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SUVREMENI PRISTUPI JEZIKU, KOMUNIKACIJI  
I TEHNOLOGIJI



**SUVREMENI PRISTUP JEZIKU, KOMUNIKACIJI I TEHNOLOGIJI**  
**Zbornik radova s međunarodnoga znanstveno-stručnog skupa**  
**Modern Aspirations**  
**održanoga 22. svibnja 2025. godine u Splitu**

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Veleučilište Aspira, Split, 2026.

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## PREDGOVOR

Ovaj zbornik radova nastao je kao rezultat prve znanstveno-stručne konferencije **Modern Aspirations**, u organizaciji Veleučilišta Aspira. Cilj konferencije bio je okupiti znanstvenike i stručnjake iz različitih područja te pokušati odgovoriti na neke od suvremenih izazova u obrazovanju, komunikaciji i tehnologiji. Polazeći od ideje da se suvremeni društveni problemi ne mogu tumačiti ni rješavati unutar uskih disciplinarnih okvira, konferencija (pa i zbornik) ističu važnost interdisciplinarnog pristupa.

Radovi uvršteni u ovaj zbornik tematski su raznoliki, ali povezuje ih fokus na aktualna pitanja znanja, kompetencija i prakse u suvremenom društvu. Poseban naglasak stavljen je na jezik i komunikaciju u profesionalnom i obrazovnom kontekstu te na ulogu tehnologije u oblikovanju novih obrazaca rada, učenja i suradnje. Autori se bave pitanjima razine i uloge znanja stranog jezika, motivacije za učenje, komunikacijskih potreba određenih profesionalnih sektora, ali i širim temama poput forenzičke lingvistike, zaštite intelektualnog vlasništva te sigurnosti i razvoja softverskih rješenja.

Zbornik odražava suvremene aspiracije akademske i stručne zajednice: povezivanje teorije i prakse, otvaranje prostora za empirijska istraživanja usmjerena na stvarne potrebe profesionalnih okruženja te poticanje suradnje između obrazovnih institucija i profesionalnih sektora. Upravo se u tome krije njegova vrijednost – radovi ne nude isključivo teorijske uvide, već i konkretne implikacije za nastavu, poslovnu komunikaciju, tehnološki razvoj i interdisciplinarna istraživanja.

Objavom ovog zbornika nastojimo pridonijeti razvoju znanstvene i stručne rasprave te potaknuti daljnja istraživanja u područjima obrazovanja, jezika, komunikacije i tehnologije. Vjerujemo da će radovi objedinjeni u ovom izdanju biti poticajni ne samo autorima i sudionicima konferencije, nego i široj akademskoj i stručnoj javnosti.

Zahvaljujemo svim autorima na doprinosu, recenzentima na stručnim i konstruktivnim komentarima te organizatorima konferencije na uloženom trudu. Nadamo se da će ovaj zbornik poslužiti kao poticaj za buduće znanstvene i stručne susrete.

Branka Šegvić i Đurđica Vukić

## FOREWORD

These conference proceedings have been prepared as a result of the first scientific and professional conference Modern Aspirations, organized by Aspira University of Applied Sciences. The aim of the conference was to bring together scholars and professionals from various fields and to address some of the contemporary challenges in education, communication, and technology. Starting from the idea that contemporary social issues cannot be interpreted or resolved within narrow disciplinary frameworks, the conference (and, consequently, these conference proceedings) emphasize the importance of an interdisciplinary approach.

The papers included in these conference proceedings are thematically diverse, yet they are connected by a shared focus on current issues of knowledge, competencies, and practice in contemporary society. Particular emphasis is placed on language and communication in professional and educational contexts, as well as on the role of technology in shaping new patterns of work, learning, and collaboration. The authors address issues related to the level and role of foreign language proficiency, motivation for learning, communication needs of specific professional sectors, as well as broader topics such as forensic linguistics, intellectual property protection, and the security and development of software solutions.

These conference proceedings reflect the contemporary aspirations of the academic and professional community: the integration of theory and practice, the creation of space for empirical research oriented towards the real needs of professional environments, and the encouragement of cooperation between educational institutions and professional sectors. It is precisely in this integration that their value lies – the papers do not offer exclusively theoretical insights, but also provide concrete implications for teaching, business communication, technological development, and interdisciplinary research.

By publishing these conference proceedings, we seek to contribute to the development of scientific and professional discourse and to encourage further research in the fields of education, language, communication, and technology. We believe that the papers collected in these conference proceedings will be stimulating not only for the authors and conference participants, but also for the wider academic and professional community.

We extend our gratitude to all authors for their contributions, to the reviewers for their expert and constructive comments, and to the conference organizers for their dedicated efforts. We hope that these conference proceedings will serve as an incentive for future scientific and professional gatherings.

Branka Šegvić and Đurđica Vukić

# **Analiza razina znanja poslovnog engleskog jezika studenata Veleučilišta Aspira i prilagodba nastavnih materijala**

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## **SAŽETAK**

*CEFR (Common European Framework of Reference for Languages) ili Zajednički europski referentni okvir za jezike sustav je koji se koristi za ocjenjivanje i opisivanje jezičnih vještina i sposobnosti na standardiziran način, a definira šest razina jezične kompetencije, od najnižih (A1) do najviših (C2). Cilj ovog rada je analiza te usporedba razine znanja poslovnog engleskog jezika studenata prve godine Sportskog menadžmenta i studenata na studiju Međunarodnog menadžmenta u hotelijerstvu i turizmu Veleučilišta Aspira kako bi se istražila potreba za prilagodbom nastavnih materijala prema razlikama u njihovim jezičnim vještinama. Polazi se od pretpostavke da većina studenata posjeduje B1+/B2 razinu poslovnog engleskog jezika te da su upoznati s osnovama pa im je potreban zahtjevniji i složeniji nastavni sadržaj koji bolje odgovara njihovom predznanju i potrebama na tržištu rada. Stoga, može se zaključiti da je razina B1+/B2 prejednostavna za većinu studenata poslovnog engleskog na studiju Međunarodnog menadžmenta u hotelijerstvu i turizmu, kao i na Sportskom menadžmentu. Temeljem analize pisanih testova i zapisnika s usmenih ispita ispituje se i druga hipoteza koja pretpostavlja da studenti obaju studijskih smjerova uspješnije rješavaju zadatke čitanja i slušanja, nego pisanja, odnosno da lakše savladavaju pasivne nego aktivne vještine. Usporedbom i analizom pisanih zadataka na temelju 30 ispita utvrđeno je da su studenti podjednako uspješni u rješavanju zadataka čitanja, dok se razlika očituje u vještinama slušanja gdje studenti Međunarodnog menadžmenta u turizmu i hotelijerstvu pokazuju bolje rezultate. Na temelju dobivenih rezultata, preporučuje se prilagodba nastavnih materijala s ciljem unapređenja specifičnih*

vještina. Također, potrebno je razmotriti unaprjeđenje nastavnih sadržaja poput pisanih tekstova i popratnih vježbi kako bi se osigurao veći izazov i poticanje razvoja komunikacijskih vještina kod studenata obaju studija.

**Ključne riječi:** CEFR, individualne razlike, nastavni materijali, razine poznavanja engleskog jezika

## 1. UVOD

Engleski jezik zauzima središnje mjesto u suvremenom poslovnom i akademskom kontekstu, posebice u područjima poput sportskog menadžmenta i turizma. Kao globalni *lingua franca*, engleski jezik omogućuje nesmetanu komunikaciju među govornicima različitih materinskih jezika te se smatra ključnim za profesionalnu uspješnost na globaliziranom tržištu rada (Byram, 1997; Culpeper, 2018). Poslovni engleski jezik usmjeren je na razvoj jezičnih vještina relevantnih za poslovnu komunikaciju, a njegovo kvalitetno usvajanje prepoznato je kao jedan od preduvjeta za konkurentnost na tržištu (Hutchinson i sur., 1987; Harding, 2007). Unatoč uvođenju poslovnog engleskog jezika u visokoškolske kurikulume, često se zanemaruje stvarna razina jezične kompetencije studenata prilikom oblikovanja nastavnih materijala (Dudley-Evans, 1998). Upravo zato u ovom se radu analiziraju razine znanja poslovnog engleskog jezika studenata prve godine dvaju studijskih smjerova na Veleučilištu Aspira, Sportskog menadžmenta te Međunarodnog menadžmenta u hotelijerstvu i turizmu, kako bi se utvrdilo jesu li postojeći nastavni sadržaji primjereni njihovim jezičnim sposobnostima. Temeljni referentni okvir istraživanja je CEFR (Common European Framework of Reference for Languages), koji razvrstava jezične kompetencije u šest razina, od A1 do C2, i koji je široko prihvaćen kao standard u obrazovanju (Council of Europe, 2001; North, 2011).

S obzirom na to da studenti Veleučilišta Aspira moraju položiti minimalno nižu razinu ispita državne mature iz engleskog jezika, polazi se od pretpostavke da je njihovo predznanje ujednačeno, no kako sami studenti navode, češće se odlučuju za višu razinu ispita. Također, podaci NCVVO-a<sup>1</sup> pokazuju da engleski jezik redovito ostvaruje najbolje prosječne ocjene u usporedbi s ostalim obveznim predmetima što potvrđuje da studenti imaju relativno visoku razinu predznanja pri upisu na studij. Dakle, iz toga se može zaključiti da su nastavni

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<sup>1</sup> [https://www.srednja.hr/app/uploads/2025/07/Konacni-rezultati-\\_DM-2025\\_16\\_7\\_VF\\_FINALNA.pdf](https://www.srednja.hr/app/uploads/2025/07/Konacni-rezultati-_DM-2025_16_7_VF_FINALNA.pdf) (zadnje posjećeno 15. kolovoza 2025.)

sadržaji i razina B1/B2 na kolegiju Poslovni engleski jezik 1 prejednostavni u odnosu na stvarne sposobnosti studenata, što je u skladu s prethodnim istraživanjima koji ističu potrebu preciznije prilagodbe nastavnih materijala u ESP kontekstu. Kako je navedeno u istraživanju Blažević i sur. (2023), materijali koji se koriste u nastavi ESP često nisu prikladni za određene grupe studenata. U istraživanju se navodi kao jedan od primjera kolegij Engleski jezik u prirodnim znanostima u kojem je uočeno da u nastavnim materijalima nije stavljen dovoljno velik naglasak na tehnički vokabular već se ističu komunikacijske vještine. Također, navodi se i problematika edukacije predavača koja je slabo dostupna u Hrvatskoj. Sve to potvrđuje da je potrebno prilagoditi nastavni plan i materijale prema vrsti vokabulara i prema potrebama studenata. Nadalje, studenti uspješnije rješavaju zadatke koji uključuju pasivne vještine (čitanje i slušanje), dok pokazuju slabije rezultate u aktivnim vještinama poput pisanja i govorenja. Zaključci prethodnih istraživanja potvrđuju ovaj stav te navode da se jezici usvajaju ponajprije kroz receptivne procese (slušanje i čitanje razumljivog inputa), a produkcija (govor, pisanje) dolazi kasnije, kao “posljedica” usvajanja. (Krashen, 1985). Nadalje, u istraživanju koje je provela Vrhovac (2001), uloga govorne interakcije te produkcije postavlja se kao ključna. Odnosno, aktivne vještine moraju dobiti veću ulogu u nastavi.

Svrha ovoga rada je analizom testova potkrijepiti tvrdnje da su nastavni materijali kolegija Poslovni engleski jezik 1 prejednostavni za nove generacije studenata te dokazati da studenti uspješnije razvijaju pasivne u odnosu na aktivne jezične vještine. Metodološki, rad se temelji na analizi trideset pisanih i usmenih ispita, a rezultati se interpretiraju kroz kvalitativnu sintezu podataka. Dobiveni rezultati poslužit će kao podloga za prijedloge prilagodbe nastavnih materijala, s ciljem poboljšanja učinkovitosti nastave poslovnog engleskog jezika i podizanja razine jezičnih kompetencija studenata.

## **2. TEORIJSKI OKVIR**

Učenje jezika u kontekstu visokog obrazovanja, posebice specijaliziranih studijskih programa poput Sportskog menadžmenta i Međunarodnog turizma, zahtijeva sustavni pristup koji uzima u obzir specifične profesionalne potrebe studenata. Poslovni engleski kao predmet treba biti oblikovan u skladu s jezičnim kompetencijama studenata, kao i s njihovim budućim stručnim okruženjem (Hutchinson i sur., 1987; Dudley-Evans i sur., 1998). U tom smislu,

Zajednički europski referentni okvir za jezike (CEFR) pruža ključni alat za procjenu i usmjeravanje nastave jezika (Vijeće Europe, 2001; North, 2011).

CEFR je dokument Vijeća Europe, a predstavlja standardizirani alat za procjenu, opis i planiranje učenja jezika (Vijeće Europe, 2001). Okvir definira šest razina jezične kompetencije: A1 i A2 (početne), B1 i B2 (srednje) te C1 i C2 (napredne). Svaka razina opisuje što učenik „može“ učiniti u odnosu na vještine slušanja, čitanja, govorenja i pisanja. U visokoškolskom obrazovanju, razine B1+/B2 smatraju se pragom funkcionalne pismenosti u stranom jeziku za akademske i profesionalne svrhe (North, 2011). Međutim, pojedini autori naglašavaju kako CEFR, iako koristan, ne nudi dovoljno smjernica za oblikovanje nastavnih sadržaja u specifičnim profesionalnim kontekstima (Little, 2006; Basturkmen, 2010). Stoga se u nastavi poslovnog engleskog preporučuje kombinacija CEFR-a i analize potreba studenata, čime se osigurava usklađenost nastavnih sadržaja s realnim komunikacijskim situacijama (Byram, 1997; Culpeper, 2018). Primjena CEFR-a u poslovnom engleskom jeziku za studente menadžmenta, turizma i sporta može poslužiti kao početna točka, no učinkovit kurikulum trebao bi uključivati i profesionalno orijentirane zadatke, poput pisanja hotelskih izvještaja, izrade marketinških prezentacija ili vođenja pregovora o sportskim ugovorima. Time se postiže ravnoteža između standardiziranog mjerenja kompetencija i autentičnih potreba studenata.

Poslovni engleski dio je šireg područja engleskog jezika struke (ESP), koje naglašava važnost usklađivanja jezične nastave s potrebama određene struke (Hutchinson i sur., 1987; Dudley-Evans i sur., 1998). ESP se temelji na načelu da učenje jezika mora biti svrhovito i povezano s potrebama ciljne skupine učenika. U visokoškolskim programima vezanim za menadžment, turizam i sport, poslovni engleski jezik ima zadatak razviti funkcionalne kompetencije u specifičnim komunikacijskim situacijama: vođenje sastanaka, pisanje e-mailova, pregovaranje, prezentiranje i izradu poslovne dokumentacije (Harding, 2007). U tom smislu, poslovni engleski jezik u visokoškolskom obrazovanju ne bi se trebao temeljiti samo na općim jezičnim strukturama, već na specifičnom stilu, žanrovima i komunikacijskim situacijama koje studenti mogu očekivati u svom profesionalnom životu (Dudley-Evans i sur., 1998).

Ovaj rad usmjeren je na dva specifična poslovna sektora, turizam i sport. Razlike između sportskog menadžmenta i menadžmenta u turizmu i hotelijerstvu pokazuju važnost prilagodbe nastavnih sadržaja. U turizmu i hotelijerstvu naglasak je na međukulturalnoj komunikaciji i interakciji s gostima i klijentima

te pružanju usluga i pregovaračkim vještinama, dok sportski menadžment zahtijeva terminologiju i komunikacijske obrasce vezane uz organizaciju događaja, ugovaranje sponzorstva te sportsku diplomaciju (Harding, 2007). Ove specifičnosti potvrđuju da jedinstveni kurikulum poslovnog engleskog može biti nedostatan te da je potrebna ciljano oblikovana nastava (Blažević, 2023).

## 2.1. Aktivne i pasivne jezične vještine

Jezične vještine dijele se na pasivne (čitanje i slušanje) i aktivne (pisanje i govorenje). Prema modelu komunikacijske kompetencije Canalea i Swaina (1980), jezična sposobnost obuhvaća ne samo gramatičku točnost, već i sociolingvističku, diskurzivnu i strategijsku kompetenciju. Upravo te razine kompetencije čine pisanje i govorenje složenijima od pasivnih vještina čitanja i slušanja. Studenti u kontekstu poslovnog engleskog jezika često pokazuju nedostatke upravo u aktivnim vještinama – pisanju i govorenju – jer one zahtijevaju integraciju više razina jezične kompetencije, uključujući pragmatičku i kulturnu dimenziju (Byram, 1997). Studenti postižu bolje rezultate u pasivnim vještinama jer im je dostupno mnogo razumljivog sadržaja kroz medije i obrazovne materijale (Krashen, 1985). Aktivne vještine, naprotiv, zahtijevaju veću jezičnu samostalnost, sigurnost u izražavanju i poznavanje konteksta, što predstavlja veći izazov (Vrhovac, 2001). Razlog uspješnijeg savladavanja pasivnih vještina može se pronaći i u teoriji usvajanja jezika Krashena (1985), koja razlikuje „pristup inputu“ (*comprehensible input*) i „hipotezu o afektivnom filtru“. Studenti su izloženi velikoj količini razumljivog sadržaja (čitanje tekstova, gledanje medijskih sadržaja), dok je aktivno izražavanje često ograničeno zbog manjka prakse, straha od pogrešaka i nedostatka strategija za ispravljanje pogrešaka. To je posebno vidljivo u pisanju formalnih poslovnih tekstova, gdje se od studenata očekuje visoka razina točnosti i stilističke prikladnosti.

Učenje jezika snažno je uvjetovano individualnim razlikama, među kojima se motivacija, predznanje i strategije učenja ističu kao ključni faktori (Dörnyei, 2005). Motivirani studenti češće traže prilike za aktivnu uporabu jezika i pokazuju bolje rezultate u razvoju govorne i pisane komunikacije. Osim toga, iskustva međunarodne mobilnosti ili rada u multikulturnom okruženju dodatno povećavaju razinu sigurnosti u aktivnim vještinama (Culpeper, 2018; Blažević, 2023). U kontekstu studenata Veleučilišta Aspira, potrebno je uzeti u obzir različite obrazovne kontekste i razinu predznanja s kojom studenti dolaze. Iako izvješća NCVVO-a (2025) potvrđuju da, u prosjeku, studenti dolaze s relativno

visokim predznanjem engleskog jezika, ipak je potrebno naglasiti da njihova razina sigurnosti u komunikaciji i uporabi engleskog jezika može znatno varirati. To je dodatni argument za fleksibilniji pristup u oblikovanju nastavnih materijala.

### **3. CILJEVI ISTRAŽIVANJA**

Cilj ovog istraživanja jest analizirati razinu znanja poslovnog engleskog jezika studenata Veleučilišta Aspira te ispitati u kojoj mjeri postojeći nastavni materijali odgovaraju njihovim stvarnim potrebama na osnovi rezultata ispita. Posebna se pažnja posvećuje razlikama u vokabularu između područja turizma i sporta, što upućuje na potrebu ciljanog prilagođavanja nastavnih sadržaja kako bi oni bili relevantni za oba studijska smjera. U istraživanju se polazi od pretpostavke da studenti bolje usvajaju pasivne jezične vještine (čitanje i slušanje) u odnosu na aktivnu vještinu pisanja, koja im predstavlja veći izazov.

U skladu s navedenim, postavljene su dvije hipoteze:

- H1: Razina B1+/B2 prejednostavna je za većinu studenata poslovnog engleskog jezika na oba studija.
- H2: Studenti uspješnije rješavaju zadatke čitanja i slušanja nego pisanja, odnosno lakše savladavaju pasivne nego aktivnu vještinu pisanja.

### **4. METODOLOGIJA**

Metodologija istraživanja uključuje analizu 30 ispita iz kolegija Poslovnog engleskog jezika 1 koji su provedeni u prosincu 2024. godine, od kojih je 15 ispita prikupljeno sa studija Međunarodnog menadžmenta u hotelijerstvu i turizmu, a 15 sa studija Sportskog menadžmenta. Od ukupnog broja studenata na kolegiju Poslovni engleski jezik 1 obrađen je uzorak od 37,03% ispita. Ispiti su obuhvatili provjeru triju jezičnih vještina: slušanja, čitanja i pisanja. Vještina govorenja isključena je iz analize jer nije bilo moguće osigurati pouzdano i standardizirano vrednovanje, što predstavlja metodološko ograničenje istraživanja. Rezultati su analizirani primjenom kvantitativnih metoda.

#### **4.1. Opis uzorka i načina ispitivanja**

Uzorak obuhvaća 15 testova studenata Međunarodnog menadžmenta u hotelijerstvu i turizmu te 15 testova studenata Sportskog menadžmenta. Važno je

napomenuti da ispiti nisu isti i sadrže različitu terminologiju povezanu sa strukom te različite teme u zadatcima slušanja i čitanja. No, isti je koncept testova. U analiziranim testovima studenti su rješavali zadatke čitanja, pisanja i slušanja te zadatke koji obuhvaćaju vokabular i uporabu gramatičkih struktura. Zadatak čitanja obuhvaćao je 8 pitanja s izborom točno/netočno u kojem su studenti trebali odabrati slažu li se s navedenom tvrdnjom ili ne s obzirom na pročitani tekst. U zadatku slušanja studenti su također imali 8 ponuđenih rečenica za koje su trebali odlučiti jesu li točne ili netočne s obzirom na sadržaj koji su čuli iz audiozapisa. Oba zadatka obuhvaćala su teme koje su obrađivane u sklopu kolegija. Zadatak pisanja sastojao se od 5 pitanja, odnosno zadataka dopunjavanja formalne elektroničke pošte s frazama koje nedostaju, a koje su uobičajeni dio pisane poslovne komunikacije. Zadatci koji su uključivali vokabular i gramatičke strukture bili su formirani kao zadatci višestrukog izbora. Studenti su imali sveukupno 60 pitanja u testu i 45 minuta za ispunjavanje istog.

#### **4.2. Očekivani ishodi učenja**

Ishodi učenja kolegija Poslovni engleski jezik 1 uključuju razvoj sposobnosti razumijevanja stručnih tekstova, pisanja formalnih poslovnih poruka te usmene poslovne komunikacije. U skladu s načelom konstruktivnog poravnanja, zadatci u ispitu usklađeni su s predviđenim ishodima učenja kolegija. Zadaci čitanja povezani su s ishodom koji predviđa razumijevanje stručnih pisanih tekstova relevantnih za područja turizma, hotelijerstva i sportskog menadžmenta (ovisno o studiju), pri čemu se provjerava sposobnost prepoznavanja ključnih informacija i terminologije. Zadaci slušanja usmjereni su na ishod koji obuhvaća razumijevanje govorenog poslovnog diskursa, uključujući praćenje glavnih ideja i specifičnih detalja u autentičnim audiozapisima. Zadaci pisanja odgovaraju ishodu koji se odnosi na sposobnost pisanja koherentne, formalno primjerene poslovne elektroničke pošte, pri čemu se vrednuje upotreba odgovarajućih fraza, registara i strukture teksta. Na taj način, vrste zadataka izravno odražavaju ciljeve učenja i omogućuju provjeru kompetencija koje se očekuju na završetku kolegija.

## 5. ANALIZA

### 5.1. Analiza rezultata ispita

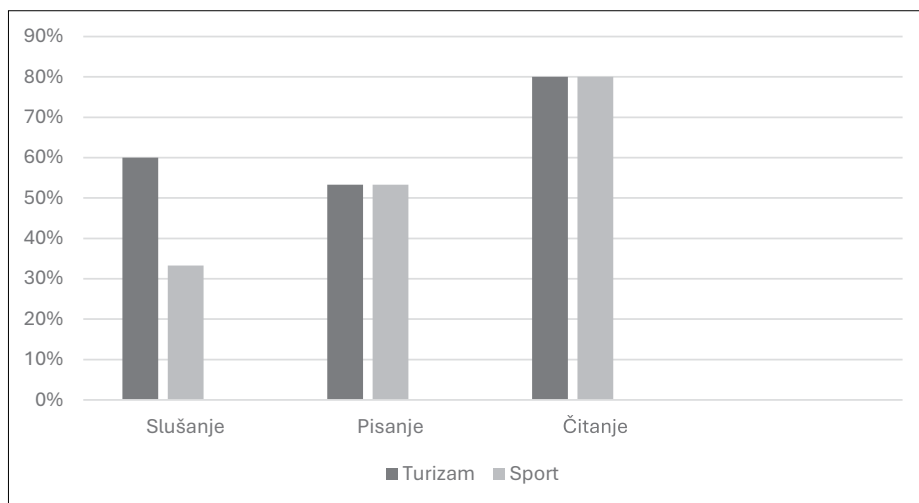
Ukupan broj studenata Veleučilišta Aspira u akademskoj godini 2024./2025. koji su upisali kolegij Poslovni engleski jezik 1 na studiju Međunarodnog menadžmenta u ugostiteljstvu i turizmu iznosio je 41, a na Sportskom menadžmentu 50 studenata. Na uzorku od 30 ispita (37,03%) analizirao se konačni uspjeh na prvom kolokviju iz Poslovnog engleskog jezika 1 za oba smjera. Od 30 testova, 18 testova imalo je ocjenu odličan što predstavlja 60%, a 8 studenata dobilo je ocjenu vrlo dobar. Iz toga se može zaključiti da je 86% studenata dobilo ocjenu odličan ili vrlo dobar. Za procjenu uspješnosti konačnih rezultata, uzet je prag riješenosti od 80% kao minimum za kojeg se smatra da predstavlja rezultat koji pretpostavlja visoku ocjenu. Uzevši u obzir da su kriteriji ocjenjivanja ispita za ocjenu odličan od 90 do 100%, a za ocjenu vrlo dobar od 80 do 89%, može se zaključiti da je razina zahtjevnosti testa niska s obzirom na to da je velika većina studenata dobila odlične i vrlo dobre ocjene.

