URBANI IZZIV

ISSN: 0353-6483

2
leto/year 2023
letnik/volume 34

URBANI IZZIV
PUBLIKACIJE

Urbani izziv, letnik **34**, številka **2**, december **2023**
Urbani izziv, volume **34**, number **2**, December **2023**

ISSN
Tiskana izdaja/Print edition: 0353-6483
Spletna izdaja/Online edition: 1855-8399

UDK/UDC: 71/72
COBISS.SI-ID: 16588546
Spletna stran/Web page: http://urbani-izziv.uirs.si
Naslovnica/Cover: Fotografija/Photo: Simon Koblar

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Urbani izziv ("Urban Challenge") is intended for the dissemination of research and technical information as well as the discussion of issues relating to spatial planning. The journal is published twice a year. The first issue is published in June, and the second in December. *Urbani izziv* is divided into two parts. The first (longer) part is titled "Articles" and includes original research, review articles, short studies and technical studies. Articles in this part of the journal are subject to blind peer review. The second (shorter) part of the journal is titled "Reviews and information" and contains reviews, announcements (e.g., announcements of books, projects, events, lectures, conferences, etc.), library information and other material. The material published in this part of the journal is not peer-reviewed. The journal is published in two languages: all contributions are published in Slovenian and English. Abstracts and full texts of articles are included in the Slovenian COBISS database and the Digital Library of Slovenia (dLib.si), as well as in the international bibliographic databases SCOPUS Elsevier, ERIH PLUS, EBSCOhost (Art & Architecture Complete, Academic Search Complete), ESCI (Clarivate Analytics), ProQuest (ProQuest Central), CEEOL (Central and Eastern European Online Library), IBSS (Intenational Bibliography of Social Sciences), IBZ (International Bibliography of Periodical Literature in the Humanities and Social Sciences), GEODOK (Geographic Literature Database), EZB (Electronic Journals Library), CGP (Current Geographical Publications), ICONDA (International Construction Database), DOAJ (Directory of Open Access Journals), OCLC (Online Computer Library Center), Ulrich's Periodicals Directory, Academic Journals Database, Sciencegate, Index Copernicus International, J-Gate and Genamics JournalSeek. *Urbani izziv* is registered in the media register kept by the Ministry of Culture of the Republic of Slovenia under serial number 595. The journal is subsidised by the Slovenian Research Agency.

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Izdajatelj/Publisher
Urbanistični inštitut Republike Slovenije/Urban Planning Institute of the Republic of Slovenia

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Lektoriranje slovenskih besedil/Slovenian copy editor
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DEMAT, d. o. o.
Zasnova naslovnice/Cover layout
Nina Goršič
Tisk/Print
DEMAT, d. o. o.
Naklada/Print run
500 izvodov/copies

Letna naročnina/Annual subscription
40 € za ustanove/€40 for companies, institutions, 30 € za posameznike/€30 for individuals
Cena posamezne številke/Single issue rate
25 € za ustanove/€25 for companies, institutions, 20 € za posameznike/€20 for individuals

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Katero mesto zmaga?

V člankih v naši reviji se pogosto navajajo cilji trajnostnega razvoja, ki so jih voditelji 193 držav soglasno sprejeli na vrhu Organizacije združenih narodov leta 2015. Med sedemnajstimi cilji je – skladno s tematiko revije – največkrat izpostavljen enajsti cilj: trajnostna mesta in naselja. Kako uspešno mesta sledijo temu cilju, spremljajo številne raziskave, v tokratnem *Urbanem izzivu* so tako objavljene ugotovitve o madžarskih in turških mestih.

Mesta se merijo med seboj in osvajajo naslove, imamo najbolj zelena, najbolj pametna in najbolj trajnostna mesta. Iz primerjav med leti je razvidno, ali neko mesto ohranja svoj položaj ali ga je morda prehitelo drugo mesto, ki hitreje in uspešneje zasleduje cilje in izpolnjuje merila. Seveda so tudi za to, da se doseže trajnostni razvoj, potrebni kapital in premišljene naložbe. Med najbolj trajnostnimi mesti na svetu je večina tudi gospodarsko zelo uspešnih. Podobno kot mesta vsako leto tekmujejo tudi ljudje – kdo bo najuspešnejši na svetu, v Evropi oziroma v posamezni državi. Le upamo lahko, da se del dobička prelije tudi v dobro celotne skupnosti. Kot v primeru uspešnega podjetnika iz srednje velikega mesta v Sloveniji, ki je po prodaji podjetja del kupnine podaril občini. Ena od naložb, ki jo je občina s temi sredstvi izvedla, je ozelenitev glavnega mesta z drevesi in ureditev javnih površin, ki so namenjene vsem prebivalcem. Ker se občina zaveda, da vložena sredstva ne morejo ostati le v mestih, so poskrbeli tudi za ureditev manjših krajev na podeželju, ki so pogosto zapostavljeni in v senci središča, kakor da njihovi prebivalci nimajo istih potreb in želja. Projekt navdušuje s preprostostjo in velikim učinkom, tudi zato, ker so po zasaditvi poskrbeli za redno in strokovno vzdrževanje.

Izboljšanje življenjskega okolja, ki ga občutijo prebivalci, seveda opazijo tudi obiskovalci. Predvsem tisti iz sosednih občin jih spremljajo z občudovanjem in upanjem, da se bo tudi pri njih kaj premaknilo. Upamo lahko, da dobri zgledi vlečejo in da, kdor le more, podeli del svojega uspeha tudi s skupnostjo in okoljem.

Damjana Gantar, glavna urednica

Which city wins?

The articles in this journal often refer to the sustainable development goals (SDGs) that the leaders of 193 countries unanimously adopted at the UN summit in 2015. In line with this journal's topic, SDG 11 – sustainable cities and communities – is the goal that is highlighted most frequently among the seventeen adopted. Many studies have analysed cities' performance in achieving this goal, and this issue of *Urbani izziv* presents findings for Hungarian and Turkish cities.

Cities compete against one another to win various titles, such as the greenest, the smartest, and the most sustainable city. Comparisons between years show whether a city maintains its position, or whether it has been overtaken by another city that pursues the goals and meets the required criteria faster and more successfully. Of course, achieving sustainable development also requires extensive capital and wise investments. The most sustainable cities in the world are usually also the ones with the best economic performance. Just like cities, people also compete every year to be the most successful in the world, in Europe, or in an individual country. We can only hope that some of their profits are also used to benefit the entire community. A good example is a successful businessman from a medium-sized city in Slovenia, who sold his company and donated part of the money to his municipality. One of the projects that the municipality carried out using these funds included planting trees in the municipal seat and building public open spaces intended for all. However, because the municipality is aware that the funds donated cannot stay in cities alone, it has also used them to lay out green areas in the surrounding villages, which often remain neglected and overshadowed by the municipal seat, as though their residents did not have the same needs and wishes. The project's simplicity and great impact are truly inspiring – also because, once completed, the green areas are regularly and professionally maintained.

The improved living environment experienced by the locals has, of course, also been noticed by visitors. Especially those from neighbouring municipalities have been following these changes with strong approval, hoping things will also improve where they live. Let us hope that these good examples encourage others to emulate them, and that people that can share part of their success with their community and environment choose to do so.

Damjana Gantar, Editor-in-Chief

UDK: 711.4:004.8:005.52 (497.115)
doi:10.5379/urbani-izziv-2023-34-02-01

Prejeto: 4. 4. 2023
Sprejeto: 16. 6. 2023

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Elvida PALLASKA

Raziskava napovednikov pametnega upravljanja mest: primer Prištine

Avtorja sta s kvantitativnim pristopom proučevala ključna gonila pametnega upravljanja mest na primeru Prištine. Potrebne podatke sta zbrala z anketo, ki sta jo izvedla med 1.536 posamezniki, izbranimi s stratificiranim verjetnostnim vzorčenjem. Z analizo glavnih komponent sta proučila notranjo strukturo vprašalnika, z regresijsko analizo pa sta določila napovednike pametnega upravljanja. Pametni urbani menedžment in pametno sodelovanje sta se izkazala za odločilna dejavnika upravljanja mesta, pri čemer je bila korelacija med pametnim urbanim menedžmentom in pametnim upravljanjem malce močnejša. Izsledki potrjujejo pomemben vpliv učinkovitih praks urbanega menedžmenta in sodelovanja med deležniki na rezultate upravljanja pametnih mest. Oblikovalci politik bi zato morali pri pobudah za razvoj pametnih mest dati večji poudarek sodelovanju med deležniki. V primeru Prištine bi morali okrepiti vključenost deležnikov ter preglednost in dostop do podatkov na področju urbanega menedžmenta, poleg tega bi se morali osredotočiti na infrastrukturo in javne storitve, saj bi to izboljšalo pametno upravljanje mesta.

Ključne besede: pametni urbani menedžment, pametno sodelovanje, pametno upravljanje, Priština, Kosovo

1 Uvod

Učinkovito izvajanje projektov, povezanih z razvojem pametnih mest, zahteva močne upravljavske mehanizme, ki povezujejo različne deležnike (Ruhlandt, 2018). Uporaba informacijske in komunikacijske tehnologije (IKT) lahko izboljša splošno upravljanje in posledično omogoči učinkovito razporejanje virov, sodelovanje, obveščanje o pravilih in politikah ter družbene inovacije, za kar se uporablja izraz pametno upravljanje (Backus, 2001; O'Reilly, 2011). Pametno upravljanje združuje tehnologije, ljudi, politike, prakse, vire, družbene norme in informacije, ki spodbujajo prizadevanja v okviru mestnega upravljanja (Chourabi idr., 2012). Obsega poslovanje med vladnimi organi in prebivalci (*Government to Citizen* ali G2C), vladnimi organi in poslovnimi subjekti (*Government to Business* ali G2B) ter poslovanje vladnih organov med seboj (*Government to Government* ali G2G) (prim. Bernardo, 2017; Anindra idr., 2018). Pametno upravljanje vključuje tri glavni sestavine: vključenost deležnikov, storitve IKT in povezave, usmerjene k mreženju, kot so razne oblike sodelovanj ali partnerstev (Gil-Garcia idr., 2015).

Komponente pametnega upravljanja zajemajo vloge in dolžnosti deležnikov, okvire in ustanove, ki urejajo medsebojne vplive in povezave med deležniki, ter postopke, povezane z izmenjavo informacij, sodelovanjem, sprejemanjem odločitev in njihovo izvedbo. Poleg tega vključujejo tehnologije in podatke, ki omogočajo učinkovito upravljanje, ter politiko in zakonodajne strukture, ki rešujejo izzive, povezane s pametnimi mesti (Bolivar in Meijer, 2016; Meijer, 2016; Chelvachandran idr., 2020; El-Ghalayini in Al-Kandari, 2020; Razmjoo idr., 2021). Pozitivni učinki pametnega upravljanja so dobro počutje prebivalcev, družbena in digitalna vključenost, nova infrastruktura, sodelovanje javnosti, sredstva, namenjena projektom pametnega upravljanja, rast gospodarstva in nova delovna mesta (Castelnovo idr., 2016; Ruhlandt, 2018; Herdiyanti idr., 2019; Alsaid, 2021). Rezultate in komponente pametnega upravljanja lahko napovejo tudi prvine, kot so stopnja avtonomnosti pametnih mest ali lokalne okoliščine (Bolívar in Meijer, 2016; Meijer, 2016; Ruhlandt, 2018).

Pametno upravljanje mest temelji na hibridnem modelu sodelovanja med vladnimi organi, zasebnim sektorjem in prebivalci (Sancino in Ve Hudson, 2020). Ne sloni samo na uporabi tehnologije, ampak vključuje tudi strateško uporabo upravnih ureditev, upravljavskih politik in informacijskih virov (Nam in Pardo, 2011). Upravljanje, ki temelji na IKT (Chourabi idr., 2012), vključuje veliko več kot samo uporabo tehnologije; združuje družbene norme in informacijske vire, s čimer izboljšuje urbani menedžment in odločanje. Razvoj pametnega upravljanja mest ustvarja novo dinamiko v odnosih med deležniki. Kot ugotavljajo Shelton in sodelavci (2015), se s projekti s področja podatkovno vodenega upravljanja oblikujejo nadregionalna omrežja ključnih akterjev in ustanov, ki s ciljnim financiranjem in izvedbo vplivajo na prihodnost mest. Angelidou (2015) navaja, da sta aktivno sodelovanje in usklajevanje med deležniki temelj pametnega upravljanja. Pametno upravljanje mest je odvisno od vključenosti tehnologije, strateških partnerstev in aktivnega sodelovanja deležnikov, kar nakazuje premik k podatkovno vodenemu urbanemu menedžmentu, osredotočenemu na prebivalca.

Za izboljšanje sistema pametnega upravljanja mest ob upoštevanju raznih razsežnosti je treba strateško določiti prednostne naloge in uvesti inovativne mehanizme financiranja, kar bo pospešilo razvoj pametne infrastrukture in izboljšalo storitve, še zlasti v državah v razvoju, v katerih je močno razvita siva ekonomija. Za premostitev vrzeli v raziskavah je treba proučiti, katere razsežnosti pametnega upravljanja imajo največji vpliv na izvajanje pametnega upravljanja na območjih, kot je Kosovo, ki še niso bila podrobno raziskana. Kosovo je država v razvoju, v kateri je zaradi proračunskih omejitev težko zadovoljiti vse potrebe mestnih uprav. Izsledki raziskave, predstavljene v tem članku, bi bili lahko uporabni za razne mestne upravljavske strukture v državah v razvoju, ki se spopadajo s podobnimi finančnimi in drugimi izzivi. Na njihovi podlagi bodo bolje razumele, kako morajo določiti strateške prednostne naloge za izboljšanje sistema pametnega upravljanja mest.

Glede na definicijo pametnega mesta Priština ni pametno mesto (Nimani, 2014). Eden izmed glavnih izzivov, s katerim se spopada pri uvedbi pametnega upravljanja, je, kako čim bolj izkoristiti inovacije in tehnologijo za učinkovito uporabo virov. Poleg tega mora mesto poskrbeti za vključenost prebivalcev prek e-sodelovanja in e-uprave, ki sta ključna za reševanje raznovrstnih vprašanj in izboljšanje kakovosti življenja prebivalcev (Ubo Consulting, 2020). Dostop do interneta ima 97 % prebivalcev Prištine, industrija IKT v mestu cveti, poleg tega v njem živijo mladi (milenijski) podjetniki in strokovnjaki z disruptivnimi poslovnimi vizijami. Kljub temu še vedno ni jasno, ali Priština vse te vire učinkovito izrablja za postopno preobrazbo v trajnostno in digitalno mesto (Musliu, 2021). Zato je za dolgoročni uspešni razvoj Prištine in drugih mest na Kosovu ključno, da se v ospredje postavi pametno upravljanje, ki temelji na kazalnikih pametnih mest (Pallaska, 2020). Oblikovalci mestne politike bi morali predlagati ukrepe, ki bi podpirali pametni razvoj mesta.

Da bi zapolnila odkrite vrzeli v mednarodni literaturi in v raziskavah mest, ki se hitro urbanizirajo, avtorja v članku proučujeta najpomembnejše napovednike pametnega upravljanja v Prištini. Članek tako pomembno dopolnjuje literaturo s tega področja, zlasti z osredotočanjem na najpomembnejše vidike, ki vplivajo na pametno upravljanje.

1.1 Pregled literature

Pregled dosedanjih raziskav je pokazal, da avtorji različno razumejo, kaj je pametno mesto. Nekateri ga enačijo s pametno upravo, drugi pa z inovativnimi načini odločanja, inovativnim menedžmentom in inovativnimi oblikami sodelovanja (Meijer in Bolívar, 2016). Ena izmed oblik inovativnega menedžmenta v razvitih pametnih državah je podatkovno vodeno odločanje (Ahvenniemi idr., 2017), ki zahteva celosten pristop k menedžmentu, pri katerem deležniki na podlagi sodelovanja dosegajo skupne cilje (Spence, 2017). Obsega lahko uporabo inovativnih oblik sodelovanja, kot so soustvarjanje, sooblikovanje in soproizvajanje, ki poudarjajo vključenost prebivalcev in drugih deležnikov v načrtovanje in izvajanje pobud za razvoj pametnega mesta (Ahvenniemi idr., 2017).

