sastavni deo nastavne prakse u srednjem obrazovanju u Srbiji. Dosledno pozitivne percepcije nastavnika ukazuju da je proces digitalne transformacije prevazišao fazu početnog usvajanja tehnologije i prešao ka njenoj rutinskoj integraciji u svakodnevne nastavne aktivnosti. Nastavnici u velikoj meri prepoznaju digitalne alate kao važan faktor u unapređenju kvaliteta nastave, organizaciji časova i pristupu obrazovnim

resursima. Ovi nalazi su u skladu sa prethodnim istraživanjima koja pokazuju da digitalne tehnologije doprinose efikasnijim pedagoškim praksama, poboljšanoj efikasnosti nastave i višim nivoima angažovanja učenika (Redecker, 2017; Lucas et al., 2021; Pajić et al., 2025; Trifunović et al., 2023). Ovo podudaranje sa ranijim studijama ukazuje da uspešna integracija digitalnih tehnologija sve više zavisi ne samo od tehnološke infrastrukture već i od pedagoških kompetencija nastavnika i institucionalne podrške.

Rezultati su takođe u skladu sa nalazima iz regionalnog konteksta, koji ukazuju da su digitalne kompetencije nastavnika postale osnovni preduslov za uspešnu integraciju tehnologije u obrazovanje, iako i dalje postoje značajne razlike u zavisnosti od dostupnosti stručnog usavršavanja i institucionalne podrške (Stošić, 2023). Do sličnih zaključaka došla su i domaća istraživanja, koja digitalne kompetencije nastavnika prepoznaju kao jedan od najsnažnijih prediktora uspešne primene inovativnih nastavnih metoda i digitalnih tehnologija (Mandić & Ristić, 2023; Trifunović et al., 2024). Ovi nalazi dodatno potvrđuju stav da održiva digitalna transformacija zahteva kontinuirano ulaganje u stručno usavršavanje nastavnika, a ne samo obezbeđivanje tehnološke infrastrukture.

Posebno važan nalaz odnosi se na gotovo jednoglasno slaganje ispitanika u pogledu doprinosa digitalnih platformi za učenje organizaciji nastavnih aktivnosti i dostupnosti obrazovnih resursa. Široko prihvatanje platformi kao što su *Google Classroom* i *Moodle* ukazuje da su ove tehnologije postale u potpunosti integrisane u svakodnevnu nastavnu praksu, odražavajući relativno zrelu fazu digitalne transformacije u školama. Prema okviru *DigCompEdu*, ovaj obrazac može se tumačiti kao dokaz da su nastavnici dostigli solidan nivo digitalnih kompetencija, koji im omogućava da rutinski integrišu digitalne tehnologije u nastavnu praksu (Redecker, 2017). Istovremeno, ovi nalazi ukazuju na to da se digitalne tehnologije više ne doživljavaju samo kao dopunski nastavni alati, već kao suštinske komponente savremene obrazovne prakse.

Iz teorijske perspektive, ovi nalazi se mogu tumačiti i kroz Model prihvatanja tehnologije (Davis, 1989), prema kojem na usvajanje tehnologije prvenstveno utiču percepcije korisnika o njenoj korisnosti i lakoći upotrebe. Široka upotreba digitalnih platformi zabeležena u ovoj studiji ukazuje da nastavnici ove tehnologije smatraju i korisnim i praktičnim za podršku svakodnevnim nastavnim aktivnostima. Međutim, ovaj obrazac se ne odnosi u istoj meri na primene veštačke inteligencije,

što ukazuje da različite kategorije digitalnih tehnologija mogu biti u različitim fazama usvajanja.

Iako su nastavnici izrazili izrazito pozitivne stavove prema digitalnim tehnologijama uopšte, rezultati otkrivaju jasnu razliku između rutinske upotrebe digitalnih alata i usvajanja veštačke inteligencije u obrazovnoj praksi. Dok su digitalne tehnologije postale redovan deo nastavnih aktivnosti, upotreba alata VI kao što su *ChatGPT*, *Gemini* i *Copilot* za pripremu nastavnih materijala ostaje relativno ograničena. Većina ispitanika navela je da još uvek ne koristi ove tehnologije u svojoj profesionalnoj praksi, što ukazuje da je generativna veštačka inteligencija još u ranim fazama integracije u obrazovni sistem Srbije. Ovi nalazi su u skladu sa OECD-om (2024), koji naglašava da su se pozitivni stavovi nastavnika prema generativnoj VI razvijali brže od njene stvarne primene u učionicama. Izveštaj navodi nedovoljno stručno usavršavanje, etičke nedoumice, neizvesnost u pogledu pedagoških primena i odsustvo jasnih institucionalnih smernica kao glavne prepreke usvajanju VI.

Ovi nalazi dodatno podržavaju novija međunarodna istraživanja koja pokazuju da, iako nastavnici prepoznaju značajan obrazovni potencijal veštačke inteligencije, njena praktična primena ostaje ograničena zbog nedovoljnih mogućnosti za obuku, etičkih dilema i nedostatka institucionalnih smernica (Kasneci, E. et al., 2023; Galindo-Domínguez et al., 2024; Joksimović et al., 2026). U tom pogledu, ova studija potvrđuje postojanje uočljivog jaza između pozitivnih percepcija nastavnika o VI i njene stvarne upotrebe u učionici. Ova razlika ukazuje na to da nastavnici razlikuju digitalizaciju kao ustaljenu obrazovnu praksu i pedagogiju podržanu VI kao inovaciju u nastajanju koja zahteva nove kompetencije, pedagoške strategije i etičke okvire. Istovremeno, ispitanici su izrazili visok nivo poverenja u potencijal veštačke inteligencije da poboljša ishode učenja učenika. Ovaj kontrast između pozitivnih očekivanja i relativno ograničene primene odražava ono što novija literatura opisuje kao „jaz rane primene“, u kojem nastavnici prepoznaju vrednost novih tehnologija, ali ih još nisu u potpunosti integrisali u svoju svakodnevnu profesionalnu praksu (Hava & Babayiğit, 2024). Shodno tome, nalazi ukazuju da će sledeća faza digitalne transformacije zavisiti ne samo od tehnološke dostupnosti već i od spremnosti nastavnika da uključe VI u smislene pedagoške kontekste. Još jedan značajan nalaz odnosi se na percepcije nastavnika o odnosu između digitalnih tehnologija i održivog razvoja (Bučalina Matić et al., 2024). Ispitanici su se u velikoj meri složili da digitalne tehnologije doprinose ostvarivanju Ciljeva održivog razvoja, naročito COR 4 –

Kvalitetno obrazovanje. To ukazuje da nastavnici digitalnu transformaciju ne doživljavaju samo kao tehnološki proces već i kao širi društveni i obrazovni mehanizam koji promoviše dostupnost, inkluzivnost, obrazovnu pravičnost i mogućnosti celoživotnog učenja. Ovi nalazi su u skladu sa strateškim okvirom UNESCO-a, koji naglašava centralnu ulogu digitalne transformacije u ostvarivanju globalnih obrazovnih ciljeva (UNESCO, 2023).

Posmatrani zajedno, rezultati ukazuju na to da obrazovni sistem Srbije trenutno prolazi kroz dvostruki proces digitalne transformacije. Prvu dimenziju karakteriše široka i stabilna integracija konvencionalnih digitalnih tehnologija u svakodnevnu nastavnu praksu, dok druga obuhvata postepeno i još uvek relativno ograničeno usvajanje veštačke inteligencije. Ova dvostruka transformacija pokazuje da digitalne inovacije u obrazovanju nisu homogen proces, već višeslojan razvoj na koji utiču kompetencije nastavnika, institucionalna spremnost, podrška obrazovnih politika i mogućnosti za kontinuirano profesionalno učenje (Trifunović & Tankosić, 2013; Lalić & Trifunović, 2026).

Iz praktične perspektive, ovi nalazi naglašavaju potrebu za obrazovnim politikama koje prevazilaze ulaganja u tehnološku infrastrukturu. Veći naglasak treba staviti na sistematske programe stručnog usavršavanja usmerene na pismenost u oblasti VI, pedagoški smislene primene generativne VI, etičke smernice za upotrebu VI i institucionalne strategije koje podržavaju odgovorne inovacije u školama. Takve mere omogućile bi nastavnicima da pređu sa osnovne upotrebe digitalnih tehnologija na naprednije i transformativne obrazovne prakse.