Tim je rezultatima hipoteza da nastavni materijali koji podrazumijevaju B1+/B2 razinu poslovnog engleskog jezika, a koji su uobičajeni za prvu godinu studija, nisu dovoljno zahtjevni za studente prve godine Veleučilišta Aspira koji studiraju na studiju Međunarodnog menadžmenta u hotelijerstvu i turizmu te na Sportskom menadžmentu, potvrđena. No, iznimno dobre rezultate testa nije moguće isključivo povezati s nedovoljno zahtjevnom razinom nastavnih materijala bez uzimanja u obzir drugih čimbenika. Iznimno uspješni rezultati testova svakako su potaknuti i kvalitetom nastave te jasnoćom i načinom na koji su sadržaji obrađeni, kao i motivacijom studenata za učenje engleskog jezika u kontekstu struke. Važno je napomenuti da su i sami studenti kroz nastavu izrazili svoje mišljenje da su nastavni materijali prvog semestra lakši od očekivanog i da teško pronalaze nešto što im je novo i nepoznato. Upravo je i taj stav studenata bio jedan od poticaja za ovo istraživanje.

### 5.2. Analiza razlike između pasivnih i aktivnih jezičnih vještina

Cilj analize rezultata ispita bio je ispitati hipotezu koja tvrdi da studenti Međunarodnog menadžmenta u hotelijerstvu i turizmu i Sportskog menadžmenta na Veleučilištu Aspira uspješnije rješavaju zadatke koji podrazumijevaju pasivne jezične vještine (slušanje i čitanje) nego one koji podrazumijevaju aktivnu vještinu (pisanje).

Kako bi se postavila jasna odrednica uspješnosti, odličan rezultat podrazumijevao je da studenti imaju najviše jednu pogrešku ili nemaju niti jednu pogrešku po zadatku.



**Grafikon 1** *Usporedba rezultata zadataka iz vještina slušanja, pisanja i čitanja (izvor: autorice)*

Rezultati za vještine slušanja, pisanja i čitanja za obje skupine studenata vidljivi su u Grafu 1. Kada je riječ o studentima Međunarodnog menadžmenta u hotelijerstvu i turizmu, rezultati pokazuju da je prosječni postotak uspješnosti u dijelu vještina slušanja 60%, odnosno 9 od 15 studenata imalo je sve točne odgovore ili samo jednu pogrešku. U zadacima čitanja s razumijevanjem 12 od 15 studenata imalo je odličan uspjeh, odnosno 80% studenata.

U dijelu ispita koji se odnosi na pisanje, 53,3% studenata, odnosno 8 od 15, imalo je odličan uspjeh dok je u govorenju 10 od 15 studenata dobilo ocjenu odličan, a dodatna 4 vrlo dobar, što ukazuje na visoku razinu uspješnosti od 93%.

Kod studenata na studiju Sportskog menadžmenta, prosječni rezultat u zadacima slušanja je 33,3%, odnosno samo 5 od 15 studenata imalo je sve točne odgovore ili samo jednu pogrešku. U čitanju s razumijevanjem studenti Sportskog menadžmenta pokazali su isti rezultat (80%) kao i studenti Međunarodnog menadžmenta u hotelijerstvu i turizmu. Kod zadataka pisanja, rezultat je također bio isti kod obje skupine, 53.3%.

Kao što je vidljivo iz navedenih podataka, dobiveni rezultati ne potvrđuju razliku između uspješnosti u pasivnim i aktivnim vještinama ni kod jedne skupine studenata. Međutim, deskriptivni podaci pokazuju jasan podatak da su studenti podjednako uspješni u čitanju i pisanju, dok se rezultati razlikuju u slušanju. Također, kod studenata Međunarodnog menadžmenta u turizmu postoji razlika između aktivnih i pasivnih vještina. Rezultati pokazuju da je vještina pisanja najlošija, a posebno je neočekivan rezultat slušanja kod studenata Sportskog menadžmenta koji je lošiji od očekivanog. Zbog toga, kod studenata Sportskog menadžmenta, ne možemo govoriti o razlici između aktivnih i pasivnih vještina, dok kod studenata Međunarodnog menadžmenta u hotelijerstvu i turizmu uočavamo bolje rezultate kod pasivnih vještina.

## 6. REZULTATI

Rezultati analize testova obje skupine studenata potvrdili su prvu hipotezu istraživanja, prema kojoj nastavni materijali predviđeni za prvu godinu studija, a koji se temelje na B1+/B2 razini poslovnog engleskog jezika, ne predstavljaju dovoljan izazov studentima Veleučilišta Aspira upisanima na studij Međunarodnog menadžmenta u hotelijerstvu i turizmu te na studij Sportskog menadžmenta.

Suprotno tome, druga hipoteza nije potvrđena. Rezultati ne ukazuju na postojanje značajne razlike u uspješnosti između pasivnih jezičnih vještina (čitanje i slušanje) i aktivne vještine (pisanje) u jednoj od promatranih skupina. No, iako se ne uočavaju očite razlike, deskriptivni podaci sugeriraju određene specifičnosti među studentima različitih studijskih programa. Kod studenata Međunarodnog menadžmenta u hotelijerstvu i turizmu vidljiva je razlika između aktivnih i pasivnih vještina, ali ne u značajnom omjeru. Kod studenata na studiju Sportskog menadžmenta, rezultati su nešto lošiji kod vještine slušanja, što je zapravo suprotno početnoj pretpostavci da će aktivne vještine biti lošije od pasivnih. Neočekivano slabiji rezultati u vještini slušanja kod studenata Sportskog menadžmenta mogu se objasniti nizom čimbenika. Moguće je da je audio materijal bio terminološki zahtjevniji ili sadržajno udaljeniji od područja sportskog menadžmenta, što je studentima otežalo razumijevanje. Dodatno, studenti ovoga studija često su manje izloženi autentičnim govorima i poslovnom diskursu, što može dovesti do niže razine sigurnosti u praćenju složenijih audiozapisa. Na rezultate su mogli utjecati i tehnički elementi, poput brzine govora, akcenta govornika ili razine buke u učionici.

Zaključno, kao što je navedeno i u ranijim istraživanjima (Blažević i sur., 2023), važno je uočiti jasan cilj poučavanja Poslovnog engleskog jezika kako bi se nastavni materijali i sam tijek nastave usmjerili prema potrebama određene struke. Jasno je da u kontekstu turizma postoji veća potreba za razvijanjem svih vještina, i pasivnih i aktivnih, u usporedbi s kontekstom sportskog menadžmenta, no naglasak je ipak više na komunikaciji, odnosno na vještinama pisanja i govorenja te na unaprjeđenju komunikacijskih vještina. S druge strane, na studiju Sportskog menadžmenta, usvajanje komunikacijskih vještina poput pregovaranja, vođenja sastanaka i slično, te vještine slušanja preuzima dominantnu ulogu. Upravo su te ciljane potrebe ono što treba biti smjernica pri prilagodbi nastavnih materijala.

### **6.1. Preporuke**

Potrebno je dodatno raditi na razvijanju pisane kompetencije kod obje skupine studenata, a kod skupine studenata Sportskog menadžmenta, potrebno je razvijati i vještinu slušanja u skladu s potrebama struke. Nadalje, nastavne materijale treba prilagoditi tako da sadrže više pisanih zadataka i vježbi koje potiču strukturalno, terminološki te gramatički bogato izražavanje.

Za obje skupine studenata preporučuje se unaprjeđenje pisanih tekstova i složenijih zadataka razumijevanja teksta, čime bi se povećala zahtjevnost i omogućilo bolje razvijanje akademskih i profesionalnih kompetencija. S obzirom na to da su upravo u vještini čitanja obje grupe imale iznimno uspješan rezultat, može se zaključiti da su tekstovi prejednostavni i ne predstavljaju dobar temelj za unaprjeđenje ove vještine, no isto tako može značiti i da su studenti vještinu čitanja unaprijedili na kolegiju Poslovni engleski jezik 1. Stoga treba razmotriti i mogućnost da se promijeni način testiranja takvih zadataka čitanja te da ih se kombinira s vještinom pisanja u formi pisanja sažetka kako bi studenti istodobno vježbali vještinu razumijevanje teksta kao i vještinu pisanja. Na taj način studenti bi dobili izazovnije zadatke koji bi doprinijeli vježbanju aktivnih i pasivnih vještina.

Uzevši u obzir ograničenja istraživanja, u budućim istraživanjima preporučuje se analiza rezultata s većim uzorkom te uvrštavanje u istraživanje detaljnije statističke analize i vještinu govorenja te precizniji test koji je usmjeren na cjelokupnu vještinu pisanja.

## 7. OGRANIČENJA ISTRAŽIVANJA

Jedno od ključnih ograničenja istraživanja odnosi se na vještinu govorenja, koja je izostavljena iz analize. Usmeni ispiti provedeni tijekom kolegija pokazali su se teško usporedivima jer nisu svi studenti imali identične zadatke, a i sama procjena uključivala je visoki stupanj subjektivnosti nastavnika. Kako bi se osigurala pouzdanost rezultata, odlučeno je da se vještina govorenja isključi iz analize, a istraživanje se fokusira na tri mjerljive vještine – slušanje, čitanje i pisanje. Ovo ograničenje upućuje na potrebu razvoja standardiziranih instrumenata za procjenu govorne kompetencije u budućim istraživanjima. Nadalje, iako se vještina pisanja formalno provjerava kroz zadatak dopunjavanja elektroničke pošte, takav zadatak primarno mjeri poznavanje fraza i struktura, a ne samostalnu produkciju pisanog teksta. Stoga rezultati trebaju biti interpretirani s oprezom. Također, u radu nije izvršena statistička analiza podataka, a što može biti temelj budućeg kvantitativnog istraživanja. Još jedno ograničenje je broj analiziranih uzoraka koji predstavlja udio od 37,03 % od ukupnog broja napisanih testova na kolegiju Poslovni engleski jezik 1 za Međunarodni menadžment u ugostiteljstvu i turizmu i Sportski menadžment, što, iako daje jasan uvid, ipak predstavlja mali uzorak.

## 8. ZAKLJUČAK

Rezultati istraživanja potvrđuju teoretske postavke iz područja nastave Engleskog jezika u struci (ESP), prema kojima se nastavni materijali trebaju prilagođavati stvarnim jezičnim kompetencijama i profesionalnim potrebama studenata (Hutchinson i sur., 1987; Dudley-Evans i sur., 1998; Basturkmen, 2010). Prva hipoteza je potvrđena: ispiti iz kolegija Poslovni engleski jezik 1 pokazali su da većina studenata ostvaruje rezultate koji nadilaze B1+/B2 razinu, što ukazuje na to da trenutačni nastavni plan i program ne osigurava dovoljan izazov niti optimalno potiče razvoj komunikacijske kompetencije. Time se potvrđuje važnost načela koje ističe Harding (2007), a prema kojemu ESP nastava mora biti osmišljena u skladu s ulaznom razinom znanja i ciljevima studenata, kako bi bila motivirajuća i relevantna.

Druga hipoteza, prema kojoj se očekivalo da će studenti biti uspješniji u pasivnim nego u aktivnim vještinama, nije potvrđena analizom, no deskriptivni rezultati djelomično podupiru tvrdnje Krashena (1985) i Vrhovac (2001) o razlikama između receptivnih i produktivnih vještina. Pisanje se pokazalo

najslabijom vještinom, dok je čitanje ostalo najstabilnije, a aktivne vještine su pokazale bolje rezultate kod studenata Međunarodnog menadžmenta u turizmu. Neočekivano, studenti Sportskog menadžmenta pokazali su slabije rezultate u slušanju, što upućuje na potrebu detaljnijeg ispitivanja čimbenika koji utječu na razvoj te vještine.

Dobiveni rezultati ukazuju da je za daljnje unaprjeđenje kolegija Poslovnog engleskog jezika potrebno podići zahtjevnost zadataka na razinu B2+/C1, u skladu s CEFR smjernicama (Council of Europe, 2001; North, 2011), te obogatiti sadržaj vježbama koje razvijaju pisane kompetencije u specifičnim poslovnim kontekstima. Na taj bi se način nastava poslovnog engleskog uskladila s preporukama iz literature (Blažević, 2023), koja naglašava važnost autentičnih i izazovnih zadataka u razvoju stručne komunikacije.

U budućim istraživanjima preporučuje se uključivanje šireg uzorka studenata, kao i standardiziranih instrumenata za procjenu usmenih vještina, čime bi se osiguralo dublje razumijevanje specifičnih potreba različitih studijskih skupina. Time bi se omogućilo sustavno unaprjeđenje nastave poslovnog engleskog jezika, u skladu s teorijskim načelima ESP-a i zahtjevima globalnog tržišta rada.

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# **ANALYSIS OF BUSINESS ENGLISH PROFICIENCY LEVELS OF ASPIRA UNIVERSITY STUDENTS AND THE ADAPTATION OF TEACHING MATERIALS**

## **ABSTRACT**

*The CEFR (Common European Framework of Reference for Languages) is a system used to assess and describe language skills and abilities in a standardized way, as it defines six levels of language competence from the lowest (A1) to the highest (C2). This paper aims to analyse and compare the business English proficiency levels of first-year students of Sports Management and students in the International Management in Hospitality and Tourism program at Aspira University of Applied Sciences, in order to explore the need for adapting teaching materials according to differences in their language skills. It is assumed that most students possess a B1+/B2 level of business English and are familiar with the basics, thus requiring more advanced and complex teaching content that better corresponds to their prior knowledge and labour market needs. Consequently, it can be concluded that the B1+/B2 level is too simple for most business English students in both the International Management in Hospitality and Tourism and Sports Management programs. Based on the analysis of the written tests and oral exam records, a second hypothesis was examined, which assumes that students in both study programs perform better in reading and listening tasks than in writing, suggesting that they more easily acquire passive rather than active skills. A comparison and analysis of written tasks from 30 exams showed that students are equally successful in reading tasks, while differences appear in listening skills, where International Management in Hospitality and Tourism students achieve better results. Based on the findings, it is recommended to adapt teaching materials in order to enhance specific skills. Additionally, it is necessary to consider improving teaching content, such as written texts and accompanying exercises, to provide*

*greater challenge and foster the development of communication skills among students of both programs.*

**Keywords:** *CEFR, individual differences, teaching materials, English proficiency levels*

*Prethodno priopćenje / Preliminary communication*

## **The Role of Prior Level of Knowledge of General English Language on Motivation for Learning Business English**

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### **ABSTRACT**

*Learning Business English has become an essential component of contemporary education, reflecting the evolving communication demands of an increasingly internationalised labour market. However, individual differences among students significantly influence the process of acquiring language competencies. It is generally expected that students enrolled in a Business English course at a higher education level possess a certain degree of General English proficiency, which supports the acquisition of business-related language. This level is typically assumed to be B1+/B2 according to the Common European Framework of Reference for Languages (CEFR). The analysis suggests that students' prior knowledge levels often vary and, in many cases, exceed these expectations. Despite this, improvements in their Business English knowledge and skills do not appear to be directly correlated with their General English proficiency. This paper examines how students' prior knowledge of General English influences their motivation to learn Business English. Motivation is widely recognised as a central factor in language acquisition, contributing significantly to the development of linguistic competence. This leads to the initial premise that students with higher levels of motivation tend to achieve better results in Business English, regardless of their initial language proficiency. To explore this assumption, focus groups were organised at the University of Applied Sciences Aspira with first-year students in order to gain insight into their language proficiency, self-perception, and motivation for learning Business English, as well as the interrelationship between these factors. An open interview was conducted with 22 students—one group comprising international students and the other,*

*Croatian students. To enhance the reliability of responses and minimise the risk of socially desirable answers, the interviews were conducted by a peer student who had been carefully mentored and fully briefed on the study. All interviews were recorded and transcribed for analysis. Findings indicate that while most students entered the course with B1–B2 proficiency, prior knowledge alone did not predict success in acquiring Business English competencies. Instead, motivation emerged as the more significant factor shaping learning outcomes. Students with moderate linguistic proficiency often demonstrated higher motivation and greater engagement than their more advanced peers, suggesting that motivational orientation plays a critical role in navigating the linguistic, pragmatic, and professional demands of Business English. This outcome supports theoretical perspectives such as Schema Theory, Krashen's Input Hypothesis, and Dörnyei's L2 Motivational Self System, which highlight the interaction between prior knowledge, input processing, and motivational constructs in second language learning.*

**Key words:** *Business English, focus groups, motivation, prior level of knowledge*

## **1 INTRODUCTION**

At the Aspira University of Applied Sciences, Business English is introduced as a mandatory course from the first year of undergraduate studies in both *International Management in Hospitality and Tourism* and *Sports Management*. These programmes are designed to prepare students for dynamic, international careers in sectors where English is the dominant language of professional communication. Given the practical and industry-focused nature of these programmes, Business English is not taught as an isolated linguistic subject, but as a key tool for real-world communication, in meetings, emails, negotiations, and client interactions.

Students entering Aspira are expected to have at least a B1 level of General English, as this is the minimum language requirement for admission. However, in practice, their prior knowledge varies significantly. While some students enter with strong communicative skills and formal language abilities, others may struggle with grammar, vocabulary, or confidence in speaking. This variation becomes especially apparent once teaching and learning shift from General to Business English, which introduces more formal registers, specialised vocabulary, and culturally sensitive communication skills.

In addition to prior knowledge, another important factor influencing students' progress is motivation. Many students at Aspira choose their study programmes with a clear professional goal in mind, such as working in tourism, hospitality, or sports management internationally. For these students, Business English is not merely an academic requirement, but a practical asset that can enhance their employability and future career success. Others may perceive it as less relevant, particularly if they are uncertain about how the language will be used in their specific job roles.

Understanding the interaction between students' existing language proficiency and their motivational orientations is essential for developing effective pedagogical approaches within Business English courses. In light of these considerations, this study investigates how differences in students' prior knowledge and motivational levels influence their engagement, academic performance, and perceptions of the relevance of Business English at Aspira University of Applied Sciences.

### **1.1 General vs. Business English**

General English and Business English, while both based on the same core language system, serve different communicative purposes and are shaped by distinct sociolinguistic contexts. General English primarily focuses on everyday communication skills and aims to develop learners' competence in informal, non-specialized situations such as traveling, socializing, or consuming popular media. Teaching at this stage typically emphasizes fluency, comprehension, and grammatical accuracy through a broad range of familiar topics and situations (Richards, 2001; Harmer, 2007). Learners are encouraged to develop the four language skills—reading, writing, listening, and speaking, through exposure to authentic materials and communicative tasks suited for general use.

In contrast, Business English is a branch of English for Specific Purposes (ESP), designed to meet the language needs of learners functioning in professional and business-related environments (Hutchinson & Waters, 1987; Basturkmen, 2006). Unlike General English, which is relatively flexible in its practical application, Business English is goal-oriented and context-dependent. It equips learners to perform tasks such as writing formal emails, interpreting business reports, delivering presentations, and participating in intercultural negotiations. Effective use of Business English involves mastering not only professional terminology (e.g., finance, marketing, hospitality) but also discourse

conventions such as formality, indirectness, and pragmatic strategies like hedging and politeness (Nickerson, 2005; Bhatia, 1993). These skills are not intuitive and require explicit instruction and practice.

Research indicates that effective Business English teaching relies heavily on needs analysis and incorporates task-based and experiential learning approaches, such as situational role-plays, case studies, and simulations that reflect real-world professional scenarios (Ellis, 2003; Dudley-Evans & St John, 1998). These methods help ensure that learning is both contextually relevant and motivating. Indeed, motivation is considered both a prerequisite and a result of coherent Business English pedagogy (Dörnyei & Ushioda, 2011).

Given these complexities, Business English is generally intended for learners whose general English proficiency corresponds to the B1 or B2 levels as defined by the Common European Framework of Reference for Languages (CEFR). Learners at the B1 level are generally expected to comprehend the main ideas of clear, standard input on familiar topics and manage most communicative situations encountered in everyday professional or travel-related contexts. At the B2 level, learners are expected to demonstrate greater fluency and spontaneity in interaction, produce coherent and detailed written texts, and articulate well-supported opinions on a variety of subjects (Council of Europe, 2001). These proficiency levels provide an essential foundation for engaging in the more complex, domain-specific communication tasks characteristic of Business English contexts.

## **1.2 Prior Knowledge in Language Learning**

The role of prior knowledge in second language acquisition (SLA) has been extensively studied and is considered a key factor influencing comprehension, skill development, and learner confidence. One of the foundational theoretical models is Schema Theory (Anderson, 1984), which explains that individuals process and retain new information more effectively when it can be connected to pre-existing cognitive structures (schemata). In language learning, this means that learners understand unfamiliar vocabulary, grammar, and discourse types by relating them with linguistic knowledge they already possess. In the context of Business English, prior competence in General English often provides the grammatical and lexical foundation upon which specialised knowledge can be built.

This theoretical perspective is supported by constructivist learning theories, which emphasise that knowledge is constructed progressively, through meaningful engagement with new input based on what learners already know (Bruner, 1966). Likewise, Krashen's Input Hypothesis (1985) highlights the need for teaching that introduces content slightly beyond the learner's current level of competence ( $i+1$ ). In Business English classrooms, the effectiveness of learning depends on the extent to which it builds upon learners' existing general language proficiency while systematically introducing business-specific terminology, formats, and communicative tasks.

Vygotsky's Sociocultural Theory (1978) adds a social dimension, suggesting that learning is most effective within the Zone of Proximal Development (ZPD), a space in which learners perform tasks they could not accomplish independently, but can complete with appropriate scaffolding. In Business English, this scaffolding may involve guided simulations, collaborative writing, or structured speaking exercises that help learners' transition from general to more formal and professional language use.

While these theoretical models underline the importance of building on existing knowledge, empirical studies indicate that prior general English proficiency does not automatically guarantee success in Business English. For instance, Stojković & Bošković (2011) found that Serbian university students with high general English proficiency still encountered difficulties when adapting to the register, style, and communicative norms required in business-related contexts. Their study emphasised that the specific demands of Business English, such as formal tone, clarity, and task-oriented communication, require targeted instruction and are not merely an extension of General English.

Similarly, research by Bocanegra-Valle (2010) on Spanish learners of Business English showed that while general language competence was a necessary precondition for success, it was insufficient without domain-specific awareness and genre familiarity. Students often struggled with interpreting and producing texts such as business emails or reports, despite having high scores in general language skills. This supports the idea that genre knowledge and pragmatic competence, both being important parts of Business English courses, must be explicitly taught and practiced.

Furthermore, a study by Evans (2013) in a Hong Kong university context found that students with stronger general English backgrounds still experienced

challenges with the interactive and strategic dimensions of Business English, such as negotiation or intercultural communication. These findings suggest that prior knowledge plays a supportive role but does not eliminate the need for pedagogical adaptation to the demands of workplace discourse.

These theoretical and empirical insights collectively support the view that, although prior General English knowledge can facilitate the transition into Business English, it requires strategic activation and expansion through carefully designed learning experiences. Curricular approaches in Business English should not presume that learners are able to transfer everyday language skills seamlessly into professional contexts without guidance. Rather, teaching practices must recognise students' initial proficiency levels and ensure systematic exposure to the linguistic forms, communicative functions, and conventions characteristic of business communication.

### **1.3 Motivation in Second Language Acquisition**

Motivation plays a central role in the process of acquiring a second language, influencing learners' engagement, persistence, and overall success. It shapes not only the amount of effort students invest but also their attitudes toward the learning process. Early research by Gardner and Lambert (1972) identified two primary types of motivation relevant to language learning: instrumental motivation, which is driven by practical goals such as career advancement or academic requirements, and integrative motivation, characterized by a desire to connect with the culture and community of the target language.

In the context of Business English, instrumental motivation tends to predominate. Learners are often motivated by clear, pragmatic reasons, such as enhancing employability, improving communication skills in professional environments, or meeting the demands of international business. This practical orientation is typically accompanied by a strong focus on achieving specific career-related objectives, which can sustain motivation over time.