Pametni urbani menedžment temelji na povezovanju in optimizaciji infrastrukture (npr. prometne, energetske in druge komunalne infrastrukture). V novejših raziskavah je bilo predlaganih več pristopov k izboljšanju trajnosti in učinkovitosti urbane infrastrukture. Liu in sodelavci (2017) so na primer predstavili model, ki povezuje prometni, energetski in komunikacijski sistem. Uvedba pametne urbane infrastrukture zahteva precejšnja sredstva, močna siva ekonomija pa lahko otežuje doseganje ciljev, povezanih z razvojem pametnega mesta (Allam in Dhunny, 2019). S strateškim pristopom, ki daje prednost inovativnim mehanizmom financiranja in tehnologiji, lahko navedene izzive uspešno rešujemo in olajšamo uvedbo pametnih tehnologij na mestnih območjih. Tako lahko mestne uprave ustvarijo učinkovitejša in bolj trajnostna mesta, ki prebivalcem zagotavljajo boljšo kakovost življenja (Caragliu idr., 2011). Ključen vidik pametnega urbanega menedžmenta je tudi dostop do javnih storitev. Tehnologija in inovacije lahko izboljšajo zagotavljanje javnih storitev v mestu (Atthahara, 2018), za preobrazbo mesta pa je ključno sodelovanje med deležniki, tudi med podjetji in skupnostjo (Ziozias in Anthopoulos, 2022). Kot navajata Bibri in Krogstie (2020), se v Barceloni čedalje bolj uveljavlja trend podatkovno vodenega pametnega urbanega menedžmenta, ki temelji na uporabi inovativnih rešitev, vključno z umetno inteligenco (Rijab in Mellouli, 2018). Poleg tega so v mestu uvedli nekatere izboljšave na področju pametnega urbanega menedžmenta, zlasti v povezavi z digitalizacijo javnega prevoza, pri čemer so uvedli možnost elektronskega nakupa in validacije vozovnic (Chiscano in Darcy, 2022) ter sistem enotne vozovnice (Smith in Martin, 2021). Na splošno je vključenost skupnosti ključna za učinkovito strateško načrtovanje in uspešno preobrazbo mesta.

Mestna uprava bi morala upoštevati interese prebivalcev in deležnikov ter jih vključiti v upravljanje (Lopes 2017; Vrabie in Tirziu, 2021). Dostopnost podatkov, ki jo omogoča digitalizacija mest, lahko izboljša odločanje in upravljanje mest (Deakin in Al Waer, 2011), s preglednimi podatki o odločanju pa lahko mesta dosežejo večjo legitimnost pri javnosti (de Fine Licht in de Fine Licht, 2020). Dostopnost podatkov, preglednost odločanja in vključenost prebivalcev v obveščanje o odločitvah izboljšajo upravljanje mesta in njegovo strukturo odločanja (Jurado-Zambrano idr., 2023). Preglednost ustvarja večje zaupanje in posledično omogoča jasnejše odločanje mestnih upravnih struktur (Jacobs idr., 2022). Ob tem dostopnost podatkov posameznikom in skupnostim pomaga, da so bolj vključeni v odločanje glede vprašanj, ki se nanašajo na njihovo življenje. Dostopnost podatkov poveča preglednost za javnost in zaupanje javnosti, hkrati pa prebivalcem omogoča, da dajejo smiselne pobude, kar na splošno izboljša mestni sistem odločanja in upravljanja. Poleg tega lahko preglednost podatkov pomaga negovati digitalno kulturo med prebivalci in mestnimi upravljavci (Kaluarachchi, 2022). Sistemi, ki jih podpira IKT, posameznikom in podjetjem omogočajo, da so bolje obveščeni o odločitvah mestne uprave (Demirel in Mülazımoğlu, 2022).

S podatkovno vodenim oblikovanjem politik, partnerstvi in sodelovanjem javnosti pametno upravljanje mest v mladih demokratičnih državah izboljša kakovost življenja prebivalcev (Pereira idr., 2018). Navedeni pristop, ki temelji na načelih sodelovalnega upravljanja (Angelidou, 2015; Grossi idr., 2020), se osredotoča na izboljšanje infrastrukture in računalniške pismenosti ter odpravljanje socialnoekonomskih razlik, kar je ključno za razvoj mlade demokratične drčave, kot je Kosovo (Dzihic, 2019; Domagala, 2020; Mustafa, 2020). Država močno podpira vključenost javnosti v odločanje (Lombardi idr., 2012; Bifulco idr., 2017), kar omogočajo tudi orodja, kot je portal e-Kosova (E-Kosova Platform, 2023), ki deluje v okviru e-uprave. Zaupanje, boljše usklajevanje, varnost in preglednost se spodbujajo tudi s sodelovanjem med deležniki (Parenti idr., 2022), kar je pomemben vidik glede na zapleteno politično zgodovino Kosova (Pallaska, 2020). Pri prehodu k sodelovalnemu upravljanju država izkorišča svoje edinstvene prednosti, kot sta mlado prebivalstvo in cvetoči tehnološki sektor (Angelidou, 2015), ki zagotavljata idealne razmere za razvoj inkluzivnih, odpornih in trajnostnih mest (Domagala, 2020; UNDP Kosovo, 2023).

Pametno sodelovanje omogoča vključevanje raznovrstnih deležnikov v odločanje, kar spodbuja sodelovanje in spreminja upravljanje mest (Oschinsky idr., 2022). Pri odločanju je prispevek prebivalcev ključen, e-sodelovanje pa je učinkovit način uresničevanja pristopa k pametnemu upravljanju, ki se osredotoča na uporabnika ali prebivalca (Lim in Yigitcanlar, 2022). Če so prebivalci vključeni v odločanje, lahko podajo pobude v zvezi z razvojem pametnega mesta, hkrati pa se izboljša izvedba teh pobud, kar povečuje učinkovitost sodelovanja med deležniki (Bastos idr., 2022; Parenti idr., 2022). Učinkovito sodelovanje med njimi je namreč poglavitno za ustvarjanje zaupanja, boljše usklajevanje, ohranjanje varnosti in spodbujanje preglednosti med vsemi, ki sodelujejo pri izvajanju pobud za razvoj pametnega mesta (Parenti idr., 2022). Z omogočanjem sodelovanja raznovrstnih deležnikov pri načrtovanju in odločanju postanejo upravljavski mehanizmi ključni za pametno upravljanje mest (Ruhlandt, 2018).

Pametno upravljanje, znano tudi kot e-upravljanje ali e-demokracija, vključuje uporabo sodobnih komunikacijskih kanalov za vključevanje prebivalcev v odločanje. Poudarja preglednost upravnih sistemov in razpoložljivost javnih storitev, ki spodbujata sodelovanje javnosti (Lombardi idr., 2012; Vanolo, 2014). Raven pametnega upravljanja v mestu se meri na podlagi načel preglednosti, sodelovanja, vključenosti in partnerstva ter odgovornosti mestne uprave, ki ima pozitiven vpliv na kakovost življenja prebivalcev (Demirel in Mülazımoğlu, 2022). Zaupanje javnosti v odločitve mestne uprave omogoča boljše in jasnejše odločanje, kar posledično vpliva tudi na upravljanje mesta. Preglednost zagotavlja večje zaupanje, kar mestni upravi omogoča tehtnejše odločanje (Jacobs idr., 2022). Dobra odzivnost lokalne uprave zmanjša zaskrbljenost prebivalcev in poveča vrednost njihovega prispevka (Guo idr., 2022). Če se mestna uprava odziva na pomisleke prebivalcev, jo ti dojemajo kot bolj učinkovito, kar pripomore k pametnemu upravljanju (Wolf idr., 2020).

Na podlagi podrobnega pregleda literature avtorja v članku obravnavata raziskovalno vprašanje: Katere komponente napovedujejo pametno upravljanje v Prištini?

2 Metode

Avtorja sta uporabila kvantitativno raziskovalno metodo, tj. korelacijsko metodo, s katero sta proučevala statistična razmerja med spremenljivkami. Izbrala sta jo zato, ker daje informacije o moči in smeri povezanosti dveh spremenljivk (Burns in Grove, 2005; Leedy in Ormrod, 2010). Da bi pojasnila največji delež celotne variance (ne samo skupne variance) v korelacijski matriki, sta uporabila analizo glavnih komponent, v okviru katere sta osnovne spremenljivke pretvorila v kombinacijo linearnih komponent (Field, 2017). Spremenljivke sta združila v komponente na podlagi njihovih uteži ali medsebojne odvisnosti, napovednike pametnega upravljanja pa sta proučila z metodo multiple regresije.

2.1 Zgradba raziskave

Avtorja sta v raziskavi uporabila vprašalnik, sestavljen iz dveh delov (prim. Grum in Temeljotov Salaj, 2011). Prvi del je vseboval tri vprašanja, ki so se nanašala na demografske podatke anketirancev (spol, starost in izobrazbo). Drugi del pa je vključeval dvanajst vprašanj, povezanih s proučevanimi spremenljivkami, kot so pametni urbani menedžment, pametno odločanje, pametno sodelovanje in pametno upravljanje, pri katerih so morali anketiranci označiti odgovore na petstopenjski Likertovi lestvici (1 = močno se strinjam, 5 = močno se ne strinjam). Vprašanja v tem delu so se nanašala na naslednje teme: 1. dostop do mestne infrastrukture (javnega prevoza, energetike in storitev zbiranja in odvoza odpadkov), 2. dostop do javnih storitev (zdravstva, izobraževanja in javne varnosti), 3. uporaba tehnologije za izboljšanje mestnih storitev, 4. preglednost odločanja, 5. dostopnost podatkov, 6. obveščanje o odločitvah mestne uprave, 7. vloga prebivalcev pri odločanju o mestnih zadevah, 8. sodelovanje med deležniki in mestno upravo, 9. učinkovitost mestne uprave pri reševanju pomislekov raznovrstnih deležnikov, 10. odgovornost mestne uprave, 11. javno zaupanje v odločitve mestne uprave in 12. odziv mestne uprave na pomisleke in potrebe prebivalcev.

Avtorja sta anketirance izbrala s stratificiranim naključnim vzorčenjem, pri čemer sta zagotovila ustrezno reprezentativnost prebivalcev Prištine v raziskovalnem vzorcu (prim. Jonker in Pennink, 2010). V raziskavi je sodelovalo 1.536 anketirancev iz Prištine, ki sta jih razdelila na stratume glede na spol, starost, izobrazbo, zaposlenost in vrsto zaposlitve. Pri tem sta njihove deleže v posameznem stratumu določila v sorazmerju z ustreznimi deleži iz popisa prebivalcev Prištine iz leta 2011. Vzorec 1.807 udeležencev, ki sta ga naključno izbrala na Facebooku, je ustrezal proporcionalni stratifikaciji, prikazani v preglednici 1. Stopnja odzivnosti je bila 85 %, kar pomeni, da je vprašalnik izpolnilo 1.536 posameznikov.

V preglednici 1 je prikazana porazdelitev anketirancev glede na spol, starost in izobrazbo. Stratumi, uporabljeni v raziskavi, so enaki stratumom kosovskega prebivalstva v starostni skupini od 18 do 65 let iz zadnjega popisa prebivalstva (Kosovo Agency of Statistics, 2011).

Prebivalci, stari od 18 do 65 let, zajemajo 67 % vseh prebivalcev Prištine. Starostni skupini od 0 do 18 ter od 65 do 85 let nista bili vključeni v vzorec. Pri izobrazbi sta avtorja za izračun števila anketirancev v vsakem stratumu upoštevala število delovno aktivnega prebivalstva v starostnih skupinah od 18 do 65 let.

Glede na to, da je v Prištini skupno 133.909 prebivalcev, starih od 18 do 65 let (Kosovo Agency of Statistics, 2011), je velikost uporabljenega vzorca (tj. 1.536 anketirancev) v mejah napake 2,44 %, kar je še dopustna meja v družboslovju, ki naj bi znašala od 3 do 7 % (Cochran, 1977).

Preglednica 1: Sestava anketirancev

Vrsta/kategorija anketirancev	Anketiranci		Prebivalci Prištine, 18–65 let	
	n	Delež (v %)	n	Delež (v %)
Priština	1.536	100,00	133.909	100,00
Spol				
Moški	766	49,90	66.821	49,90
Ženski	770	50,10	67.088	50,10
Skupaj	1.536	100,00	133.909	100,00
Starost				
18–35 let	722	47,00	62.893	47,00
36–55 let	583	38,00	51.127	38,00
56–65 let	231	15,00	19.889	15,00
Skupaj	1.536	100,00	133.909	100,00
Izobrazba				
Osnovna šola	291	19,00	24.792	19,00
Srednja šola	614	40,00	54.682	40,00
Dodiplomski študij	552	36,00	48.004	36,00
Magisterij ali doktorat	79	5,00	6.431	5,00
Skupaj	1.536	100,00	133.909	100,00

2.2 Postopek

Avtorja sta anketirancem dostop do vprašalnika omogočila prek povezave do funkcije Google Obrazci, to povezavo sta jim poslala po elektronski pošti. Vprašalnik sta dopolnila s kratko predstavitvijo raziskave in navodili za izpolnjevanje. Za spletno anketo sta se odločila zato, ker ima večji doseg, je priročna, prožnejša in omogoča preprosto vnašanje podatkov. Navedeno sta ugotovila tudi Evans in Mathur (2005), ki poleg tega navajata, da je ena izmed pomembnih prednosti spletnih anket to, da pomanjkanje reprezentativnosti ni več težava, saj ima večina današnjih družb dostop do svetovnega spleta in ga zna spretno uporabljati. Ker na Kosovu svetovni splet uporablja kar 96 % prebivalcev (Kosovo ICT Association, 2019), spletna anketa ni vplivala na verodostojnost raziskovalnega instrumenta. Vabilo k sodelovanju spletne ankete sta objavila na Facebooku, ki ga na Kosovu uporablja 932.000 prebivalcev (Digital Kosovo, 2023), v Prištini pa 170.000 (Hallakate, 2020) oziroma 86 % vseh prebivalcev mesta.

2.3 Statistična analiza

Avtorja sta zbrane podatke v sklopu kvantitativnega raziskovalnega modela analizirala s programom IBM SPSS 23.0. Z analizo glavnih komponent sta proučila notranjo strukturo vprašalnika in pridobljene komponente. Po določitvi komponent z metodo glavnih komponent sta ob predpostavki, da so soodvisne, uporabila metodo poševne rotacije (Promax). Z rotacijo sta dosegla preprostejšo strukturo komponent, ki jo je hkrati tudi lažje pojasniti. Na koncu sta z multiplo regresijsko analizo proučila razmerja med odvisnimi in neodvisnimi spremenljivkami.

3 Rezultati

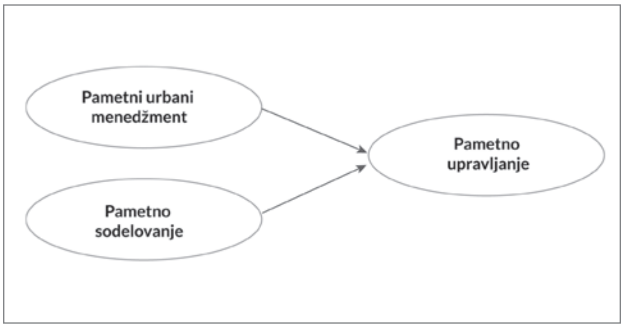
Avtorja sta najprej opravila analizo zanesljivosti v programu IBM SPSS 23.0, s katero sta preverila doslednost 12 spremenljivk, povezanih s pametnim urbanim menedžmentom, pametnim odločanjem, pametnim sodelovanjem in pametnim upravljanjem. Najprej sta opravila test primernosti vzorca in Bartlettov test sferičnosti. Kaiser-Meyer-Olkinov (KMO) test je znašal 0,835, kar pomeni, da je bil izbrani vzorec primeren. Bastič (2006) navaja, da mora biti za to, da je vzorec dovolj reprezentativen, vrednost testa KMO večja od 0,5. Rezultat testa sferičnosti je znašal 3927,751 točk, kar kaže na statistično značilno razsežnost, ki napovedujejo mnenja anketirancev glede pametnega upravljanja. Matrika korelacij med postavkami[1] je pokazala, da so bile korelacije med postavkami močne, zato ni bilo mogoče nobene izločiti iz modela (prim. Field, 2017).