Treba ukazati i na nekoliko ograničenja ove studije. Prvo, relativno mali uzorak nastavnika srednjih škola ograničava mogućnost generalizacije nalaza na širu populaciju nastavnika. Drugo, studija se oslanja na samoprocene ispitanika, koje se mogu razlikovati od stvarnih praksi u učionici. Treće, presečni dizajn istraživanja ne omogućava donošenje zaključaka o uzročnim odnosima između stavova nastavnika i usvajanja tehnologije. Buduća istraživanja bi stoga trebalo da obuhvate veće i raznovrsnije uzorke, primene pristupe mešovitih metoda i ispitaju dugoročni uticaj veštačke inteligencije na kvalitet nastave, angažovanje učenika i ishode učenja.

Sveukupno, rezultati potvrđuju značaj kontinuiranog stručnog usavršavanja u jačanju digitalnih kompetencija nastavnika i kompetencija povezanih sa VI, u skladu sa evropskim i međunarodnim okvirima za digitalno obrazovanje (Redecker, 2017; Stošić, 2023). Bez sistematske obuke, institucionalne podrške i jasno definisanih

pedagoških smernica, malo je verovatno da će transformativni potencijal naprednih tehnologija kao što je veštačka inteligencija biti u potpunosti ostvaren u obrazovnoj praksi. Ovaj zaključak dodatno podržavaju Mandić et al. (2025), koji tvrde da uspešna primena veštačke inteligencije u obrazovanju prvenstveno zavisi od razvoja digitalnih kompetencija nastavnika i kompetencija u oblasti VI, uz kontinuiranu institucionalnu podršku školama.

5. Zaključak

Nalazi ove studije ukazuju da nastavnici srednjih škola u Srbiji pokazuju visok nivo prihvatanja digitalnih tehnologija u obrazovnoj praksi. Digitalne tehnologije se pretežno doživljavaju kao vredni instrumenti za unapređenje kvaliteta nastave, poboljšanje organizacije nastavnog procesa i povećanje pristupa učenika obrazovnim resursima. Sveukupno, rezultati ukazuju na to da se digitalizacija nastave čvrsto ukorenila u svakodnevnoj pedagoškoj praksi i sada predstavlja stabilnu komponentu savremenog obrazovnog okruženja.

Istovremeno, studija otkriva jasnu razliku između širokog usvajanja konvencionalnih digitalnih alata i još uvek ograničene upotrebe veštačke inteligencije u nastavnoj praksi. Iako nastavnici prepoznaju značajan potencijal tehnologija VI da poboljšaju ishode učenja, njihova praktična primena ostaje u ranoj fazi. Ovi nalazi ukazuju na to da će uspešna integracija VI u obrazovanje zavisiti ne samo od tehnološke dostupnosti već i od profesionalnih kompetencija nastavnika, etičke svesti i kontinuirane institucionalne podrške. Kako naglašava OECD, efikasno usvajanje generativne veštačke inteligencije u obrazovanju zahteva razvoj novih kompetencija nastavnika, jasne etičke okvire i kontinuirane institucionalne smernice.

Pored toga, nalazi pokazuju da nastavnici prepoznaju širu obrazovnu i društvenu vrednost digitalne transformacije, naročito u odnosu na ostvarivanje Cilja održivog razvoja 4 (COR 4) – Kvalitetno obrazovanje. Digitalne tehnologije se ne posmatraju samo kao nastavni alati već i kao mehanizmi za promovisanje dostupnosti, inkluzivnosti, pravičnosti i kvaliteta obrazovanja, čime podržavaju šire ciljeve održivog razvoja obrazovanja. Ovi nalazi su u skladu sa međunarodnim okvirima politika koji digitalnu transformaciju prepoznaju kao ključni pokretač održivih i inkluzivnih obrazovnih sistema (UNESCO, 2023; OECD, 2023).

Posmatrani zajedno, rezultati ukazuju da obrazovni sistem Srbije prolazi kroz dvostruku digitalnu tranziciju koju karakterišu široka integracija uspostavljenih digitalnih tehnologija i postepeno usvajanje veštačke

inteligencije. Ova tranzicija odražava prelazak sa osnovne digitalizacije ka naprednijim oblicima nastave i učenja unapređenim tehnologijom, naglašavajući značaj kontinuiranog stručnog usavršavanja, institucionalne spremnosti i obrazovnih politika zasnovanih na dokazima.

Iz praktične perspektive, ova studija pruža vredne uvide koji mogu podržati osmišljavanje programa stručnog usavršavanja nastavnika, informisati obrazovnu politiku i doprineti razvoju institucionalnih smernica za odgovornu i pedagoški smislenu upotrebu veštačke inteligencije u srednjem obrazovanju. Buduća istraživanja treba da obuhvate veće i raznovrsnije uzorke, primene komparativne i longitudinalne istraživačke nacrte i dodatno ispitaju dugoročne efekte digitalne transformacije i nastave podržane VI na kvalitet obrazovanja, angažovanje učenika i ishode učenja.

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TEACHER INNOVATION, ARTIFICIAL INTELLIGENCE, AND SUSTAINABLE DEVELOPMENT IN SECONDARY EDUCATION

***Nađa Petrović*[1]**

Abstract

Digital transformation has become a key component of contemporary education, influencing teaching quality and the achievement of Sustainable Development Goals (SDGs). Teachers play a central role in integrating digital technologies and artificial intelligence (AI) into teaching and assessment practices. However, empirical evidence on teachers' readiness to adopt AI in secondary education remains limited.

This study examines secondary school teachers' attitudes toward digital technologies, the use of AI in education, digital competencies, and perceptions of digitalization in relation to sustainable development. A quantitative survey was conducted with 31 secondary school teachers.

The results show a high level of acceptance of digital technologies in teaching practice and generally positive attitudes toward their educational value. However, a clear gap exists between the widespread use of digital tools and the limited application of AI in classroom practice. Teachers recognize the potential of AI for improving learning outcomes, but its implementation remains low. Respondents also strongly perceive digitalization as a mechanism for improving educational quality, efficiency, and accessibility, particularly in relation to SDG 4 – Quality Education.

These findings provide insights for educational policy and teacher professional development focused on digital and AI competencies.

Keywords: *digital transformation, artificial intelligence, teachers, digital competencies, secondary education, SDG 4*

1. Introduction

The digital transformation of education represents one of the key directions of contemporary educational reforms, aiming to improve the

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quality of teaching, increase access to education, and align educational systems with the demands of the digital society. Within this process, digital technologies and artificial intelligence (AI)-based tools have become increasingly integrated into educational practice, transforming traditional approaches to teaching and learning.

Contemporary research indicates that the integration of digital technologies into teaching contributes to the development of students' competencies, enhances teaching effectiveness, and improves assessment processes (Stošić & Mikhailova, 2023). Previous studies have demonstrated that artificial intelligence enables personalized learning, automates administrative tasks, and supports teachers in making pedagogical decisions (Holmes et al., 2019; Zawacki-Richter et al., 2019). More recent research highlights that generative AI tools further expand teachers' capabilities by facilitating the creation of teaching materials, adaptive lesson planning, and the improvement of student assessment processes (Tlili A. et al., 2023).

In this context, teachers occupy a central role in the digital transformation of education. Their digital competencies, attitudes toward technology, and willingness to adopt innovations directly influence the quality and successful implementation of digital tools in educational practice. Continuous professional development is therefore considered essential, as the development of digital competencies represents a prerequisite for the effective use of contemporary technologies, including AI-based systems (Mandić et al., 2025; Gajić et al., 2024).

Beyond its pedagogical significance, the digital transformation of education has broader social and developmental implications. It is closely associated with the achievement of Sustainable Development Goal 4 (SDG 4 – Quality Education), which promotes inclusive, equitable, and quality education for all. Digital innovations contribute to greater educational accessibility, more efficient resource utilization, and improved learning outcomes, thereby reinforcing their strategic importance within contemporary educational policies (UNESCO, 2023).

In recent years, particularly with the emergence of generative artificial intelligence based on large language models, new questions have arisen regarding the role of teachers, the ethical use of AI in education, and the need to develop AI literacy. Research suggests that teachers generally recognize the potential of AI tools to enhance teaching and learning; however, they also express concerns regarding their reliability, ethical implementation, and possible impact on pedagogical interaction (Kasneci, E. et al., 2023, Trifunović et al., 2026; Damnjanović, 2026).

Despite the growing availability of digital tools, teachers' readiness to implement them continues to vary considerably, indicating the need for a systematic approach to developing digital competencies within educational systems. A particular challenge lies in understanding and integrating artificial intelligence into everyday teaching practice while preserving the quality of education and teachers' pedagogical autonomy. In the Republic of Serbia, the process of digital transformation in education has intensified through the introduction of national digital platforms, electronic textbooks, and various teacher professional development programs (Dašić et al., 2024; Kostić, 2023; Budimir, 2024; Babić, et al., 2024; Savić et al., 2025). Nevertheless, the implementation of modern AI tools has not yet been systematically regulated, resulting in significant differences among teachers in terms of digital competencies, readiness to use generative artificial intelligence, and perceptions of its contribution to the teaching process. Consequently, there is a clear need for empirical research examining teachers' attitudes toward the implementation of digital innovations and AI technologies in secondary education.