Dörnyei's (2005) L2 Motivational Self System offers a more nuanced understanding of language learning motivation by identifying three interrelated components: the Ideal L2 Self, the Ought-to L2 Self, and the L2 Learning Experience. The Ideal L2 Self represents the learner's aspirations and self-image as a competent user of the second language, such as envisioning oneself confidently delivering a business presentation in English. This component is a powerful driver

of sustained motivation. The Ought-to L2 Self encompasses external expectations and obligations, such as academic requirements or professional pressures. Finally, the L2 Learning Experience relates to the learner's immediate educational environment, including factors such as course design, teacher effectiveness, and peer support.

Empirical studies have consistently highlighted the importance of the Ideal L2 Self in maintaining motivation. Csizér and Dörnyei (2005) found that learners who hold a positive image of their future selves using English in meaningful professional contexts are more likely to invest effort, persist through challenges, and remain highly engaged in their studies.

Recent research further distinguishes between intrinsic and extrinsic motivation in the context of language learning. Intrinsic motivation, which derives from genuine interest, curiosity, and personal enjoyment of the learning process, has consistently been associated with deeper cognitive engagement and more sustainable long-term learning outcomes. In contrast, extrinsic motivation, which arises from external pressures or rewards such as grades, employment opportunities, or societal expectations, also plays a significant role, particularly in professional contexts such as Business English, where learners clearly perceive the practical benefits of language proficiency.

Krstinić and Pauković (2020) demonstrated that a combination of both intrinsic and extrinsic motivators results in higher levels of student engagement and improved learning outcomes in Business English courses. Similarly, Prošić and Popović (2022) observed that university students who perceive greater autonomy and personal relevance in their language learning are more likely to develop intrinsic motivation, which in turn contributes to deeper and more meaningful learning experiences. Further empirical support comes from a recent study conducted in China, which demonstrated that learners' self-efficacy, defined as their confidence in their own language abilities, acts as a mediating variable in the relationship between both types of motivation and their academic performance in English language learning (Zhang et al., 2023).

Similar findings by Ali and Wang (2024), based on research involving university students across a range of academic disciplines, suggest that while both intrinsic and extrinsic motivators contribute to overall learning effort, intrinsic motivation exerts a stronger influence on learners' persistence, depth of cognitive engagement, and overall satisfaction. Theoretical frameworks such as

Self-Determination Theory (Deci & Ryan, 2000) emphasize the importance of fulfilling basic psychological needs, autonomy, competence, and relatedness, to foster intrinsic motivation. When learners feel that they have control over their learning, perceive themselves as capable, and experience supportive social interactions, they are more likely to develop sustained motivation. Additionally, Expectancy-Value Theory (Eccles et al., 1983) suggests that motivation is shaped by learners' expectations for success and the value they attach to the task, including its utility, importance, and enjoyment.

These motivational constructs are particularly relevant for Business English learners, who often encounter complex, unfamiliar language demands that require high linguistic accuracy and pragmatic awareness. Creating learning environments that foster the development of a strong professional identity while offering meaningful and engaging experiences is essential for sustaining motivation and achieving successful outcomes. Students who can vividly imagine their future selves using English in meaningful, professional contexts are more likely to invest effort, persist through challenges, and maintain high engagement levels (Csizér & Dörnyei, 2005).

#### **1.4 Interplay Between Motivation and Prior Knowledge**

Although prior knowledge establishes a necessary structural foundation for language learning, motivation ultimately influences how effectively learners utilize that knowledge. Interestingly, students at intermediate proficiency levels often demonstrate higher motivation than their more advanced peers, a phenomenon known as the intermediate plateau (Richards, 2008), where progress is more visible and engagement remains strong.

Additionally, learners' metacognitive beliefs about their language abilities affect motivation; those who overestimate their skills may become discouraged when confronting the complexities of Business English, while learners with modest proficiency but strong instrumental motivation tend to persist and achieve better results, particularly when instruction aligns with their personal or professional objectives.

This intricate interplay highlights the need for differentiated teaching approaches tailored to different proficiency levels and learner interests, alongside motivational scaffolding techniques such as goal setting, constructive feedback, and autonomy support (Ushioda, 2011). Furthermore, learners' self-efficacy

and their confidence in performing specific language tasks significantly influences their engagement. Achievements in activities such as mock interviews or business writing help boost motivation and create a positive cycle of ongoing learning and accomplishment.

## 2 METHODOLOGY

To better understand how students at Aspira University of Applied Sciences experience learning Business English, this study examines the combined effects of their prior General English knowledge and their motivation to use the language in a professional setting. Business English, as a form of English for Specific Purposes (ESP), places unique demands on learners—not only requiring a solid linguistic foundation but also a high level of pragmatic competence and context awareness (Basturkmen, 2006; Bhatia, 1993). These requirements are particularly relevant for students entering hospitality, tourism, or sports industries, in which English is often the primary language of international communication.

This research therefore addresses the following questions:

1. What role does motivation play in students' success and engagement in Business English?
2. How does prior knowledge of General English support or hinder learning in a Business English context?
3. What are the main motivational factors shaping students' attitudes toward Business English, particularly regarding career goals?
4. What challenges do students face in transitioning from General English to Business English, and how do they evaluate their own preparedness?

To address these questions, a qualitative research approach was utilised. Two focus groups were conducted with a total of 22 first-year students enrolled in Business English as part of their undergraduate programmes in International Management in Hospitality and Tourism and in Sports Management. The groups consisted of 12 Croatian and 10 international students. To establish the participants' initial English language proficiency, all students completed the 'Test Your English: General English' online test, developed by Cambridge English (n.d.). It included multiple-choice questions targeting grammar, vocabulary, and reading comprehension. It is designed to provide an estimated CEFR level and was used here to standardise baseline language competence among Croatian and international students. This was especially useful given that Croatian students

enter university having completed the high school final exam, while international students often arrive with a broader range of qualifications, not all of which are formally aligned with CEFR levels.

Following the initial test, students participated in open interviews conducted by a trained peer student interviewer. The choice to use a peer as interviewer was intentional, aiming to reduce social desirability bias and create a more relaxed and authentic conversational atmosphere. The questions presented to the students were grouped into four thematic areas, mirroring the main research questions. The interview included the following questions:

1. What kind of final English exam did you take in your home country, and at what level?
2. What grade did you achieve on that exam?
3. How many years have you studied English, and when did you start?
4. What were your expectations before starting the Business English course?
5. Did you find Business English more complex or demanding compared to General English? Did your General English knowledge help in any way?
6. On a scale from 1 (not motivated) to 5 (extremely motivated), how would you rate your motivation to learn Business English at the beginning of the course? Did this motivation change over time? Why?
7. What factors influence your motivation for learning Business English (e.g., grades, work goals, personal reasons)?
8. What do you find most challenging when learning Business English – speaking, listening, reading, or writing? Why?

### **3 FOCUS GROUP RESULTS**

The analysis of the responses revealed a complex and dynamic relationship between motivation, prior knowledge, and students' ability to adapt to the formal, professionalised style of Business English. The majority of students discussed that they had studied English for ten years or longer, frequently starting formal English education in primary school. Croatian students had a more standardised background, with many having taken the advanced level of the English final exam in high schools and achieving grades of 4 ("very good"), while international students came from more varied systems. Some had taken multiple English exams, once in secondary school and again at university and their levels did not consistently align with the CEFR standards. Therefore, the preliminary

assessment achieved through Cambridge tests was helpful and demonstrated immediately that most students exhibited language proficiency corresponding to the B1–B2 levels, which aligns with the anticipated entry requirements for Business English courses.

Students generally reported that they felt reasonably prepared for Business English courses and that they expected specific type of vocabulary and grammar tasks. While the initial Cambridge test was perceived as “okay” or “not too difficult,” many students stated that, having studied Business English for almost two semesters, they realise that Business English requires a different set of skills. The most frequently mentioned difference was the specific vocabulary, particularly in areas such as client communication, service management, and formal correspondence. Several students noted that this vocabulary was “completely new” or “much more specific” than what they had encountered in General English.

These findings support Schema Theory (Anderson, 1984) and constructivist models (Bruner, 1966), which emphasize that new linguistic knowledge is more effectively acquired when it is built on existing cognitive structures. However, as many students found the business-specific vocabulary in areas such as client communication and service management to be “completely new,” their prior knowledge of General English was insufficient without structured pedagogical guidance. This has been confirmed by empirical evidence (e.g., Stojković & Bošković, 2011; Bocanegra-Valle, 2010), showing that proficiency in General English does not ensure effectiveness in business-specific situations. Instead, Business English demands genre awareness, pragmatic competence, and familiarity with formal discourse conventions, as outlined in ESP theory (Hutchinson & Waters, 1987; Bhatia, 1993). The gap students experienced highlights the need for focused support to help them move from everyday English to specialised professional language.

Motivation emerged as a particularly influential factor in shaping students’ experiences. An average motivation score of 3 out of 5 indicates that students began the course with a balanced, though not highly motivated, outlook. While one student reported being “extremely motivated,” most expressed that their motivation either stayed the same or declined over time. The most commonly mentioned cause of reduced motivation was the lecture format: a single weekly session lasting three academic hours, which many students found challenging to stay focused throughout. Several students recommended splitting the lecture into two shorter sessions per week to help maintain attention and engagement.

In theoretical terms, these findings reflect the importance of the L2 Motivational Self System (Dörnyei, 2005), particularly the Learning Experience component. While students' Ideal L2 Self – their vision of themselves using English professionally – remained intact, their engagement was affected by the structure of the course. Furthermore, Self-Determination Theory (Deci & Ryan, 2000) helps explain the fluctuations in motivation. Many students did not feel sufficient autonomy or relatedness within the current classroom environment, which may have contributed to their lower engagement levels.

Nevertheless, motivation was predominantly instrumental, with most students stating that their main reason for learning Business English was to improve future employment opportunities, especially in tourism and hospitality. Some students added that Business English would be “essential for getting a job abroad” or “helpful in running a business or dealing with clients from other countries.” A few responses highlighted extrinsic motivators, such as grades or the desire to “avoid failing the year,” while others reflected intrinsic interests, such as a personal enjoyment of languages or self-improvement. This interplay of extrinsic and intrinsic factors aligns with the findings of Prošić and Popović (2022) and Krstinić and Pauković (2020), who observed that students who attribute greater personal significance to their learning are more likely to sustain both forms of motivation over time.

In terms of challenges, students identified grammar and speaking as the most demanding areas. Some expressed uncertainty in using appropriate tenses and sentence structures in formal contexts, while others mentioned difficulty maintaining fluency when required to speak in front of others. Interestingly, listening was rarely reported as a problem, with one student describing the listening exercises as “clear and easy to follow.” These perceived challenges suggest that students operate within Vygotsky's Zone of Proximal Development (1978), where targeted support and scaffolding through structured tasks such as role plays or collaborative writing could help bridge the gap between their current level and course expectations.

Additionally, some students exhibited high motivation despite average prior knowledge, highlighting the important role of self-efficacy, belief in their ability to perform language tasks. As shown by Zhang et al. (2023), students with higher self-efficacy tend to engage more deeply with the learning process and achieve better outcomes, even when starting from a lower level of competence.

In summary, the data collected from focus group interviews and initial testing demonstrate a complex relationship between prior knowledge, motivation, and learning outcomes in Business English. While General English competence provides a necessary starting point, it is neither sufficient nor predictive of success without the presence of sustained motivation and methodical support tailored to learners' professional aspirations. These findings emphasise the importance of learner-centred, professionally relevant, and motivationally responsive pedagogical approaches in the design of Business English curricula.

## **4 CONCLUSION**

This study explored the relationship between learners' prior knowledge of General English and their motivation within the context of Business English education at Aspira University of Applied Sciences. Through qualitative analysis of focus group interviews and initial testing, the research provides insights into how students' linguistic foundations and motivational orientations shape their engagement, perceived challenges, and academic performance in Business English courses designed for future professionals in tourism, hospitality, and sports management.

Findings indicate that while prior knowledge of General English, typically at B1/B2 CEFR level, offers a necessary foundation for entering Business English course, it is not a definitive predictor of success. Students often encounter a significant change in discourse conventions, vocabulary complexity, and communicative expectations between General and Business English. These findings support theoretical perspectives from Schema Theory and constructivist learning, emphasizing the need for purposeful activation and contextual development of prior knowledge rather than assuming skills apply automatically across different contexts.

Motivation proved to be a key factor affecting students' persistence, effort, and ability to meet the challenges of Business English. Instrumental motivation, particularly career-related goals and perceived employability advantages, prevailed in students' responses. However, the role of intrinsic motivation, driven by curiosity, pleasure, and self-improvement, also proved critical in sustaining engagement. Theoretical frameworks like Dörnyei's L2 Motivational Self System and Self-Determination Theory explain how students' visions of their

ideal future selves, their sense of autonomy, and their classroom experiences work together to shape their learning behaviours.

Importantly, the study revealed that even students with modest prior knowledge, but strong motivation and self-efficacy were often better able to engage with the course content than those with stronger linguistic backgrounds but weaker motivation. This aligns with existing research suggesting that motivation can mediate or even surpass the influence of prior proficiency, particularly in context-specific areas of language learning such as Business English.

The pedagogical implications are clear in that Business English curricula need to address varying linguistic proficiency levels while fostering learning environments that are relevant to real-world contexts, supportive of student motivation, and intellectually engaging. Incorporating shorter, more interactive sessions, well-defined professional goals, and authentic communication tasks can significantly improve both student motivation and academic achievement.

Ultimately, this study emphasizes the importance of a learner-centred approach in English for Specific Purposes, one that considers students' prior knowledge as a support tool rather than a certainty, and views motivation as a changing and context-dependent factor that drives both language learning and professional growth.

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# ULOGA PRETHODNE RAZINE ZNANJA OPĆEG ENGLESKOG JEZIKA U MOTIVACIJI ZA UČENJE POSLOVNOG ENGLESKOG JEZIKA

## SAŽETAK

*Učenje poslovnog engleskog jezika postalo je ključna komponenta suvremenog obrazovanja, odražavajući sve veće komunikacijske zahtjeve međunarodno orijentiranog tržišta rada. Međutim, individualne razlike među studentima značajno utječu na proces stjecanja jezičnih kompetencija. Općenito se očekuje da studenti upisani na kolegij Poslovnog engleskog jezika na visokoškolskoj razini posjeduju određenu razinu općeg znanja engleskog jezika, što olakšava usvajanje poslovno orijentiranog jezika. Ta se razina obično pretpostavlja kao razina B1+/B2 prema Zajedničkom europskom referentnom okviru za jezike (CEFR). Analiza sugerira da razina prethodnog znanja studenata često varira i u mnogim slučajevima nadmašuje očekivanja. Unatoč tome, poboljšanja u znanju i vještinama poslovnog engleskog jezika ne pokazuju izravnu korelaciju s njihovom razinom općeg engleskog jezika. Ovaj rad istražuje kako prethodno znanje općeg engleskog jezika utječe na motivaciju za učenje poslovnog engleskog jezika. Motivacija se široko prepoznaje kao središnji čimbenik u učenju jezika, značajno doprinoseći razvoju jezične kompetencije. To vodi do početne pretpostavke da studenti s višom razinom motivacije postižu bolje rezultate u poslovnom engleskom jeziku, bez obzira na početnu jezičnu razinu. Kako bi se ispitala ta pretpostavka, na Veleučilištu Aspira organizirane su fokus grupe sa studentima prve godine kako bi se dobio uvid u njihovu jezičnu kompetenciju, samopercepciju i motivaciju za učenje poslovnog engleskog jezika, te u međusobnu povezanost tih čimbenika. Proveden je otvoreni intervju s ukupno 22 studenta – jednom skupinom međunarodnih studenata i drugom skupinom hrvatskih studenata. Kako bi se povećala pouzdanost odgovora i smanjio rizik od društveno poželjnih odgovora, intervju je provodio vršnjački student koji je bio pažljivo mentoriran i u potpunosti upoznat s istraživanjem. Svi intervjui bili su snimljeni i transkribirani za analizu. Rezultati pokazuju da, iako*

je većina studenata došla na studij s razinom B1–B2, samo prethodno znanje nije prediktor uspjeha u stjecanju kompetencija iz poslovnog engleskog jezika. Umjesto toga, motivacija se pokazala značajnijim čimbenikom koji oblikuje ishode učenja. Studenti s umjerenom jezičnom kompetencijom često su pokazali veću motivaciju i angažman od svojih naprednijih kolega, što sugerira da motivacijska orijentacija ima ključnu ulogu u savladavanju jezičnih, pragmatičnih i profesionalnih zahtjeva poslovnog engleskog jezika. Ovaj rezultat podupire teorijske perspektive poput Teorije shema, Krashenove hipoteze unosa i Dörnyeijevog Motivacijskog L2 sustava, koje ističu interakciju između prethodnog znanja, obrade inputa i motivacijskih konstrukata u učenju drugog jezika.

**Ključne riječi:** poslovni engleski, fokus grupe, motivacija, prethodna razina znanja

*Prethodno priopćenje / Preliminary communication*

## **Comparative analysis between the IT sector communication needs and IT students' expectations**

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### **ABSTRACT**

*In order to successfully communicate, one has to consider communication skills and communication tools used in a certain workplace which is precisely what this study aims to. The goal of this paper is to investigate the communication within an IT team to determine the communication needs of the employers in the IT sector, as well as to research the expectations of computer engineering students in terms of business communication in the workplace. The paper aims to identify whether the communication needs of the employers' match students' expectations. The research was conducted in two phases, the first one referring to an interview conducted with the employers, and the second one referring to the questionnaire distributed among computer engineering students. The results of the first part of the research indicate that online communication is the most dominant form of communication used. As for the style, the employers prefer formal and professional communication. Active listening, presentation skills and conflict management skills were recognized as the most important communication skills. MS Office and Microsoft Teams are the most frequently used tools in analyzed IT companies. The second part of the research indicated that although the students recognize the importance of communication skills, they find their technical knowledge and knowledge of communication tools to be more important for their future job. The students expect online communication to be the most dominant form of communication although they are not sure what to expect in terms of level of communication formality. Furthermore, they agree with the employers as regards the importance of active listening, presentation skills and conflict management skills as most of them*

*expect that they will need them for their future job. It can be concluded that most of the students' expectations are correct although they do not show a high level of confidence about what the employers' expectations in terms of communication are.*

*The research results may be used to improve the teaching process of Business Communication and IT System Design courses at the Computer Engineering Study and to assist the employers in planning the life-long education trainings and workshops.*

**Keywords:** *business communication, communication skills, communication tools, computer engineering sector*

## 1 INTRODUCTION

IT or information technology refers to the development, research, implementation, design, and management of information and computer systems, especially software and hardware. It is the backbone of all modern business operations. This means that all business sectors depend on IT in one way or another, which puts IT in the centre of the business world in general. Just in Croatia, there were 6 714 IT companies in 2023, realizing an income of 3.84 billion Euros and employing 37 358 people in total. The number of IT companies continues to grow, and the IT sector continues to play an important role in the Croatian economy, significantly contributing to the national gross domestic product<sup>2</sup>.

IT specialists, responsible for maintaining, configuring, and running computer servers and systems, are the ones that make sure that the technical structure of an organization runs efficiently. They support business operations and assist other employees in troubleshooting technical problems. This means that, apart from expertise and technical knowledge, an IT specialist must possess solid soft skills such as critical thinking, active listening and communication skills, conflict management and collaboration skills, intercultural fluency, and knowledge of languages. One of the soft skills, that is communication skills, is precisely what the paper focuses on. The goal of the paper is to compare the communicational needs of the growing number of employees in the IT sector in Croatia and the expectations of IT students, in order to improve the higher education teaching process and assist employers in planning their life-long education trainings.

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<sup>2</sup> IT industrija 2023. U susret novim izazovima. HGK. <https://hgk.hr/documents/it-analiza-674e1cd16ae1c.pdf> (last accessed: 30 January 2025).

Considering the growing number of IT companies, it is logical that there are more than a few higher education institutions focusing on educating IT experts. Just in Croatia, there are institutions with undergraduate IT programs in 18 cities. These include 7 state faculties, 15 private higher education institutions, 39 different faculties, and 71 undergraduate IT programs<sup>3</sup>. One of the institutions providing an undergraduate study program in computer engineering is Aspira University of Applied Sciences, whose students were respondents in this research. The authors of this paper work directly with the students and have noticed that the students tend to disregard soft skills in their education, and consequently face difficulties when they are required to communicate effectively. Most students consider practical knowledge and IT expertise more important than communication skills for their future careers and find any kind of public speaking or communication skills challenging. It was precisely these observations and experience in working with IT students that have led the authors to this research.

## 2 THEORETICAL FRAMEWORK

As a term, business communication refers to the process of generating, transmitting, receiving and interpreting business messages within interpersonal, group, public or mass communication, both in written and spoken format (Hanna and Wilson, 1998). Segetlija (2009) defines communication as a skill of understanding one another, or as an exchange of experience. Successful communication always means that the participants involved in the process of communication have mastered communication skills. In other words, it means they have the capability of successfully communicating with others, expressing their thoughts clearly and understanding the other person's views. Mehrabian (1972) was a key scholar who explored the concept of communication skills. According to Mehrabian (1972), communication skills go beyond just what we say - they also heavily involve how we say it and the way we present ourselves. However, it has to be noted that communication skills are learned and trained, most often through work experience, different training programs and workshops. Communication skills are frequently a pre-requirement for the business world as employers tend to employ persons with good knowledge of communication skills. Tomašević Lišanin (2010) lists the following key communication skills:

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3 <https://www.bug.hr/obrazovanje/gdje-2020-studirati-informatiku-u-hrvatskoj-it-studiji-su-predvodnici-14993> (last accessed: 30 January 2025).

voice strengthening, listening, nonverbal communication, self-confidence and control of emotions. Bovée and Thill (2021) approach communication skills differently and classify them into: professional writing skills, oral communication skills, non-verbal communication skills, interpersonal and collaborative skills, listening and feedback skills and digital communication skills, which is a classification that is to be considered in this research due to its comprehensiveness and applicability to the business context, namely the IT sector which is known to benefit from all the above skills.

Numerous scholars have reported that the business success of both an individual and an organization depend on communication skills (Coffelt, Baker and Corey, 2016; Certo, 2000). Numerous handbooks written on the topic of communication and public speaking (Nelson and Pearson, 1996; Osborn and Osborn, 1997; Lucas, 1998) speak in favour of the field's importance. Therefore, it is not surprising that business communication nowadays is taught in almost all universities, regardless of the field of study.

Communication skills are especially important in the IT sector as both working with teams and working with clients requires efficient communication. If the ideas and information are clearly communicated, projects are successfully finalized resulting in greater client satisfaction (Senge, 2006). IT experts often work in teams and are required to cooperate with colleagues, share their opinions and knowledge, and solve problems as a team (Bass and Bass, 2008). Apart from the mentioned factors, IT project leaders regularly cooperate with different professionals (programming experts, experts in design, experts in safety etc.) and thus require excellent communication and management skills. A Delphi study with 19 IT project leaders was implemented in the US. The study listed 18 key skills, including: verbal communication skills, listening skills, writing skills, communication management skills, motivating employees, negotiating skills, and conflict management (Keil et al., 2013). As it can be noted, teamwork is the key to business success in the dynamic IT sector, and teamwork depends on efficient communication and mutual trust.

Software development teams are usually formed with a structure that is geographically dispersed across time zones and cultures. Due to the global spread of COVID-19, software development teams had to adapt and shift their work to a remote setup, with employees working from home. This resulted in reimagining how they communicate and collaborate by transitioning to both synchronous and asynchronous communication using various tools within agile and

distributed work environments. As a result of this global situation, new digital tools have emerged as opportunities for knowledge sharing, higher-performing collaboration, and communication work. Many studies have highlighted the effectiveness of these tools – such as Slack, Jira, Trello, Asana, Confluence, and Microsoft Project – to centralize information, coordinate activities, and connect multi-site team members (Milojević et al., 2023; Calefato et al., 2020; Tanner & Naidoo, 2021).

As reported in studies (Calefato et al., 2020; Tanner & Naidoo, 2021), the use of Slack as the central hub for internal communication at a large software company led to improved transparency, greater accessibility of team-relevant information, and improved integration of knowledge. Tools such as Jira brought automation capabilities that further improved workflow efficiency by decreasing manual work and improving visibility of bottlenecks and progress (Calefato et al., 2020). GitHub offers task management and collaboration capabilities for multiple team members, ensuring no merge conflicts. It also aids in conflict resolution and knowledge sharing within the team. Confluence, a knowledge management tool, integrates with Jira for advanced communication mechanisms, supplementing other methods like emails and direct messages. It also contributes to information gathering, enabling the acquisition of necessary information for task performance (Tanner & Naidoo, 2021).

Although these tools aim to support agile teams, challenges also arise in collaboration and communication. Jackson et al. (2022) report the challenges faced by teams when experimenting with new tools for a project, particularly when information overload occurs due to too many alerts generated by the tools, and the failure to leverage the full capabilities of these tools. Tanner & Naidoo (2021) found that memes, GIFs, and emojis supported positive communication as non-verbal feedback tools and helped convey tone and ease tensions. The specific requirements of the team and project determine the effectiveness of each tool. Furthermore, Milojević et al. (2023) found that a number of factors, such as pricing, team preferences, simplicity of use, customisation, and connection with other tools, affect the choice and uptake of agile project management systems.