Avtorja sta poleg tega v začetni fazi analize določila lastne vrednosti vsake komponente v podatkovnem nizu. Pri treh komponentah so presegale vrednost Kaiserjevega kriterija 1 (prim. Field, 2017), skupaj pa so pojasnile 51,53 % variance. Poleg tega sta avtorja zaradi velikega vzorca in konvergence grafa drobirja in Kaiserjevega kriterija pri lastnih vrednostih ohranila tri komponente. Ker se vprašanja v anketi nanašajo na različne vidike pametnega urbanega menedžmenta, odločanja, sodelovanja in upravljanja, bi se lahko prekrivale postavke ali bi nastala korelacija med njimi. Zato sta avtorja s poševno

Preglednica 2: Komponentne uteži vprašalnika o pametnem upravljanju mesta

	Komponenta		
	1	2	3
Dostop do mestne infrastrukture (javnega prevoza, energetike in storitev zbiranja in odvoza odpadkov)	,619	,028	–,073
Dostop do javnih storitev (zdravstva, izobraževanja in javne varnosti	,831	–,038	–,199
Uporaba tehnologije za izboljšanje storitev	,708	–,224	,144
Preglednost odločanja	,500	,198	,201
Dostopnost podatkov	,483	,310	,029
Obveščanje o odločitvah mestne uprave	,228	,482	,118
Vloga prebivalcev pri odločanju o mestnih zadevah	–,063	–,041	,679
Sodelovanje med deležniki (podjetji, lokalnimi skupnostmi, interesnimi skupinami) in mestno upravo	,086	–,086	,766
Učinkovitost reševanje skrbi raznovrstnih deležnikov	–,050	–,022	,777
Odgovornost mestne uprave	–,161	,447	,414
Javno zaupanje v odločitve mestne uprave	–,065	,901	–,109
Odziv mestne uprave na skrbi in potrebe prebivalcev	–,047	,804	–,073

Opomba: metoda ekstrakcije = analiza glavnih komponent; metoda rotacije = Promax s Kaiserjevo normalizacijo.



Slika 1: Predpostavljeni model pametnega upravljanja mesta (ilustracija: avtorja)

rotacijo (Promax) določila komponentne uteži, navedene v preglednici 2.

Postavke, utežene z istimi komponentami, so tiste, katerih komponentne uteži so večje od 0,5, kot predlaga Field (2017). Na tej podlagi je mogoče določiti naslednje tri glavne komponente:

- komponenta 1: pametni urbani menedžment, ki se meri s petimi postavkami: dostop do mestne infrastrukture, dostop do mestnih storitev, uporaba tehnologija za izboljšanje storitev, preglednost odločanja in dostopnost podatkov;
- komponenta 2: pametno upravljanje, ki se meri s štirimi postavkami: obveščanje o odločitvah mestne uprave, odgovornost mestne uprave, javno zaupanje v njene odločitve in njen odziv na skrbi in potrebe prebivalcev;
- komponenta 3: pametno sodelovanje, ki se meri s tremi postavkami: vloga prebivalcev pri odločanju o mestnih zadevah, sodelovanje med deležniki in mestno upravo ter učinkovitost reševanja skrbi raznovrstnih deležnikov.

Na podlagi izračunanih uteži in glavnih komponent sta avtorja oblikovala model, prikazan na sliki 1.

Komponente so pogosto zanesljivejša metoda za merjenje kompleksnih pojavov kot pa posamezna vprašanja. Avtorja sta zanesljivost treh glavnih komponent preverila tako, da sta za vsako izračunala Cronbachov koeficient alfa (vrednosti so bile: 0,84 za komponento 1, 0,85 za komponento 2 in 0,78 za komponento 3). Rezultati so za vse tri komponente pokazali vrednosti, višje od 0,69, kar naj bi bila po Nunnallyju (1978) spodnja sprejemljiva meja. Zaradi izračunanih visokih vrednosti sta avtorja z linearno regresijo določila še vpliv komponent 1 in 3 kot neodvisnih spremenljivk na komponento 2 kot odvisno spremenljivko.

Nato sta z multiplo regresijsko analizo napovedala pametno upravljanje kot odvisno spremenljivko. Rezultati regresije so pokazali, da je vrednost R^2 0,346, kar kaže, da komponenta 1 (pametni urbani menedžment) in komponenta 3 (pametno sodelovanje) pojasnita 34,6 % variance pametnega upravljanja, preostanek (1 – R^2 ali 65,4 %) pa pojasnjujejo druge razsežnosti, ki niso bile vključene v regresijski model. Rezultati regresije kažejo, da komponenti pametnega urbanega menedžmenta in pametnega sodelovanja pojasnita pomemben delež variance pametnega upravljanja ($F(2, 1532) = 405{,}91$, $p < 0{,}001$, $R^2 = 0{,}59$, $R^2_{adj} = 0{,}35$).

Preglednica 3: Koeficienti linearne regresije

Model	Nestandardizirani koeficienti		Standardizirani koeficienti: beta	95-% interval zaupanja za B	
	B	SE		Spodnja meja	Zgornja meja
(Konstanta)	1,005	,084		,841	1,169
Pametni urbani menedžment	,375*	,023	,365	,330	,419
Pametno sodelovanje*	,332*	,021	,350	,291	,374

* p < 0,001.

V preglednici 3 so navedeni koeficienti korelacije, iz katerih je razvidna statistično značilna pozitivna korelacija med obema neodvisnima spremenljivkama in odvisno spremenljivko. Standardizirani koeficienti kažejo, da je korelacija med pametnim urbanim menedžmentom in pametnim upravljanjem malce močnejša od tiste med pametnim sodelovanjem in pametnim upravljanjem.

4 Razprava

Raziskava je pokazala, da sta pametni urbani menedžment in pametno sodelovanje močno povezana s pametnim upravljanjem, pri čemer je povezava med pametnim urbanim menedžmentom in pametnim upravljanjem malce močnejša. Izsledki torej kažejo, da je pametni urbani menedžment najmočnejši napovednik pametnega upravljanja v Prištini, kar se ujema z drugimi raziskavami, ki so potrdile močno povezavo med omenjenima komponentama. Bakıcı in sodelavci (2013) navajajo, da lahko prakse pametnega urbanega menedžmenta izboljšajo učinkovitost upravljanja. To opozarja na pomen vlaganja v prakse pametnega urbanega menedžmenta in mestom ponuja priložnost, da izboljšajo kakovost upravljanja, spodbudijo prebivalce k aktivnejšemu sodelovanju in izboljšajo trajnostnost mest.

S praktičnega vidika bi morali mestna uprava in odločevalci prizadevanja usmeriti v financiranje tehnologij in sprejemanje strategij, ki omogočajo učinkovit nadzor mestne infrastrukture in storitev ter hkrati poudarjajo preglednost, odgovornost in vključenost prebivalcev, kar omogoča učinkovito pametno upravljanje mesta. V prihodnje bi lahko proučevali instrumente, s katerimi pametni urbani menedžment vpliva na pametno upravljanje, ter morebitne blažilne vplive lokalnih okoliščin na njun odnos. Financiranje pobud v okviru urbanega menedžmenta, kot so krepitev dostopa do mestne infrastrukture in javnih storitev, uporabe tehnologije za izboljšanje storitev, preglednosti odločanja in dostopnosti podatkov, bi imelo za Prištino kot glavno mesto države v razvoju pomembne finančne posledice, hkrati pa bi bilo lahko to za mestno upravo in oblikovalce politike izziv, saj morajo najti ravnovesje med vsemi zahtevami po omejenih virih. Izziv bi bil lahko tudi ohranjanje preglednosti in odgovornosti pri tovrstnih vlaganjih. Preglednost odločanja in vključenost prebivalcev zahtevata odprto komunikacijo in sodelovanje med mestno upravo in prebivalci, ki poskrbita za to, da so projekti usklajeni z najboljšimi interesi mesta.

Močan napovednik pametnega upravljanja v Prištini je tudi pametno sodelovanje, močna povezanost med njima pa je pomembna tako v teoriji kot praksi. Ob upoštevanju tega izsledka lahko bolje razumemo komponente, ki so ključne za uspešno uresničitev pobud za razvoj pametnih mest v proučevani regiji. Poleg tega je ta ugotovitev lahko koristna za oblikovalce politik, ki poskušajo izboljšati pametno upravljanje v Prištini. Da je sodelovanje ključna komponenta učinkovitega pametnega upravljanja, so ugotovili tudi drugi raziskovalci (Marsal-Llacuna, 2016; Bifulco idr., 2017; Ruhlandt, 2018). Sodelovanje med deležniki, kot so prebivalci, podjetja in mestne uprave, ima ključno vlogo pri uspešni izvedbi pobud in projektov, povezanih z razvojem pametnih mest (Caragliu idr., 2011; Lombardi idr., 2012). Raziskovalci, kot so Nam in Pardo (2011), Bifulco in sodelavci (2017) ter Lombardi in sodelavci (2012), poudarjajo pomembno vlogo sodelovanja med deležniki pri oblikovanju in širjenju tovrstnih pobud. Navedena ugotovitev je pomembna tako za znanost kot družbo. Prvič, potrjuje izsledke v literaturi o pametnem upravljanju mest, drugič, daje podlago za nadaljnje raziskave v zvezi z uspešnim sodelovanjem in tretjič, urbane upravljavce in oblikovalce politik lahko usmerja k temu, da pri zagotavljanju učinkovitega uresničevanja pobud za razvoj pametnih mest sodelovanju dajo večjo vlogo. Poleg tega je lahko podlaga za razvoj izobraževalnih programov in drugih virov, ki lahko izboljšajo sodelovanje med deležniki in posledično izvedbo pobud v okviru pametnega upravljanja v Prištini in drugje. Pri uresničevanju tovrstnega sodelovanja v državah v razvoju, kot je Kosovo, se lahko pojavijo raznovrstni izzivi. Na primer, težava je lahko, ali se doseže zaupanje med deležniki, zlasti na območjih, kjer je zaupanje prebivalcev v državne ustanove šibko. Izziv je lahko, ali se zagotovi učinkovita komunikacija med deležniki z različnimi interesi, cilji in pričakovanji. Zato je ključno, da oblikovalci politik pri krepitvi sodelovanja pri pametnem upravljanju mest te izzive upoštevajo in razvijejo strategije za njihovo reševanje.

Na podlagi navedenih izsledkov bi morala Priština v prizadevanjih za razvoj pametnega upravljanja mesta poudariti prakse pametnega sodelovanja in pametnega urbanega menedžmenta. Ker sta oba najmočnejša napovednika pametnega upravljanja, bi se morala Priština osredotočiti na izboljšanje sodelovanja med deležniki ter razvoj preglednih, podatkovno vodenih in tehnološko podprtih praks pametnega urbanega menedžmenta, usmerjenih v izboljšanje infrastrukture in javnih storitev. Oblikovalci politik, strokovnjaki in raziskovalci v Prištini bi si morali prizadevati, da bi izboljšali pametno sodelovanje in pametni urbani menedžment, kar bi omogočilo učinkovitejše pametno upravljanje mesta.

5 Sklep

Izsledki, predstavljeni v tem članku, so lahko oblikovalcem politik podlaga za to, da krepijo sodelovanje med deležniki in v Prištini uvedejo pregleden in tehnološko podprt pametni urbani menedžment s poudarkom na infrastrukturi in javnih storitvah, ki omogoča učinkovitejše upravljanje. Avtorja sta se v raziskavi osredotočila na pametno sodelovanje kot ključni napovednik pametnega upravljanja, kar je novost in pomembno dopolnjuje literaturo s področja pametnega upravljanja mest. Menita, da lahko boljše odločanje vpliva na boljše rezultate upravljanja v pametnih mestih, ob tem sta izpostavila pomembno vlogo pametnega urbanega menedžmenta v državah v razvoju, kot je Kosovo.

Raziskava je imela nekatere omejitve, povezane z metodologijo določanja korelacij med spremenljivkami, zaradi katerih ni mogoče oblikovati vzročno-posledičnih povezav. Podatki, ki jih sporočajo udeleženci (samoporočanje) in so pridobljeni s samo enim instrumentom, so lahko pristranski in lahko vključujejo merske napake. Izsledki, ki temeljijo na vzorcu, ki morda ni dovolj reprezentativen, ne morejo biti splošno veljavni, ampak veljajo zlasti za mesta, podobna Prištini. Prihodnje raziskave bi se lahko osredotočile na razumevanje vpliva praks pametnega urbanega menedžmenta na upravljanje, določanje dejavnikov, ki ovirajo učinkovito sodelovanje, in proučevanje stroškovne učinkovitosti strategij in tehnologij, kar bi dalo boljši vpogled v strategije urbanega menedžmenta, ustvarjanje zaupanja in sodelovanje ter strategije komunikacije med deležniki z nasprotujočimi si interesi. Izsledki raziskave izražajo demokratično naravo Kosova, pri čemer se pričakovanja prebivalcev ujemajo s pričakovanji prebivalcev razvitih držav, a je zaupanje v državne organe zaradi centraliziranega odločanja šibko. Zato je za mesta, kot je Priština, prav sodelovanje najboljša rešitev.

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Opomba

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UDK: 349.414:332.142.6 (560.11)
doi:10.5379/urbani-izziv-2023-34-02-02

Prejeto: 27. 3. 2023
Sprejeto: 19. 6. 2023

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Večfaktorska analiza občutljivosti območij kot podlaga za prostorsko načrtovanje v Izmirju, Turčija

Analiza občutljivosti zagotavlja podatke, ki usmerjajo ukrepe na področju prostorskega načrtovanja, saj se z njo določijo območja, ki bi jih bilo treba zavarovati. Avtorica je proučevala Izmir, turško mesto z bogatimi ekološkimi vrednotami, a s hitro spreminjajočim se prostorom. Določila je ekološko občutljiva območja v mestu ter analizirala povezavo med njimi in prostorskimi odločitvami. Občutljiva območja je določila z analitičnim hierarhičnim procesom, nato pa jih je primerjala z urbanističnim načrtom mesta. Ekološke dejavnike in procese je proučila na podlagi devetih glavnih parametrov in 21 podparametrov. Vsak parameter je razdelila na več stopenj ekološke občutljivosti. Izsledki analize so pokazali, da je 16,8 % proučevanega območja zelo visoko občutljivega, 18,5 % je visoko občutljivega, 22,7 % območja ima povprečno, 28,5 % nizko, 13,5 % pa zelo nizko stopnjo občutljivosti. Primerjava teh območij z urbanističnim načrtom mesta v merilu 1 : 100.000 je razkrila, da se prostorske odločitve, razvidne iz načrta, ne skladajo z ekološko občutljivostjo proučevanega območja. Model ugotavljanja ekološke občutljivosti, predstavljen v članku, lahko pomaga izboljšati odločevalske procese pri sprejemanju urbanističnih načrtov.