Based on the above, this study examines the attitudes of secondary school teachers in Serbia toward the implementation of digital innovations, the use of artificial intelligence in education, and their role in achieving the Sustainable Development Goals, with a particular emphasis on SDG 4.

The aim of this study is to investigate secondary school teachers' attitudes toward the use of digital technologies and artificial intelligence-based tools in the teaching process, as well as to assess their contribution to improving educational quality and achieving Sustainable Development Goal 4 (SDG 4).

Based on the defined research objective, the following hypothesis was formulated:

H1: Secondary school teachers have positive attitudes toward the use of digital technologies and perceive them as contributing to the improvement of teaching quality and the achievement of the Sustainable Development Goals, while the practical application of AI tools in teaching remains limited.

2. Research Methodology

This study employed a quantitative research approach to examine secondary school teachers' attitudes toward the digital transformation of

education, the use of artificial intelligence in teaching, and the contribution of digital technologies to the achievement of the Sustainable Development Goals (SDGs). A quantitative approach was selected because it enables the systematic measurement of respondents' attitudes and perceptions, as well as the identification of general patterns in their responses (Creswell & Creswell, 2018).

The study was conducted on a sample of 31 secondary school teachers employed in Serbia. The sample included teachers of different age groups and varying levels of professional experience, providing insight into potential differences in attitudes related to teaching experience and exposure to digital technologies.

Data were collected using a structured questionnaire designed in Google Forms. Participation was voluntary and anonymous, and all respondents were informed about the purpose of the study and the exclusive use of the collected data for scientific research. The research instrument was developed based on previous studies addressing teachers' digital competencies and technology integration in education (Redecker, 2017; Lucas et al., 2021).

The questionnaire consisted of two sections. The first section collected demographic information, including respondents' age and years of teaching experience. The second section focused on teachers' attitudes toward the use of digital technologies, learning platforms, and artificial intelligence in education, as well as their perceptions of these technologies' contribution to teaching quality and sustainable development.

Respondents indicated their level of agreement with each statement using a five-point Likert scale, where 1 represented *strongly disagree* and 5 represented *strongly agree*. The questionnaire items were designed based on technology acceptance models, which emphasize perceived usefulness and perceived ease of use as key determinants of technology adoption (Davis, 1989).

The questionnaire included statements addressing the frequency of digital tool use in teaching, teachers' perceptions of their impact on instructional quality, the use of learning management systems such as Google Classroom and Moodle, the contribution of digital learning materials to improving students' access to educational resources, students' engagement when using digital technologies, and the use of artificial intelligence tools, including ChatGPT, Gemini, and Copilot, in the preparation of teaching materials.

In addition, the study examined teachers' perceptions of the impact of digital competencies on their professional development, as well as their views regarding the contribution of digital technologies to educational accessibility and inclusiveness. The questionnaire also included a statement assessing respondents' perceptions of the level of digital transformation in the schools where they are employed.

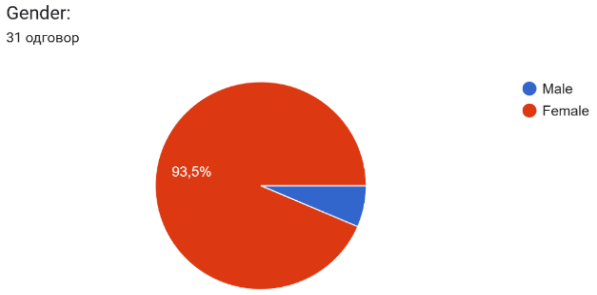
The theoretical framework of the study is based on the concept of teachers' digital competencies, emphasizing their crucial role in contemporary education and the importance of continuous professional development (Redecker, 2017). Furthermore, the research is aligned with the United Nations Sustainable Development Goals framework, particularly SDG 4 (Quality Education), which advocates inclusive, equitable, and high-quality education for all (UNESCO, 2023).

The collected data were analyzed using descriptive statistical methods. Frequencies and percentages were calculated to summarize respondents' answers, while the findings are presented graphically in the following section to provide a clear overview of the distribution of teachers' attitudes.

3. Research Results

This section presents the results of the descriptive statistical analysis based on the responses of 31 teachers employed at the Secondary School of Economics "Nada Dimić" in Zemun, Serbia. The findings are presented through graphical illustrations accompanied by textual interpretation in order to provide a clear overview of the sample structure and the respondents' key demographic characteristics.

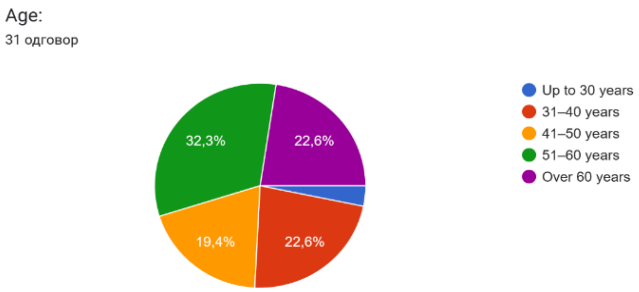
Figure 1



Source: Prepared by the authors based on the survey data

Figure 1 illustrates the gender distribution of the respondents. The majority of participants were female, with 29 teachers (93.5%), while only 2 respondents (6.5%) were male. These findings indicate a pronounced predominance of female teachers in the sample, which is consistent with the general gender structure of the teaching profession, where women are significantly more represented than men.

Figure 2.

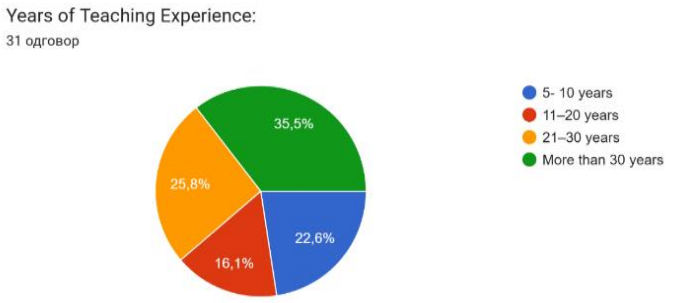


Source: Prepared by the authors based on the survey data

Figure 2 presents the age distribution of the respondents. The analysis indicates that the sample is heterogeneous in terms of age. The largest proportion of respondents belonged to the 51–60 years age group (10 teachers, 32.3%). Two age groups were equally represented: teachers over 60 years of age (7 respondents, 22.6%) and those between 31 and 40 years of age (7 respondents, 22.6%). The 41–50 years age group included 6 respondents (19.4%), while the under 30 years age group was the least represented, comprising only one respondent (3.2%).

This age distribution indicates that the sample was predominantly composed of middle-aged and older teachers, which is particularly relevant for interpreting the findings in relation to digital competencies and teachers' readiness to adopt and implement contemporary educational technologies.

Figure 3

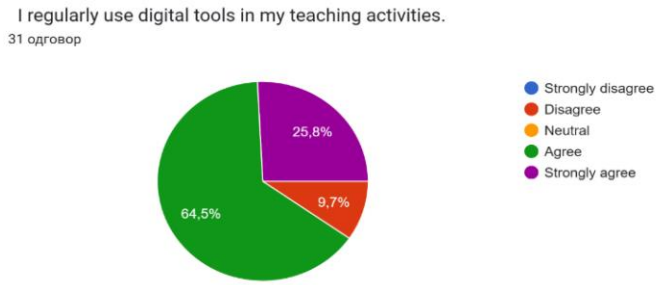


Source: Prepared by the authors based on the survey data

In the third segment of the results, the structure of respondents is presented according to years of teaching experience. The analysis indicates that respondents are distributed across four experience categories, with the most represented group consisting of teachers with more than 30 years of professional experience, comprising 11 respondents (35.5%). This category reflects a substantial proportion of teachers with long-standing professional experience, which may significantly influence their attitudes toward digital transformation and the implementation of contemporary technologies in education.Teachers with 21 to 30 years of experience represent the second largest group, with 8 respondents (25.8%). They are followed by teachers with 5 to 10 years of experience, totaling 7 respondents (22.6%), while the least represented group consists of teachers with 11 to 20 years of experience, with 5 respondents (16.1%).

Such a sample structure indicates that the study includes teachers with varying levels of professional experience, with a predominance of those who have been engaged in the educational system for more than 20 years. This distribution is particularly important for the interpretation of the results, as years of professional experience may influence the level of acceptance of digital tools, readiness to implement artificial intelligence in teaching, as well as perceptions of the importance of digital competencies in contemporary education.