Considering the above, the IT sector is the leading sector in using communication tools and thus tends to face challenges caused by such business practice. Therefore, this study aims to address some of the challenges both from an educational and business perspective.

### **3 RESEARCH GOAL**

This paper focuses on researching communication within an IT team and the needs the IT sector has in the field of communication skills and tools. Furthermore, the paper investigates the attitudes of undergraduate IT students towards communication skills and tools. Therefore, the goal of this paper is to compare the needs of the employees in the IT sector in terms of communication with the students' expectations.

The research results might be used to improve the teaching process in the courses of Business Communication and IT Systems Design at the Computer Engineering Study implemented at Aspira University of Applied Sciences. Furthermore, they can be used by employees in the IT sector in planning their life-long education workshops.

Considering the above, the research included three research questions and two different hypotheses which are as follows:

- RQ1: What are the most dominant types of communication and communication skills used when working in the IT sector?
- RQ2: What are the most dominant communication tools used by IT teams in their daily communication?
- RQ3: What challenges do IT teams face in terms of communication and communication tools usage?
- H1: The perception of computer engineering students regarding the communication skills importance for their careers differs from the potential employers' expectations and needs.
- H2: Students find knowledge of communication tools more important for their work than knowledge of communication skills.

### **4 METHODOLOGY**

#### **4.1 Interview**

The research was implemented in two phases. The first phase included an open interview which focused on responding to the above defined research questions. Therefore, the first part of the research was of a qualitative nature. The interviewees were familiar with the interview purpose; their participation was voluntary, and their answers were anonymous. There were six interviewees in

total who work in either the human resources sector or as team leaders in four prominent IT companies: Ericsson Nikola Tesla, Hrvatski Telekom, Infobip, and Studion. According to the information provided by the interviewees, their companies together employ approximately 1200 people, making them a representative sample for analysis. Having a small number of respondents in mind, the interview method was found suitable considering that it is flexible and allows an in-depth analysis of a relatively small sample size. Furthermore, the interview method was considered appropriate as it focuses on the research of the interview participants' views and enables a deeper understanding of an issue than that provided by a regular survey. Thus, in order to examine IT employers' communication needs, the interview implemented within this research included open-type questions providing the interviewees with an opportunity to elaborate and explain their answers. All the interviews were implemented within a week in October 2024 (14 – 20 October 2024), recorded and transcribed in order to make further analysis more accurate.

## **4.2 Questionnaire**

The second part of the research was of a quantitative nature and focused on the two hypotheses. The goal of this part of the research was to examine the students' perception of the importance of communication skills and the knowledge of communication tools. In order to do so, a questionnaire developed in Google Forms was distributed among undergraduate IT students studying at Aspira University of Applied Sciences. The questionnaire included three parts. The first part referred to the respondents' demographic data, the second to a Likert scale questionnaire with the answers ranging from 1 to 5 (1 - Strongly disagree, 2 - Disagree, 3 - Nor agree nor disagree, 4 - Agree, 5 - Strongly agree) and the third referred to an open-ended question about communication tools.

The undergraduate study of computer engineering at Aspira University of Applied Sciences includes both foreign and Croatian students. However, only Croatian students were included in this research. The total number of Croatian students studying at Computer Engineering at Aspira University of Applied Sciences is 70, and 23 (33 %) students took part in the research, which is a relatively moderate sample size. The respondents' ages ranged from 20 to 37 years ( $M = 24.22$ ,  $SD = 4.68$ ).

The respondents' gender and year of study are shown in the table below.

**Table 1** Respondents' demographic data.

Gender		Year of study:	
Male:	18; 69.57 %	1 <sup>st</sup>	14; 52.17 %
Female:	7; 30.43 %	2 <sup>nd</sup>	7; 30.43 %
Prefer not to say:	0; 0 %	3 <sup>rd</sup>	4; 17.39 %

As seen from Table 1, 52.17 % of students were first-year, 30.43 % were second-year, and 17.39% were third-year students. In terms of gender, 69.57 % of the participants were men, and 30.43% were women. Therefore, most respondents are male, which is in accordance with the trends in the IT sector considering that the IT sector is still a male-dominated industry. For example, statistics shows that there were 13 % of women working in ICT in 2019<sup>4</sup>.

As previously mentioned, the Likert scale questionnaire results were used to confirm or reject the two posed hypotheses. Descriptive statistics (mean, standard deviation, Cronbach alpha) were used in order to interpret the questionnaire results. As for the inferential statistics, the strength of the correlation between the statements was tested.

Finally, the results of the two research phases were compared in order to identify a potential mismatch and draw conclusions on the similarities and differences between the two researched groups of respondents.

## 5 RESULTS AND DISCUSSION

### 5.1 Interview results

As it has already been noted, an open-type interview was implemented with six representatives of prominent IT companies in Split-Dalmatia County. This method was chosen in order to answer the posed research questions.

The first research question was: *What are the most dominant types of communication and communication skills used when working in the IT sector?* Prior to answering the question on the most dominant types of communication used, the interviewees were informed about different types of communication – verbal, nonverbal, visual, written and digital (Hybels and Weaver, 2012). Having been explained different types of communication, none of the respondents

<sup>4</sup> <https://digital-strategy.ec.europa.eu/en/library/women-digital-scoreboard-2019-country-reports> (last accessed: 30 January 2025)

mentioned visual communication when answering the question on the communication types most commonly used in their companies. Two respondents mentioned nonverbal communication. However, these respondents stated all types of communication apart from visual communication in their answers. All respondents noted that verbal and written online communication are the most important and most commonly used. Figure 1. The word cloud of the most dominant types of communication and communication skills, effectively summarizes the most emphasized communication types and skills that employers find to be critical in the IT work environment.



**Figure 1** *The word cloud of the most dominant types of communication and communication skills*

Some of the statements used to emphasize the importance of written online communication are shown in examples (1) and (2) below.

- (1) As we mostly work in a remote manner, we use email, tools, and other chat formats the most.
- (2) Considering hybrid work from home and cooperation within an international organization, most of our communication is done via MS Teams or via instant messaging.

These answers might be expected and logical, but they should be considered more when planning the curriculum in business communication courses at higher education institutions, as students are rarely required, or even taught, how to communicate online in an educational setting. They mostly rely on their own knowledge, which might not be enough, as online communication in a business

context might be challenging in terms of estimating the formality level and choosing an appropriate register for various business communication situations. This is confirmed in the interview with the respondents, as they all claim they use both formal and informal communication in their business communication, depending on the context (3).

- (3) There are over a dozen IT teams which I regularly communicate with, so my communication can vary a lot depending on the team, from strictly formal to private.

When trying to find the answer to the first research question, the respondents were also asked about communication skills they find to be the most important for the employees in the IT sector. Once again, they were explained what is meant by communication skills in a business context, relying on the theoretical framework by Bovée & Thill (2021) who differentiate between professional writing skills (emails or reports), oral communication skills (public speaking or sales pitches), non-verbal communication skills (personal branding), interpersonal and collaborative skills (team communication, conflict management), listening and feedback skills (giving feedback, active listening) and digital communication skills (virtual meetings, emails). Two of the respondents could not give priority to any skill, stating they are all important and that the importance largely depends on the context (4).

- (4) All communication skills are implemented within team communication. Depending on the position, sometimes presentation skills are more important. For example, if you are a team leader, you have to know how to manage meetings and conflicts. If you are not in a high position, listening and presentation skills are more important.

The other four respondents all mentioned active listening as the most important communication skill. When elaborating on this, they explained that active listening is important in terms of listening to and understanding the instructions, but also in terms of taking someone else's opinion into consideration. As for the other skills, two respondents mentioned conflict management; one mentioned managing meetings and one thought presentation skills are among the most important communication skills when working in the IT sector. It can be concluded that all the respondents recognize the importance of communication skills for their work, especially active listening and conflict management. This was additionally confirmed as they were also asked whether they found

communication skills important for their work. All the respondents agree that communication skills are very important for their work. Some respondents said that communication skills are even more important than technical knowledge (5), and some emphasized the importance of mastering communication skills in conversation with different stakeholders in order for the work process to be efficient (6).

- (5) Soft skills, and especially communication skills are even more important than technical knowledge and are necessary if you wish to work in any larger or cross-functional teams.
- (6) Communication skills are important both if you communicate with the person organizing your tasks and schedule, and with the person you are transferring your knowledge to and whom you are trying to keep motivated.

Considering that the respondents have previously already emphasized the importance of written online communication, finding the answer to the second research question (*What are the most dominant communication tools used by IT teams in their daily communication?*) was not as challenging. When asked about the most frequently used communication tools, all respondents emphasized the use of email (Gmail or MS outlook) and Microsoft Teams. As for other communication tools, they mention frequent use of Zoom and Slack. They explained their choice by confirming that these are the tools officially used in their companies.

The third question focused on communication challenges employees in the IT sector face (*What challenges do IT teams face in terms of communication and communication tools usage?*) When asked about the challenges employees in the IT sector face in the context of communication, just one respondent said that they do not have any. Others stated poor meeting management, inability to articulate attitudes and opinions clearly, and conflicts. One research participant emphasized how training the employees in communication skills results in less challenges (7).

- (7) We worked a lot on that; HR organized many workshops and we learned a lot about communication skills. There are occasionally some challenges, but we solve them easily by an argumentative conversation.

An interesting answer was provided by a respondent who said that the greatest challenges occur when people make conclusions without listening to all relevant facts or all relevant stakeholders involved in a discussion. This is in accordance with the answer to the first research question, emphasizing active listening as the most important communication skill when working in IT. It was also emphasized when the respondents were asked about challenges they face when using communication tools (8).

- (8) When using online tools, you cannot see feelings or body language. It is very important to use emojis and carefully read what was written as you might have a wrong impression of sarcasm, verbal attack or implications, which make the communication and cooperation more difficult.

Therefore, active listening is important both when communicating orally or in writing. Apart from listening, the respondent suggests the use of emojis, which is in accordance with studies indicating that emojis have a positive impact on business communication (Tanner and Naidoo, 2021). Emojis present an emotional compensation in the context of written business communication, give an impression of benevolence, and may even remove intercultural communication obstacles (Ćorić, Primorac and Leko, 2018).

As for other challenges with communication tools, two respondents said it is often challenging to handle and prioritize many simultaneous requests (“*cutting the noise*”). This requires the employees to be able to determine the important, delegate and multitask. Two other respondents said they have no greater challenges with communication tools and one mentioned the transition from one platform to another

## **5.2 Questionnaire results**

### **5.2.1 Sample Characteristics and Descriptive Analysis**

The second part of the research, referring to a Likert scale questionnaire, included a study sample of 23 Computer Engineering students from the Aspira University of Applied Sciences. Survey data were analysed using Python in Google Colaboratory with libraries including pandas, numpy, scipy.stats, matplotlib, and seaborn

The reliability analysis using Cronbach's alpha was implemented to measure the internal consistency of a Likert scale, and the results indicated good internal consistency for the grouped statements: Communication Skills ( $\alpha = 0.715$ ) and Communication Tools ( $\alpha = 0.716$ ).

Analysis of the 15 Likert scale statements (Table 2) revealed the highest agreement with "I expect that knowledge and use of communication tools will significantly facilitate teamwork at the workplace." (S11,  $M = 4.04$ ,  $SD = 0.93$ ) and "I expect that knowledge and active use of communication tools will improve the efficiency of task performance at my future workplace." (S10,  $M = 3.91$ ,  $SD = 1.08$ ). The strongest disagreement was found for "Listening skills are not important for my future everyday work." ( $M = 1.56$ ,  $SD = 0.99$ ). Considering that the strongest agreement was found in terms of S10 and S11, both referring to the knowledge and use of communication tools, it can be concluded that the students find the application of communication tools more relevant in the context of their future workplace than communication skills. This is further supported by the strong agreement with S2 statement (S2: Technical knowledge is more important than communication skills for my future job.) where the students explicitly state that they find communication skills less important than technical knowledge needed in order to successfully manage their daily work tasks. As for the communication skills, listening skills seem to be perceived as the most important aspect of communication skills, which is also confirmed in the interviews implemented with employers. Furthermore, the respondents acknowledge the importance of giving presentations and managing meetings (S7).

**Table 2** Means and Standard Deviations for Statements that Comprise the Communication skills and tools application

Statements	mean	Std
S1: Communication skills are extremely important for my future job.	3.826087	1.072473
S2: Technical knowledge is more important than communication skills for my future job.	3.913043	1.164359
S3: In my everyday work I will mostly use online communication.	3.434783	1.160959
S4: Nonverbal communication is not important for successful everyday team communication in my future job.	2.521739	0.947224

S5: In my job I do not expect to use verbal face-to-face communication much.	2.695652	1.063219
S6: Listening skills are not important for my future everyday work.	1.565217	0.992063
S7: I expect that I will have to give presentations and participate in meetings in my future job.	3.869565	1.391675
S8: I do not expect that I will have to resolve conflicts in my future job.	2.130435	1.179536
S9: I expect that most of my everyday communication will be informal.	3	1.167748
S10: I expect that knowledge and active use of communication tools will improve the efficiency of task performance at my future workplace.	3.913043	1.083473
S11: I expect that knowledge and use of communication tools will significantly facilitate teamwork at the workplace.	4.043478	0.928256
S12: Knowledge and use of communication tools give me a greater advantage in the workplace than developed communication skills.	3.217391	1.312753
S13: I believe that women are better at communication skills than men.	2.956522	1.521909
S14: I believe that men handle communication tools better than women.	2.695652	1.222322
S15: If I had to choose between improving communication skills and knowledge of communication tools, I would always give priority to communication tools.	2.826087	1.11405

At the end of the questionnaire the respondents were asked an open-ended question regarding which communication tools they are familiar with. It was found that Microsoft Teams was the most frequently mentioned category, with WhatsApp, Zoom, and e-mail also dominating.

Table 3 further elaborates on the concrete frequencies of the most dominant communication tools used by the respondents in this research. The greatest frequency of the Microsoft Teams usage aligns with the responses provided by the employers as they also emphasized MT as one of the most used, and thus most relevant tools in their work.

**Table 3** *Top 10 mentioned tools and their frequencies*

<b>Communication Tools</b>	<b>Frequency</b>
microsoft_teams	8
Whatsapp	4
Zoom	3
Email	3
Discord	3
social_media	2
Telegram	2
Unknown	1
spoken_word	1
writing:	1

### 5.2.2 Correlation analysis

The correlation analysis was implemented to investigate the connections between the statements. The correlation matrix for all statements assessing students' attitudes toward communication skills and communication tools is shown in Figure 2. Statements S10 and S11 showed the strongest positive correlations ( $r = 0.66$ ,  $p < 0.01$ ). Since both statements relate to the perceived advantages of using communication tools in a professional setting, the found relation between the statements is significant in terms of the second hypothesis (H2).

A correlation of 0.61 between S12 and S15 indicates a moderately strong positive relationship. This agreement that communication tools provide a greater workplace advantage also prioritizes improving communication tools over general communication skills, showing that this correlation supports H2.

Furthermore, this association points to a consistent pattern in the participants' answers, addressing the advantages of using communication tools in the work environment. A strong negative correlation was found between statement S3 and S10 ( $r = -0.43$ ,  $p < 0.05$ ), indicating that respondents who think that online communication will dominate their everyday work are less likely to recognize that communication tools may improve the efficiency of task performance. It seems that the respondents perceive online communication as a regular part

of their future career. However, they do not seem to perceive that the active use and knowledge of communication tools will impact their work efficiency. The reason for such a correlation might be hidden in the fact that computer engineering students naturally accept online communication and tools and thus do not think they have to pay special attention to upgrading their skills in this field. Furthermore, a negative correlation between S4 and S10 indicates that respondents, who disagree that nonverbal communication is important, tend to agree less with the statement that communication tools improve task efficiency. Since communication tools include nonverbal cues in face-to-face or video interactions that enhance task performance, it is evident that nonverbal communication is acknowledged as a critical component of effective teamwork and workplace interaction.

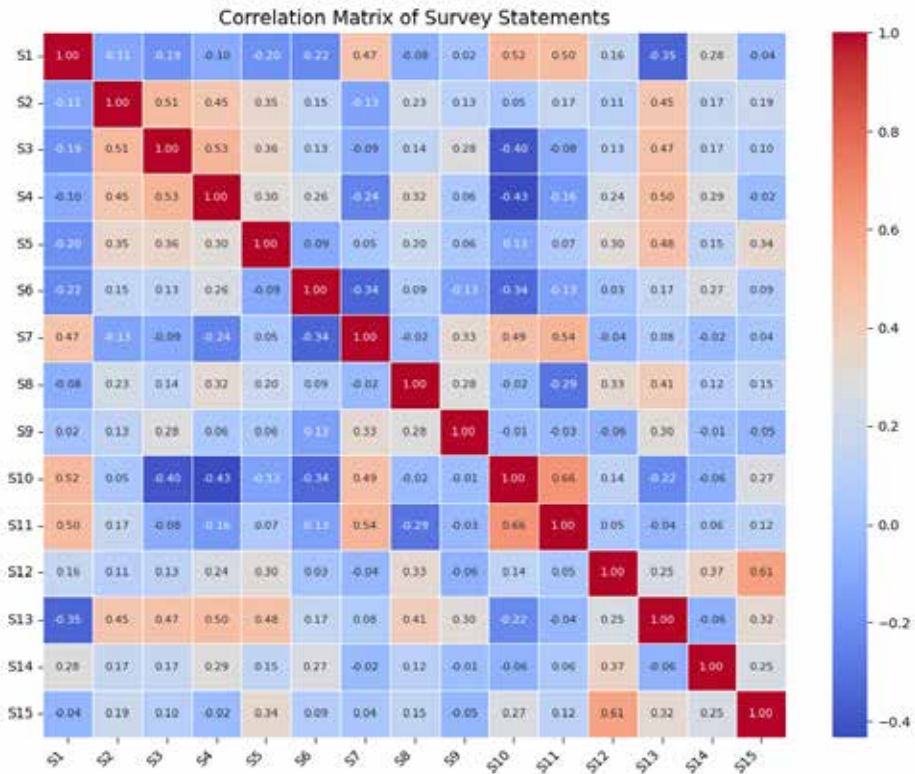


Figure 2 Correlation matrix of questionnaire statements

### 5.3 Comparative analysis

Using quantitative data from students' questionnaires and qualitative data from interviews with company representatives, a comparison study was carried out to examine the alignment between industry experts' expectations and student perceptions of communication tools and skills.

Interviews with employers revealed that strong communication skills, especially active listening and conflict management, are perceived as essential for workplace effectiveness. Furthermore, the employers' representatives also emphasized challenges related to poor meeting management, and the inability to articulate attitudes and opinions clearly. Many highlighted a strong reliance on digital communication tools, such as Microsoft Teams, e-mail, and instant messaging, pointing out the importance of applying emojis in digital communication.

These tools are also widely known to Computer Engineering students, who also mention WhatsApp and Discord as relatively dominant tools for communication. The value students place on active listening and clear communication reflects similar priorities highlighted in employers' feedback. In contrast, questionnaire responses from students indicated a general awareness of the importance of communication tools but varied significantly regarding how students perceived the relevance of communication skills. While many students highlighted the importance of online communication, fewer recognized the importance of professional training in the use of communication tools, probably because they already feel comfortable using them.

Considering the above, it can be concluded that the students' expectations regarding the use of communication tools align with the practice that employers described. However, there are some differences in the perception of communication skills use in the IT sector. Although the two tested groups recognize the importance of active listening, the students do not seem to be aware of the complexity and challenges of communication skills they will face in their future work due to the lack of communication skills, as emphasized by the employers. Given the above, the first hypothesis can be considered to be partially confirmed.

## **6 RESEARCH LIMITATIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH**

The research results might be beneficial for both higher education institutions providing programs in the field of computer engineering and IT. However, they can also be useful for IT companies when developing and planning lifelong education programs or employing young people.

Nevertheless, the research has certain limitations, due to which the research results should be considered cautiously. The greatest research limitation refers to the small number of respondents in both parts of the research. In terms of the interview, the small number of six interviewed IT companies' representatives can be justified by the size of the companies. All the respondents work in companies with over 70 employees, which means that their experience is relevant to this study. What is more, they are even more relevant as they all work either in human resources or as team leaders, which are two sectors where communication skills are of key importance. The small number of students who took part in the questionnaire is another research limitation. However, there are approximately 70 students in total currently studying in the undergraduate computer engineering program at Aspira University of Applied Sciences, which means that the research included approximately 33 % of all Croatian students at Aspira, which is a relatively moderate sample. It is, therefore, recommended that further research be implemented on a larger scale, among more students, studying at different higher education institutions, in order to get an insight into the perception of the overall population of IT students. Larger-scale research should also be implemented among employers as well. However, this research may be considered a pilot study, focusing on just one higher education institution and providing a valuable insight into the communication needs of IT employers and students' perception of the importance of communication skills and tools. Such results present a solid base for further, larger-scale research.

## **7 CONCLUSION**

Effective communication is crucial for the IT sector, as it impacts both individual and organisational performance. It is cultivated through training and experience and includes both communication skills and tools. Digital communication tools are essential for facilitating collaboration, information sharing, and workflow efficiency in contemporary work contexts, particularly in remote

and agile teams. However, choosing the appropriate tools based on team needs and making sure they are used efficiently are also essential for successful communication. Along with the tools, effective communication skills are highly relevant to collaboration, project success, and adjusting to changing work contexts.

An interview with employers and a questionnaire implemented with students were conducted with the aim of assessing the importance of communication skills and communication tool usage in practice. The results have shown that the most dominant types of communication tools are Microsoft Teams and email, as agreed upon by both tested groups. Both groups also agree that active listening, conflict management, and presentation skills are the most important communication skills for the IT sector. Furthermore, the employers' representatives emphasize communicational challenges such as poor meeting management and the inability to articulate attitudes and opinions clearly. However, the perception of computer engineering students regarding the importance of communicational skills for their future careers is partially aligned with the employers' expectations and needs. Finally, the research indicated that the students find the knowledge of communication tools more important for their work than the knowledge of communication skills.

Given that the data were drawn from a small sample at one Croatian institution, the findings may not be fully applicable to other contexts, but they report important insights that could help form practical strategies for quality improvement in studies: adjusting learning outcomes to focus on essential communication competencies, tailoring activities to foster relevant workplace communication skills, adapting evaluation methods for both traditional skills and communication tools, and modifying teaching approaches to incorporate practical, technology-based communication training that meets current workplace needs. Respondents' gender might also impact the findings, which was not considered in this research and might be a good implication for further studies. Further studies should also expand the sample size and explore different regions and institutions to provide a more comprehensive understanding of the communication needs in the IT sector.