Ključne besede: analiza ekološke občutljivosti, postopek analitične hierarhije, GIS, prostorsko načrtovanje, Izmir

1 Uvod

Zaradi izkoriščanja naravnih virov in nenadzorovanih človeških dejavnosti se danes ekološko občutljiva območja hitro spreminjajo ali celo izginjajo (IPBES, 2019; Powers in Jetz, 2019; Almond idr., 2020). Z njihovim uničevanjem izginjajo naravni habitati, manjša se biotska raznovrstnost, hkrati izginjajo tudi ekosistemi, ki so ključni za človeka (McPhearson idr., 2015; Ritchie in Roser, 2021). Da bi vse to preprečili, je treba v načrtovalskem procesu upoštevati tudi ekološko občutljivost. Razvita so bila že mnoga orodja in metodologije, ki odločevalske postopke povezujejo z okolju prijaznimi vidiki (Singh idr., 2012; Dizdaroglu in Yiğitcanlar, 2016). Eno izmed teh orodij je analiza ekološke občutljivosti, ki zagotavlja zanesljive ekološke podatke o proučevanem območju in omogoča sprejemanje ustreznih načrtovalskih odločitev (Dai idr., 2012; Liang in Li, 2012; Xie idr., 2015; Leman idr., 2016; Niu idr., 2020).

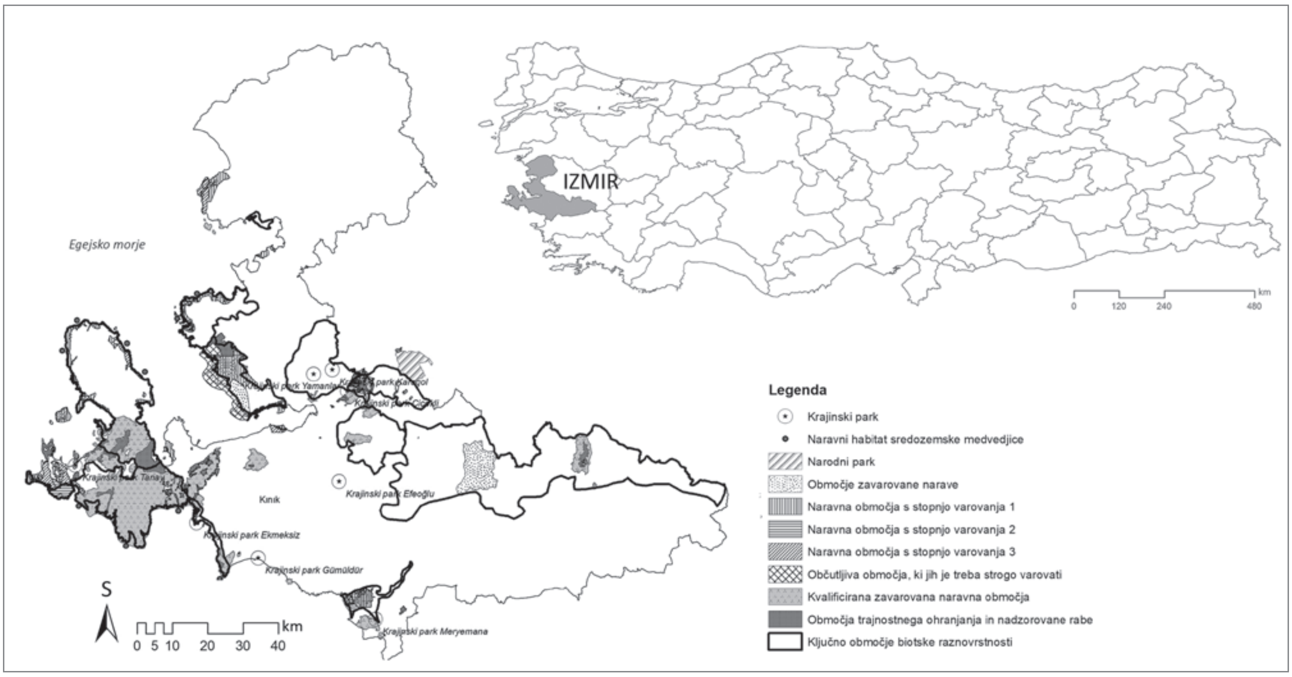
Ekološko občutljiva območja so tista, na katerih so razni ekosistemi, potrebni za trajnostno upravljanje prsti, vode in drugih naravnih virov ter zlasti za ohranjanje biotske raznovrstnosti. Med takšna območja spadajo gozdovi, mokrišča, strma pobočja in kmetijska zemljišča (Ndubisi idr., 1995; Steiner idr., 2000). Ekološko občutljiva območja so bila z raznimi pristopi opredeljena že v številnih študijah (npr. Jennings in Reganold 1991; Steiner idr., 2000, Hong idr., 2017), na splošno pa so opredeljena kot raven odziva in/ali prilagodljivosti posameznega območja na okoljske spremembe, ki jih povzročajo notranji in zunanji dejavniki (Mingwu idr., 2010; Liang in Li, 2012). Zunanji posegi na naravna območja povzročajo prostorske spremembe, kot so perforacija, razkosanost, razdrobljenost, skrčenje ali odmiranje (Forman, 1995). Eden glavnih vzrokov navedenih sprememb so napačne odločitve glede prostorske rabe (Dai idr., 2012). V zadnjih treh desetletjih so analize ekološke občutljivosti postale najnaprednejše področje raziskav, zlasti v smislu proučevanja in določanja ekološko občutljivih območij kot podlage za prostorsko načrtovanje (Liang in Li, 2012).

Za analizo ekološke občutljivosti se uporabljajo mnogi pristopi in metode (Steiner idr., 2000; Xie idr., 2015; Leman idr., 2016). Prvotne raziskave so se osredotočale bolj na okoljska vprašanja, povezana s posamezno živalsko vrsto ali dogodkom (Liang in Li, 2012), poznejše pa na konkretnejša vprašanja, kot so dovzetnost za erozijo, širjenje puščav in zasoljevanje tal (Leman idr., 2016). V zadnjih letih se je področje raziskav še bolj razširilo, pri čemer se tiste, ki proučujejo več dejavnikov hkrati, izvajajo na več prostorskih ravneh. Nekatere se osredotočajo na posamezna območja, kot so mokrišča in porečja (Steiner idr., 2000; Mingwu idr., 2010; Butt idr., 2019, Chi idr., 2019), naravni rezervati (Liang in Li, 2012; Düzgüneş in Demirel, 2016) in parki (Deng in Hu, 2012), druge pa se izvajajo na ravni mest (Zhang idr., 2011; Pan idr., 2012; Niu idr., 2020; Yilmaz idr., 2020) in regij (Dai idr., 2012; Xie idr., 2015; Leman idr., 2016; Hong idr., 2017; Tsou idr., 2017).

Raziskave, katerih cilj je določiti ekološko občutljiva območja, se po navadi izvajajo z geografskimi informacijskimi sistemi (GIS) in metodami daljinskega zaznavanja. Uporabljajo se integrirane metode, ki jih omogoča GIS (npr. analize, sinteze, prostorske poizvedbe, kvantitativne meritve in upravljanje podatkov). Raziskovalci poleg tega uporabljajo postopek analitične hierarhije (Huang idr., 2010; Mingwu idr., 2010; Leman idr., 2016), metodo mehke logike (Zhang idr., 2011), metode določanja uteži (Hong idr., 2017; Butt idr., 2019) ali kombinacijo naštetih metod (Niu idr.; 2020). Z omenjenimi metodami proučujejo občutljivost območij na podlagi parametrov, kot so stanje tal, atmosferske razmere, biotska raznovrstnost in hidrološka zgradba (Xie idr., 2015). Ekološko občutljivost večinoma določajo na štiri- ali petstopenjski lestvici, od izjemne občutljivosti do neobčutljivosti (Zhang idr., 2011; Dai idr., 2012; Liang in Li, 2012; Pan idr., 2012; Niu idr., 2020).

Številni raziskovalci navajajo, da neprimerne odločitve glede prostorske rabe vplivajo na funkcionalnost ekološko občutljivih območij (Su idr., 2011; Dai idr., 2012; Butt idr., 2019; Niu idr., 2020). Sodobno prostorsko načrtovanje bi moralo vključevati nove pristope, kot je analiza ekološke občutljivosti, ki zmanjšujejo uničevalne posledice človeških dejavnosti (Steiner idr., 2000; Liang & Li, 2012; Leman idr., 2016). Zaradi neoliberalne politike sta nepremičninski in gradbeni sektor v prvem desetletju 21. stoletja v Turčiji postala ključni področji, ki pospešujeta gospodarsko rast (Balaban, 2012), posledično pa je načrtovalski proces postal eden izmed najpomembnejših orodij, ki javni sektor usmerjajo pri izvajanju omenjenega modela rasti v mestih (Öktem Ünsal, 2023). V tem pogledu bi lahko rekli, da je načrtovalski sistem v Turčiji vzpostavil ravnovesje med trgom in javnimi interesi (Salata idr., 2022). Opisani model rasti, podprt z načrtovanjem in drugimi dejavniki, kot je nejasna pristojnost pri načrtovanju in revidiranju načrtov, povzroča širjenje mestnih območij in degradacijo okolja ter ne upošteva ekološko občutljivih območij v mestih.

Avtorica v članku določi ekološko občutljiva območja in jih primerja z urbanističnim načrtom, na podlagi česar opredeli neskladja med prostorskimi odločitvami, predstavljenimi v načrtu, in ekološko občutljivostjo ter predstavi model analize ekološke občutljivosti, ki lahko olajša odločanje na področju prostorskega načrtovanja.



Slika 1: Lokacija proučevanega območja, varovanih območij narave in ključnih območij biotske raznovrstnosti (ilustracija: avtorica)

2 Gradivo in metode

2.1 Opis proučevanega območja

Raziskava se osredotoča na Izmir, tretje največje turško mesto po številu prebivalcev in stopnji urbanizacije (slika 1). Pomembno vlogo pri razporeditvi naravnega in grajenega okolja v njem ima morfološka zgradba mesta, ki se razteza na površini približno 12.012 km^2.

Na proučevanem območju so številni kopenski in vodni ekosistemi. V Turčijo se že od petdesetih let 20. stoletja zgrinjajo migracijski valovi in ti vplivajo tudi na Izmir, ki se je v šestdesetih letih 20. stoletja začel hitro širiti, kar je povzročalo čedalje večje pritiske, zlasti na ekosisteme. Ker je za mesto značilna velika ekološka raznovrstnost, so bila v upravnopravnem okviru vzpostavljena varstvena območja različnih statusov (območja zavarovane narave, krajinski parki, naravni spomeniki, območja iz Ramsarske konvencije, posebna varstvena območja in naravna varovana območja različnih ravni), ki se upoštevajo tudi v prostorskih načrtih.

V Turčiji se načrti sprejemajo na različnih ravneh in v različnih merilih. Na najvišji ravni so državni prostorski načrti, tem sledijo državni prostorski strateški načrti in urbanistični načrti v merilih 1 : 100.000 in 1 : 25.000, ki jih pripravlja Ministrstvo za podnebne spremembe, okolje in urbanizem. Poleg tega metropolitanske občine pripravljajo glavne urbanistične načrte v merilih 1 : 25.000 in 1 : 5.000, upravne enote na ravni okrožij pa prostorske izvedbene načrte v merilu 1 : 1.000. Pregled načrtov in odločitev, ki so usmerjale prostorski razvoj mesta, kaže, da so bili po začetnem obdobju Turške republike sprejeti številni prostorski načrti, med njimi tudi leta 1973 glavni urbanistični načrt za izmirsko metropolitansko območje v merilu 1 : 25.000. Načrt je veljal do leta 2002, v tem obdobju pa so bile sprejete tudi mnoge spremembe in dopolnitve v merilih 1 : 5.000 in 1 : 1.000. Leta 2007 je bil sprejet urbanistični načrt v merilu 1 : 100.000, ki je vključeval tudi območja Izmirja, Manise in Kütahye. Pripravila ga je centralna vlada, veljal pa je do leta 2011. Leta 2012 je bilo z zakonom št. 6360 mesto Izmir razglašeno za metropolitansko občino, leta 2014 pa je bila k njej priključena celotna provinca Izmir. Leta 2013 je metropolitanska občina sprejela urbanistični načrt v merilu 1 : 25.000.

Nov urbanistični načrt za območji Izmirja in Manise je bil pripravljen in sprejet leta 2014. Do zdaj je bil že večkrat spremenjen, a še vedno velja. Javnost je bila do načrta kritična, saj ni bil pripravljen na podlagi najnovejših podatkov o območju, ki ga pokriva, pripombe pa so letele tudi na postopek njegove izdelave (TMMOB, 2020; Salata idr., 2022). Ta načrt je na vrhu načrtovalske hierarhije, ena njegovih največjih pomanjkljivosti pa je, da ne upošteva ekološke občutljivosti območij.

2.2 Metode

2.2.1 Določitev enot za analizo ekološke občutljivosti

Raziskava je potekala v petih fazah. V prvi fazi je avtorica proučevano območje razdelila na ekološke enote. V literaturi prevladujeta dve metodi določanja ekoloških enot. Prva temelji na prekrivanju območij v okviru izbranega parametra na podlagi ocenjevalne lestvice, večinoma pa se uporablja v raziskavah, ki temeljijo na vektorskih podatkih (Mingwu idr., 2010; Zhang idr., 2011; Yilmaz idr., 2020). Pri drugi metodi se območje razdeli na različno velike celice. Večinoma se uporablja v raziskavah z izključno rastrskimi podatki ali kombinacijo rastrskih in vektorskih podatkov (Dai idr., 2012; Leman idr., 2016; Hong idr., 2017; Butt idr., 2019; Niu idr., 2020). Avtorica je uporabila drugoomenjeno metodo, pri čemer je območje celotnega Izmirja pretvorila v rastrsko mrežo z velikostjo celic 500 × 500 m. Z navedeno metodo je namreč lahko pridobila podatke, ki so združljivi z merilom načrta, s katerim jih je nameravala primerjati, kar je tudi glavni razlog za to odločitev.

2.2.2 Izbor parametrov za analizo

V drugi fazi je avtorica izbrala parametre za analizo ekološke občutljivosti. Za objektivno presojo ekološko občutljivih območij in točnost raziskave je zelo pomembno, da se izberejo primerni parametri in določijo stopnje presoje (Zhang idr., 2011; Leman idr., 2016). Poleg tega mora biti vsak parameter, ki ima pomembno vlogo pri določanju ekološke občutljivosti, določen na podlagi značilnosti proučevanega območja in obsega raziskave (Hong idr., 2017).

Vsak parameter, ki ga je avtorica določila na podlagi že opravljenih raziskav in značilnosti območja, vključuje ekološke dejavnike in procese (preglednica 1) kot glavni kategoriji presoje. Ekološki dejavniki so značilnosti (topografija, tla, mikroklima itd.), ki določajo občutljivost območij. Na to občutljivost vpliva tudi oddaljenost od industrijskih območij, zato jo je avtorica vključila med proučevane dejavnike. Ekološki procesi, ki se spreminjajo, so opredeljeni kot ekološki cikli, ki potekajo na posameznem območju, nanje pa neposredno vplivajo ekološke značilnosti območja.

Na posameznem območju lahko potekajo številni procesi, od infiltracije vode v tla in erozije tal do kroženja ogljika, avtorica pa se je v raziskavi osredotočila na infiltracijo vode in erozijo tal. Kategoriji ekoloških dejavnikov in ekoloških procesov je analizirala na podlagi devetih parametrov in 21 podparametrov, pri čemer je določila pet referenčnih vrednosti: 1 – zelo nizka občutljivost, 2 – nizka, 3 – povprečna, 4 – visoka in 5 – zelo visoka občutljivost. Referenčne vrednosti občutljivosti za vsak parameter je določila na podlagi izsledkov v literaturi (Mingwu idr., 2010; Zhang idr., 2011; Dai idr., 2012; Deng in Hu, 2012; Pan idr., 2012; Düzgüneş in Demirel, 2016; Leman idr., 2016; Özhancı in Yılmaz, 2018; Alphan in Çoşkun Hepcan, 2019; Karadağ in Şenik, 2019; Niu idr., 2020; Yilmaz idr., 2020) in značilnosti proučevanega območja.