Figure 4.

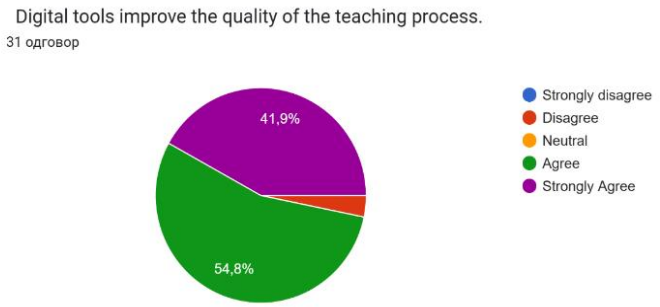


Source: Prepared by the authors based on the survey data

Figure 4 presents the distribution of responses to the statement "I regularly use digital tools in my teaching activities," which refers to the frequency of digital tool usage in instructional practice. The results indicate a distinctly positive attitude among teachers toward the use of digital technologies in education. Out of a total of 31 respondents, 8 teachers (25.8%) selected "strongly agree," while 20 respondents (64.5%) indicated that they "agree" with the statement. Only 3 respondents (9.7%) reported that they "disagree," whereas no respondents selected "strongly disagree."

These findings suggest that the vast majority of teachers regularly use digital tools in their teaching practice, confirming a high level of acceptance of digital technologies within the educational process. At the same time, the small proportion of negative responses may indicate the presence of certain constraints, such as insufficient training, technical limitations, or individual differences in digital competencies. Overall, the results imply that digital tools have become an integral part of everyday teaching practice rather than merely occasional support for traditional instructional methods.

Figure 5.

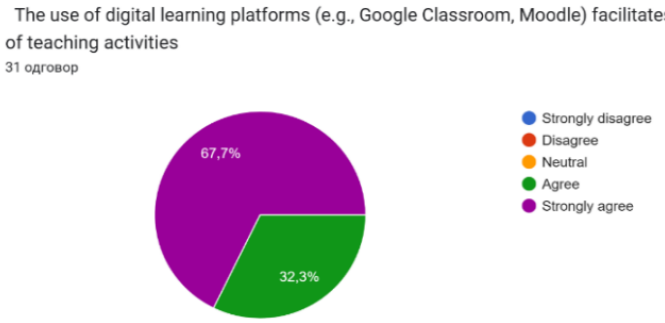


Source: Prepared by the authors based on the survey data

This section analyzes the statement "Digital tools improve the quality of the teaching process," which refers to teachers' perceptions of the impact of digital technologies on the quality of instruction. The results indicate a highly positive attitude among respondents toward the role of digital tools in enhancing teaching quality. Out of a total of 31 respondents, 14 teachers (45.2%) selected "strongly agree," while 16 respondents (51.6%) indicated that they "agree" with the statement. Only one respondent (3.2%) reported "disagree," while no respondents selected "strongly disagree."

The obtained results indicate a very high level of agreement among teachers regarding the positive impact of digital tools on the quality of the teaching process. The dominance of positive responses suggests that teachers recognize digital technologies as an important factor in improving instructional efficiency, enhancing lesson organization, and facilitating better access to educational content. At the same time, the minimal proportion of negative responses may point to individual barriers in the application of digital tools or varying levels of digital competence among teachers.

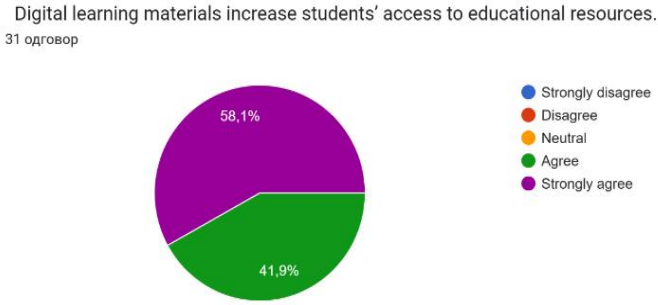
Figure 6.



Source: Prepared by the authors based on the survey data

Out of a total of 31 respondents, 21 teachers (67.7%) selected "strongly agree," while 10 respondents (32.3%) indicated that they "agree" with the statement. None of the respondents selected any form of disagreement.These results indicate an almost unanimous perception among teachers that digital platforms such as Google Classroom and Moodle significantly contribute to better organization of teaching activities. The high level of strong agreement suggests that these technologies have become key tools in contemporary teaching practice, particularly in the context of lesson planning, material distribution, and communication with students.

Figure 7.

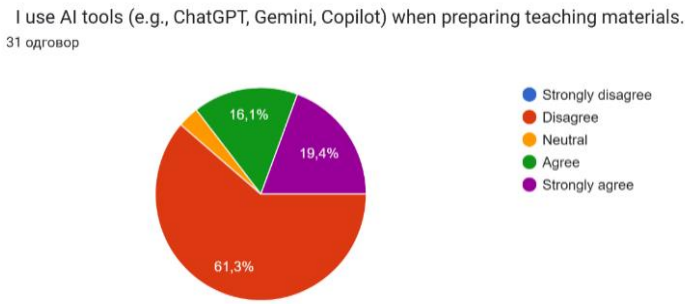


Source: Prepared by the authors based on the survey data

This segment analyzes the statement "Digital learning materials increase students' access to educational resources," which refers to teachers' perceptions of the impact of digital instructional materials on the

availability of educational resources for students. The results indicate a very high level of agreement among respondents. The majority of teachers, 18 respondents (58.1%), selected "strongly agree," while 13 respondents (41.9%) indicated that they "agree" with the statement. No respondents expressed disagreement. The obtained results demonstrate an almost unanimous belief among teachers that digital learning materials significantly contribute to increasing access to educational resources. Such findings suggest a perception that the digitalization of education enables easier access to content for students, greater flexibility in learning, and broader availability of educational materials beyond the traditional classroom setting.

Figure 8.



Source: Prepared by the authors based on the survey data

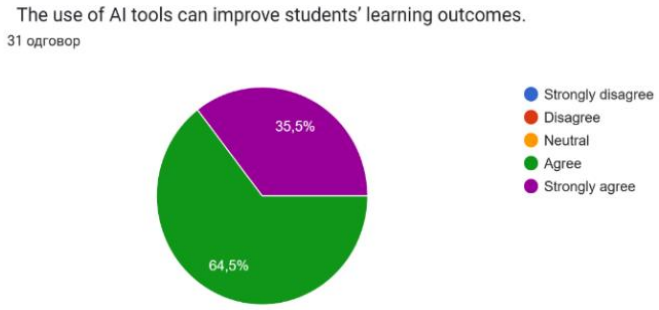
This segment analyzes the statement "I use AI tools (e.g., ChatGPT, Gemini, Copilot) when preparing teaching materials," which refers to the extent to which teachers use artificial intelligence tools in the preparation of instructional materials. The results reveal considerable variation in respondents' answers, with negative responses clearly predominating. Out of a total of 31 respondents, 6 teachers (19.4%) selected "strongly agree," while 5 respondents (16.1%) indicated that they "agree" with the statement. One respondent (3.2%) selected the neutral option, whereas 19 respondents (61.3%) reported that they "disagree." No respondents selected "strongly disagree"; instead, disagreement was expressed exclusively through the "disagree" category.

These findings indicate that, although a minority of teachers have already incorporated artificial intelligence tools into the preparation of teaching materials, the majority of respondents have not yet adopted these technologies in their instructional practice. This pattern suggests that the integration of AI tools into education remains at an early stage

and may be constrained by factors such as insufficient professional training, limited awareness of the capabilities of AI technologies, or concerns regarding their pedagogical application.

At the same time, the results highlight substantial opportunities for expanding teachers' professional development in the use of generative artificial intelligence, particularly for instructional material design, lesson planning, and formative assessment.

Figure 9.

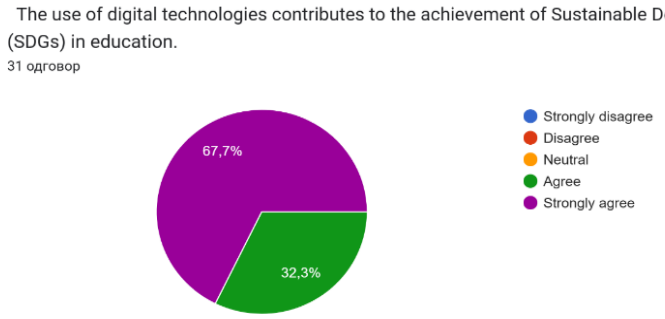


Source: Prepared by the authors based on the survey data

Figure 9 illustrates the distribution of responses to the statement concerning the potential of artificial intelligence to improve learning outcomes. Out of a total of 31 respondents, 11 teachers (35.5%) selected "strongly agree," while 18 respondents (58.1%) indicated that they "agree" with the statement. Two respondents (6.5%) selected "disagree," whereas no respondents expressed a neutral opinion or selected "strongly disagree."