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# KOMPARATIVNA ANALIZA KOMUNIKACIJSKIH POTREBA IT SEKTORA I OČEKIVANJA IT STUDENATA

## SAŽETAK

*Kako bi se uspješno komuniciralo, potrebno je uzeti u obzir komunikacijske vještine i komunikacijske alate korištene na određenom radnom mjestu, što je u fokusu ovog istraživanja. Cilj rada jest istražiti komunikaciju unutar IT tima kako bi se utvrdile komunikacijske potrebe poslodavaca u IT sektoru, kao i istražiti očekivanja studenata računalnog inženjerstva u pogledu poslovne komunikacije na radnom mjestu. Rad također ima za cilj utvrditi podudaraju li se komunikacijske potrebe poslodavaca s očekivanjima studenata. Istraživanje je provedeno u dvije faze: prva se odnosila na intervjue s poslodavcima, a druga na upitnike koji su distribuirani studentima računalnog inženjerstva. Rezultati prve faze istraživanja ukazuju da je online komunikacija najdominantniji oblik komunikacije koji se koristi. Što se tiče stila, poslodavci preferiraju formalnu i profesionalnu komunikaciju. Aktivno slušanje, vještine prezentacije i upravljanje sukobima prepoznati su kao najvažnije komunikacijske vještine. MS Office i Microsoft Teams najčešće su korišteni alati u analiziranim IT tvrtkama. Drugi dio istraživanja pokazao je da, iako studenti prepoznaju važnost komunikacijskih vještina, smatraju da su njihovo tehničko znanje i poznavanje komunikacijskih alata važniji za budući posao. Studenti očekuju da će online komunikacija biti najdominantniji oblik komunikacije, iako nisu sigurni što očekivati u pogledu formalnosti komunikacije. Nadalje, slažu se s poslodavcima u pogledu važnosti aktivnog slušanja, vještina prezentacije i upravljanja sukobima, jer većina očekuje da će im te vještine biti potrebne u budućem poslu. Može se zaključiti da su većina studentskih očekivanja točna, iako ne pokazuju visok stupanj sigurnosti u vezi s očekivanjima poslodavaca. Rezultati istraživanja mogu se koristiti za unaprijeđenje nastavnog procesa kolegija Poslovna komunikacija i Dizajn IT sustava, kao i za pomoć poslodavcima u planiranju cjeloživotnih edukacija i radionica.*

**Ključne riječi:** poslovna komunikacija, komunikacijske vještine, komunikacijski alati, sektor računalnog inženjerstva



*Prethodno priopćenje / Preliminary communication*

## **Forensic Linguistics and Trademark Protection: Croatian Case Study**

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### **ABSTRACT**

*This paper explores the application of forensic linguistics in trademark infringement litigation, with a particular focus on analysing the linguistic aspects of the trademarks Pevec and Pevex. Through an overview of the ten most prominent trademark infringement cases in the USA, the study demonstrates the extent to which linguistic analyses of trademarks have been employed in dispute resolution and how such analyses can contribute to understanding the similarities and differences between trademarks and their potential to cause consumer confusion. The central linguistic research question is which linguistic elements contribute to the perception of similarity or difference between trademarks, and how can these perceptions be quantified? The methodology combines qualitative and quantitative analyses. The qualitative analysis examines phonological, morphological, and semantic characteristics of trademarks to identify key linguistic features that influence perception and reviews the criteria of existing trademark protection protocols. The quantitative part involves perception experiments conducted with a sample of 100 respondents, who assess the similarity between selected pairs of trademarks. The study also includes an overview of the ten most significant court rulings in which linguistic elements played a key role, presenting linguistic and perceptual analyses alongside judicial arguments. The research findings reveal that phonological similarities, such as syllable count and rhythm, as well as semantic associations, are critical factors influencing the perception of similarity among trademarks. The study highlights the importance of contextual factors, such as specific industries and market environments, and underscores the need to standardize linguistic methodologies in legal proceedings. The significance of this paper lies in demonstrating*

*the potential of forensic-linguistic analysis of trademarks, a method that is not yet systematically included in protocols for trademark protection or in expert evaluations during disputes. Incorporating such analyses into trademark protection processes would enable more accurate risk assessments, reduce litigation frequency, and achieve significant cost savings in legal processes.*

**Keywords:** *forensic linguistics, linguistic analysis, trademark, protection, infringement*

## 1 INTRODUCTION

Forensic linguistics has gained increasing recognition as a valuable tool in criminal investigations, legal proceedings, and national security in countries such as the United Kingdom, the United States, Germany, Sweden, and Australia, and is emerging in Spain (Olsson, 2014). It is a field of applied linguistics primarily dealing with authorship attribution, threat assessment, and the analysis of anonymous communications. However, it has also expanded beyond the discipline into civil and commercial law, to the point that Trademark linguistics has become an established area of forensic linguistic theory and practice (Butters, 2010).

One of the most famous linguists in the field of Forensic linguistics and Trademark disputes, Roger Shuy (2002) states that trademark law is about the right to monopolize the use of language, and that Trademark Law is a form of language planning. Building on these premises, the scope of this paper is twofold. First, it provides a systematic overview of the application of forensic linguistics in U.S. trademark infringement cases and presents a qualitative doctrinal analysis of trademark registration practice before the Croatian and U.S. intellectual property authorities. Second, it develops and applies a replicable forensic linguistic protocol for trademark comparison and examines how forensic linguistics can contribute to trademark-infringement disputes, using the Croatian Pevac vs. Pevex dispute as a case study. Two guiding research questions structure the analysis:

- (1) Which linguistic elements most strongly contribute to perceived similarity or difference between trademarks?
- (2) How can those perceptions be quantified in ways that are linguistically valid and legally usable?

Trademarks function as legal mechanisms that encode market identity through language and signs. According to Linford (2015), a trademark is created when a new meaning is assigned to an existing word or when a new word is invented in order to identify the source of a product. According to Croatia's State Intellectual Property Office (DZIV), a trademark is an exclusive right granted for a sign used to distinguish the goods and/or services of one person from those of others in commercial trade ([www.dziv.hr](http://www.dziv.hr)). Likewise, the World Intellectual Property Organization Training Manual (WIPO, 1993) defines a trademark as any sign that individualizes the goods of a given enterprise and distinguishes them from the goods of its competitors. Because disputes about trademarks are, fundamentally, disputes about form, sound, and meaning, linguistic expertise is central rather than ancillary. According to recent data, retrieved from the World Intellectual Property Indicators (WIPI, 2024), the number of registered trademarks worldwide grew by an average of 10.95% per year from 2020 to 2023, reaching a total of 88,226,400 registered trademarks.

In the United States, a central authority has different filing logics but similar Procedural checkpoints administer the European Union and Croatia trademarks. The United States Patent and Trademark Office (USPTO) allows filing on a use-in-commerce or intent-to-use basis. Applications approved for publication enter a 30-day opposition window before the Trademark Trial and Appeal Board, and Intent-To-Use applications must be converted with a statement of use (specimen) before registration is granted. ([www.uspto.gov](http://www.uspto.gov))

The European Union Intellectual Property Office operates a unitary European Union Trade Mark (EUTM) system on a first-to-file basis, examining absolute grounds *ex officio* and initiating a three-month opposition period for relative grounds. ([www.euipo.europa.eu](http://www.euipo.europa.eu)) Croatia's State Intellectual Property Office (SIPO) follows the EU model for national marks, examining absolute grounds *ex officio* and providing a three-month opposition window for earlier-right owners (DZIV, 2011/2021).

One of the key reasons for the rejection of most applications is the existence of similar trademarks that are already registered. It is crucial that trademarks within the same category are distinctive. Therefore, the process of automatically identifying similar trademarks from existing ones for a given trademark application is of utmost importance (Liu, 2021).

In both EU and Croatian trademark practice, decision-makers compare signs visually, aurally, and conceptually from the standpoint of the average consumer. EUIPO's current Guidelines (EX-19-4, in force since 1 February 2020) formalize this triadic test, and Croatian law follows the same structure the Trademarks Act (NN 14/19) and the Rulebook on Trademark Protection. Although Croatia does not require external linguists, the Rulebook includes linguistic assessment as part of the examiner's routine work. For verbal marks, examiners apply source-language pronunciation rules where identifiable, or Croatian phonetics when unclear, and evaluate similarity under imperfect recollection. Thus, the analysis is not purely visual: phonetics and semantics can be decisive, alongside the separate assessment of goods and services.

While DZIV accepts expert statements and consumer surveys, mainly for acquired distinctiveness, this research found no prior linguistic expert reports, which further motivated the paper's contribution. Incorporating forensic linguistic analysis more systematically could reduce trial costs, lower the number of infringement disputes, and strengthen decision-making at every stage of the trademark process.

## **2 RELATED WORK**

Ronald Butters (2010) outlines the principles of trademark linguistics and illustrates how linguists can systematically analyse visual, phonetic, and semantic similarity as well as how this analysis applies to trademark similarity and distinctiveness. Trappey et al. (2020) made a significant leap in the field. Trappey et al. (2020) analysed image, spelling, and phonetic features for the first time by using machine learning methodologies to assess similarity. Although machine learning was not used in this paper, the significance of this case study lies strongly in the fact that it is the first time that a linguistic analysis of two trademarks in Croatia has been done. More importantly, the case study concerns a legal dispute that is still ongoing and, according to the available data, does not appear to have included a linguistic expert analysis in the case file. This case study introduces a neglected area of expertise in trademark analysis and evaluation, which may constitute an important methodological contribution with implications for future trademark legal disputes.

Although the broader literature on language and law has expanded, there has long been no single volume presenting a sustained, linguist-led methodology

for trademark disputes. Roger Shuy's work (2002) addresses this gap by systematizing how linguistic analysis can inform the adjudication of similarity, distinctiveness, and confusion. Accordingly, the most influential infringement cases, covering diverse linguistic approaches, are synthesized in the following section of this chapter.

## 2.1 An overview of the linguistic expertise in ten TM infringement cases

To provide a balanced account of jurisprudence that has explicitly engaged forensic-linguistic evidence, this study employs purposeful sampling of landmark cases for which both reasoned judicial opinions and publicly available Expert reports are available. All cases were synthesized and are presented in Table 1. The table presents summarized conclusions and examples, adapted from Roger Shuy (2002), followed by further description and reasoning for each case.

**Table 1** Overview of the linguistic tools of the ten most famous US TM infringement cases.

Case	Main Linguistic Question	Linguistic Tools Used
Registry Hotel v. Hospitality Mgt	Was "hospitality management" generic?	Lexicography, Morphology
Warren v. Prestone	Is "LongLife" generic or suggestive?	Lexicography, Semantics, Morphology
ConAgra v. Hormell	Similarity of "Healthy Choice" vs "Health Selections"	Semantics, Morphology, Phonetics
Woodroast v. Restaurants Unlimited	Is "Woodroast" a style or unique name?	Morphology, Syntax, Semantics
McDonald's v. Quality Inns	Is "Mc-" prefix proprietary?	Semantics, Corpus Analysis
AMR Pharm v. Acme Home Products	"OVRAL" vs "B-OVAL"	Phonetics, Semantics
Pyewacket v. Mattel	"GUK" vs "GAK"	Phonetics, Morphology, Semantics
AutoNation v. CarMax	"AutoNation" vs "AutoMation"	Phonetics, Morphology, Semantics, Syntax, Pragmatics
Alixandre Furs v. Alexandros Furs	Similarity in pronunciation	Phonetics
Matrix Essentials v. F&M Distributors	Misleading disclaimer	Syntax, Pragmatics

### 2.1.1 Registry Hotel v. Hospitality Mgt

The case turned on whether “hospitality management” could function as a trademark. The plaintiff argued that the phrase had gained secondary meaning, while linguistic evidence showed it was widely used as a generic industry term. Through lexicographic and morphological analysis, the expert demonstrated four distinct categories of common usage, supporting the conclusion that the phrase merely described a business type rather than identifying a source. The court dismissed the claim, effectively accepting the linguistic finding that the term was generic and non-protectable, thus avoiding a consumer survey, which would have been the next step. This case showed that it could be financially helpful to have the early use of linguistic expertise (Shuy, 2002:53).

### 2.1.2 Warren v. Prestone

The dispute was whether “LongLife” for antifreeze was generic, descriptive, or suggestive. Both parties used linguistic experts, but Warren’s linguist provided stronger semantic and morphological analysis, showing that although “long” and “life” were common words, their combination required consumer imagination, aligning the term with the suggestive category. A corpus search also documented 71 instances of co-occurrence of “long” and “life” with antifreeze, helping the jury understand patterns of meaning and the “imagination test.” The court ultimately accepted the linguistic reasoning, and ruled that “LongLife” was protectable, and awarded Warren substantial damages of \$ 832.00 in actual damages and \$ 839,360 in deterrent damages. This case demonstrates how linguistic explanation, particularly of semantic shift and consumer inference, can directly shape judicial conclusions in trademark classification.

### 2.1.3 ConAgra v. Hormell

ConAgra claimed that Hormel’s “Health Selections” imitated “Healthy Choice”, raising both classification (descriptive vs. suggestive) and similarity questions. Linguistic experts on both sides analysed phonetics, semantics, morphology, syntax, and real-world usage. Although both agreed “Healthy Choice” was a laudatory mark, the court found it closer to descriptive, noting that the mental link between words and product benefits was “almost instantaneous.” This weakened ConAgra’s position and shifted focus to similarity. The judge found the marks conceptually similar but phonetically and visually distinct, reducing the likelihood of confusion, and dismissed the flawed consumer

surveys. The appellate court affirmed. The case demonstrated how linguistic analysis can outweigh survey evidence in determining descriptiveness, semantic equivalence, and the overall impression of competing marks.

#### **2.1.4 Woodroast v. Restaurants Unlimited**

The central question was whether “Woodroast” was a protectable name or simply a generic cooking-style descriptor. Linguistic analysis examined dictionary evidence, menu usage, syntax, and marked/unmarked forms. The expert showed that Shelly’s Woodroast used “Woodroast” as a proprietary style name, while competitors used “wood-roasted” in its adjectival, method-of-cooking sense, reflecting a revived but historically unmarked term. The distinction between the noun (brand) and the modifier (process) helped demonstrate the differing semantic roles and reduced the risk of consumer confusion. The case settled before trial, but the linguistic affidavit strongly influenced negotiations. The case highlights how nuanced analysis of morphology, usage patterns, and semantic marking can clarify whether a term functions as brand identity or common culinary vocabulary.

#### **2.1.5 McDonald’s v. Quality Inns**

This case examined whether the prefix “Mc-” had acquired secondary meaning as part of McDonald’s family of marks, making “McSleep” confusingly similar. The central linguistic question was the morphological productivity of “Mc-” and whether real-world usage showed it functioned as a brand-anchored morpheme rather than a generic prefix. McDonald’s linguist used corpus and media analysis to show that “Mc-X” consistently evoked attributes associated with the brand (basic, convenient, inexpensive, and standardized). The court accepted this pragmatic, usage-based approach and rejected the opposing expert’s narrow, context-free theory of word meaning. Finding strong associative value in the prefix, the court held that “McSleep” would likely confuse consumers and enjoined its use. The case became a leading example of linguistic evidence supporting family-of-marks protection.

#### **2.1.6 AMR Pharm v. Acme Home Products**

The dispute concerned whether OVRAL and B-OVAL were confusingly similar contraceptive-pill trademarks. Linguistic analysis focused on phonetics, pronunciation variants, and semantic associations. OVRAL had an established

PDR pronunciation with stress on the second syllable, while B-OVAL was intended to stress the first syllable and introduce a salient initial “B,” potentially linked, through contextual medical associations, to “breast” or “breast cancer.” Semantically, both names referenced the Latin root ovum, but B-OVAL also invoked the English word oval, adding an additional layer of meaning. The expert concluded that the marks differed in sound, morphology, and likely consumer interpretation. Although the ultimate legal outcome was never reported, the case illustrates how identical linguistic tools (phonetics, semantics, and etymology) can produce non-similarity findings, independent of client preference.

### **2.1.7 Pyewacket v. Mattel**

Pyewacket alleged that Mattel’s toy product name GAK infringed its existing GUK mark. The linguistic task was to determine whether the two invented monosyllabic forms were sufficiently similar in sound, spelling, and meaning to cause consumer confusion. Analysis showed that although both are short C-V-C sequences with low semantic content, they differ in vocalic quality and articulatory profile, reducing phonetic overlap. The expert also checked whether GUK functioned as a descriptive word, which would weaken the mark. The case never reached trial, and the settlement terms remained confidential, but the matter demonstrates that even highly playful, non-dictionary words can undergo a structured linguistic comparison. It also illustrates the ambiguity of “win/loss” determinations in civil cases when matters resolve without a judicial decision.

### **2.1.8 AutoNation v. CarMax**

This dispute centered on whether CarMax’s inventory system name AutoMation and its slogan, “The New Way to Buy Used Cars”, infringed on AutoNation’s name and slogan, “The Better Way to Buy a Car.” Linguistic analysis examined phonetic contrasts, morphemic structure, lexical minimal pairs, pragmatic meaning, and semiotic cues. Media corpus data was used to determine how consumers actually referred to “AutoNation” versus “AutoNation USA,” informing similarity assessment. The jury ultimately found no trademark violation against AutoNation, but paradoxically awarded CarMax punitive damages for unfair competition, which the judge later vacated. The linguistic evidence showed that despite superficial resemblance, the marks differed in structure, stress pattern, and communicative framing. The case underscores that linguists

must present objective analyses even when strategic outcomes are unpredictable or mixed.

### 2.1.9 Alixandre Furs v. Alexandros Furs

Alixandre Furs argued that “Alexandros Furs” was confusingly similar in sound, appearance, and meaning, particularly because both businesses operated in the same small area of New York’s fur district. Linguistic experts evaluated phonetic similarity (shared onset, overlapping stress pattern), orthographic resemblance (parallel letter sequences), and semantic alignment (“Alexander/Xandros” name-base). The plaintiff also noted that the defendant could use its alternative mark (“Alex Furs”) without such similarity. Although no judicial outcome was recorded – suggesting settlement – the linguistic analysis clarified how small phonetic and orthographic shifts in proper-name-based marks may nonetheless create a strong overall perceptual resemblance, especially where geographic proximity heightens the likelihood of consumer misattribution.

### 2.1.10 Matrix Essentials v. F&M Distributors

This case did not involve similarity of marks but the adequacy of a disclaimer, required when unauthorized retailers sell salon-only Matrix hair products. Linguistic evaluation focused on syntax, pragmatics, Gricean maxims, and noticeability. The store’s handwritten disclaimer, which was small, informal, and poorly placed, failed to communicate unambiguously that the seller lacked an affiliation with Matrix, thereby potentially misleading consumers about product origin and professional authorization. The opposing expert lacked basic pragmatic awareness, reinforcing the importance of qualified linguistic testimony. Although the case settled before trial, the analysis demonstrated how wording, formatting, and pragmatic clarity determine whether a disclaimer effectively prevents consumer confusion under trademark law.

The trial never happened, only depositions of experts took place, and the parties settled.

## 3 METHODOLOGY

This study employs a convergent mixed-methods triangulation design (Jamaledin & Lashkarian, 2016), combining qualitative analysis of the trademarks Pevec and Pevex. The statistical models employed follow McMenamin’s

guidelines on forensic stylistics (2002), specifically measuring the Jaccard distance between two sets of linguistic data. In this case, the sets (A and B) consist of single words rather than complex linguistic corpora; nevertheless, the calculation remains valid and meaningful. The edit distance (Levenshtein) was measured to quantify surface differences. Special focus was placed on the C→X substitution in word-final position, given its salience in short, two-syllable forms.

Furthermore, this paper presents the quantitative results of the conducted consumer survey (N = 100) which measures how visual, aural, and conceptual linguistic elements shape trademark recognition and confusion in the case of Pevec vs Pevex. All strands are systematically aligned with the average-consumer benchmark and the *visual-aural-conceptual* triad used by EU and Croatian authorities ([www.euipo.europa.eu](http://www.euipo.europa.eu)), ensuring the study's relevance and applicability. Because the likelihood of confusion (LoC) is ultimately an empirical question about consumer perception, the linguistic strand is coupled with market evidence. Following DeRosia (2024), the analysis explicitly aligns linguistic diagnostics with survey outcomes to minimize the risk that either method alone over- or underestimates confusion. This approach mirrors the EU case law's "overall impression" standard and provides a practical blueprint for evidentiary synergy, serving as the core methodological framework for the paper.

Using Croatian pronunciation rules (and source language rules where relevant), marks were transcribed in IPA. Segmental contrasts were analysed (final clusters /ts/ vs /ks/), syllable structure (CV.CVC), stress (initial), and phonotactics. A phoneme-level and feature-based distances were computed and interpreted with reference to confusability literature (e.g., separation of the alveolar affricate vs velar stop-fricative in final position).

## **4 RESULTS AND DISCUSSION**

### **4.1 Background of the Pevec Case**

The Croatian dispute concerning PEVEC and PEVEX is best understood against the background of a well-known domestic retail chain specializing in home improvement, construction materials, furniture, and household goods. The original company, Pevec, publicly associated with its founder, Zdravko Pevec, entered serious financial difficulties and was subsequently taken over by

a new corporate entity. Following this takeover, Zdravko Pevec initiated court proceedings to prevent the successor company from continuing to trade under the PEVEC name/brand (i.e., the founder's surname as a market identifier). In other words, the core controversy initially focused on the permissibility of using PEVEC after the change in ownership.

After the successor company was barred from using the PEVEC name, it rebranded in 2020 as Pevec d.d. and registered PEVEC as its own trademark. The subsequent conflict unfolded primarily in administrative trademark proceedings before the Croatian State Intellectual Property Office (DZIV), including invalidation requests (2018, 2022) and an opposition relating to later filings. DZIV's first-instance decisions in March and April 2022 invalidated two figurative PEVEC marks (Z20190554 and Z20190556), but these rulings were challenged in administrative litigation. The Administrative Court refused to grant suspensive effect, and in 2024, the High Administrative Court (Usz-1255/2024-5) ultimately dismissed the appeal, confirming the validity of the PEVEC registration.

Although the administrative and judicial decisions contain observations that are linguistic in nature (e.g., graphemic and phonetic differences such as the final consonants and the C↔X distinction), the available record does not indicate that either party formally advanced a standalone, methodologically structured linguistic comparison of PEVEC and PEVEC. Moreover, the broader dispute indicates that the focus was on restricting the use of PEVEC, rather than on a standalone assessment of whether PEVEC was so similar to PEVEC that it should have been excluded from registration in the first place. This paper, therefore, provides a structured linguistic analysis to clarify measurable phonetic and semantic distinctions beyond the generic assertion of a "one-letter difference."

#### **4.2 Qualitative Analysis of mark Pevec vs Pevec**

The decision of the High Administrative Court of Croatia, Usz 1255/2024-5 (IUS-Info), in reviewing a DZIV invalidation of a PEVEC figurative mark, rejected bad faith and found sufficient difference between Pevec (surname) and Pevec (coined form) to produce distinct consumer perceptions.

The orthographic and visual comparison showed that both signs are five-letter uppercase words; both begin with PEVE and differ only in the final letter (X vs C).

**Table 2** Shared graphemes of Pevec – Pevex TM

<b>P</b> EV <b>E</b> C	<b>P</b> EV <b>E</b> X
<b>P</b> E <b>V</b> EC	<b>P</b> E <b>V</b> EX
PE <b>V</b> EC	PE <b>V</b> EX
PEV <b>E</b> C	PEV <b>E</b> X
PEVEC <b>C</b>	PEVEX <b>X</b>

The shared graphemes were measured as percentages, according to Sadi Makangila's measurements in cases Adidas vs Abidas and Dubblemint&DoubiemInt. (Sadi Makangila et al, 2020; Sadi Makangila et al, 2021).

Accordingly, graphemes are 80% (8/10) identical:

P-E-V-E-C 4/5

P-E-V-E-X 4/5

8/10 = 80%

From PEVEC's perspective: 4/5 = 80%

From PEVEX's perspective: 4/5 = 80%

Total: 8 shared graphemes out of 10 graphemes combined = 80% graphic similarity.

Jaccard Similarity & Distance for two sets A and B:

$$J(A, B) = |A \cap B| / |A \cup B|$$

Jaccard distance = 1 - J(A, B).

Note: n-grams are treated as sets (unique n-grams), not multisets.

Bigrams (PEVEX vs PEVEC)

Extract bigrams (word length L = 5; number of bigrams = L - 2 + 1 = 4):

PEVEX → {PE, EV, VE, EX}

PEVEC  $\rightarrow$  {PE, EV, VE, EC}

Intersection and union:

$A \cap B = \{PE, EV, VE\} \rightarrow \text{size} = 3$

$A \cup B = \{PE, EV, VE, EX, EC\} \rightarrow \text{size} = 5$

Jaccard similarity and distance:

$J_{\text{bigrams}} = 3 / 5 = 0.6$

distance =  $1 - 0.6 = 0.4$

The conclusion is that there is a high local overlap, primarily driven by the shared onset PEVE-.

Trigrams (PEVEX vs PEVEC)

Extract trigrams (number of trigrams =  $L - 3 + 1 = 3$ ):

PEVEX  $\rightarrow$  {PEV, EVE, VEX}

PEVEC  $\rightarrow$  {PEV, EVE, VEC}

Intersection and union:

$A \cap B = \{PEV, EVE\} \rightarrow \text{size} = 2$

$A \cup B = \{PEV, EVE, VEX, VEC\} \rightarrow \text{size} = 4$

Jaccard similarity and distance:

$J_{\text{trigrams}} = 2 / 4 = 0.5$

distance =  $1 - 0.5 = 0.5$

The conclusion is that there is a moderate-to-high structural overlap between the items, with the primary divergence occurring in the final trigram (VEX versus VEC).

**Table 3** Summary of qualitative linguistic analysis

Measure	Result	Interpretation
Length	5 vs 5	Same length (maximal comparability)
Shared prefix	4/5 (“PEVE”)	Identical onset segment is highly salient in glance reading
Levenshtein (abs.)	1	One substitution (X ↔ C)
Normalized Levenshtein	0.20	1 change / 5 positions
Bigrams	PEVEX {PE, EV, VE, <b>EX</b> } vs PEVEC {PE, EV, VE, <b>EC</b> }	Shared bigrams { <b>PE, EV, VE</b> }
Bigram Jaccard	0.60	High local overlap
Trigrams	PEVEX { <b>PEV, EVE, VEX</b> } vs PEVEC { <b>PEV, EVE, VEC</b> }	Shared trigrams { <b>PEV, EVE</b> }
Trigram Jaccard	0.50	Moderate–high structural overlap

Orthographic (visual) similarity is high. The identical initial sequence (PEVE) dominates quick consumer processing; single tail-end substitutions are typically less discriminative under imperfect recollection. The graphemes show 80% similarity (1 change / 5 positions), which equals the normalized Levenshtein distance. They occupy the same initial positions and occur in the same grapheme order, differing only in the final grapheme. This was the argument that contributed to the perceived dissimilarities and distinctiveness of the two TMs, but in this linguistic analysis, quantified using Jaccard’s index, it is clear that different codas in such short words are not enough. [A1]

#### 4.3 Phonetic (aural) comparison

PEVEX /'pɛ.vɛks/

PEVEC /'pɛ.vɛts/

The Prosody and structure are both disyllabic with initial stress ('pɛ.vɛ-); identical onsets and nuclei across syllables (P-E / V-E). According to Dinnsen

(2017), a good trademark name would be one that employs highly distinctive speech sounds in a sequence or context that ensures the unambiguous identification of the name.