Prvi proučevani podparameter je bil naklon. Večji ko je naklon, manj primerno je območje za uspevanje rastlin. Nakloni, ki otežujejo nastajanje prsti, negativno vplivajo na rast rastlin. Drugi proučevani podparameter je bila lega območij, ki prek vpliva na temperaturo in vlago vpliva tudi na občutljivost rastlin. Severna pobočja, ki so osenčena, imajo gostejše rastlinstvo ter so zaradi bolj vlažnih tal in večje vsebnosti organskih snovi v tleh manj ekološko občutljiva. Južna pobočja pa so toplejša in bolj suha, zaradi česar rastline tam slabše in manj pogosto rastejo ter so bolj občutljive na notranje in zunanje dejavnike (Sternberg in Shoshany, 2001). Pri podparametru nadmorska višina se stopnja občutljivosti zlasti za rastline viša glede na čedalje višjo nadmorsko višino in posledično čedalje nižjo temperaturo (Odum in Barrett, 2008). Pri parametru pridelovalna sposobnost zemljišč so referenčne vrednosti pripisane na podlagi stopenj občutljivosti posameznih razredov zemljišč glede na pridelovalno sposobnost. Prsti razreda I-II so primerne za kmetijstvo in so visoko občutljive, prsti razreda VII-VIII pa so manj občutljive. Pri podparametru skupine prsti so bile proučene značilnosti posameznih vrst prsti in njihova občutljivost na notranje in zunanje dejavnike.

Avtorica je ekološko občutljivost mikroklimatskih parametrov določila na podlagi zmerno optimističnih podnebnih scenarijev (RCP 4.5) za Izmir, predstavljenih v knjigi *A Framework for Climate Change Resistant Cities: A Green Oriented Adaptation Guide* (Alphan in Çoşkun Hepcan, 2019). Večja ko je sprememba povprečne količine padavin, večja je občutljivost. Podparameter povprečne temperature je bil oblikovan na podlagi scenarija RCP 4.5, ob upoštevanju geografskih značilnosti območij, na katerih se spremembe letne povprečne temperature večajo ali manjšajo.

Avtorica je pri podparametru varstvena območja virov pitne vode proučila stopnjo občutljivosti območij z jezovi in ribniki ter njihovih varstvenih pasov. Zaradi obsega raziskave je podparameter reke proučila samo na območjih rek z najvišjo stopnjo občutljivosti. Pri podparametru naravni rezervati je analizirala vsa zavarovana naravna območja ter območja v 500- in 1.000-metrskem pasu okoli njih. V okviru podparametra indeks NDVI (tj. indeksa normalizirane razlike v vegetaciji) je gostoto rastlinstva na območju raziskave določila na podlagi satelitskih posnetkov Landsat 2020. Bolj ko se vrednost indeksa približuje 1, večja je ekološka občutljivost.

Preglednica 1: Parametri in podparametri analize ekološke občutljivosti

Parameter	Podparameter	Občutljivost				
		Zelo nizka	Nizka	Povprečna	Visoka	Zelo visoka
Dejavniki						
Topografija	Naklon (v %)	0–5	5–10	10–20	20–30	> 30
	Lega	S	SV–SZ	Z–V	JV–JZ	J
	Nadmorska višina (v m)	0–100	100–200	200–500	500–1.000	> 1.000
Tla	Razred pridelovalne sposobnosti zemljišč	VII-VIII	VI	IV-V	III	I-II
	Skupine prsti	–	Hidromorfne prsti, regosoli	Rjave, kostanjeve, rjave gozdne, rdeče sredozemske, rdečerjave sredozemske in rdečkasto kostanjeve prsti, rendzine in vertisoli	Rjave gozdne, koluvialne, rdečkasto rjave in organske prsti	Aluvialne prsti
Mikroklima	Povprečna količina padavin (v mm)	–	–	50–150	150–200	> 200
	Povprečna temperatura (v °C)	–	–	0,5 in 1	0,5 in –1	–2 in –1
Hidrologija	Varstvena območja virov pitne vode	–	Velika oddaljenost območja od virov pitne vode	Srednja oddaljenost območja od virov pitne vode	Majhna oddaljenost območja od virov pitne vode	Prisotnost virov pitne vode in 1. varstveno območje
	Reke	–	–	–	–	Prisotne
	Poplavna območja	–	–	–	–	Prisotna
Habitati	Naravni rezervati (m)	–	–	500–1.000	500	Prisotni
	Indeks NDVI	0,02 (nizek)	0,02–0,2	0,2–0,3	0,3–0,5	> 0,5
	Vrstna različnost	–	–	–	–	Prisotna
	Pokritost s krošnjami	Zelo majhna	Majhna	Povprečna	Velika	Zelo velika
Raba zemljišč	Pokrovnost tal	Mestna in podeželska naselja	Njive	Makija, vresje	Gozd	Mokrišča
	Oddaljenost od mesta (v m)	–	5.000	1.000–2.000	500–1.000	500
	Oddaljenost od vasi (v m)	–	–	–	500–1.000	500
	Ceste	–	–	–	–	Prisotne
	Oddaljenost od območij kulturne dediščine in arheoloških najdišč (v m)	–	–	500–100	500	Območja kulturne dediščine in arheoloških najdišč
Oddaljenost od industrijskih območij	Industrijske cone	–	–	–	Manjša industrijska in skladiščna območja	Urejene industrijske cone, predelovalnice odpadkov, rudniki, bencinske črpalke
	Vetrne elektrarne	–	–	–	–	Prisotne
Procesi						
Infiltracija vode		Zelo majhna	Majhna	Povprečna	Velika	Zelo velika
Ohranjenost tal		Zelo majhna	Majhna	Povprečna	Velika	Zelo velika

Med proučevanimi merili podparametra habitati je bila tudi vrstna pestrost. Podatki so bili pridobljeni samo za gozdove in ključna območja biotske raznovrstnosti v Izmirju (Eken idr., 2006). Ker podatki o vrstni pestrosti niso bili na voljo za celotno proučevano območje, so bila za območja z zelo visoko ekološko občutljivostjo določena samo območja z naravnimi rezervati. Pri podparametru pokritost z drevesnimi krošnjami je ekološko občutljivost območij izračunala na podlagi deleža pokritosti tal s krošnjami dreves, pri podparametru pokrovnost tal pa na podlagi vrst rabe zemljišč na proučevanem območju.

Podparametri oddaljenost od mesta, oddaljenost od vasi in oddaljenost od območja kulturne dediščine ali arheološkega najdišča so bili analizirani z vidika oddaljenosti območij od grajenega okolja. Bližje ko so grajenemu okolju, večja je njihova ekološka občutljivost. Tudi pri podparametru ceste se ekološka občutljivost veča glede na to, ali so na območju ceste, saj te neposredno vplivajo na ekološke tokove. Pri podparametru oddaljenost od industrijskega območja so bila za ekološko občutljiva določena območja z industrijskimi conami in vetrnimi elektrarnami, ki neposredno vplivajo na okolje. Avtorica je obravnavala tudi infiltracijo vode v tla in ohranjenost tal, pri čemer je območja z možno erozijo tal določila za ekološko občutljiva. Nazadnje je občutljivost območij glede na posamezen parameter kartirala v programu ArcGIS 10.4.

2.2.3 Izračun uteži proučevanih parametrov

Najpogostejša metoda določanja uteži je analitični hierarhični proces (AHP) (Dai idr., 2012; Liang in Li, 2012; Wang idr., 2014). Z njo odločevalci ali strokovnjaki primerjajo vse pare parametrov in oblikujejo hierarhijo. Utež vsakega parametra se določi na podlagi njegove relativne pomembnosti v primerjavi z drugimi parametri (Saaty, 1990). Primerjava temelji na oceni pomembnosti na lestvici od 1 do 9 (1 – enako pomemben, 9 – najbolj pomemben). Koeficient uteži za vsak parameter se izračuna na podlagi števila uporabljenih parametrov. Avtorica je zato metodo AHP uporabila za določanje ekološko občutljivih območij in uteži vseh parametrov, ki jih je uporabila v raziskavi. Parno primerjavo parametrov sta opravila strokovnjaka, ki sta sodelovala pri projektu urbanistične preobrazbe Izmirja (Izmir Urban Transformation Roadmap).

V nadaljevanju je avtorica uporabila metodo tehtane linearne kombinacije (angl. *weighted linear combination*, v nadaljevanju: WLC), ki je tudi najpogosteje uporabljena metoda v literaturi. Z njo je seštela tehtana povprečja vseh parametrov.

$$WLC = \sum_{i=1}^{n} w_i x_i$$

pri čemer je WLC skupna občutljivost, w_i je utež parametra i, x_i je občutljivost parametra i, n pa je število parametrov.

2.2.4 Določanje združenih ekološko občutljivih območij

V četrti fazi raziskave je avtorica na podlagi koeficientov uteži, navedenih v preglednici 2, določila stopnje ekološko občutljivih območij.

2.2.5 Primerjava ekološko občutljivih območij in urbanističnega načrta v merilu 1 : 100.000

Avtorica je v zadnji fazi raziskave primerjala predhodno določena ekološko občutljiva območja z urbanističnim načrtom v merilu 1 : 100.000. Osnovne prostorske odločitve v načrtu, ki neposredno usmerjajo prostorski razvoj mesta, vključujejo odločitve glede prostorskega umeščanja stanovanjskih naselij, industrijskih območij, urejenih industrijskih con, logističnih središč, javnih ustanov, za katere je potrebnega veliko prostora, in turističnih območij. Pridobljene podatke je najprej kvantitativno proučila na ravni province, nato pa še na ravni okrožij. Čeprav se upravne meje ne ujemajo z mejami naravnih sistemov, je ekološko občutljiva območja v posameznih okrožjih primerjala z urbanističnim načrtom, da bi proučila sprejete prostorske odločitve. Na podlagi podatkov, pridobljenih na ravni posameznih okrožij, je določila tri glavna ali fokusna območja, na katerih se je ekološka občutljivost prostora najmanj skladala s sprejetimi prostorskimi odločitvami. Pri določanju navedenih območij je upoštevala lokacijo okrožij, njihove povezave z mestnim središčem in vpliv načrtovalskih odločitev na prostorski razvoj. V skladu s fokusnimi območji je mogoče lažje ugotoviti, ali so prostorske odločitve primerne z vidika ekološke občutljivosti prostora.

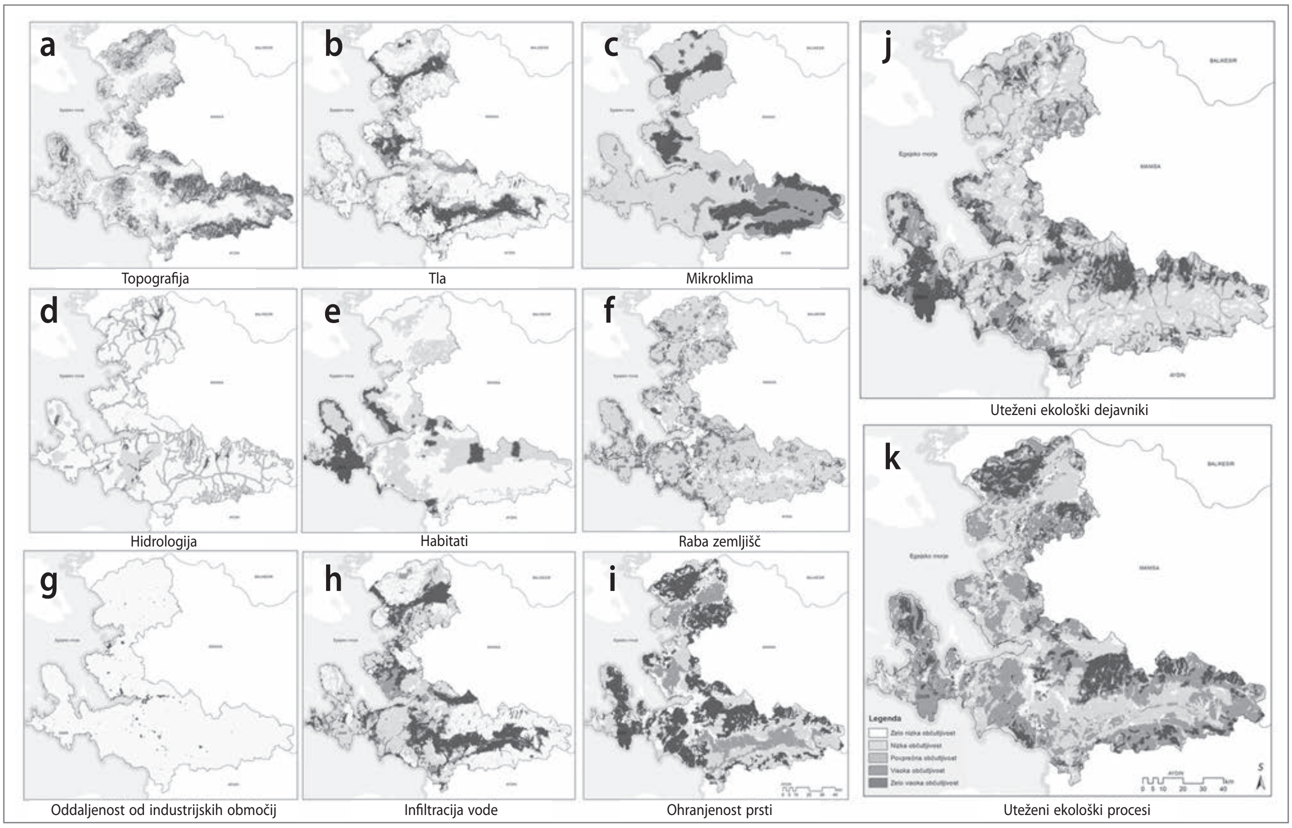
3 Rezultati in razprava

3.1 Prostorska porazdelitev ekološko občutljivih območij v Izmirju

Avtorica je v raziskavi glavne kategorije analize (tj. ekološke dejavnike in ekološke procese) utežila z uporabo metode AHP. Stopnja konsistentnosti je pri ekoloških dejavnikih znašala 0,10, kar je v še sprejemljivih mejah, ki jih je določil Saaty (1990). Parametre ekoloških procesov je določila na podlagi splošnih značilnosti proučevanega območja in drugih raziskav, predstavljenih v literaturi (Dai idr., 2012; Deng in Hu, 2012; Leman idr., 2016; Mingwu idr., 2010; Niu idr., 2020). Z zgoraj omenjeno metodo je za vsak parameter določila in kartirala območja ekološke občutljivosti (glej sliko 3 in preglednico 3).