The results indicate a high level of confidence among teachers in the potential of artificial intelligence to enhance learning outcomes. The predominance of positive responses suggests that respondents perceive AI as a valuable tool for improving students' understanding of instructional content, supporting personalized learning, and increasing the overall effectiveness of the educational process. At the same time, the small proportion of negative responses indicates that a limited number of teachers still express some reservations regarding the integration of AI into educational practice.

Figure 10.



Source: Prepared by the authors based on the survey data

The obtained results indicate an almost unanimous perception among teachers that digital technologies play a significant role in achieving the Sustainable Development Goals (SDGs) within education. In particular, respondents emphasized the contribution of SDG 4 – Quality Education, recognizing digitalization as a key factor in enhancing the accessibility, inclusiveness, and overall quality of the educational process. These findings suggest that teachers perceive digital technologies not only as instructional tools but also as broader instruments for educational development with important social implications.

The results demonstrate a high level of acceptance of digital technologies in teaching practice, particularly regarding their contribution to improving instructional quality, enhancing the organization of the teaching process, and increasing access to educational resources. However, the adoption of artificial intelligence remains relatively limited, indicating that its integration into the educational system is still at an early stage. These results highlight the need for further professional development opportunities and institutional support to facilitate the effective and pedagogically meaningful implementation of AI technologies in education.

4. Discussion

The findings of this study demonstrate that digital technologies have become an integral component of teaching practice in Serbian secondary education. The consistently positive perceptions reported by teachers suggest that the process of digital transformation has progressed beyond the stage of initial technology adoption toward its

routine integration into everyday instructional activities. Teachers largely recognize digital tools as an important factor in improving instructional quality, lesson organization, and access to educational resources. These findings are consistent with previous research demonstrating that digital technologies contribute to more effective pedagogical practices, improved teaching efficiency, and higher levels of student engagement (Redecker, 2017; Lucas et al., 2021; Pajić et al., 2025; Trifunović et al., 2023). This convergence with earlier studies suggests that the successful integration of digital technologies increasingly depends not only on technological infrastructure but also on teachers' pedagogical competencies and institutional support.

The results are also consistent with findings reported in the regional context, indicating that teachers' digital competencies have become a fundamental prerequisite for the successful integration of technology into education, although considerable differences remain depending on the availability of professional training and institutional support (Stošić, 2023). Similar conclusions have been reached by domestic studies, which identify teachers' digital competencies as one of the strongest predictors of the successful implementation of innovative teaching methods and digital technologies (Mandić & Ristić, 2023; Trifunović et al., 2024). These findings reinforce the view that sustainable digital transformation requires continuous investment in teachers' professional development rather than solely the provision of technological infrastructure.

A particularly important finding concerns the almost unanimous agreement among respondents regarding the contribution of digital learning platforms to the organization of teaching activities and the accessibility of educational resources. The widespread acceptance of platforms such as Google Classroom and Moodle suggests that these technologies have become fully integrated into everyday teaching practice, reflecting a relatively mature stage of digital transformation within schools. According to the DigCompEdu framework, this pattern may be interpreted as evidence that teachers have achieved a solid level of digital competence, enabling them to routinely integrate digital technologies into instructional practice (Redecker, 2017). At the same time, these findings indicate that digital technologies are no longer perceived merely as supplementary instructional tools but as essential components of contemporary educational practice.

From a theoretical perspective, these findings may also be interpreted through the Technology Acceptance Model (Davis, 1989), which

argues that technology adoption is primarily influenced by users' perceptions of its usefulness and ease of use. The widespread use of digital platforms observed in this study suggests that teachers perceive these technologies as both useful and practical for supporting everyday teaching activities. However, this pattern does not extend equally to artificial intelligence applications, indicating that different categories of digital technologies may be at different stages of adoption.

Although teachers expressed overwhelmingly positive attitudes toward digital technologies in general, the results reveal a clear distinction between the routine use of digital tools and the adoption of artificial intelligence in educational practice. While digital technologies have become a regular part of instructional activities, the use of AI tools such as ChatGPT, Gemini, and Copilot for preparing teaching materials remains relatively limited. Most respondents reported that they do not yet use these technologies in their professional practice, suggesting that generative artificial intelligence is still in the early stages of integration within the Serbian educational system. These findings are consistent with the OECD (2024), which emphasizes that teachers' positive attitudes toward generative AI have developed more rapidly than its actual implementation in classrooms. The report identifies insufficient professional training, ethical concerns, uncertainty regarding pedagogical applications, and the absence of clear institutional guidelines as major barriers to AI adoption.

These findings further support recent international studies demonstrating that, although teachers recognize the considerable educational potential of artificial intelligence, its practical implementation remains limited due to insufficient training opportunities, ethical dilemmas, and the lack of institutional guidance ((Kasneci, E. et al., 2023; Galindo-Domínguez et al., 2024; Joksimović et al., 2026). In this regard, the present study confirms the existence of a noticeable gap between teachers' positive perceptions of AI and its actual classroom use. This discrepancy suggests that teachers distinguish between digitalization as an established educational practice and AI-supported pedagogy as an emerging innovation that requires new competencies, pedagogical strategies, and ethical frameworks. At the same time, respondents expressed a high level of confidence in the potential of artificial intelligence to improve student learning outcomes. This contrast between positive expectations and relatively limited implementation reflects what

recent literature describes as an "early adoption gap," in which educators recognize the value of emerging technologies but have not yet fully integrated them into their everyday professional practice (Hava & Babayiğit, 2024). Consequently, the findings suggest that the next stage of digital transformation will depend not only on technological availability but also on teachers' preparedness to incorporate AI into meaningful pedagogical contexts. Another significant finding concerns teachers' perceptions of the relationship between digital technologies and sustainable development (Bučalina Matić et al., 2024). Respondents overwhelmingly agreed that digital technologies contribute to the achievement of the Sustainable Development Goals, particularly SDG 4 – Quality Education. This indicates that teachers perceive digital transformation not merely as a technological process but also as a broader social and educational mechanism that promotes accessibility, inclusiveness, educational equity, and lifelong learning opportunities. These findings are consistent with UNESCO's strategic framework, which emphasizes the central role of digital transformation in achieving global educational objectives (UNESCO, 2023).

Taken together, the results suggest that the Serbian educational system is currently experiencing a dual process of digital transformation. The first dimension is characterized by the widespread and stable integration of conventional digital technologies into everyday teaching practice, while the second involves the gradual and still relatively limited adoption of artificial intelligence. This dual transformation illustrates that digital innovation in education is not a homogeneous process but rather a multi-layered development influenced by teachers' competencies, institutional readiness, policy support, and opportunities for continuous professional learning (Trifunović & Tankosić, 2013; Lalić & Trifunović, 2026).

From a practical perspective, these findings emphasize the need for educational policies that extend beyond investments in technological infrastructure. Greater emphasis should be placed on systematic professional development programs focused on AI literacy, pedagogically meaningful applications of generative AI, ethical guidelines for AI use, and institutional strategies that support responsible innovation in schools. Such measures would enable teachers to move from basic digital technology use toward more advanced and transformative educational practices.

Several limitations of this study should also be acknowledged. First, the relatively small sample of secondary school teachers limits the generalizability of the findings to the broader teaching population. Second, the study relies on self-reported perceptions, which may differ from actual classroom practices. Third, the cross-sectional research design does not allow conclusions about causal relationships between teachers' attitudes and technology adoption. Future research should therefore include larger and more diverse samples, employ mixed-method approaches, and examine the long-term impact of artificial intelligence on teaching quality, student engagement, and learning outcomes.

Overall, the results confirm the importance of continuous professional development in strengthening teachers' digital and AI-related competencies, consistent with both European and international frameworks for digital education (Redecker, 2017; Stošić, 2023). Without systematic training, institutional support, and clearly defined pedagogical guidelines, the transformative potential of advanced technologies such as artificial intelligence is unlikely to be fully realized in educational practice. This conclusion is further supported by Mandić et al. (2025), who argue that the successful implementation of artificial intelligence in education depends primarily on the development of teachers' digital and AI competencies, accompanied by sustained institutional support for schools.

5. Conclusion

The findings of this study indicate that secondary school teachers in Serbia demonstrate a high level of acceptance of digital technologies in educational practice. Digital technologies are predominantly perceived as valuable instruments for improving teaching quality, enhancing the organization of the instructional process, and increasing students' access to educational resources. Overall, the results suggest that the digitalization of teaching has become firmly embedded in everyday pedagogical practice and now represents a stable component of the contemporary educational environment.