**Table 4** *Segmental contrast (final coda)*

Position	PEVEX	PEVEC	Features
Coda-2	/k/	/t/	Both voiceless stops; <b>place contrast: velar vs alveolar</b>
Coda-3	/s/	/s/	Identical fricative

The sole aural difference lies in the stop's place of articulation immediately before /s/ (/ks/ vs /ts/) in the final position; a relatively low-salience contrast in casual speech and noisy retail environments, especially compared with the identical rhythm and shared segmental skeleton.

Aural similarity is high. Rhythm, stress, and most segments coincide, while the terminal /k/↔/t/ contrast provides some separation but is localized and occurs late.

#### 4.4 Conceptual (semantic/pragmatic) comparison

1. Public rebrand messaging in 2020 framed *PEVEX* as a “*subtle change*” (one-letter shift) with unchanged category cues (same retail format, recognizable green trade-dress). These cues signal continuity, strengthening conceptual linkage for consumers.
2. *PEVEC* functions as a surname in Croatian; meanwhile, *PEVEX* is a coined form without independent lexical meaning. Surname vs. neologism can create conceptual asymmetry, supporting separate mental representations, although the conceptual outcome depends on which narrative the tribunal credits.

The semantics depend on the context and on the perception of the community. Therefore, the linguistic survey was conducted on the perception of the meaning of the words *Pevec* – *PeveX*, following DeRosia's triangular method (2024).

Pragmatic analysis was intentionally excluded, as it requires a different analytical framework and a broader dataset, including collocational patterns and contextual uses of the *PEVEC/PEVEX* marks. Such an approach would be appropriate in a full linguistic expert report or in an assessment of the advertising slogan, but it is not essential for the specific aims of this paper.

#### 4.5 Quantitative analysis

A total of 100 adult, native Croatian speakers completed an online questionnaire administered via Google Forms. Participants were recruited by convenience sampling from professional networks and were all residents of Split-Dalmatia County. The sample consisted predominantly of entrepreneurs from the tourism sector, including caterers and hotel managers or owners (approximately 75 participants), with the remaining respondents drawn from other occupational backgrounds, such as public-sector employment and non-employed adults. All participants were active customers of home-improvement and household retail stores such as Pevec/PeveX, purchasing goods either for private household use or for business-related purposes.

The respondents' ages ranged from 30 to 55 years, with an average age of 45, and the gender distribution was approximately 60% men and 40% women. Exclusion criteria included current employment in branding or intellectual property roles and any prior involvement with the parties. The survey was anonymous, distributed with an information sheet explaining the study purpose and consent terms; only minimal, non-sensitive data were collected in accordance with GDPR norms. The aggregate results are reported in the figures that follow.

**Figure 1** Results for Survey Q 1

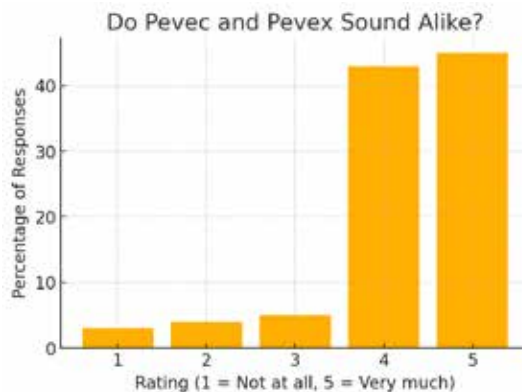


Figure 1 shows that the vast majority of participants rated the names as highly similar (ratings 4 and 5), indicating that most respondents perceive Pevec and PeveX sound very much alike.

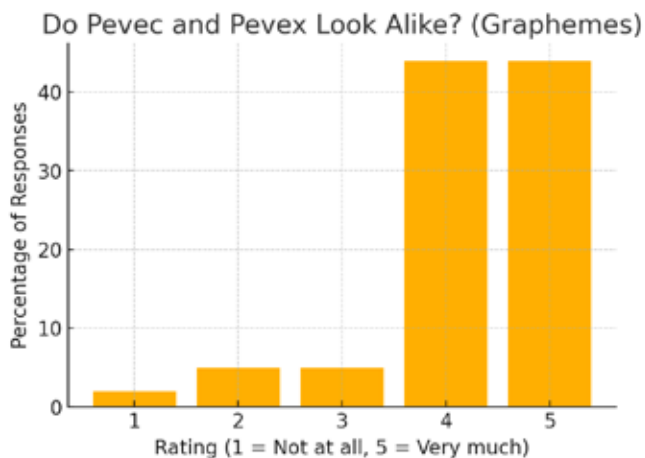
**Figure 2 Results for Survey Q 2**

Figure 2 shows that most respondents rated the visual similarity of the names as high (ratings 4 and 5), indicating that participants generally perceive Pevac and Pevex look very similar in their written form.

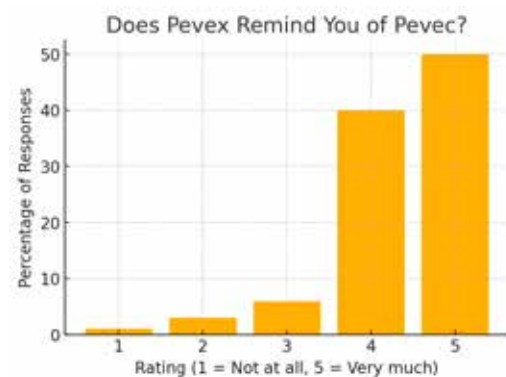
**Figure 3 Results for Survey Q 3**

Figure 3 shows that the majority of participants selected the highest similarity ratings (4 and 5), indicating that *Pevex* strongly reminds most respondents of *Pevac*.

**Figure 4** Results for Survey Q 4

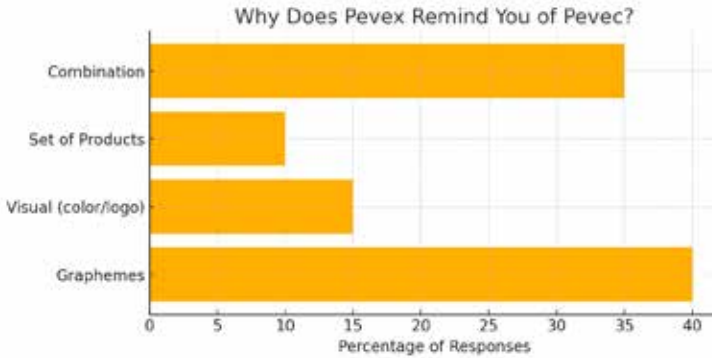


Figure 4 shows that respondents most commonly attributed the association between Pevex and Pevec to grapheme similarity, followed by a combination of factors, indicating that the written form of the names plays the strongest role in why does one remind them of the other.

**Figure 5** Results for Survey Q 5

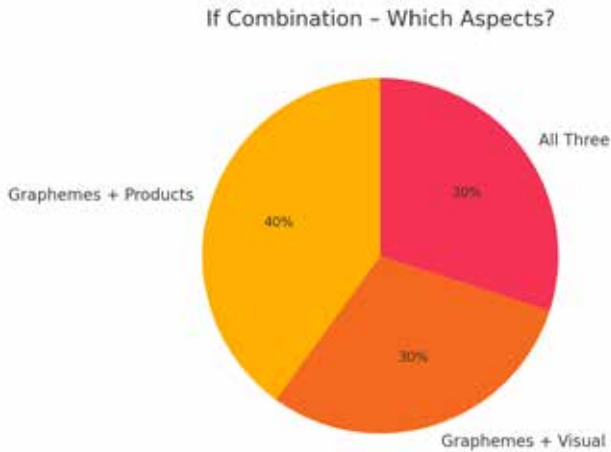


Figure 5 shows that among respondents who selected combination of factors most attributed the similarity to graphemes plus products, while smaller but equal proportions cited either all three aspects or the combination of graphemes and visual features.

**Figure 6** Results for Survey Q 6

Figure 6 shows that most respondents (70%) understood Pevac primarily as a surname, while a smaller portion (30%) associated it with a store selling garden or household products.

**Figure 7** Results for Survey Q 7

Figure 7 shows that most respondents (78%) interpreted Pevex as the name of a shop, while a smaller share (22%) reported that the word carried no particular meaning for them.

The survey results strongly corroborate linguistic analysis with respect to visual and aural similarity. Respondents reported a very high-perceived overlap for both graphemes and sounds, with 88% rating the similarity at four or five on a five-point scale. This pattern is entirely consistent with the linguistic

finding that both marks share the identical PEVE- onset, have the same rhythm and stress pattern, and differ only in a single terminal consonant contrast (/ts/ versus /ks/), a relatively low-salience position in ordinary speech perception.

Conceptually, two opposing forces coexist. On the one hand, continuity and linkage are prominent: 90% of respondents reported that Pevex reminds them of Pevec, explicitly attributing this association primarily to the grapheme similarity of the names, with the green color trade dress and the unchanged product assortment acting as secondary cues that amplify the sense of continuity. On the other hand, a certain degree of separation is also apparent. Most respondents (70%) reported perceiving Pevec as a surname, while nearly all treated Pevex as a brand name only. This distinction reflects the well-known asymmetry between personal-name marks and coined terms, as noted in EU case law, and may mitigate, but not eliminate, the overall associative pull between the signs.

Taken together, the results of both the qualitative and quantitative analyses indicate that, under the EU and Croatian global appreciation test, there is strong visual and aural proximity, reinforced by a salient associative link, as well as a conceptual distinction that is available to consumers. Whether the similarity ultimately tips into a likelihood of confusion will depend on how a tribunal chooses to weigh conceptual distance relative to the very high visual and aural alignment, particularly in the context of identical retail categories and overlapping visual identity.

These findings should be read with the usual limitations in mind: percentages are rounded, the sample was drawn from a convenience panel, and the stimuli were presented as words only, without complete packaging or advertising context. Nevertheless, the results are internally consistent with the phonetic and orthographic diagnostics and provide decision-useful empirical evidence that can support either party's theory of the case, depending on the doctrinal weighting assigned to conceptual distance.

## **5 CONCLUSION**

This paper aimed to demonstrate how forensic linguistics can enhance the transparency, replicability, and alignment of trademark adjudication with the way consumers actually perceive signs. It has also provided insights into the unresolved Croatian TM infringement case and offered evidence-based solutions informed by linguistic analysis and comparative review of similar international

cases. Across the US litigations, the Croatian PEVEC/PEVEX dispute, and a targeted consumer survey (N = 100), we found the same through-line: courts and offices reason, implicitly or explicitly, through the visual–aural–conceptual triad and the average-consumer standard under imperfect recollection. Linguistic evidence strengthens that reasoning by turning impressions (“they look/sound alike”) into analysable features (grapheme overlap, phonotactic contrasts, conceptual fields) and by clarifying when conceptual asymmetry (e.g., surname vs. coined term) can outweigh high surface similarity.

In Croatia, the State Intellectual Property Office (DZIV) already embeds linguistic assessment inside routine examination. Even without a mandatory, systematic external linguistics stage, examiners evaluate three similarity criteria: visual, aural (phonetic), and conceptual (semantic). For verbal marks, they apply source-language pronunciation rules or, where unclear, Croatian phonetics. Nevertheless, court disputes in Croatia, or preliminary checks of the TM at the DZIV office, do not include systematic linguistic expert reports. Although external expert opinions are not required, DZIV does accept outside expert statements and surveys (notably for acquired distinctiveness), which is precisely where linguists can and should contribute. This paper has precisely shown how forensic linguistics can make trademark adjudication more transparent, replicable, and aligned with how consumers actually perceive signs. The comparative analysis revealed where Croatian practice already aligns with these principles and where it lacks systematic, linguistically informed evaluation.

The practical contribution of this paper is evident. Linguistically informed protocols can prevent weak or confusing marks from entering the register, reducing later oppositions, invalidations, and litigation. Ex-post expert reports, when incorporated early, help courts to articulate which specific features drive similarity or distinctiveness, as shown across the international cases reviewed. These combined tools strengthen legal predictability and protect consumers by making the tribunal’s reasoning explicit.

The study has two limitations. Linguistic analysis cannot replace the market evidence where secondary meaning must be proven, and our empirical sample used word-only stimuli without full trade-dress context. Future research should incorporate logos, packaging, and direct confusion questions, which would then include the pragmatic perspective into linguistic analysis.

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## ULOGA FORENZIČKE LINGVISTIKE U ZAŠTITI ŽIGOVA – HRVATSKA STUDIJA SLUČAJA

### SAŽETAK

Ovaj rad istražuje primjenu forenzičke lingvistike u parnicama vezanim uz povredu žigova, s posebnim naglaskom na analizu jezičnih aspekata žigova Pevec i Pevec. Kroz pregled deset najistaknutijih slučajeva povrede žigova u SAD-u, istraživanje pokazuje u kojoj su mjeri jezične analize žigova korištene u rješavanju sporova i kako takve analize mogu pomoći u razumijevanju sličnosti i razlika među žigovima te koji potencijal imaju za izazvati zabunu kod potrošača. Glavno jezično istraživačko pitanje odnosi se na to koji jezični elementi pridonose percepciji sličnosti ili razlike među žigovima i kako se te percepcije mogu kvantificirati. Metodologija kombinira kvalitativne i kvantitativne analize. Kvalitativna analiza ispituje fonološke, morfološke i semantičke karakteristike žigova kako bi identificirala ključne jezične značajke koje utječu na percepciju, te pregledava kriterije postojećih protokola zaštite žigova. Kvantitativni dio uključuje eksperimente percepcije provedene na uzorku od 100 ispitanika, koji procjenjuju sličnost između odabranih parova žigova. Studija također uključuje pregled deset najznačajnijih sudskih presuda u kojima su jezični elementi imali ključnu ulogu, prezentirajući jezične i perceptivne analize uz sudske argumente. Rezultati istraživanja otkrivaju da fonološke sličnosti, poput broja slogova i ritma, kao i semantičke asocijacije, predstavljaju ključne čimbenike koji utječu na percepciju sličnosti među žigovima. Studija naglašava važnost kontekstualnih čimbenika, poput specifičnih industrija i tržišnih okruženja, te ističe potrebu standardizacije jezičnih metodologija u pravnim postupcima. Značaj ovog rada leži u prikazivanju potencijala forenzičko-lingvističke analize žigova, metode koja još nije sustavno uključena u protokole zaštite žigova niti u stručne procjene tijekom sporova. Uključivanje takvih analiza u procese zaštite žigova omogućilo bi preciznije procjene rizika, smanjenje učestalosti parnica i značajnu uštedu troškova u pravnim procesima.

**Ključne riječi:** forenzička lingvistika, jezična analiza, žig, zaštita, povreda

*Prethodno priopćenje / Preliminary communication*

# **DevContainers: Enhancing Development and Collaboration in Software Engineering**

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## **ABSTRACT**

*DevContainer technology provides an innovative approach to standardizing and accelerating development environments in software engineering. By encapsulating all tools, libraries, and dependencies within containers, DevContainers ensure that development teams operate in consistent and reproducible environments. This paper explores the practical benefits of DevContainers, focusing on improving collaboration, consistency, and productivity. The primary hypothesis is that implementing DevContainers can significantly reduce setup time and enhance compatibility between local and production systems. To validate this, experimental setups were conducted for popular programming languages and tools. Performance evaluation metrics such as initialization time, compatibility, and ease of use were analyzed. The findings reveal a substantial decrease in environment setup time and a marked reduction in compatibility issues, owing to the isolated nature of containerized environments. In the rapidly evolving landscape of software engineering, maintaining consistency and efficiency across development workflows remains a persistent challenge. DevContainers address this by eliminating discrepancies between developers' local setups and deployment environments. This approach significantly mitigates the notorious "it works on my machine" problem while simplifying the onboarding of new team members. DevContainers also streamline collaboration in distributed teams, ensuring that all members share an identical environment, regardless of their operating systems or toolsets. The experimental results confirm that DevContainers enhance productivity and reduce*

*friction in cross-functional teams. In conclusion, DevContainers are a transformative tool for modern development teams, fostering consistency, collaboration, and efficiency. The versatility and standardization of DevContainers make them indispensable for addressing challenges in dynamic development ecosystems. This study underlines their potential to revolutionize software engineering practices across industries, making them an essential component of the modern development workflow.*

**Keywords:** *DevContainer, Development Environments, Compatibility, Collaboration*

## 1 INTRODUCTION

In the rapidly evolving landscape of software engineering, maintaining consistency and efficiency across development workflows remains a persistent challenge. Modern applications are complex ecosystems, and the need for reliable software releases through automation is paramount [1]. This complexity is mirrored in the development environment, which requires specific versions of runtimes, compilers, and tooling. Development teams are often geographically distributed and use a diverse range of operating systems and local configurations. This diversity frequently leads to discrepancies between developers' local setups and deployment environments, causing the notorious "it works on my machine" problem. Such inconsistencies can result in significant delays and a decrease in overall productivity. This paper investigates the hypothesis that DevContainer technology can eliminate these discrepancies, thereby significantly improving onboarding time, collaboration, and overall productivity.

The purpose of this paper is to analyse DevContainer technology as a robust solution to these challenges. By leveraging containerization, DevContainers provide a method for defining and sharing complete, reproducible development environments as code [2]. The central argument is that the adoption of DevContainers can lead to a substantial improvement in team collaboration, developer productivity, and software quality. This is achieved by ensuring that every team member operates within an identical and predictable environment that closely mirrors production.

This paper begins by providing a brief overview of the evolution of development environments, from virtual machines to containerization. It then provides a detailed examination of the DevContainer specification and its core

components [3]. Subsequently, the paper conducts an in-depth analysis of the key benefits based on a case study performed. Finally, it concludes by summarizing the transformative potential of DevContainers in modern software engineering practices.

The remainder of this paper is structured as follows. Section 2 reviews the evolution of development environments preceding DevContainers. Section 3 provides a detailed technical examination of the DevContainer specification. Section 4 analyses the broad conceptual benefits of this technology. Section 5 presents a qualitative case study and experience report from implementing DevContainers in a university course. Section 6 discusses the study's limitations and proposes a framework for future work. Finally, Section 7 concludes the paper.

The authors confirm that AI-powered tools were utilized to assist in analysing peer-review feedback and drafting revisions during manuscript preparation. All original data collection, data analysis, and the core intellectual contributions of this study remain those of the authors.

## **2 REVIEW OF EXISTING TECHNOLOGIES**

The concept of an isolated development environment has evolved significantly over the past decades, driven by the need for greater consistency and efficiency. The journey began with dedicated physical servers for each project, a method that was costly, inflexible, and difficult to scale.

### **2.1 Virtual Machines (VMs)**

The first major leap forward came with hardware virtualization and Virtual Machines (VMs). VMs emulate an entire computer system, including the hardware, allowing developers to run a complete, isolated guest operating system (e.g., Linux) on top of their host OS (e.g., Windows). Tools like VirtualBox and VMware became popular for creating project-specific environments. While VMs provide strong isolation, they come with significant overhead. Each VM includes a full copy of an operating system, consuming gigabytes of disk space and substantial CPU and RAM resources. They are slow to boot, and sharing large VM images among team members is often impractical due to their size. For modern, fast-paced development that involves switching between multiple microservices, the resource-intensive nature of VMs presents a major bottleneck.

## 2.2 The Rise of Containerization with Docker

The next evolutionary step was OS-level virtualization, or containerization, popularized by Docker. Unlike VMs, containers share the host system's kernel and virtualize the operating system instead of the hardware [4]. They package an application's code with all its dependencies (such as libraries, system tools, and runtimes) into a single, runnable unit called a container image. Containers are incredibly lightweight, start in seconds, and run consistently across different computing environments. This technology revolutionized application deployment and was a critical enabler for the microservices architecture and CI/CD (Continuous Integration/Continuous Deployment) practices [5]. However, while Docker solved the problem of consistent *runtime* environments, it did not inherently standardize the *development* environment itself. Developers still needed to install Integrated Development Environments (IDEs), configure linters, debuggers, and manage local toolchains, leaving significant room for inconsistency.

## 3 DevContainer TECHNOLOGY

DevContainers, or Development Containers, build upon the foundation of containerization to bridge the final gap between development and production. A DevContainer is a running Docker container with a well-defined tool and runtime stack, but it is specifically designed to be a full-featured development environment [6]. The key innovation is the `devcontainer.json` file - a specification that tells a supporting tool (like Visual Studio Code) how to create and connect to this environment.

### 3.1 The `devcontainer.json` Specification

The `devcontainer.json` file is the heart of a DevContainer setup. It is a declarative JSON file that defines every aspect of the environment. By checking this file into the project's source control repository, the entire environment becomes versioned and shareable. Key properties include:

- **name:** A human-readable name for the development container.
- **image or dockerFile:** Specifies the pre-built Docker image to use or points to a Dockerfile in the repository to build a custom image. This defines the base operating system and core dependencies.

- **features:** Allows for the easy addition of common tools and runtimes (like Node.js, Python, or the Azure CLI) through pre-packaged, modular scripts. This avoids cluttering the main Dockerfile. These features are pre-packaged, modular scripts often sourced from the official DevContainer Features repository, providing a reliable and maintainable way to add common tools and dependencies.
- **customizations:** A powerful section, often used for IDE-specific settings. For VS Code, this can specify a list of extensions that should be automatically installed and enabled inside the container, ensuring every developer has the same linters, debuggers, and productivity tools.
- **forwardPorts:** An array of port numbers to automatically forward from the container to the host machine, making it easy to access running web applications from a local browser.
- **postCreateCommand:** A command or script to be executed after the container is created but before the IDE connects. This is typically used for tasks like installing project dependencies (e.g., `npm install` or `pip install -r requirements.txt`).
- **mounts:** Specifies how to mount local filesystems into the container beyond the project workspace, useful for sharing tools or configuration files.

```
.devcontainer.json

{
  "name": "Python Network Programming Course",

  // 1. Use the pre-built Python 3.12 image
  // This image already includes Python, pip, git, and common utilities.
  "image": "mcr.microsoft.com/devcontainers/python:3.12-bookworm",

  "features": {
    "ghcr.io/rocker-org/devcontainer-features/apt-packages:1": {
      "packages": "nmap, tcpdump, iproute2"
    }
  },

  "customizations": {
    "vscode": {
      "extensions": [
        "ms-python.python",
        "ms-python.vscode-pylance",
        "ms-python.black-formatter",
        "github.vscode-pull-request-github",
        "visualstudioexpteam.vscodeintellicode"
      ],
      "settings": {
        "python.defaultInterpreterPath": "/usr/local/bin/python"
      }
    }
  },

  "postCreateCommand": "pip install -r requirements.txt"
}
```

**Figure 1** An abbreviated example of the `devcontainer.json` file used in the Network Programming course, demonstrating the 'features' (e.g., Python), 'customizations' (VS Code extensions), and 'postCreateCommand' (e.g., `pip install`) properties.

### 3.2 Developer Workflow

The workflow for a developer using a DevContainer is remarkably streamlined:

1. A developer clones a project repository containing a `.devcontainer` folder.
2. Upon opening the folder in a supported editor like VS Code, a notification appears, offering to reopen the project in the container.

3. The editor reads the `devcontainer.json` file, builds or pulls the specified Docker image, and starts the container.
4. It then executes any specified commands, installs the defined extensions, and forwards the necessary ports.
5. Finally, the editor's UI connects to a server running inside the container, providing a seamless experience. The developer can edit files, use the integrated terminal, and debug applications as if they were running locally, but all processes are actually executing inside the isolated container.

## **4 ANALYSIS OF BENEFITS AND USE CASES**

The adoption of DevContainers brings a host of benefits that directly address the challenges outlined in the introduction. This section analyzes these advantages through a conceptual lens.

### **4.1 Improving Collaboration & Onboarding**

For distributed teams, ensuring that all members share an identical environment is crucial for collaboration. DevContainers achieve this by codifying the environment's definition. Consider the onboarding of a new team member. Traditionally, this process involves days of following complex README files, installing specific software versions using package managers, and troubleshooting cryptic OS-specific errors. With a DevContainer, this entire process is reduced to cloning the repository and having Docker installed. The environment configuration is self-contained and automated, allowing new developers to become productive in minutes, not days.

### **4.2 Ensuring Consistency**

The primary benefit of DevContainers is the elimination of inconsistencies. Because the development environment is defined in a Dockerfile, it can be built using the same base image and dependencies as the final production container. This parity mitigates the "it works on my machine" problem, as code that runs successfully in the DevContainer has a much higher probability of running correctly in staging and production. This consistency reduces friction between development and operations teams and streamlines the entire development lifecycle.