Preglednica 2: Koeficienti uteži parametrov, uporabljenih v raziskavi

Kategorija, utež	Parameter	Utež	Podparameter	Utež
Ekološki dejavniki, 0,6	Topografija	0,07	Naklon	0,70
			Lega	0,05
			Nadmorska višina	0,23
	Tla	0,15	Pridelovalna sposobnost	0,33
			Skupine prsti	0,66
	Mikroklima	0,06	Povprečna količina padavin	0,50
			Povprečna temperatura	0,50
	Hidrologija	0,26	Varstvena območja virov pitne vode	0,38
			Reke	0,44
			Poplavna območja	0,16
	Habitati	0,35	Naravni rezervati	0,46
			Indeks NDVI	0,14
			Vrstna različnost	0,31
			Pokritost s krošnjami	0,07
	Raba zemljišč	0,04	Pokrovnost tal	0,07
			Oddaljenost od mesta	0,50
			Oddaljenost od vasi	0,19
			Ceste	0,50
			Oddaljenost od območij kulturne dediščine in arheoloških najdišč	0,07
	Oddaljenost od industrijskih območij	0,01	Industrijske cone	0,50
			Vetrne elektrarne	0,50
Ekološki procesi, 0,4	Infiltracija vode	0,50		
	Ohranjenost tal	0,50		



Slika 2: Občutljivost območij glede na ekološke dejavnike in procese: a) topografija, b) tla, c) mikroklima, d) hidrologija, e) habitati, f) raba zemljišč, g) oddaljenost od industrijskih območij, h) infiltracija vode, i) ohranjenost prsti, j) uteženi ekološki dejavniki, k) uteženi ekološki procesi (ilustracija: avtorica)

Preglednica 3: Ekološka občutljivost območij glede na parameter

		Občutljivost									
		Zelo nizka		Nizka		Povprečna		Visoka		Zelo visoka	
Kategorija analize	Parameter	Površina (v ha)	Delež (v %)	Površina (v ha)	Delež (v %)	Površina (v ha)	Delež (v %)	Površina (v ha)	Delež (v %)	Površina (v ha)	Delež (v %)
Ekološki dejavniki	Topografija	362.070	30,4	299.400	25,1	199.100	16,7	227.175	19,1	103.550	8,7
	Tla	595.350	50,0	180.350	15,1	126.650	10,6	153.500	12,9	135.400	11,4
	Mikroklima	642.650	53,9	127.000	10,7	87.725	7,4	193.825	16,3	140.100	11,8
	Hidrologija	747.100	62,7	159.250	13,4	171.900	14,4	98.975	8,3	14.075	1,2
	Habitati	596.325	50,1	182.200	15,3	245.575	20,6	48.025	4,0	119.175	10,0
	Raba zemljišč	136.350	11,4	309.650	26,0	460.525	38,7	216.650	18,2	68.125	5,7
	Oddaljenost od industrijskih območij	1.181.050	99,1	–	–	–	–	1.125	0,1	9.125	0,8
Ekološki procesi	Infiltracija vode	355.714	29,9	295.073	24,8	140.162	11,8	130.862	11,0	267.806	22,5
	Ohranjenost tal	170.706	14,3	150.088	12,6	272.559	22,9	164.309	13,8	433.566	36,4

Preglednica 4: Stopnje ekološke občutljivosti v provinci Izmir

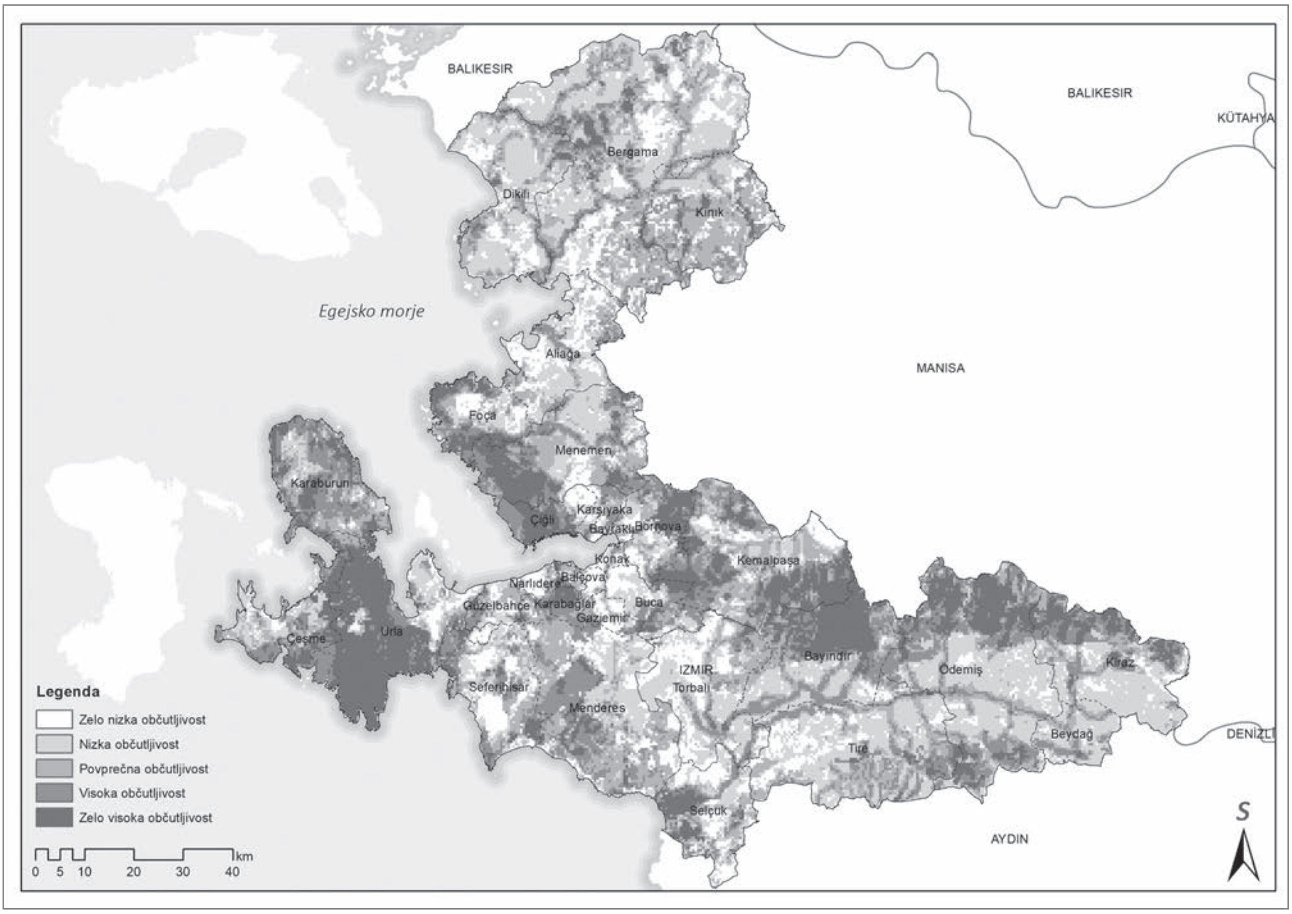
Stopnja občutljivosti	Površina (v ha)	Delež (v %)
Zelo visoka	197.931	16,8
Visoka	218.365	18,5
Povprečna	268.310	22,7
Nizka	336.810	28,5
Zelo nizka	160.075	13,5

Avtorica je nato prekrila karti obeh glavnih kategorij analize, na podlagi česar je pridobila skupno karto območij ekološke občutljivosti (slika 3). Deleži območij z različnimi stopnjami ekološke občutljivosti v provinci Izmir so predstavljeni v preglednici 4. Z vidika prostorske porazdelitve ekološko občutljivih območij na ravni okrožij imajo največ območij z zelo visoko ekološko občutljivostjo okrožja Urla (62,2 %), Çiğli (43,6 %) in Bayındır (34,3 %), največ območij z visoko občutljivostjo pa okrožja Karaburun (39,2 %), Karabağlar (31,1 %) in Çiğli (27,9 %). Po velikem deležu zelo visoko in visoko občutljivih območij izstopajo zlasti okrožja Urla (74,6 %), Çiğli (71,5 %) in Karaburun (62,3 %). Nekatera med njimi (Urla, Karaburun, Karabağlar in Çiğli) vključujejo raznovrstna varovana območja, druga (npr. Bayındır) pa pomembno prispevajo k vodnemu krogu.

Območja s povprečno stopnjo ekološke občutljivosti skupaj pokrivajo 268.310 ha ali 22,7 % celotne province. Čeprav so razpršena po vsej provinci, jih je največ v okrožjih Kınık (47,1 %), Balçova (35,9 %) in Menderes (33,3 %). Območja s to stopnjo občutljivosti (npr. industrijska, stanovanjska in turistična območja) imajo povprečne vrednosti analiziranih parametrov, prostorske odločitve na njih pa vplivajo na njihovo ekološko občutljivost. Zato je pomembno, da se prihodnje prostorske odločitve na teh območjih osredotočijo na ohranjanje narave in da se pri prostorskem umeščanju posamezne rabe zemljišč upošteva ravnovesje med ohranjanjem narave in prostorsko rabo.

Nizko ekološko občutljiva območja so zgoščena v severnem in jugozahodnem Izmirju, natančneje v okrožjih Dikili (47,9 %) in Bergama (38,8 %) na severu in v okrožjih Beydağ (54,7 %) in Kiraz (41,4 %) na jugu. Večina ima zelo nizko občutljivost tal in habitatov ter nizko ali zelo nizko občutljivost ekoloških procesov. To kaže, da bi morale prostorske odločitve na teh območjih bolj upoštevati občutljivost posameznih predelov. Navedena območja bi bilo treba natančneje proučiti na nižjih prostorskih ravneh, prostorske odločitve pa bi morale izboljšati njihove okoljske značilnosti.

Največ območij z zelo nizko ekološko občutljivostjo v provinci Izmir je v okrožjih (45,4 %), Narlıdere (44,3 %) in Gaziemir (38,4 %). Zlasti območja, na katerih prevladuje grajeno okolje, nimajo večje vloge z vidika ekoloških procesov in nimajo varstvenega statusa. Čeprav so območja s to stopnjo ekološke občutljivosti primerna za gradnjo, bi morali biti zunanji posegi bolje urejeni s prostorskimi odločitvami, zaradi obsega raziskave, ki jo je opravila avtorica, pa bi bile za ta območja potrebne podrobnejše analize izbranih parametrov.



Slika 3: Zemljevid ekološko občutljivih območij v provinci Izmir (ilustracija: avtorica)

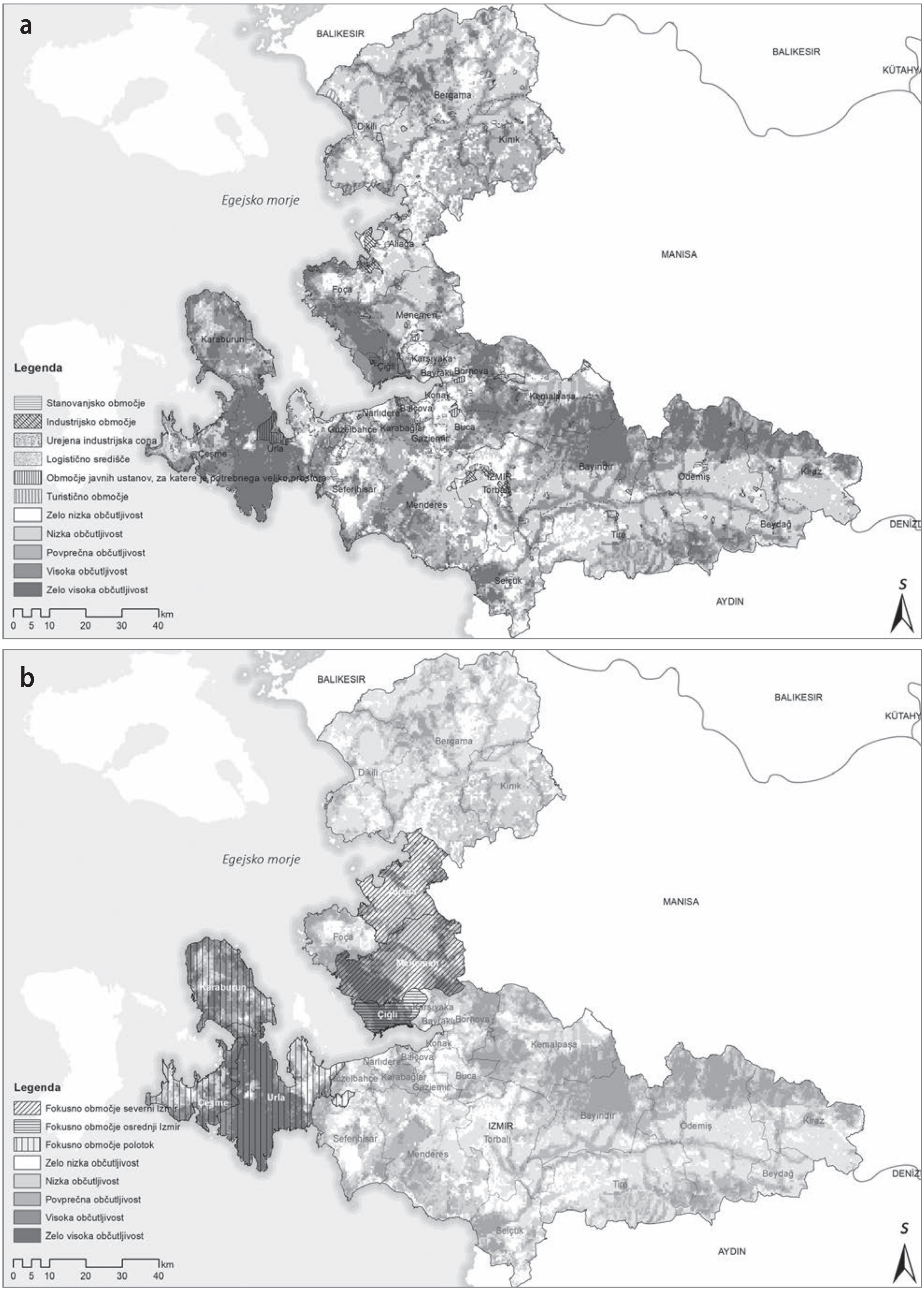
3.2 Primerjava z urbanističnim načrtom v merilu 1 : 100.000

Avtorica je v programu ArcGIS 10.4 zemljevid ekološko občutljivih območij prekrila z urbanističnim načrtom v merilu 1 : 100.000 (slika 4), pri čemer je proučila, s katerimi območji na načrtu se prekrivajo zelo visoko in visoko ekološko občutljiva območja. Ugotovila je, da je zelo visoko ali visoko občutljivih 69,6 % območij javnih ustanov, za katere je potrebnega veliko prostora, 10,3 % stanovanjskih območij, 48,6 % območij logističnih središč, 19,6 % urejenih industrijskih con, 8 % industrijskih območij in 27,8 % turističnih območij (slika 5).

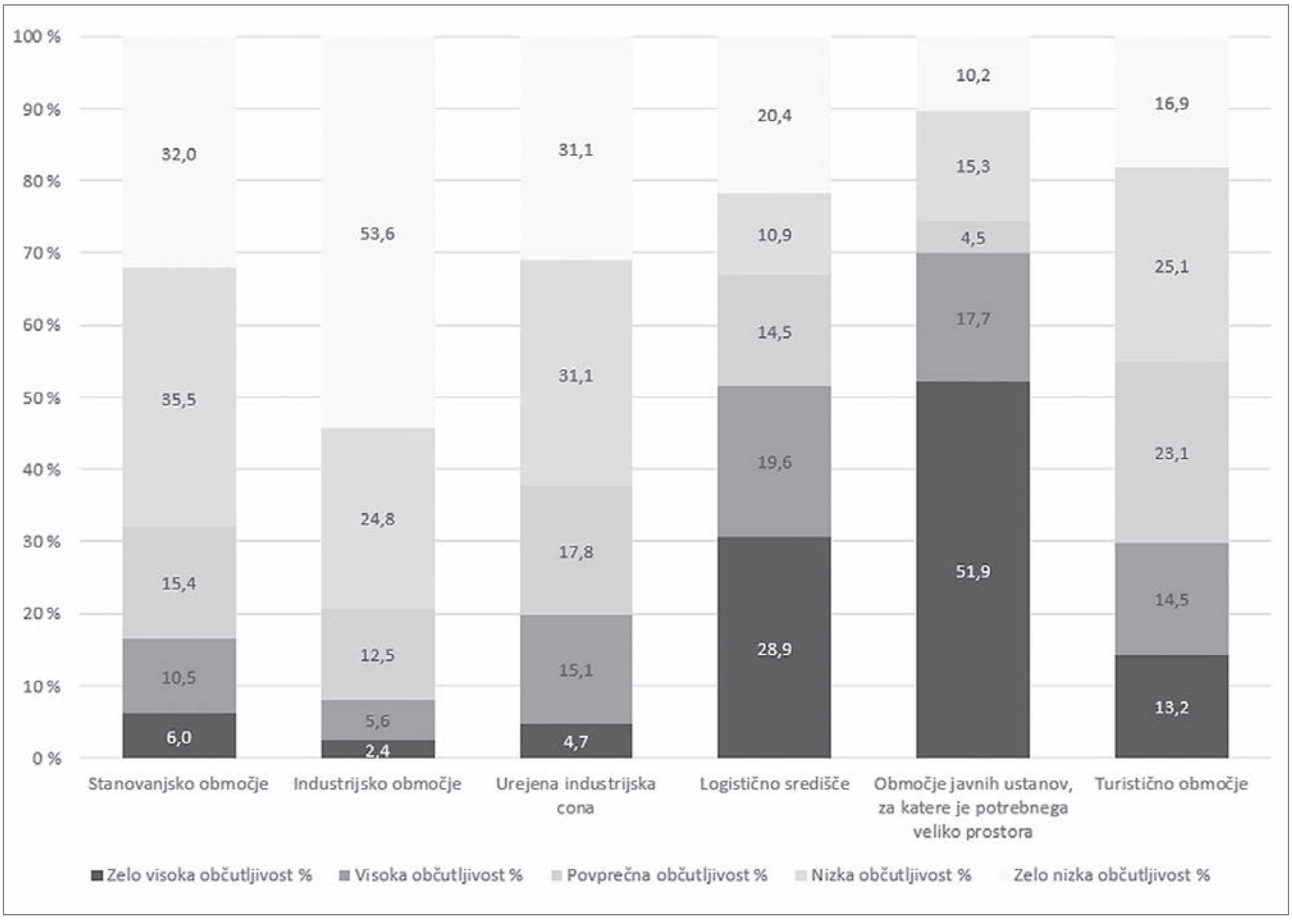
Avtorica je nato stanje proučila še na ravni okrožij. Določila je tri fokusna območja, na katerih so se ugotovljene stopnje ekološke občutljivosti najmanj ujemale s sprejetimi prostorskimi odločitvami. Pri tem je upoštevala lokacijo okrožij, njihove povezave z mestnim središčem in vpliv načrtovalskih odločitev na dinamiko prostorskega razvoja. Opredelila je tri fokusna območja: severni Izmir (okrožji Aliağa in Menemen), osrednji Izmir (okrožje Çiğli) in polotok (okrožja Çeşme, Karaburun in Urla).