At the same time, the study reveals a clear distinction between the widespread adoption of conventional digital tools and the still limited use of artificial intelligence in teaching practice. Although teachers recognize the considerable potential of AI technologies to improve learning outcomes, their practical implementation remains at an early

stage. These findings suggest that the successful integration of AI into education will depend not only on technological availability but also on teachers' professional competencies, ethical awareness, and sustained institutional support. As emphasized by the OECD, the effective adoption of generative artificial intelligence in education requires the development of new teacher competencies, clear ethical frameworks, and continuous institutional guidance.

Furthermore, the findings demonstrate that teachers recognize the broader educational and societal value of digital transformation, particularly in relation to the achievement of Sustainable Development Goal 4 (SDG 4) – Quality Education. Digital technologies are viewed not only as instructional tools but also as mechanisms for promoting educational accessibility, inclusiveness, equity, and quality, thereby supporting the broader objectives of sustainable educational development. These findings are consistent with international policy frameworks that identify digital transformation as a key driver of sustainable and inclusive education systems (UNESCO, 2023; OECD, 2023).

Taken together, the results indicate that the Serbian educational system is undergoing a dual digital transition characterized by the widespread integration of established digital technologies alongside the gradual adoption of artificial intelligence. This transition reflects a shift from basic digitalization toward more advanced forms of technology-enhanced teaching and learning, highlighting the importance of continuous professional development, institutional readiness, and evidence-based educational policies.

From a practical perspective, this study provides valuable insights that may support the design of teacher professional development programs, inform educational policy, and contribute to the development of institutional guidelines for the responsible and pedagogically meaningful use of artificial intelligence in secondary education. Future research should involve larger and more diverse samples, adopt comparative and longitudinal research designs, and further investigate the long-term effects of digital transformation and AI-supported teaching on educational quality, student engagement, and learning outcomes.

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ПОКРЕТ НЕСВРСТАНОСТИ – ПРАВНА НАЧЕЛА И ЕКОНОМСКИ ИНТЕРЕСИ

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Апстракт

Међународни односи су у зависности од стања политика и друштвених стања у свету увек били комплексни и представљали прихватљива или неприхватљива начела у политичком амбијенту. Један од посебних покрета који је настао у међународним односима је покрет несврстаности. Свесни блоковских и економских подела оснивачи покрета несврстаности желели су да остваре неке своје циљеве у међународној заједници. Циљ рада је да покаже да и други учесници међународних односа могу допринети активној мирољубивој коегзистенцији и допринети спречавању подела на светском нивоу који у крајњој инстанци подразумева праведнији правни поредак и економску корист. Резултати показују да су идеје покрета несврстаности допринеле спречавању нежељених међународних догађаја и праведнијем правном и политичком амбијенту.

Кључне речи*: међународни односи, покрет несврстаности, економска и правна начела*

1. Увод

Покрет несврстаности настао је као политика регулисања целине односа у свету на прихватљивој платформи која ће имати одређени значај у међународним односима. Покрет несврстаности настао је на платформи блоковске поделе света након другог светског рата, и међународне кризе и опасности за свет у контексту изазивања различитих врста сукоба. Он је у ствари имао тежњу да окупи земље које нису тежиле прихватању концепција блоковске поделе света,

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односно имао је тежњу успостављања дугорочније друштвене и историјске везе засноване на правним начелима и економским интересима свих.

Реч је о најприсутнијој тежњи народа и њиховој активној борби да постигну пуну националну слободу и да обезбеде право да се у тој слободи друштвено развијају сагласно свом властитом избору (Кардељ, 1997). Циљ покрета је, у ствари, покушај спречавања сукоба и интерес међународне заједнице, у ширем контексту и пре појединачних циљева чланица покрета или колективних интереса. Са веома малим правним и економским могућностима земље чланице покрета покушале су скренути пажњу на друге приоритете у међународним односима у односу на могућност избијања нових већих ратова и спречавања јачања сиромаштва.

Према томе, несврстани свет у било којој фази своје еволуције, имао је увек своје јасно политичко лице у виду истакнутих лидера који су долазили са више континената, а југословенски председник Тито је, у том погледу, уживао и најдужи стаж и највише поштовање међу својим саборцима (Чавошки, 2024).

Тако је покрет имао здраве принципе оснивања и функционисања у датим околностима међународне политике и тежио успостављању демократских принципа одлучивања и пребацивање дипломатских активности на организацију Уједињених нација. Акценат је стављан на реактивацију мирољубиве политике и анализе активности, до постизања успешних резултата и осмишљавања практичне улоге покрета.

Тако се у демократском развоју међународних односа, на основама Повеље УН, супроставила политика блоковске поделе у свету (Марковић, 2021).

Циљ рада је да наведе читаоца на закључак да покрет несврстаности у датом међународном тренутку, има жељу да постигне прихватљив концепт остваривања циљева у међународној заједници, пре свега избегавање свих сукоба а посебно блоковске супротстављености. Постоји значајна литература из ове области код нас и у свету, која се превасходно налази у документима и архивској грађи, али недостаје анализа моћи несврстаних земаља и њихов капацитет у супротстављању блоковске подељености и налажења заједничких чинилаца.

2. Настанак и принципи оснивања

Оснивању покрета несврстаности претходили су бројни сусрети и конференције новоослобођених држава и покрета за стварање услова за унапређење антиблоковских тенденција. Бандушка конференција је у својој бити, по садржини закључака које је усвојила, одржавала дух несврставања, јер је стварала услове за унапређење антиблоковских тенденција и политике независности (Тадић, 1968).

Један од најважнијих таквих сусрета односно дипломатских догађаја је иницијатива, Тита, Нехруа, Насера, Сукарна и Нкрумаха, у седишту Уједињених нација у Њујорку 1960. године. Најбитнији догађаји у оснивању и раду покрета несврстаности су три конференције:

- Оснивачка конференција у Београду 1961. године где је основана организација несврстаних земаља и представљена начела и принципи функционисања.
- Конференција у Алжиру 1973. године, која се одржавала у периоду нафтне кризе и која је створила могућности економских интереса чланица покрета.
- Конференција 1979. године, где је донета декларација о сврси постојања покрета несврстаности у којој су као најважнији циљеви покрета обезбеђење:
    - Националне независности,
    - Суверенитета,
    - Територијалног интегритета и безбедности несврстаних земаља,
    - Борба против империјализма, колонијализма, неоколонијализма, апартхејда, расизма укључујући и ционизам,
    - Свих облика агресије, окупације, доминације, мешања или хегемоније,
    - Блоковске политике (Радовановић, 1973).

Дакле, узајамна кооперативност и сарадња у односима између супер сила и блокова, значила је покрету као могућност њиховог укључивања у светску политику и догађаје у међународној заједници.

С друге стране, немоћ новоуспостављених режима у несврстаним земљама да на прави начин приступе разрешењу привредних проблема водила је сталној политичкој нестабилности у тим земљама, а бурна унутрашња политичка превирања, опет, имала за

последицу учестале преврате (Индонезија, Камбоџа, Гана, Нигерија) (Богетић, 2018).

Основна начела на којима је покрет несврстаних земаља инсистирао у процесу нуклеарног разоружања су транспарентност, верификација и неповратност (Костић, 2021). Међутим, и поред званичног залагања за разоружање, несврстани су оставили могућност и право на самоодбрану и поседовање различитих врста конвенцијалног наоружања као гарант остваривања њихових начела и принципа који гарантују економску експлоатацију, борбу против колонијализма и уплив у суверенитет и територијални интегритет држава кроз појаве и спонзорисање сецесионизма.

На основу доступне историјске литературе и прегледа интернет сајтова кључни принципи оснивања и рада несврстаних земаља су:

- Независна спољна политика,
- Одрицање од укључивања у војне савезе,
- Забрана оснивања војних база,
- Подршка деколонизацији,
- Суверенитет и равноправност.

Из наведених основних принципа и начела оснивања покрета, видимо да је централно питање везано за проблеме колонијализма, расизма и апартхејда, које се на политичким дебатама током одржавања конференција односило понајвише на афричке земље. У вези сиромаштва и колонијализма афричких земаља и борбе против неоколонијализма. У вези са овим проблемом усвојено је чак пет посебних резолуција (АЈ, КПР, 1970). Потребно је напоменути да је скоро постигнута потпуна сагласност земаља чланица покрета по овом питању, што представља спровођење једног од основних постулата настанка – борба против сиромаштва.