### **4.3 Enhancing Productivity**

Productivity is enhanced through several mechanisms. First, the significant reduction in environment setup time allows developers to focus on writing code. Second, context-switching between projects becomes seamless. A developer can move from a Python/Django project to a Java/Spring project without any risk of conflicting dependencies on their local machine, as each project's environment is completely isolated. This also allows for safe experimentation; a developer can test a new database or library for one project without affecting any other work on their machine.

### **4.4 Security Benefits**

Developing inside an isolated container can enhance security. Project dependencies, especially those from open-source registries, can sometimes have vulnerabilities. By running the development server and tools inside a container, access to the host machine's filesystem and network is restricted by default. This sandboxing prevents a compromised dependency from potentially accessing sensitive files or moving laterally across the developer's network.

### **4.5 Integration with CI/CD Pipelines**

DevContainers promote a powerful synergy with CI/CD pipelines. The same Dockerfile or image definition used to create the development environment can be leveraged by the CI system to run automated tests, linting, and builds. This ensures that the environment where the code is tested is identical to the one where it was written, eliminating a whole class of integration bugs that arise from environmental drift. This creates a true end-to-end consistency, from a developer's laptop to the production deployment.

### **4.6 Challenges and Considerations**

Despite the numerous benefits, adopting DevContainers is not without challenges. There is a learning curve, particularly for developers unfamiliar with Docker and containerization concepts. Initial setup of the `devcontainer.json` and Dockerfile for a complex project can be time-consuming. Furthermore, Docker itself consumes system resources (CPU, RAM, and disk space), which can be a concern on lower-end hardware. Finally, certain workflows that require deep integration with host hardware, such as mobile app development with

emulators or specific device drivers, can be more complex to configure within a container.

## 5 CASE STUDY: PRELIMINARY QUALITATIVE OBSERVATIONS FROM INTRODUCING DevContainer TECHNOLOGY IN THE NETWORK PROGRAMMING COURSE

### 5.1 Context and Initial Challenges (Baseline)

The Network Programming course in the Computer Science program in Aspira traditionally relied on a Python environment installed locally on students' laptops and on laboratory computers. This setup caused several operational challenges:

- **Environment fragmentation:** different Python versions (e.g., 3.8, 3.10, 3.12), pip conflicts, and inconsistent library versions.
- **OS heterogeneity:** Windows/macOS/Linux differences in paths, permissions, virtual environments, and networking settings.
- **Portability issues:** assignments that worked in the lab often failed on home machines (and vice versa), creating the “works on my machine” syndrome.
- **Onboarding time:** first lab sessions were frequently spent troubleshooting installations and dependency mismatches instead of coding.
- **Networking assignments:** tasks with client–server components and multiple sockets/ports were sensitive to firewall rules and system defaults.

In computer science classes, it can be a challenge to make sure every student has a working development environment [7]. To move beyond qualitative assessment, we developed an evaluation framework to quantify the impact of this intervention across several key metrics.

### 5.2 Research Method: A Qualitative Experience Report

This section is presented as a qualitative experience report, a methodology used in computer science education to evaluate the practical impact of a new technology or pedagogical intervention. The study's context, as noted in 5.1,

is the Network Programming course at Aspira University of Applied Sciences during the 2024/2025 academic year.

- **Participants:** The cohort consisted of eight undergraduate students in their second year of the Computer Science program.
- **Instruments and Data Collection:** This preliminary study employed qualitative instruments. Data was collected via structured, non-participant observations by the course instructor during lab sessions, and informal, anecdotal feedback collected from students during office hours and post-assignment discussions.
- **Data Analysis Procedure:** The analysis presented in Section 5.5 is qualitative. The authors synthesized observation notes and student feedback to identify recurring themes related to onboarding time, environment-specific errors, and overall student frustration or satisfaction.
- **Validity and Reliability:** As a preliminary qualitative report, validity is established through the authors' direct embeddedness as instructors, providing a high-fidelity record of the classroom experience. The authors acknowledge that these findings are not generalizable. This report serves to document the experience and establish the foundation for the formal, quantitative follow-up study proposed in Section 6 (Future Work).

### 5.3 Intervention: DevContainer + GitHub Codespaces

Starting in the academic year 2024/2025, DevContainer technology was introduced in combination with GitHub (repositories and Codespaces). The setup followed an Infrastructure as Code approach, ensuring consistent and reproducible development environments.

Design Principles:

1. **Environment as code:** the entire dev stack declared in the `.devcontainer/` directory.
2. **Consistency across contexts:** students work with the same tools and versions regardless of location.
3. **Fast onboarding:** prebuilt dependencies and VS Code extensions, automatic port forwarding.
4. **Security by least privilege:** development in a non-root user.

## 5.4 Workflow in Practice

The practical application of this setup is divided into distinct workflows for students and instructors, ensuring clarity and efficiency for both roles.

Student:

1. Accepts the assignment.
2. Opens the repository in Codespaces or locally in VS Code → Reopen in Container.
3. First start triggers postCreateCommand; ports are auto-forwarded.
4. Works on tasks, uses Run & Debug profiles, and an integrated terminal.

Instructor/Teaching Assistant:

1. Provides templates.
2. Maintains .devcontainer setup.
3. Grades completed assignments.



*Figure 2 The standardized development environment as presented to students, illustrating the pre-configured VS Code extensions and integrated terminal running inside the container.*

## 5.5 Observations and Educational Impact

- **Faster onboarding:** most students start coding within the first session, without local installation issues.

- **Reduced “works on my machine” problems:** same Docker image + same VS Code extensions across environments.
- **More predictable grading:** Setup ensures reliable evaluation also for the instructor.
- **Better focus on networking concepts:** less time on setup, more on protocol design, error handling, and concurrency.
- **Improved learning experience:** Students reported less frustration with technical issues and were able to delve deeper into the abstract concepts of network programming. This qualitative shift in focus, from setup debugging to conceptual learning, is summarized in **Table 1**.

**Table 1** *Before/After Summary (Qualitative)*

Aspect	Before	After
Environment setup	Manual installs, troubleshooting across OSes	Instantaneous
Lab ↔ Home differences	Frequent, hard to reproduce	Rare, easily identifiable, and reproducible
TA support	Spent on setup/debugging	Spent on reviewing code and concepts

## 5.6 Best Practices for Teaching

To maximize the educational benefits and ensure smooth implementation, the following best practices are recommended:

1. **Template-first:** every assignment starts with an official template.
2. **Automated grading:** minimum passing threshold via pytest in CI, plus rubrics for code style and documentation.
3. **Version pinning:** lock image tags and dependency versions.
4. **Observability:** collect aggregated metrics (e.g., % of passing tests) anonymously for pedagogical insights.
5. **Progressive complexity introduction:** Start with a fully configured DevContainer, and later in the curriculum, introduce assignments where students must modify the devcontainer.json or Dockerfile themselves to also develop environment management skills.

- 6. Provide a Fallback Option:** While encouraging the use of the DevContainer, ensure students know how to run the code locally if they encounter insurmountable hardware limitations (e.g., low RAM) or technical issues with Docker. This prevents them from being completely blocked, though it comes with the caveat that the environment is no longer standardized.

## 5.7 Conclusion of the Case Study

The introduction of DevContainers and GitHub Codespaces in the Network Programming course proved to be an effective solution for eliminating environment heterogeneity, accelerating onboarding, and improving grading consistency. By standardizing the development layer, students focus more on networking concepts, while instructors benefit from reproducible evaluation pipelines. The proposed evaluation framework will help quantify these effects in future iterations and provide a solid basis for academic dissemination.

## 6 FUTURE WORK AND LIMITATIONS

This paper has presented a technical overview and a preliminary, qualitative case study of DevContainer technology. The authors acknowledge several limitations that provide clear avenues for future work.

First, the case study presented in Section 5 is qualitative and observational. While it provides strong initial evidence of the technology's benefits in an educational setting, it lacks a rigorous, quantitative framework for validating these claims. The data analysis was not formalized, and the participant pool was limited to a single course cohort.

To address this, our immediate future work is to conduct a formal, quantitative study based on the framework developed during this preliminary phase. We propose the following evaluation framework to validate the observed benefits.

To quantitatively validate the observed benefits of adopting DevContainers, we propose the following evaluation framework. While formal data collection is planned for the next academic year, based on our initial observations and the nature of the technology, we can project significant improvements across key metrics crucial for educational efficiency.

This framework will be applied in a more controlled study during the next academic year to gather empirical data. The metrics from this proposed framework, which we plan to formally measure, are detailed in **Table 2**.

**Table 2** Proposed Metrics for Future Quantitative Evaluation of DevContainer Impact

Metric	Definition	Measurement Method	Baseline (Traditional Setup)	Projected Result (With DevContainer)
<b>Onboarding Time</b>	Time from first repository clone to a successfully running application.	CI prebuild logs; Student survey timestamps.	90 - 180 min	<b>&lt; 10 min</b>
<b>Reproducibility Rate</b>	Percentage of student submissions that run successfully on the first attempt on an instructor's machine.	Automated testing in a standardized grading container.	~70%	<b>~99%</b>
<b>MTTR (Dev Env)</b>	Mean Time To Repair a broken development environment.	Time from deleting the local container to a fully functional state.	30 - 60 min	<b>&lt; 3 min</b>

By formally collecting and analysing this data, we aim to move beyond the qualitative observations of this paper and provide a statistically significant validation of the impact of DevContainers on educational efficiency and student outcomes.

Beyond this specific case study, future research should also explore the performance overhead of DevContainers on diverse, lower-end student hardware and investigate more complex use cases, such as distributed systems or projects requiring hardware-specific drivers.

## 7 CONCLUSION

DevContainers represent a transformative tool for modern development teams. By combining the power of containerization with declarative configuration, they provide a definitive solution to the long-standing problems of environment inconsistency and complex setup procedures. This technology fosters a more collaborative and efficient development culture where developers can focus on innovation rather than configuration. The ability to version-control the entire development stack alongside the application code is a paradigm shift that enhances reproducibility and quality.

The preliminary, qualitative case study conducted in the Network Programming course at Aspira University of Applied Sciences provides strong initial evidence to support these claims. Introducing DevContainers into an academic setting demonstrated an immediate and positive qualitative impact: the time required for environment setup was drastically reduced, issues caused by differences in operating systems and local configurations were largely eliminated, and instructors were provided with a more reliable and equitable grading process. This practical example serves as a strong indicator that the benefits of DevContainers are not merely theoretical but can be successfully applied in an educational context to improve learning outcomes. The case study demonstrated clear qualitative improvements in the student and instructor experience and informed the development of a quantitative evaluation framework, which is detailed in Section 6 (Future Work). The projected metrics from this proposed framework provide a clear hypothesis for our follow-on research.

The versatility and standardization offered by DevContainers make them indispensable for addressing the challenges of today's dynamic development ecosystems. As software projects become more complex and teams more distributed, the need for reproducible and consistent environments will only grow. While there are initial learning curves and resource considerations, the long-term benefits in productivity, collaboration, security, and CI/CD integration are substantial. This study underlines their potential to revolutionize software engineering practices, making them an essential component of the modern development workflow. As software projects grow in complexity and embrace distributed architectures, AI tooling, and multi-cloud deployments, the need for reproducible, declarative environments becomes critical. DevContainers are poised to be a foundational technology in this future, moving from a tool of

convenience to one of necessity for ensuring security, scalability, and developer effectiveness.

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## DEVCONTAINERS: UNAPREĐENJE RAZVOJA I SURADNJE U SOFTVERSKOM INŽENJERSTVU

### SAŽETAK

*Tehnologija DevContainer pruža inovativan pristup standardizaciji i ubrzanju razvojnih okruženja u softverskom inženjerstvu. Encapsulacijom svih alata, biblioteka i ovisnosti unutar kontejnera, DevContaineri osiguravaju da razvojni timovi rade u konzistentnim i reproducibilnim okruženjima. Ovaj rad istražuje praktične prednosti DevContainera, s naglaskom na poboljšanje suradnje, dosljednosti i produktivnosti. Primarna hipoteza rada jest da implementacija DevContainera može značajno smanjiti vrijeme postavljanja okruženja i poboljšati kompatibilnost između lokalnih i produkcijskih sustava. Kako bi se to provjerilo, provedeni su eksperimentalni testovi za popularne programske jezike i alate. Analizirani su parametri performansi poput vremena inicijalizacije, kompatibilnosti i jednostavnosti korištenja. Rezultati pokazuju značajno smanjenje vremena postavljanja okruženja i smanjenje problema s kompatibilnošću, zahvaljujući izoliranoj prirodi kontejneriziranih okruženja. U brzo mijenjajućem okruženju softverskog inženjerstva, održavanje dosljednosti i učinkovitosti kroz razvojne radne procese ostaje trajni izazov. DevContaineri na to odgovaraju uklanjanjem razlika između lokalnih razvojnih okruženja programera i produkcijskih okruženja za implementaciju. Ovakav pristup značajno ublažava dobro poznati problem „radi na mom računalu“, istodobno pojednostavljujući uvođenje novih članova tima. DevContaineri također olakšavaju suradnju u distribuiranim timovima, osiguravajući da svi članovi rade u identičnom okruženju, neovisno o operacijskim sustavima ili korištenim alatima. Eksperimentalni rezultati potvrđuju da DevContaineri povećavaju produktivnost i smanjuju prepreke u međufunkcionalnim timovima. Zaključno, DevContaineri predstavljaju transformativan alat za moderne razvojne timove jer potiču dosljednost, suradnju i učinkovitost. Njihova svestranost i standardizacija čine ih nezamjenjivima u suočavanju s izazovima dinamičnih razvojnih ekosustava. Ova studija naglašava njihov potencijal da*

*revolucioniraju prakse softverskog inženjerstva u različitim industrijama, čineći ih ključnom komponentom suvremenog razvojnog radnog procesa.*

**Ključne riječi:** *DevContainer, razvojna okruženja, kompatibilnost, suradnja*

## **Detekcija malicioznog PDF dokumenta sintaksnom analizom**

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### **SAŽETAK**

*PDF (eng. Portable Document Format ) popularan je oblik zapisa koji se koristi za pregled, odnosno prikaz dokumenata. Upravo ta popularnost pogodovala je u razvoju malicioznih tehnika koje iskorištavaju ranjivost PDF oblika zapisa te se isti koristi kao čest vektor napada. PDF dokument koji sadrži maliciozni teret predstavlja izravnu sigurnosnu prijetnju korisniku, odnosno sustavu. Rad opisuje uporabu PeePDF alata otvorenog koda za parsiranje PDF dokumenata na primjeru, odnosno primjeru pronalaska potencijalno malicioznog koda u strukturi dokumenta.*

**Ključne riječi:** *PDF, PeePDF, sintaksna analiza*

### **1. UVOD**

Kako je PDF popularan, višepatformski format za prikaz dokumenata, može biti pogodan vektor napadačima za isporuku zlonamjernog softvera (eng. *malware*). *Malware* je opći izraz za sve vrste zlonamjernog softvera koji se koristi s ciljem pokušaja provale u računalni sustav. U kontekstu računalne sigurnosti zlonamjerni softver koristi se s ciljem pokušaja provale u računalni sustav i tako narušava temeljne kriterije informacijske sigurnosti, odnosno povjerljivost, cjelovitost ili dostupnost podataka [12].

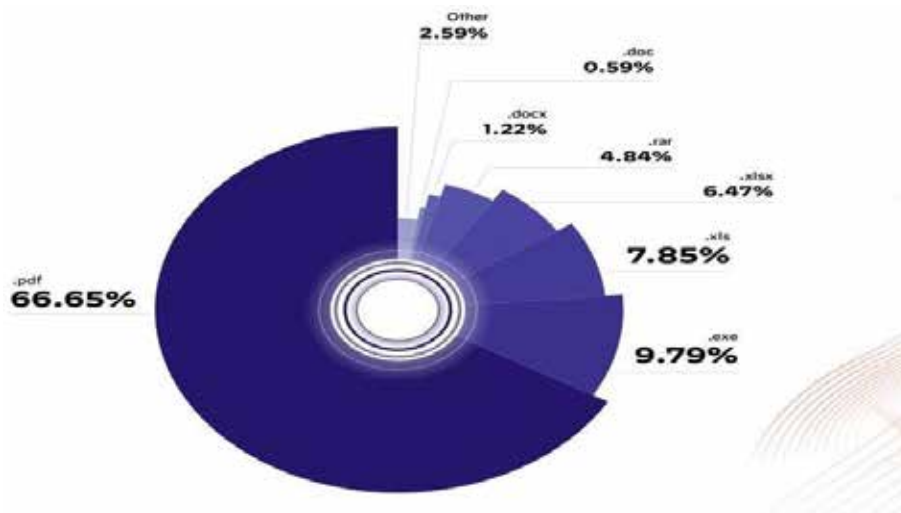
Zlonamjerni softver predstavlja visok rizik u e-poslovanju, a kojem su korisnici svakodnevno izloženi [10]. Zlonamjerni sadržaj može se prikriti na mnogo načina unutar tijela PDF dokumenta koji se kao takav distribuira putem e-pošte, odnosno privitaka. Maliciozni PDF dokument može sadržavati maliciozni JavaScript kod, poveznicu na maliciozno web sjedište, mogućnost izvršavanje naredbe u cilju preuzimanje zlonamjernog sadržaja te prikriiveni, kodirani sadržaj koji se aktivira prilikom otvaranja dokumenta. PDF dokumenti koriste se i u mrežnoj krađi identiteta (eng. *phishing*), odnosno *phishing* kampanjama.

Prema istraživanju tvrtke Palo Alto Networks u godinama 2019. i 2020. primijećeno je povećanje broja malicioznih PDF datoteka od 1160% [3]. Također, isto istraživanje identificiralo je pet najboljih shema koje su napadači koristili 2020. godine za izvođenje *phishing* napada. Zajedničko svim identificiranim shemama koje su se koristile u *phishing* kampanjama s PDF dokumentima je korištenje grafičkih elemenata (slika, logotip), odnosno gumba čijim se klikom poziva URL koji vodi do malicioznog izvora. Isto tako, pojedine kategorije koristile su slične grafičke elemente popularnih online usluga za dijeljenje datoteka (npr. *Dropbox*, *Onedrive*), a sve kako bi privukle pažnju korisnika kojeg su prethodno obavijestili da je netko s njima podijelio dokument.

Drugo istraživanje Palo Alto Networksa iz 2023. pokazuje da se 66% zlonamjernog softvera isporučuje upravo putem PDF-ova i to u obliku e-mail privitaka [1]. Razlog uporabe PDF formata zapisa kao potencijalno maliciozne platforme jest upotreba istog u svakodnevnim poslovnim aktivnostima prilikom razmjene datoteka. Primjerice, prilikom preuzimanja elektroničke pošte manja je opreznost korisnika s uobičajenom i očekivanom vrstom datoteka u usporedbi s neočekivanom vrstom datoteka poput izvršnih (.EXE).

U radu *PDF Malware Analysis* [14] autori ističu korištenje statičke (pregled binarnih datoteka što daje brzu identifikaciju) i dinamičke analize (izvođenje datoteka u izoliranom, virtualnom okruženju što daje uvid u ponašanje u stvarnom vremenu) potencijalno malicioznog PDF dokumenta s preporukom kombiniranja tehnika, odnosno korištenje hibridne metode detekcije. Za razliku od prethodnog rada koji promiče hibridne metode za učinkovitost i konceptualne je osnove, u ovom radu dan je naglasak na demonstrativan pristup u opisu specifičnog alata otvorenog koda za statičko parsiranje. Uvodno poglavlje daje pregled dosadašnjih istraživanja, drugo poglavlje daje opis strukture PDF formata zapisa, treće poglavlje opisuje primjer malicioznog tereta implementiranog unutar strukture PDF formata zapisa, dok četvrto poglavlje prikazuje primjer

sintaksne analize PDF dokumenta uporabom PeePDF alata otvorenog koda. U zaključku su dana zaključna razmatranja o korištenju PeePDF alata i sintaksoj analizi PDF formata zapisa.



**Grafikon 1** 66% malwarea se distribuira putem PDF dokumenata (Izvor: unit42.paloaltonetworks.com)

## 2. PORTABLE DOCUMENT FORMAT - PDF

### 2.1. PDF format zapisa

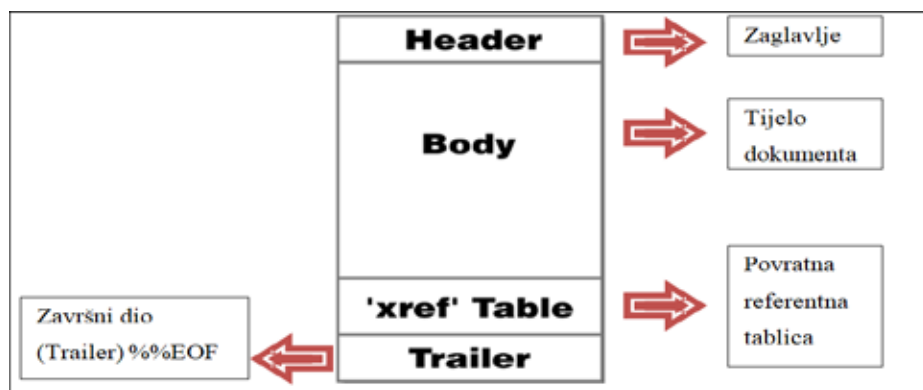
Portable Document Format, odnosno PDF format, popularan je format za pisa koji se koristi za razmjenu dokumenata, neovisno o operacijskom sustavu. Njegovo glavno obilježje je očuvanje integriteta koje mu omogućuje jedinstven prikaz sadržaja na različitim programskim platformama. Sadržaj PDF dokumenta može se prikazati jednako na svim platformama, neovisno o podršci i postavkama operacijskog sustava ili drugih programa koji mogu prikazivati PDF oblik zapisa. Stvoren 1993. godine od strane tvrtke Adobe, dok je 1998. godine postao otvoreni standard prema ISO (ISO/IEC 32000-1:2008) standardu [7]. PDF dokument može sadržavati tekst, slike, vektorsku grafiku, a može sadržavati i interaktivnu grafiku u dvodimenzionalnom ili trodimenzionalnom prostoru.

Za prikaz PDF oblika zapisa postoje preglednici poput Adobe Acrobat Reader, Foxit Reader, MuPDF, Javelin PDF Reader i drugi. PDF preglednici mogu biti i integrirani s internetskim preglednicima ili s Google Drive uslugom, koja nudi kolaboraciju i dijeljenje dokumenata među korisnicima.

## 2.2. Struktura PDF formata zapisa

PDF osim prikaza teksta, slike i multimedijских elemenata može biti zaštićen zaporkom te izvršavati *JavaScript* programski kôd. PDF dokument u osnovnoj strukturi predstavlja podatkovnu datoteku sastavljenu od objekata, a koji su povezani povratnom referentnom tablicom (eng. *cross reference table*). Prilikom dodavanja novog sadržaja dokumentu dodaju se novi objekti, pri čemu se povratna referentna tablica ažurira. Kod brisanja sadržaja, odabrani objekti se brišu iz referentne tablice, ali se ne uklanjaju iz dokumenta. Izmjene i ažuriranja zapisuju na kraju dokumenta (%%EOF) pri čemu se čuva originalna verzija. Osnovna logička struktura PDF dokumenta sastoji se od [5]:

- zaglavlja dokumenta (eng. *Header*)
- tijela dokumenta (eng. *Body*)
- povratne referentne tablice (eng. *Xref table*)
- završnog dijela (eng. *Trailer*)



Slika 1 Osnovna struktura PDF dokumenta (Izvor: autor)

Zaglavlje dokumenta predstavlja prvi redak PDF dokumenta u kojem se navodi broj verzije PDF-a u obliku “%PDF-<oznaka\_verzije>%” te druge specifikacije koju koristi dokument.

Tijelo PDF dokumenta sadrži objekte sa zapisanim informacijama o tokovima teksta, korištenom fontu, slikama te drugim multimedijским elementima. Svaki je objekt definiran definiranim oblikom: *objNbr verNbr obj << (sadržaj objekta) >> endobj* pri čemu:

[*objNbr*] predstavlja redni broj objekta

[*verNbr*] označava identifikator verzije objekta, odnosno čini jedinstvenu oznaku objekta

[*obj, endobj*] predstavljaju ključne riječi (eng. *Keywords*), a između kojih se popunjavaju vrijednosti, odnosno sadržaj objekta (eng. *Contents*)

Tijelo PDF dokumenta se koristi za držanje svih podataka dokumenta koji se prikazuju korisniku.

Povratna referentna tablica značajna je u strukturi PDF datoteke jer sadrži pokazivače na objekte, odnosno gdje se isti i nalaze unutar njezine strukture. PDF datoteka može sadržavati više povezanih povratnih referentnih (*Xref*) tablica. Pokazivač na prvu *Xref* tablicu obično se nalazi na kraju PDF datoteka, odnosno u zadnja 1024 bajta. Zbog postojanja povratne referentne tablice, PDF preglednik čita vrijednosti iz referentne tablice te učitava samo one objekte koji su potrebni, odnosno ne analizira niti učitava cijelu datoteku.