Na fokusnem območju severni Izmir je največje industrijsko območje v provinci Izmir. Prostorske odločitve glede umestitve industrijskih območij, razvidne iz urbanističnega načrta v merilu 1 : 100.000, so bile sprejete na podlagi načrtov manjšega merila (glavnih urbanističnih načrtov in prostorskih izvedbenih načrtov). Predvidena je tudi širitev industrijskih območij na okoliške površine. Na tem fokusnem območju se industrijske cone umeščajo v prostor brez upoštevanja njegove ekološke občutljivosti, na njem pa je skoraj polovica vseh industrijskih con v Izmirju, ki ležijo na območjih z zelo visoko ali visoko stopnjo ekološke občutljivosti.

Avtorica je poleg tega ugotovila, da je 48,6 % logističnih središč v provinci umeščenih na območja z zelo visoko ali visoko stopnjo ekološke občutljivosti, od tega jih je 27,2 % v severnem Izmirju. Ker je navedeno fokusno območje zelo blizu mestnega središča, je na njem načrtovanih veliko stanovanjskih območij in logističnih središč, vendar se te načrtovalske odločitve ne ujemajo z ugotovljenimi stopnjami ekološke občutljivosti. To kaže, da urbanistični načrt temelji na merilih, ki ne upoštevajo ekoloških vidikov.



Slika 4: a) Zemljevid ekološko občutljivih območij, prekrit z urbanističnim načrtom v merilu 1 : 100.000, b) fokusna območja (ilustracija: avtorica)



Slika 5: Primerjava prostorskih odločitev na urbanističnem načrtu v merilu 1 : 100.000 s stopnjami ekološke občutljivosti (ilustracija: avtorica)

Na fokusnem območju osrednji Izmir so načrtovana predvsem stanovanjska, logistična in industrijska območja, kar je v skladu z načrtovano selitvijo industrijskih in stanovanjskih območij bolj proti severu. To fokusno območje, ki leži severno od središča Izmirja, obsega samo eno okrožje, ki pa vključuje zelo visoko ali visoko ekološko občutljiva območja. Čeprav so na njih pomembni ekosistemi in zavarovani naravni predeli, je pritisk urbanizacije na okoliških območjih zelo velik, ekološke funkcije tamkajšnjih naravnih območij pa so močno ogrožene. Zelo visoko ali visoko ekološko občutljiva območja so v urbanističnem načrtu opredeljena kot stanovanjska območja, logistična središča, urejene industrijske cone in druga industrijska območja. Navedeno kaže, da bi bilo treba tudi nezavarovana visoko ekološko občutljiva območja skrbno načrtovati, hkrati pa se ne bi smel spreminjati varstveni status že zavarovanih območij.

Pri prostorskih odločitvah na fokusnem območju polotok izstopajo turistična območja in območja javnih ustanov, za katere je potrebnega veliko prostora. Pereča težava z vidika ekoloških funkcij so lokacije javnih gradbenih projektov, za katere je potrebnega veliko prostora na zelo visoko ali visoko ekološko občutljivih območjih. Celotno fokusno območje je visoko ekološko občutljivo, zlasti na nezavarovanih območjih, ki so pod močnim pritiskom zaradi turizma in gradnje počitniških domov. To še zlasti velja za nezavarovana območja, ki so na urbanističnem načrtu v merilu 1 : 100.000 opredeljena za gradnjo, dober pokazatelj pritiskov gradbenega sektorja na tem območju pa so tudi spremembe stopenj varovanja naravnih območij, uvedene z zakonom št. 2863. Poleg urbanističnega načrta gradnji na varovanih območjih odpira prosto pot tudi odločba, v skladu s katero je bil del fokusnega območja določen za območje varstva in razvoja kulture in turizma.

Za trajnostni razvoj varovanih območij je treba zaščititi visoko ekološko občutljive predele. Poleg tega bi bilo treba gradnjo preusmeriti na manj občutljiva območja. Za pravilne in učinkovite prostorske odločitve je zato ključno upoštevanje stopnje občutljivosti območij. Zemljevid ekološke občutljivosti ob pravilni uporabi zagotavlja tudi priložnosti za razvoj. Ekološko občutljiva območja se lahko varujejo s podrobno določitvijo namembnosti območij (npr. turističnih ali stanovanjskih območij) v tekstualnem delu načrtov. Trenutno se lahko z uporabo zemljevida ekološke občutljivosti zavarujejo ekološko občutljiva območja, hkrati pa se lahko oblikujejo prostorske odločitve glede na opredeljene stopnje ekološke občutljivosti.

Za omenjena tri fokusna območja bi bilo zato treba ustrezno spremeniti že sprejete prostorske odločitve. Industrijske cone bi morali v urbanističnem načrtu na primer predvideti na nizko ekološko občutljivih območjih, razvoj turističnih in stanovanjskih območij pa bi moral potekati v skladu s stopnjo njihove ekološke občutljivosti.

Čeprav ima v provinci Izmir trenutno samo 10.95 % območij status varovanega območja, sta deleža zelo visoko (16,8 %) in visoko (18,5 %) ekološko občutljivih območij veliko večja. Med ta spadajo naravna območja z različnimi varstvenimi statusi in območja, ki nimajo varstvenega statusa, a so izjemnega pomena z vidika ekoloških funkcij. Zaradi velike biotske raznovrstnosti so ključna za ohranjanje ekoloških vrednot in funkcij, zaradi zunanjih posegov, zlasti človeških dejavnosti, in neustreznih prostorskih odločitev pa jim grozi propadanje. Primerjava urbanističnega načrta v merilu 1 : 100.000 z zelo visoko ali visoko ekološko občutljivimi območji je pokazala, da sprejete prostorske odločitve ne upoštevajo ekološke značilnosti posameznih območij. Za oblikovanje primernih prostorskih odločitev na podlagi ekološke občutljivosti območij je zato treba celostno analizirati različne parametre. Zemljevid ekološko občutljivih območij daje podlago za popravke trenutno veljavnega urbanističnega načrta v merilu 1 : 100,000 in metropolitanskega urbanističnega načrta v merilu 1 : 25.000.

4 Sklep

Avtorica je v raziskavi na primeru Izmirja proučevala neskladja med prostorskimi odločitvami v urbanističnem načrtu in občutljivimi ekosistemi. Skladnost vsebine načrta z realno urbano dinamiko zagotavlja bolj trajnostna življenjska okolja. Po letu 2000 se je zaradi neoliberalne politike v Turčiji začel uveljavljati model gospodarske rasti, ki temelji na krepitvi gradbenega sektorja. Poleg tega veljavni urbanistični načrt, ki vključuje provinco Izmir, ne temelji na metodoloških pristopih, ki bi omogočali ohranjanje okoljskih značilnosti posameznih območij. Edina omejitev, ki jo zagotavlja zakonodaja, je določitev varstvenega statusa, neustrezne prostorske odločitve na nezavarovanih območjih z visoko stopnjo ekološke občutljivosti pa se lahko odpravijo tudi v okviru urbanističnih načrtov. Določanje stopenj ekološke občutljivosti lahko usmerja prostorski razvoj in razkrije, katera območja bi bilo treba zavarovati.

Avtorica je v raziskavi določila stopnje občutljivosti območja, ki ga pokriva urbanistični načrt, in opozorila na pomen sprejemanja prostorskih odločitev na podlagi teh stopenj. Namesto modelov rasti, ki temeljijo na gradnji, so nujni bolj trajnostni pristopi h gospodarski rasti, kot so na primer modeli zelene rasti. Poleg tega je ključno izvajanje analiz, ki omogočajo celovitejše razumevanje ekoloških značilnosti posameznih območij (npr. analiz ekološke občutljivosti). Prostorske odločitve bi bilo treba uskladiti s stopnjami ekološke občutljivosti območij. V tem pogledu raziskava, predstavljena v tem članku, ponuja nov model analize ekološke občutljivosti, ki lahko izboljša odločanje na področju prostorskega načrtovanja, zlasti v državah v razvoju in drugje, kjer je to potrebno.

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Zahvala

Študija je bila del raziskave ekoloških izgub, nevarnosti in tveganj v okviru projekta urbanistične preobrazbe Izmirja, ki ga je turško ministrstvo za okolje, urbanizacijo in podnebne spremembe izvajalo v sodelovanju s centrom urbane prenove.

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UDK: 502.131.1:711.433(439)
doi:10.5379/urbani-izziv-2023-34-02-03

Prejeto: 21. 6. 2023
Sprejeto: 22. 9. 2023

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Analiza gospodarske in okoljske trajnostnosti na Madžarskem: uspešnost mest z županijskimi pravicami pri doseganju ciljev trajnostnega razvoja

Zaradi velike koncentracije ljudi, podjetij, trgovine in borznih trgov so mesta najpomembnejša središča gospodarskih dejavnosti po svetu. Zaradi hitro spreminjajočih se razmer, ki so posledica dejavnikov, kot so globalizacija, industrija 4.0, umetna inteligenca, pandemije in rusko-ukrajinska vojna, se mesta danes spopadajo z novimi izzivi, za katere so potrebne inovativne in pametne rešitve za ohranjanje trajnostnosti in konkurenčnosti. Avtorja sta v članku analizirala uspešnost madžarskih mest z županijskimi pravicami z vidika pametnega razvoja, pri čemer sta se osredotočila zlasti na okoljsko in gospodarsko trajnostnost. Domnevala sta, da so gospodarsko razvitejša mesta (z vidika dohodka na prebivalca) zaradi razpoložljivih finančnih in kadrovskih virov po navadi bolj trajnostna, ni pa nujno, da so med njimi tudi največja mesta po številu prebivalcev (zaradi ekonomije obsega, manjše privlačnosti za bivanje in drugih razlogov). Analizirala sta tri od sedemnajstih ciljev trajnostnega razvoja, ki jih je opredelila Organizacija združenih narodov (OZN), pri tem pa sta uporabila kazalnike madžarskega centralnega statističnega urada in OZN ter jih prilagodila značilnostim madžarskega urbanega omrežja. Z normalizacijo min-max in izračunom povprečnih vrednosti sta oblikovala sestavljeni indeks ciljev trajnostnega razvoja. Mesta sta razvrstila v pet skupin, ki so se razlikovale predvsem po stopnji razvojne dinamike in privlačnosti mest za bivanje. Skupine, ki sta jih določila, izražajo prostorske značilnosti madžarskega urbanega omrežja, najbolj trajnostna pa so dinamična mesta na zahodu in severozahodu države.

Ključne besede: madžarska mesta, cilji trajnostnega razvoja, trajnostnost, gospodarski steber, pametna mesta

1 Uvod

Po podatkih Programa Združenih narodov za okolje (UNEP, 2018) naj bi se poraba surovin v mestih do leta 2050 povečala na 90 milijard ton (leta 2010 je znašala 40 milijard ton). Blaženje podnebnih sprememb in zmanjševanje njihovih negativnih vplivov na okolje sta postala eden največjih izzivov današnje družbe (Yigitcanlar in Kamruzzaman, 2018). Oblikovalci politik spodbujajo trajnostni razvoj kot ključno prednostno nalogo mestnega razvoja, kar je skladno tudi z 11. ciljem trajnostnega razvoja OZN, ki poudarja razvoj odprtih, varnih, vzdržljivih in trajnostnih mest (OZN, 2018).

Trajnostni razvoj sloni na treh glavnih razsežnostih, ki imajo tudi ključno vlogo pri razvoju mest – tj. na okoljski, gospodarski in socialni razsežnosti (Lehtonen, 2004). Okoljska razsežnost se nanaša na okoljske vidike (naravno okolje, vključno z rastlinami in živalmi, in proizvodnjo energije), socialna razsežnost se nanaša na enakost, dobro počutje ljudi in zadovoljevanje osnovnih človeških potreb, gospodarska razsežnost pa na gospodarsko konkurenčnost in raznolikost mestnih območij (Toli in Murtagh, 2020).

V literaturi se je zato pojavil nov pojem – trajnostno pametno mesto –, skupaj z njim pa še izrazi vzdržljivost, trajnostnost in pametnost. Avtorja v članku proučujeta, kako uspešno 25 madžarskih mest z županijskimi pravicami dosega nekatere prednostne vidike indeksa ciljev trajnostnega razvoja. Postavila sta hipotezo, da so zaradi finančnih in kadrovskih virov gospodarsko razvitejša mesta (z vidika dohodka na prebivalca) verjetno tudi bolj trajnostna, ni pa nujno, da so med njimi tudi največja mesta po številu prebivalcev (zaradi ekonomije obsega, manjše privlačnosti za bivanje in drugih razlogov). Avtorja sta na podlagi analize madžarska mesta razvrstila glede na stopnjo dosežene gospodarske in okoljske trajnostnosti, njuni izsledki pa so primerljivi z izsledki klasičnih analiz hierarhije madžarskih mest.

2 Teoretično ozadje: pojem pametnih in trajnostnih mest

Izraz *pametno mesto* je postal priljubljen na začetku devetdesetih let 20. stoletja, še vedno pa zanj ni enotne definicije. Sprva se je večina definicij osredotočala na tehnološki vidik pametnega razvoja mest. Eno najpogosteje citiranih tehnokratskih razlag so podali Harrison in sodelavci (2010), ki so poudarili, da se lahko s pametno in ustrezno uporabo informacijskih in komunikacijskih tehnologij oblikujejo pametna, institucionalizirana in povezana mesta. Pozneje je čedalje več raziskovalcev v razlage začelo vključevati mehke prvine, kot so znanje, inovacije, ustvarjalnost, človeški kapital in trajnostnost, s čimer so oblikovali kompleksne definicije (Szendi, 2021; Wataya in Shaw, 2022). Po najnovejših definicijah je za pametno mesto značilno predvsem dvoje: tehnologija in ustvarjanje dodane vrednosti za deležnike. Prizadeva si zagotoviti visoko kakovost življenja in povečati konkurenčnost na nekem geografskem območju (Glasmeier in Christopherson, 2015). V vseh definicijah se na splošno navaja, da je cilj pametnega mesta izboljšati bivalne razmere prebivalcev, in se poudarja vloga trajnostnega razvoja, inovacij in znanja. Z vključitvijo mehkih prvin je postal pojem pametnih mest čedalje kompleksnejši, merljivost njihove uspešnosti pa je za raziskovalce čedalje večji izziv. Eden najpogosteje uporabljenih modelov za ocenjevanje trajnostnosti mest je šestdelni model, ki so ga razvili Giffinger in sodelavci (2007) (vključuje gospodarstvo, ljudi, upravo, mobilnost, okolje in življenjske razmere), za razvrščanje mest pa se uporablja več kot 80 kazalnikov.