3. Улога несврстаних земаља у функционисању међународних односа

„Златно доба несврстаности“ током осамдесетих година 20. века било је тесно повезано са успоном детанта у односима између блокова и суперсила, периодом када су преговарање и сарадња на свим пољима били кључне идеје водиље међународне политике, док је свим актерима, упркос извесним кризним ситуацијама у Трећем свету, у превасходном интересу било одржавање свеопште глобалне стабилности и подстицање даљег друштвено-економског и технолошког развоја света (Чавошки, 2024).

Покрет је као и многе друге међународне организације имао и велике успехе и падове у свом раду. Највећи проблеми настали су у току самих сукоба у оквиру самих држава чланица или појединих суседних земаља због нерешених историјских и територијалних проблема. Средства за финансирање одбране саставни су део свеобухватне потрошње сваке националне економије и имају карактер јавне потрошње, која има за циљ обезбеђивање људских и материјалних ресурса потребних за извршење специфичних задатака припреме за одбрану и њеног успешног спровођења (Михајловић, Савић, 2022).

Међународни догађаји диктирали су и саме теме конференција као што су сукоб на Блиском истоку 1967 и криза у Варшавском пакту 1968. године. Трећа конференција несврстаних на врху одржана је у Лусаки 1970. године, где су доминирале друге теме у односу на рат и сукобе, већ се расправљало о питањима међународног економског поретка и политичке позиције несврстаних земаља у таквом међународном поретку. На тој конференцији донета су два врло битна документа, који су уствари и били програмски документи за даљи рад а то су:

- Декларација о миру, независности, развоју, сарадњи и демократизацији међународних односа;
- Декларација о несврстаности и економском развоју.

Као значајна конференција може се узети четврта конференција несврстаних у Алжиру 1973. године, на којој је учествовало 75 пуноправних чланица, али и три европске земље као „гости“ (посматрачи) (Финска, Шведска, Аустрија). Основне теме су биле из области привреде, науке, технологије, социјалних давања, а и посебан документ о усаглашавању покрета несврстаности по питањима сарадње и развоја. На петој конференцији на врху, одржаној у Шри Ланци учествовало је до тада највише земаља (85), али и значајни гости (Финска, Шведска, Аустрија, Филипини, Португалија, Румунија, Швајцарска). Ова конференција позната је по постизању веће координације и институционализације по питању постизања циљева. Покрет је на овој конференцији изразио јединство са основним правним начелима и економским принципима деловања.

Након одређених историјских догађаја, попут смрти Јосипа Броза Тита, као и других међународних утицаја на рад покрета, све гласнији су неспоразуми, противници истичу трошење средстава а малу ефикасност и одлучност. Судбину покрета одредили су познати

светски догађаји почетком деведесетих година и оставили покрет на идеји и синтези интереса као основи деловања у међународним односима.

Једини опипљив дипломатски успех несврстаних земаља била је деколонизација Јужне Родезије, односно стварање независног Зимбабвеа 1980. године (DeRoche, 2016).

Можемо рећи да се у последње време појавило само неколико студија, које су засноване на архивским истраживањима које се на овај или онај начин дотичу периода глобалне несврстаности (Jackson, 1983).

4. Недостаци и елементи неефикасности принципа одрживости покрета несврстаности

Историја покрета несврстаних током осамдесетих година 20. века, као и југословенске улоге у том процесу, није била детаљније обрађена у историјској литератури, већ се архивска грађа налази у архивским документима код нас и у свету. Треба констатовати да је покрет ипак одиграо једну од централних улога у процесу глобалног преговарања по разним питањима (Чавошки, 2022). Велика политичка мимоилажења на шестом самиту несврстаних у Хавани септембра 1979. године између Јосипа Броза Тита и Фидела Кастра, који је у суштини усвојио идеја Тита оставио је покрет у тешкој међународној политичкој позицији, са све већим могућностима утицаја блоковских земаља на политички процес и усмеравање покрета.

Многи у покрету позивају на то да се Куба избаци из покрета, што би несумњиво довело до институционалног слома организације (Getchell, 2020).

Све ово ставило је сам покрет у незавидну ситуацију, и то баш у тренутку када се захуктавала нова рунда блоковског сукобљавања која ће обележити прву половину осамдесетих година 20. века, а која је, по својој жестини и заоштреној идеолошкој реторици, као и бројним оружаним сукобима, стварала могућност избијања нуклеарног рата (Чавошки, 2024).

Позиција покрета је била све сложенија, и сама подела улази у критичну фазу лидерства, као једног од темељних постулата постојања и одрживости. Управо је одлазак Тита са политичке сцене оставио покрет, а и саму Југославију рањивом, и створио услове да сама организација крене у другом правцу од принципа одрживости и

начела постојања. Сама историја покрета и улога Југославије није довољно обрађена у историјској литератури, иако је покрет што се у данашњем свету јако увиђа имао елементе праведности и економске користи за цео правдољубиви свет. Постоји неколико анализа и студија заснованих на југословенским и западним архивама, а међу најпознатијим је студија професора Јована Чавошког. Без обзира на све околности рада и тадашњи глобални политички тренутак, убиство Индире Ганди 1984. године оставило је покрет несврстаних без вође. То је изазвало дубоку кризу ауторитета, која је, из више разлога, постала главна претња за опстанак покрета. Сам покрет у периоду хладног рата често није имао јасне ставове и принципе, на основу којих би се очекивали резултати. Наредни историјски период одлучио је судбину Југославије као места оснивања покрета, али и судбину самог покрета који у датом историјском и међународном политичком тренутку губи компас.

5. Закључак

На основу расположиве литературе и посебно ставова учесника на конференцијама несврстаних земаља, може се закључити да је покрет имао циљ увођење правних норми које би путем Уједињених нација омогућавале мир у што већем делу човечанства, али и економску заштиту сиромашних земаља кроз њихову борбу против колонијализма и неоколонијализма. Покрет несврстаних имао је иницијалну позитивну улогу у међународним односима, што се потврђује учешћем тада сиромашнијих земаља у данашњим глобалним међународним процесима. Поред ових главних закључака, идеја несврстаних и данас има велики број иницијатива и присталица јер у основи представља праведан светски правни и економски поредак заснован на међународном праву и односима који у основи подразумева равноправност међу државама и народима и као такав свакако има перспективу.

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NON-ALIGNED MOVEMENT – LEGAL PRINCIPLES AND ECONOMIC INTERESTS

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Abstract

International relations have always been complex, depending on the state of politics and social conditions in the world, and have represented acceptable or unacceptable principles in the political environment. One of the special movements that emerged in international relations is the Non-Aligned Movement. Aware of bloc and economic divisions, the founders of the Non-Aligned Movement wanted to achieve some of their goals in the international community. The aim of the paper is to show that other participants in international relations can also contribute to active peaceful coexistence and contribute to preventing divisions at the global level, which ultimately implies a fairer legal order and economic benefit. The results show that the ideas of the Non-Aligned Movement contributed to preventing undesirable international events and to a fairer legal and political environment.

Keywords: *international relations, Non-Aligned Movement, economic and legal principles*

1. Introduction

The Non-Aligned Movement emerged as a policy for regulating relations in the world as a whole on an acceptable platform that would have a certain significance in international relations. The Non-Aligned Movement emerged on the platform of the bloc division of the world after the Second World War, as well as international crises and threats to the world in the context of provoking various types of conflicts. It actually sought to bring together countries that did not seek to accept the concepts of the bloc division of the world, that is, it sought to establish a long-term social and historical connection based on legal principles and the economic interests of all.

It is a matter of the most prevalent aspiration of peoples and their active struggle to achieve full national freedom and to ensure the right to develop socially within that freedom in accordance with their own choice

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(Kardelj, 1997). The aim of the movement is, in fact, an attempt to prevent conflicts and to prioritize the interests of the international community in a broader context over the individual goals of the movement's members or collective interests. With very limited legal and economic capabilities, the member countries of the movement attempted to draw attention to other priorities in international relations, in relation to the possibility of new major wars breaking out and the prevention of increasing poverty.

Accordingly, the non-aligned world, at any stage of its evolution, always had a clear political face in the form of prominent leaders who came from several continents, while the Yugoslav President Tito, in this regard, enjoyed both the longest tenure and the greatest respect among his fellow leaders (Čavoški, 2024).

Thus, the movement had sound principles of establishment and functioning under the given circumstances of international politics and sought to establish democratic principles of decision-making and transfer diplomatic activities to the United Nations. Emphasis was placed on the reactivation of peaceful policies and the analysis of activities, with the aim of achieving successful results and developing a practical role for the movement.

In this way, the policy of bloc division in the world was opposed in the democratic development of international relations, based on the UN Charter (Marković, 2021).

The aim of the paper is to lead the reader to the conclusion that the Non-Aligned Movement, at a given moment in international relations, sought to achieve an acceptable concept for achieving its goals within the international community, primarily avoiding all conflicts and, in particular, bloc confrontation. There is significant literature on this subject in our country and around the world, which is primarily found in documents and archival material, but there is a lack of analysis of the power of non-aligned countries and their capacity to oppose bloc division and identify common factors.