Završni dio PDF preglednik obrađuje na početku učitavanja PDF dokumenta, odnosno svi PDF preglednici čitaju PDF datoteke od kraja prema početku. Završni dio sadrži unose koji omogućuju čitanje povratne referentne tablice, odnosno objekata datoteke. Nakon što je u procesu učitavanja datoteke obrađen *Trailer*, PDF preglednik nastavlja s čitanjem rječnika informacija o dokumentu i katalogu dokumenata. Na slici 2 prikazan je primjer sadržaja završnog dijela, odnosno *Trailer*a. Završni dio prepoznaje se po oznaci %%EOF (eng. *End Of File*) u strukturi PDF datoteke [7].

```
<<
  /Size 421
  /Root 377 0 R
  /Info 375 0 R
  /ID [ <75ff22189c0ac848dfa2afec93d0ee03> <057928614d9711db835e000d937095a2> ]
>>
```

**Slika 2** Primjer *Trailer*a unutar strukture PDF-a (izvor: <https://www.oreilly.com>)

Završni dio PDF-a sadrži sljedeće elemente [13]:

- `/Size` – predstavlja ukupan broj unosa u xref tablicu, odnosno ukupan broj objekata
- `/Root` – označava referencu na poziciju rječnika (eng. *Dictionary*)
- `/Info` – daje informacije o dokumentu
- `/ID` – jedinstveno identificira datoteku. Također daje informaciju o vremenu kreiranja dokumenta, odnosno o vremenu modifikacije

### 3. MALICIOZNI PDF DOKUMENT

PDF format zapisa od svog nastanka 1993. godina pa do standardizacije 2008. dobivao je nove mogućnosti. Od verzije 1.3 u uvedena je mogućnost dodavanja *JavaScript* kôda, dok se uvođenjem podrške za *JavaScript* izravno može utjecati na izgled stranice, forme te podatke u poljima za unos. Isto tako, kôd se može izvršavati pokretanjem akcije i od strane korisnika. Leksička pravila u PDF specifikaciji otvaraju napadačima mogućnost prikrivanja malicioznog kôda, odnosno simbole je moguće napisati na više različitih načina, dok je posljedica toga izbjegavanje otkrivanja antivirusnim programima te sustavima za detekciju upada [7].

Objekti unutar strukture PDF formata mogu izvoditi razne akcije, a značajniji primjeri odnose se na sljedeće naredbe:

- `/Launch` - izvršava komandnu liniju (CMD)<sup>5</sup>
- `/JavaScript` – izvršava javascript kôd
- `/URI` – poziva zadani URI (jedinstveni identifikator izvora (eng. *Uniform Resource Name*))
- `/Goto` or `/GotoR` – putanja na definiranu stranicu u dokumentu
- `/Hide` - skrivanje/otkrivanje poruka

Akcija `/JavaScript` može se koristiti za izvršavanje napada, dok PDF dokumenti mogu sadržavati i binarni sadržaj koji se može iskoristiti za skrivanje korisnog tereta (eng. *Payload*) korištenjem nekih od filtera poput *FlateDecode*, *ASCII85Decode*, *ASCIHexDecode*, *LZWDecode* i drugi.

Na slici 3 prikazana je izvorni kôd akcije `/Launch` unutar objekta 8 strukture PDF dokumenta, a koja pokreće komandnu liniju (*cmd.exe*) prilikom otvaranja dokumenta.

---

<sup>5</sup> Ukinuto od verzije 9.3.3. Adobe PDF preglednika

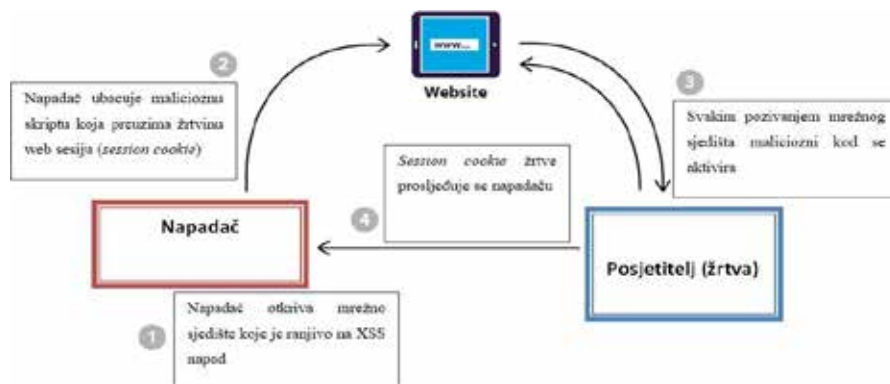
```

8 0 obj
<<
  /Type /Action
  /S /Launch
  /Win
  <<
    /F(cad.exe)
  >>
>>
endobj

```

**Slika 3** Prikaz akcije /Launch koja poziva komandnu liniju (cmd.exe) unutar objekta 8 strukture PDF-a (izvor:autor)<sup>5</sup>

Korištenjem filtera svaki znak može se napisati heksadecimalnim ASCII kôdom (primjer /Pytho#6e je isto što i /Python). PDF datoteke ranjive su na *Cross-Site Scripting* napade – XSS u kojem napadač injektira zlonamjerni kod *JavaScript-a*, *VBScript* ili *HTML-a* u internetski preglednik žrtve, a koji se potom izvršava lokalno na žrtvinom računalu [4]. Na slici 4 prikazan je slijed XSS napada.



**Slika 4 .** Tijek XSS napada (Izvor:autor)

Kako je PDF format danas *de facto* standard u elektroničkom prikazu dokumenata, isti je i pogodna platforma za distribuciju/preuzimanje malicioznog kôda. Kao primjer može se navesti otkrivanje ranjivosti alata Adobe Reader i Acrobat (oznake CVE-2007-520) iz 2007. godine, a koja je zahvaćala verzije alata 8.1 te 7.0.9 i starije [7]. Maliciozni kôd isključivao je Windows vatrozid, FTP protokolom preuzimao crva koji se potom pokretao. Dovoljno je bilo otvoriti maliciozni PDF da bi računalo postalo zaraženo. Primjer malicioznog kôda iz 2007. koji je iskorištavao ranjivost Adobe Readera prikazan je na slici 5.

```
obj<</URI(mailto :%/,/,/,/,/,/,/,/,/Windows /system32/cmd".exe"" /c /q \"@echo
off&netsh firewall set opmode mode=disable&echo o 1. 2. 3.4>1&echo binary>>1&echo
get /ldr.exe>>1&echo quit>>1&ftp -s:1 -v -A>nul&del /q 1& start ldr.exe&\" \"&\"
\"nul.bat)/S/ URI>
```

Slika 5 Primjer zloćudnog kôda koji sadrži obj tag (izvor: Nacionalni CERT)

Većina napada koji se izvode pri korištenju malicioznih PDF dokumenata temelje se na eksploataciji i izvršavanju zlonamjernog skriptnog programskog kôda. Kada se govori o popularnom Acrobat Reader čitaču PDF datoteka, postoje nekoliko osnovnih načina izvođenja eksploatacije malicioznog tereta, odnosno napada [6]:

- eksploatacija temeljena na *Java Script* kôdu
- eksploatacija temeljena na akcijskim skriptama (eng. *Action Script*)
- eksploatacija temeljena na ugniježđenoj malicioznoj datoteci (eng. *File Embedding*)

*JavaScript* napadi najčešće su korišteni u PDF datotekama zbog izravne podrške *JavaScript* jeziku, a odnose se na specifične API<sup>6</sup> pozive u PDF datotekama. Korisnik otvara malicioznu PDF datoteku te pokreće ugrađeni *JavaScript* kôd, a koji ga preusmjerava, primjerice, na malicioznu stranicu. Maliciozna stranica provjerava verziju preglednika te instalirane dodatke (eng. *plugins*) te u konačnici iskorištava *exploit* u svrhu zaobilaznja zaštite te u pozadini izvršava preuzimanje malwarea na računalo žrtve. Opasnost je još veća, ukoliko s korisničke strane nisu podešene odgovarajuće sigurnosne postavke mrežnog preglednika.

*Action Script* napadi vezani su za *Adobe Flash* tehnologiju, a čiji sadržaj može prikazati PDF datoteka. Ranjivost se odnosi na *ShockWave Flash* datoteke (ekstenzija SWF) i pozivanje akcijskih skripti u kombinaciji s *Java Script* kôdom. Kako je daljnji razvoj *Flash* tehnologije od strane Adobea obustavljen i napušten 2020. godine, ovaj tip napada napadačima u budućnosti neće biti od značaja [8].

*File Embedding* napadi odnose se na izravno izvršavanje izvršnog tipa datoteka (.exe). Izvršavanje .exe datoteka potencijalno može dovesti do učitavanja novog zlonamjernog kôda, a čiji je krajnji cilj nanijeti štetu korisniku.

<sup>6</sup> Aplikacijsko programsko sučelje (eng. *Application Programming Interface* - API) je skup određenih pravila i specifikacija koja programerima služe za pristup uslugama ili resursima operacijskog sustava kao standardne biblioteke rutina, struktura podataka, objekata i protokola.

Napadači mogu prikriti i isporučiti zlonamjerni kôd unutar strukture PDF dokumenta i putem tokova podataka (eng. *stream*). Tokovi podataka mogu sa-državati bilo koju vrstu podataka, uključujući skripte i binarne datoteke, a mogu se sažimati i kodirati što otežava otkrivanje ugrađenog kôda unutar datoteke.

#### 4. SINTAKSNA ANALIZA ALATOM PeePDF

PeePDF je alat otvorenog kôda (eng. *Open source*) pisan u Python program-skom jeziku, a osnovna namjena mu je istraživanje strukture PDF datoteke kako bi se otkrilo može li datoteka biti potencijalno štetna ili ne [2]. Prva prednost PeePDF alata je upravo to što je otvorenog kôda<sup>7</sup>, dostupan je na GitHub<sup>8</sup> plat-formi te sastavni dio REMnux Linux distribucije [11]. Softver otvorenog koda uključuje niže početne troškove, bržu iteraciju, fleksibilnije procese razvoja soft-vera, robusnu podršku koju pokreće zajednica i lakše upravljanje licencama, bez ugovorne vezanosti [9]. Druga prednost je usporedba s drugim alatima otvorenog koda za analizu strukture PDF-a, a kao što su PDFid i PhoneyPDF. PeePDF, kao parser koji se upotrebljava i u strojno učenim malware detektorima, može u potpunosti analizirati ugniježđenu (*embedded*) komponentu te dje-lomično strukturu PDF-a i *JavaScript* kôd. Alati PDFid i PhoneyPDF ne mogu izvršiti analizu ugniježđene komponente u strukturi PDF-a [8].

**Tablica 1** Usporedba parsera za analizu strukture PDF dokumenata pri strojno učenim malware detektorima (Izvor: <https://dl.acm.org/doi/abs/10.1145/3332184>)

Parser	PDF Structure	JavaScript	Embedded Files
PDFid	Partial (Key Analysis)	None	None
PeePDF	Partial (Obj. Analysis)	Partial (Code Analysis)	Complete
PhoneyPDF	None	Complete	None

Osnovna funkcionalnost PeePDF alata je pružiti sve potrebne komponente koje bi istraživaču sigurnosti mogli trebati u analizi PDF dokumenta i to bez korištenja višestrukih alata za izradu svih zadataka.

<sup>7</sup> Softver otvorenog koda (eng. *Open source*) je softver koji se javno distribuira s izvornim ko-dom, a koji svatko može koristiti ili mijenjati unutar licencnog opsega.

<sup>8</sup> GitHub platforma je platforma temeljena u oblaku (eng. *Cloud*) a koriste ju programeri za pohranu programskog koda, kontrolu i upravljanje te kolaboraciju unutar zajednice.

Alat omogućava uvid u sve objekte dokumenta koji pokazuju sumnjive elemente, podržava sve najčešće korištene filtere i kodiranja, a može analizirati i različite verzije datoteke, tokove objekata i šifrirane datoteke.

Primjer analize PDF dokumenta demonstrirati će pronalazak potencijalno malicioznog ugniježđenog *JavaScript* kôda te uporabu *xor* naredbe u pronalasku PE (eng. *Portable Executable*) kôda, odnosno izvršne datoteke.

Analiza PDF dokumenta PeePDF alatom započinje naredbom *info*, a koja sadrži osnovne informacije o strukturi dokumenta, odnosno informacije o verziji, katalogu, objektima, tokovima, sadržanom *JavaScript* kôdu te informacije o sumnjivim elementima. Nakon što se identificiraju objekti zanimljivi za analizu, naredba *object* koristi se za pregled dekodiranog sadržaja objekta. Za prikaz sirovih, neobrađenih podataka (eng. *raw data*) koristi se naredba *rawobject <id\_objekta>* ili *rawstream. <id\_objekta>*, a kao što je prikazano na slici 6.

```

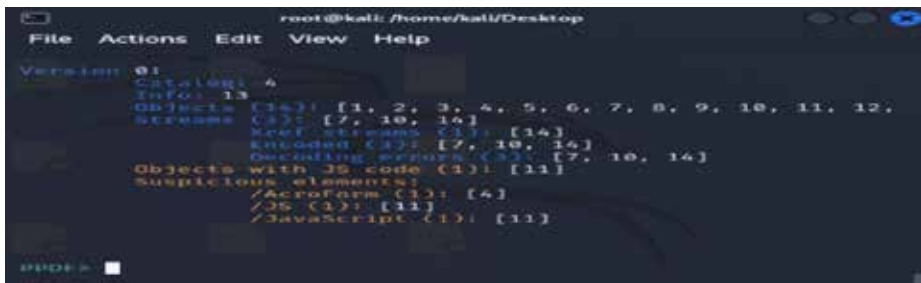
PeePDF> rawstream 7
73 74 72 65 61 6d 0d 0a 78 da 2b 54 30 04 42 73 |stream .. x.+T0.Bs|
02 05 43 4b 3d 33 85 a2 54 85 70 05 3c 05 03 3d |.. CK=) .. T.p.<..*|
0b 23 73 53 34 aa 28 5d c1 00 0c 03 dc 01 44 39 |.8554.( ).....D9|
98 69 6e a4 60 64 06 d1 97 86 90 55 70 0a 01 32 |.in. d.....Up..2|
42 0a 14 f4 03 4a 93 32 93 f3 f3 3c 52 73 ca 52 |0.....)2...<R5.R|
4b 32 93 13 15 0c 01 e2 30 95 60 03 2d f4 8c 15 |K2.....0.....|
42 52 14 34 34 15 42 b2 14 5c 43 14 02 01 24 0e |BR.44.B... \C ... $..|
21 a0 0d 0a |T ... |
PeePDF>

```

Slika 6 Prikaz sirovih, neobrađenih podataka (*raw data*) (Izvor: autori)

Osnovni elementi strukture PDF datoteke:

- *Version* – verzija PDF-a
- *Catalog* – katalog
- *Info* – informacije o strukturi PDF datoteke
- *Objects* – objekti strukture PDF datoteke
- *Streams* – tokovi u strukturi PDF datoteke
- *Objects with JS code* – objekti strukture PDF datoteke s *JavaScript* (JS) kôdom
- *Suspicious elements* – sumnjivi elementi (obično JS kôd ili *AcroForm*)



**Slika 7** Pregled elemenata PDF dokumenta. JavaScript komponenta (JS) sadržana u objektu 11 izdvojen je kao sumnjivi element (Izvor: autori)

Primjer na slici 7 prikazuje izdvajanje sumnjivih elemenata (objekata) strukture i to *AcroForm* i *JavaScript*. *AcroForm* objekti odnose se na obrasce, odnosno polja za unos, a koji se mogu popunjavati unutar PDF dokumenta. *JavaScript* (JS) objekt odnosi se na ugniježđeni *JavaScript* kôd. Korištenjem naredbe *tree* pokazuje se odnos između objekata/tokova. Ako je nadređeni objekt “/XY”, a podređeni je “/JavaScript”, tada postoji velika vjerojatnost da će se *JavaScript* kôd izvršiti nakon otvaranja PDF datoteke. Naredbom *js\_code <id\_objekta>* prikazuje se ugniježđeni *JavaScript* kôd, dok će naredba *js\_beautify* učiniti *JavaScript* kôd dodatno čitljivim kao što je prikazano na slici 8.



**Slika 8** Naredba *js\_beautify* čini *JavaScript* kôd čitljivijim (Izvor: autori)

Na slici 9 objekti 103 i 104 sadrže *Javascript* kôd, a koji je potom i prikazan. S druge strane, naredba *js\_eval* koristi se za izvršavanje ugniježđenog *JavaScript* kôda.

```

PPDF> js_code 103
this.getField("Dropdown1").setItems(this.getField("ListEntries").value.split(/[ ] + /g));
PPDF> js_code 104
this.getField("Dropdown1").clearItems();
PPDF>

```

**Slika 9** Naredbom `js_code <ID_objekta>` daje se pregled ugniježdenog JavaScript kôda (Izvor: autori)

```

root@kali: /home/kali/Desktop
File Actions Edit View Help
/CA Submit >>
/Rect [ 72 697.8898 144 676.2897 ]
/Subtype /Widget
/AP << /N 10 0 R >>
/Parent 9 0 R
/H /P
/A << /S /JavaScript
/JS var oNameField = this.getField('FullName'); if (oNameField.valueAsString.length > 2) { var arFields = new Array('FullName'); this.submitForm({ cURL: 'http://www.gnostice.com/newsletters/demos/200804/forms_test.asp', aFields: arFields, cSubmitAs: 'HTML', }); } else { app.alert('Nhyet! Nhyet! Nhyet!');}
/Type /Action >>
/F 4
/DA /RubiconHelvetica 10 Tf 0 0 0 rg >>
PPDF>

```

**Slika 10** Prikaz potencijalno malicioznog JavaScript kôda unutar PDF-a. Primjećuje se pozivanje akcije naredbom `cURL`, zajedno s URL-om i pripadajućom `asp` formom (Izvor: autori)

Drugi primjer prikazan na slici 10 odnosi se na uporabu *xor* (eng. *exclusive OR*) naredbe u potrazi dijelom programskog kôda (eng. *shellcode*), a koji može predstavljati maliciozan teret (eng. *payload*) namijenjen iskorištavanju ranjivosti softvera. XOR predstavlja logički operator koji vraća istinitu (eng. *true*) vrijednost kada je bilo koji od operandi istinit.

Naredbom *xor* `<ime varijable>` `<poznati ključ>` u kombinaciji s naredbom *js\_analyse*, ukoliko se radi o JavaScript kôdu kao na primjeru, može se analizirati PE kod, odnosno pozivanje na izvršne datoteke. XOR operacija može koristiti i dekriptijski ključ, ukoliko je poznat, a sve s ciljem dekripcije korisnog tereta.

Tehnika kompresije određena je imenom `/filter`, dok *stream* može imati više od jednog filtera. Odabirom funkcije *decode* omogućiti će se dekodiranje sadržaja specifične varijable *raw* bajtova korištenjem nekih od filtera, odnosno algoritama poput *Base64*, *ASCIHexDecode*, *ASCII85Decode* ili *LZWDecode*.

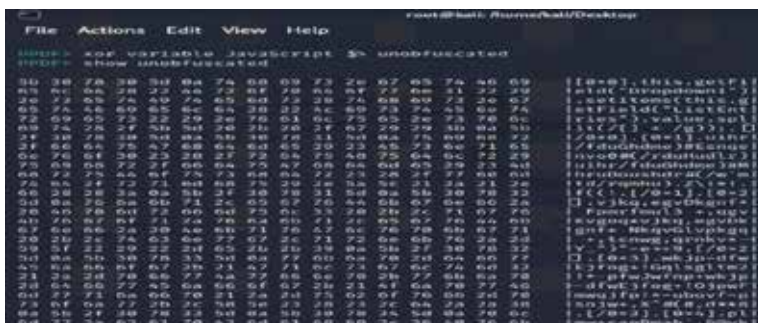
S poznatim ključem (eng. *key*), naredbom *xor* moguće je pretražiti sadržaj i potražiti referencu na PE datoteku. Ukoliko ključ nije poznat, tehnikom grube sile (eng. *brute force*) isprobati će se sve moguće kombinacije ključeva. Taj proces može potrajati dugo, a ovisi o veličini sadržaja datoteke. Naredba *xor\_search\_pe*<sup>9</sup> koristi se za brzi pronalazak PE datoteka temeljem zaglavlja (MZ...PE).

Primjer na slici 11 prikazuje referencu na izvršnu (PE) datoteku *AdobeUpdate.exe* čije izvršavanje može biti potencijalno štetno u daljnji akcijama.



Slika 11 Uporabom *xor* i *js\_analyse* naredbe u dekodiranom stream-u otkrivena je referenca na izvršnu (PE) datoteku

Slike 11 i 12 prikazuju rezultat uporabe *xor* naredbe na danom primjeru, a koja omogućava operacije nad tokovima (eng. *streams*) unutar PDF datoteke u potrazi za *shellcode-om*. Naredbom *js\_code <id\_objekta> \$> <proizvoljno\_ime\_koda>* izvršiti će se preslikavanje sadržaja objekta u željeno ime, a sve poradi jednostavnije daljnje manipulacije i analize zapisa objekta. Na primjer: *js\_code 103 \$> JavaScript* preslikati će sadržaj objekta 103 PDF dokumenta pod novim imenom *JavaScript*.



Slika 12 XOR funkcija može se primjeniti na sve operacije nad tokovima, odnosno datotekama u potrazi za programskim kôdom i malicioznim teretom (Izvor: autori)

<sup>9</sup> Naredba se koristi u *mpeepdf* alatu, a koji je modificirana verzija *PeePDF* alata

## 5. ZAKLJUČAK

Popularnost PDF formata zapisa čini isti pogodnom platformom za distribuciju i preuzimanje, odnosno pokretanje malicioznog koda, a posebice kada se PDF datoteke automatski pokreću unutar mrežnog preglednika koji nema dovoljno dobro podešene sigurnosne postavke za prikaz sadržaja.

Iako je *JavaScript* podržan od strane Adobe Reader preglednika različit u usporedbi s *JavaScript-om* podržanim od strane internet preglednika, isti podržava manje funkcionalnosti. S obzirom na razinu sigurnosti u postavkama PDF preglednika, privilegirana razina sigurnosti omogućava izvršavanje više potencijalno opasnih radnji (npr. prilagođeni zahtjevi upućeni putem *Hyper Text Transfer* protokola).

Za razliku od privilegirane, ne-privilegirana razina predstavlja zadani način upravljanja postavkama koji se odnose na izvršavanje *JavaScript* kôda, a odnose se na operacije nad strukturom dokumenta.

Prednost PeePDF u odnosu na alate PDFid i PhoneyPDF, koji se također mogu koristiti kao parseri u strojno učenim malware detektorima, ogleda se i mogućnosti potpune analize ugniježdene (*embedded*) komponente te djelomično strukture PDF-a i *JavaScript* kôda. PeePDF alat u funkciji parsiranja PDF datoteke omogućava analitičaru provjeru strukture potencijalno sumnjivog PDF dokumenta te detaljnu analizu u potrazi za prikrivenim ugniježđenim malicioznim teretom. Uporabom odabranih kao npr. *js\_analyse* ili *js\_code*, omogućena je analiza i otkrivanje ugniježđenog *JavaScript* kôda u strukturi PDF datoteke. Također uporabom XOR funkcije u kombinaciji s poznatim ključem moguće je u potpunosti otkriti pozivanje na PE datoteke, a koje će se izvršiti učitavanjem dokumenta ili aktiviranjem putem ugniježdene poveznice (URL-a).

PeePDF alatom moguće je izvršiti vizualizaciju svih objekata u PDF dokumentu, a može se koristiti u forenzičkim slučajevima kada se sumnja u postojanje malicioznog sadržaja u strukturi PDF datoteke. Moguće je analizirati i različite verzije PDF datoteke, nizove objekata i šifriranih datoteka kao i modificiranje i maskiranje PDF datoteka tamo gdje je ručna analiza apsolutno obavezna. S druge strane, veliki sustavi koji svakodnevno manipuliraju većom količinom PDF dokumenata mogu koristiti, primjerice, CDR tehnologiju (eng. *Content Disarm and Reconstruction*) koja se koristi kod nekih proizvođača aktivne mrežne opreme, a koja može automatizirano neutralizirati i potencijalno maliciozni PDF dokument. U takvim sustavima ručna analiza PDF-ova nije

prikladna već je nužno koristiti automatizirana rješenja. Za budući rad autori predlažu usporedbu PeePDF s PDFid i PhoneyPDF alatima koji se mogu koristiti kao parseri u strojno učenim malware detektorima.

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## **DETECTION OF MALICIOUS PDF DOCUMENTS VIA SYNTACTIC ANALYSIS**

### **ABSTRACT**

*PDF (Portable Document Format) is a popular file format used for viewing and presenting documents. This popularity has also facilitated the development of malicious techniques that exploit vulnerabilities in the PDF format, thereby making it a common attack vector. A PDF document containing a malicious payload poses a direct security threat to the user as well as as the system. This paper describes the use of the open-source PeePDF tool for parsing PDF documents, and demonstrates its application through an example of detecting potentially malicious code embedded within the document's structure.*



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