2. Founding and Principles of Establishment

The founding of the Non-Aligned Movement was preceded by numerous meetings and conferences of newly liberated states and movements aimed at creating conditions for the advancement of anti-bloc tendencies. The Bandung Conference, in its essence, according to the content of the conclusions it adopted, upheld the spirit of non-alignment, as it created

conditions for the advancement of anti-bloc tendencies and the policy of independence (Tadić, 1968).

One of the most important such meetings, or diplomatic events, was the initiative of Tito, Nehru, Nasser, Sukarno, and Nkrumah at the headquarters of the United Nations in New York in 1960. The most important events in the founding and work of the Non-Aligned Movement are three conferences:

- Founding Conference in Belgrade in 1961, where the organization of non-aligned countries was established and the principles and guidelines for its functioning were presented.
- Conference in Algiers in 1973, which took place during the oil crisis and created opportunities for the economic interests of the movement's members.
- Conference in 1979, where a declaration on the purpose of the existence of the Non-Aligned Movement was adopted, in which the following were identified as the most important objectives of the movement:
    - National independence
    - Sovereignty
    - Territorial integrity and security of non-aligned countries
    - The struggle against imperialism, colonialism, neocolonialism, apartheid, racism, including Zionism
    - All forms of aggression, occupation, domination, interference, or hegemony
    - Bloc politics (Radovanović, 1973).

Thus, mutual cooperation and collaboration in relations between the superpowers and blocs meant for the movement the possibility of their involvement in world politics and events in the international community.

On the other hand, the inability of the newly established regimes in the non-aligned countries to properly address economic problems led to constant political instability in those countries, while turbulent internal political upheavals, in turn, resulted in frequent coups (Indonesia, Cambodia, Ghana, Nigeria) (Bogetić, 2018).

The fundamental principles on which the Non-Aligned Movement insists in the process of nuclear disarmament are transparency, verification, and irreversibility (Kostić, 2021). However, despite their official commitment to disarmament, the non-aligned countries retained the possibility and the right to self-defense and to possess various types of

conventional weapons as a guarantee for the realization of their principles and objectives, which guarantee economic exploitation, the struggle against colonialism, and interference in the sovereignty and territorial integrity of states through the emergence and sponsorship of separatism.

Based on the available historical literature and a review of websites, the key principles underlying the founding and activities of the Non-Aligned countries are:

- Independent foreign policy
- Refraining from joining military alliances
- Prohibition of establishing military bases
- Support for decolonization
- Sovereignty and equality.

From the aforementioned fundamental principles and founding principles of the movement, we can see that the central issue was related to the problems of colonialism, racism, and apartheid, which, during the political debates held at the conferences, primarily concerned African countries. This concerned the poverty and colonialism of African countries and the struggle against neocolonialism. In relation to this issue, as many as five separate resolutions were adopted (AJ, KPR, 1970). It should be noted that almost complete agreement was reached among the member countries of the movement on this issue, which represents the implementation of one of the fundamental postulates of its founding: the struggle against poverty.

3. Role of Non-Aligned Countries in the Functioning of International Relations

The "Golden Age of Non-Alignment" during the 1980s was closely associated with the rise of détente in relations between the blocs and superpowers, a period when negotiation and cooperation in all fields were the key guiding principles of international politics, while, despite certain crises in the Third World, maintaining overall global stability and promoting further socio-economic and technological development of the world were in the primary interest of all actors (Čavoški, 2024).

The movement, like many other international organizations, experienced both major successes and setbacks in its work. The greatest problems arose during conflicts within the member states themselves or in certain neighboring countries due to unresolved historical and territorial issues. Defense financing is an integral part of the overall expenditure of every

national economy and has the character of public expenditure, aimed at providing the human and material resources necessary for carrying out specific tasks related to defense preparation and its successful implementation (Mihajlović, Savić, 2022).

International events also dictated the topics of the conferences, such as the conflict in the Middle East in 1967 and the crisis in the Warsaw Pact in 1968. The Third Non-Aligned Summit Conference was held in Lusaka in 1970, where topics other than war and conflicts dominated, and discussions focused on issues of the international economic order and the political position of non-aligned countries within such an international order. At that conference, two very important documents were adopted, which were, in fact, programmatic documents for further work, namely:

- Declaration on Peace, Independence, Development, Cooperation and Democratization of International Relations
- Declaration on Non-Alignment and Economic Development.

An important conference was the Fourth Non-Aligned Conference in Algiers in 1973, which was attended by 75 full members, as well as three European countries as "guests" (observers) (Finland, Sweden, Austria). The main topics concerned the fields of economy, science, technology, and social benefits, as well as a special document on the coordination of the Non-Aligned Movement regarding issues of cooperation and development. At the Fifth Summit Conference, held in Sri Lanka, the largest number of countries up to that time (85) participated, as well as important guests (Finland, Sweden, Austria, the Philippines, Portugal, Romania, Switzerland). This conference is known for achieving greater coordination and institutionalization concerning the achievement of its objectives. At this conference, the movement expressed unity with the fundamental legal principles and economic principles of its activities.

Following certain historical events, the death of Josip Broz Tito, as well as other international influences on the work of the movement, disagreements became increasingly vocal, while opponents emphasized the expenditure of resources and low efficiency and decisiveness. The fate of the movement was determined by well-known world events in the early 1990s, leaving the movement based on the idea and synthesis of interests as the foundation of its activities in international relations.

The only tangible diplomatic success of the Non-Aligned countries was the decolonization of Southern Rhodesia, that is, the establishment of independent Zimbabwe in 1980 (DeRoche, 2016).

We can say that only a few studies have appeared in recent times, based on archival research, which in one way or another address the period of global non-alignment (Jackson, 1983).

4. Shortcomings and Elements of Inefficiency in the Principle of Sustainability of the Non-Aligned Movement

The history of the Non-Aligned Movement during the 1980s, as well as Yugoslavia's role in that process, has not been examined in greater detail in the historical literature, but archival material can be found in archival documents in our country and around the world. It should be noted that the Movement nevertheless played one of the central roles in the process of global negotiations on various issues (Čavoški, 2022). The major political disagreements at the Sixth Non-Aligned Summit in Havana in September 1979 between Josip Broz Tito and Fidel Castro, which essentially adopted Tito's idea, left the movement in a difficult international political position, with increasing possibilities for the influence of bloc countries on the political process and the direction of the movement.

Many within the movement called for Cuba to be expelled from the movement, which would undoubtedly have led to the institutional collapse of the organization (Getchell, 2020).

All of this placed the Movement itself in an unfavorable position, precisely at the moment when a new round of bloc confrontation was gaining momentum, which would mark the first half of the 1980s and which, due to its intensity and increasingly confrontational ideological rhetoric, as well as numerous armed conflicts, created the possibility of the outbreak of a nuclear war (Čavoški, 2024).

The position of the movement became increasingly complex, and the division itself entered a critical phase of leadership, as one of the fundamental postulates of its existence and sustainability. Tito's departure from the political scene left both the movement and Yugoslavia vulnerable and created conditions for the organization itself to move in a different direction from the principles of sustainability and the principles of its existence. The history of the movement and the role of Yugoslavia have not been sufficiently addressed in the historical literature, although the movement, as is increasingly recognized in the contemporary world, had elements of justice and economic benefit for the entire justice-oriented world. There are several analyses and studies based on Yugoslav and Western archives, among the most notable being the study by Professor Jovan Čavoški. Regardless of all the circumstances

surrounding the movement's activities and the political situation in the world at the time, as well as the assassination of Indira Gandhi in 1984, the movement was left without a leader, which represented a constant threat to the movement for various reasons, and the crisis of authority became the main threat to the movement. During the Cold War, the movement itself often did not have clear positions and principles on the basis of which results could be expected. The subsequent historical period determined the fate of Yugoslavia as the place where the movement was founded, but also the fate of the movement itself, which, at that particular historical and international political moment, lost its compass.

5. Conclusion

Based on the available literature and, in particular, the views of participants at conferences of the Non-Aligned countries, it can be concluded that the movement aimed to introduce legal norms that, through the United Nations, would enable peace for as much of humanity as possible, as well as economic protection of poorer countries through their struggle against colonialism and neocolonialism. The Non-Aligned Movement had an initially positive role in international relations, which is confirmed by the participation of the poorer countries of that time in today's global international processes. In addition to these main conclusions, the idea of non-alignment still has a large number of initiatives and supporters today because it essentially represents a just world legal and economic order based on international law and relations, which fundamentally implies equality among states and peoples and, as such, certainly has prospects.

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