Na podlagi raziskave Evropskega parlamenta (2014), ki je temeljila na vzorcu 599 mest, je pametno okolje najpomembnejši vidik evropskih pametnih mest (v 33 % vseh proučevanih mest), pametno gospodarstvo pa je glavna prednostna naloga v samo 11 % mest (García Fernández in Peek, 2020). Raziskave kažejo, da bosta do leta 2025 najbolj dinamična segmenta pametnih mest postali pametna uprava in pametna energetika, ki se bosta do leta 2030 dodatno razvijali (Angelidou idr., 2022). To pomeni, da bo tudi poudarek na trajnostnosti čedalje večji. Trajnostno pametno mesto vključuje vse osnovne prvine pametnih mest, poleg njih pa še kazalnike optimalnega upravljanja omejenih virov (ravnanje z okoljem, odpadki in vodo, zelena energija itd.) (Ahvenniemi idr., 2017). To je mesto, v katerem se z informacijsko-komunikacijskimi tehnologijami zadovoljujejo potrebe sedanjih prebivalcev, ne da bi se ogrožale možnosti drugih ljudi ali prihodnjih rodov, da zadovoljijo svoje potrebe, in bi se tako presegale okoljske omejitve (Höjer in Wangel, 2014).

V raziskavi, predstavljeni v tem članku, avtorja merita gospodarsko uspešnost in trajnostnost madžarskih mest, za kar dajejo dobro podlago kazalniki trajnostnega razvoja, ki jih je opredelil OZN. Čeprav je bilo opravljenih že več študij merljivosti pametnih mest (npr.; Giffinger idr., 2007; Cohen, 2014), med njimi ni bilo podrobnejših raziskav madžarskih mest. Madžarski centralni statistični urad (HCSO) je doseganje ciljev trajnostnega razvoja meril samo na ravni županij, med madžarskimi mesti pa sta organizacija Sustainable Development Solutions Network (SDSN) in ustanova Brabant Centre for Sustainable Development (Telos) v poročilu o trajnostnem razvoju leta 2019 analizirali samo Budimpešto. Madžarska prestolnica je dosegla 55,4 točke (zmerna uspešnost) in med 45 analiziranimi evropskimi mesti zasedla 37. mesto. Mesto se še vedno spopada s precejšnjimi izzivi pri doseganju petih od skupno 15 ciljev, pri sedmih ima resne težave, dva cilja (čista voda in sanitarna ureditev ter zmanjšanje neenakosti) pa že skoraj dosega (en cilj pri Budimpešti ni bil analiziran) (Lafortune idr., 2019). Avtorja raziskave, predstavljene v tem članku, sta se odločila, da Budimpešte ne bosta vključila v analizo, saj bi lahko njene vrednosti v mnogih primerih tako močno odstopale, da bi popačile rezultate analize (predvsem pri standardizaciji), ki bi tako pokazala nerealne razlike v urbanem omrežju.

Poleg evropskih mest so bila s kazalniki trajnostnega razvoja že analizirana ameriška mesta, na podlagi obeh analiz pa je bilo opozorjeno na težave z razpoložljivostjo in primerljivostjo podatkov. Za ZDA je bil prvi indeks ciljev trajnostnega razvoja oblikovan leta 2017. Uporablja se za razvrščanje stotih največjih ameriških mest po številu prebivalcev in njihovih metropolitanskih območij, glede na to, kako uspešno se dosegajo cilji trajnostnega razvoja. Izsledki analiz kažejo, da morajo vsa mesta v ZDA, tudi tista, ki po indeksu zasedajo najvišja mesta (npr. mesta na metropolitanskem območju San Jose-Sunnyvale-Santa Clara v Kaliforniji), da bi dosegla cilje trajnostnega razvoja, storiti še veliko (Sustainable Development Solutions Network, 2017). Evropsko poročilo o trajnostnem razvoju temelji na primerjavi, kako uspešna so glavna mesta večjih metropolitanskih regij v Evropski uniji in na območju Evropskega združenja za prosto trgovino (EFTA) pri doseganju 17 ciljev trajnostnega razvoja. V prvi prototipni različici poročila so bili navedeni rezultati za 45 evropskih mest, ki temeljijo na 56 kazalnikih. Na prvem mestu je bilo Oslo, ki je doseglo 74,8 % vseh ciljev trajnostnega razvoja, sledila sta Stockholm in Helsinki. Tudi ta najuspešnejša mesta torej še vedno ne dosegajo vseh ciljev, kar zanje ostaja velik izziv (Lafortune idr., 2019). Leta 2022 je bila opravljena še analiza trajnostnega razvoja 17 kazahstanskih mest, pri kateri so avtorji razvili svoj indeks trajnostnega mestnega razvoja in mesta razvrstili v skupine. Uporabili so podobno metodo normalizacije kot pri analizi, predstavljeni v tem članku, med komponentami analize pa se niso osredotočali na cilje trajnostnega razvoja, ampak so upoštevali klasične gospodarske in socialne dejavnike (Nyussupova idr., 2022).

Avtorja sta v članku izračunala indeks ciljev trajnostnega razvoja madžarskih mest z županijskimi pravicami, s poudarkom na gospodarskih in okoljskih vidikih trajnostnosti, ter določila, kako uspešno je madžarsko urbano omrežje pri doseganju ciljev trajnostnega razvoja.

3 Metodologija in podatki

Septembra 2000 je OZN sprejel razvojne cilje novega tisočletja (ang. *Millennium Development Goals*), članice OZN pa so se zavezale k vzpostavitvi novega globalnega partnerstva, ki se bo osredotočalo na težave, s katerimi se spopadajo države v razvoju. Določenih je bilo osem ciljev, ki bi morali biti doseženi do leta 2015 (HCSO, 2022). Kljub vsem dosežkom, povezanim s temi cilji, so bile leta 2015 po svetu še vedno velike razlike med najrevnejšimi in najbogatejšimi območji ter med mesti in podeželjem (OZN, 2015). Na vrhu OZN o trajnostnem razvoju 25 in 26. septembra 2015 so zato svetovni voditelji naredili še korak dlje in sprejeli resolucijo *Transforming Our World: the 2030 Agenda for Sustainable Development* (Spreminjamo naš svet: agenda za trajnostni razvoj do leta 2030), ki je vključevala 17 globalnih ciljev trajnostnega razvoja in 169 podciljev (Evropska agencija za okolje, 2020). V Agendi 2030 so poleg področij, opredeljenih v ciljih novega tisočletja, upoštevani tudi pogledi razvitih držav, poseben poudarek pa je na okoljskem vidiku. Leta 2020 je OZN razvil jasno metodologijo za spremljanje vseh kazalnikov ciljev trajnostnega razvoja (HCSO, 2022). V tem članku so analizirani trije izmed 17 ciljev OZN, ki omogočajo merjenje trajnostnega razvoja in pametnega gospodarstva mest, in sicer dva gospodarska cilja (8. cilj – dostojno delo in gospodarska rast ter 9. cilj – industrija, inovacije in infrastruktura) in en socialni cilj (11. cilj – trajnostna mesta in skupnosti).

Cilj raziskave je bil pokazati, da imajo pri doseganju ciljev trajnostnega razvoja ključno vlogo regije in mesta, čeprav so te cilje sprejele nacionalne vlade (Lafortune idr., 2019). Na tej podlagi je bil izračunan indeks treh ciljev trajnostnega razvoja. Med vsemi 17 cilji se jih več osredotoča na gospodarsko in okoljsko trajnostnost. Z izbiro 8., 9. in 11. cilja sta avtorja želela proučiti, ali so gospodarsko najbolj razvita mesta tudi okoljsko, gospodarsko in socialno trajnostna. Z izbranimi cilji se namreč poudarjajo navedeni trajnostni vidiki, zanje so na razpolago podatki, ki se nanašajo na najrazličnejša mesta, njihovo proučevanje pa zagotavlja pomembne informacije za madžarska mesta. Avtorja sta poleg tega analizirala nekatere kazalnike 12. cilja trajnostnega razvoja (odgovorna poraba in proizvodnja), pri čemer sta uporabila podatke o ravnanju z odpadki in prejeti finančni podpori. Kazalnike sta izbrala na podlagi izsledkov madžarske in mednarodne literature. Podatke sta pridobila iz podatkovne zbirke madžarskega nacionalnega informacijskega sistema za regionalni razvoj in prostorsko načrtovanje (TEIR), podatkovne zbirke madžarskega centralnega statističnega urada ter popisa naravnih in kulturnih znamenitosti na Madžarskem. V osnovno podatkovno zbirko za analizo sta na koncu vključila 27 spremenljivk, potem ko sta jo zaradi multikolinearnosti dvakrat prečistila (v prvem koraku sta odstranila pet spremenljivk, v drugem pa še eno).

Pri oblikovanju podatkovne zbirke sta bili pomembni primerljivost podatkov in možnost dodajanja podatkov za oblikovanje sestavljenega indeksa. Avtorja sta najprej izračunala konkretne podatke, v glavnem izražene v obliki vrednosti na 1.000 ali 10.000 prebivalcev ali v odstotkih. Ker so bili podatki izraženi v različnih merskih enotah, sta morala njihove vrednosti standardizirati (Freudenberg, 2003). S spremembo obsega

Preglednica 1: Seznam kazalnikov za analizo posameznega cilja trajnostnega razvoja

Cilj trajnostnega razvoja	Kazalnik	Korelacija s cilji trajnostnega razvoja (+/–)
8. – dostojno delo in gospodarska rast	Neto razpoložljivi dohodek na prebivalca (v HUF)	+
	Stopnja dolgotrajne brezposelnosti (več kot 180 dni; v %)	–
	Koeficient starostne odvisnosti starih (več kot 65 let/15–64 let)	–
	Delež samozaposlenih (v %)	–
	Stopnja zaposlenosti mladih diplomantov (20–34 let; v %)	+
9. – industrija, inovacije in infrastruktura	Delež izdatkov za raziskave in razvoj v bruto domačem proizvodu (na ravni županij)	+
	Število internetnih priključkov na 1.000 prebivalcev	+
	Število patentov na milijon prebivalcev (na ravni županij)	+
	Dolžina državnih cest na 100 km^2 (na ravni županij)	+
	Količina emisij CO_2 na prebivalca (v t)	–
	Selitveni prirast (trajni in začasni) na 1.000 prebivalcev, 2020	+
	Delež dnevnih migrantov med zaposlenimi v posameznem mestu, 2011	–
	Najhitrejši dostop do Budimpešte po cesti (v min)	–
11. – trajnostna mesta in skupnosti	Letna povprečna vrednost PM10 (trdih prašnih delcev s premerom pod 10 mikronov) (v µg/m^3)	–
	Količina emisij NO_2 na prebivalca (v kg/leto)	–
	Povprečna cena nepremičnin na kvadratni meter	–
	Zadovoljstvo s finančnim položajem gospodinjstva (na lestvici od 0 do 10)	+
	Zadovoljstvo s kakovostjo bivalnega okolja (na lestvici od 0 do 10)	+
	Finančna podpora (delež prejemnikov občinske finančne podpore v prebivalstvu celotne občine)	–
	Število lokalnih avtobusnih prevozov na prebivalca	+
	Števílno kulturnih ustanov na 100.000 prebivalcev	+
	Število znamenitosti na 100.000 prebivalcev	+
	Število muzejev na 100.000 prebivalcev	+
	Razlika v dostopu do komunalne infrastrukture (razlika med deležem bivališč, priključenih na javni vodovod, in deležem bivališč, priključenih na javno kanalizacijo)	–
	Količina odpadkov na prebivalca (v kg)	–
	Delež ločeno zbranih odpadkov v celotni količini zbranih odpadkov (v %)	+
	Sredstva iz evropskega programa EDIOP na prebivalca za razvoj obnovljivih virov energije (v HUF)	+

Opomba: Predstavljeni kazalniki se samo v 80 % ujemajo s tistimi, opredeljenimi v prvotnih raziskavah ciljev trajnostnega razvoja, saj temeljijo na razpoložljivih podatkih o madžarskih mestih. Nekateri kazalniki (npr. število prijav modelov Skupnosti, število polnilnih postaj in količina podtalnice z dobrim kemijskim stanjem) so bili izključeni iz analize, ker se za madžarska mesta ne merijo, drugi pa so bili nadomeščeni z ustreznejšimi.

Vir: avtorja, na podlagi podatkov madžarskega centralnega statističnega urada, Eurostata, OKIR–LAIR, ingatlannet.hu, Google maps in palyazat.gov.hu.

vrednosti podatkov (z normalizacijo min-max) sta dosegla, da so bili kazalniki med seboj primerljivi. Za standardizacijo sta uporabila naslednjo enačbo:

$$x = \frac{x_i - x_{min}}{x_{max} - x_{min}} * 100$$

Glavna prednost te metode je, da omogoča združevanje podatkov, izraženih v različnih enotah (npr. kg, % in m²), in preprečuje izgubo podatkov ali pristranskost (Giffinger idr., 2007; Cohen, 2014). Pri kazalnikih, pri katerih je višja vrednost pomenila slabši rezultat (npr. število iskalcev zaposlitve ali različne mere onesnaženosti zraka), sta avtorja za izračun obratnih vrednosti uporabila naslednjo enačbo:

$$x_{popr} = \frac{x_i - x_{max}}{x_{min} - x_{max}} * 100$$

Na podlagi preproste aritmetične sredine (ker po standardizaciji v podatkovni zbirki ni več osamelcev) (Das in Imon, 2014) sta oblikovala kazalnike za indekse 8., 9. in 11. cilja trajnostnega razvoja ter končni sestavljeni indeks. V analizi sta uporabila 27 kazalnikov, navedenih v preglednici 1.

Potem ko sta avtorja določila vse kazalnike, sta njihovo porazdelitev predstavila s toplotnimi prikazi, na koncu pa sta proučevana mesta na podlagi priporočil v literaturi (npr. Bellantuono idr., 2022) razvrstila v skupine.

4 Rezultati

4.1 Toplotni prikazi

Avtorja sta s toplotnimi prikazi predstavila, kako so se mesta odrezala pri posameznem kazalniku (Dorofeev, 2022). Toplotni prikazi so dvodimenzionalne predstavitve podatkov z barvami (Cui in Zwick, 2016, str. 2), običajno v preglednicah. Vrednosti v stolpcih prikazujejo, ali je položaj mesta z vidika posameznega kazalnika dober ali slab, vrednosti v vrsticah pa prikazujejo pozitivne ali negativne rezultate kazalnikov za posamezna mesta (HCSO, 2015). Da bi zagotovila primerljivost podatkov, sta avtorja uporabila standardizirane vrednosti, vsako mesto pa sta v skladu s priporočili v literaturi (npr. Arbatli in Johansen, 2017) glede na doseženi rezultat razvrstila na ustrezno mesto na lestvici od 0 do 100.

Toplotni prikaz za 8. cilj trajnostnega razvoja (dostojno delo in gospodarska rast) je pokazal velike razlike med proučenimi mesti. Pri gospodarskih kazalnikih so najbolj stabilne pozitivne rezultate dosegla mesta Esztergom, Gjur, Tatabánya in Veszprém. Pri več kazalnikih sta se najslabše odrezali mesti Salgótarján in Szekszárd. Salgótarján je bil pri vseh kazalnikih razen pri deležu samozaposlenih v spodnji tretjini lestvice, Szekszárd pa je imel dobre rezultate pri dohodku na prebivalca in brezposelnosti, pri drugih kazalnikih pa je močno zaostajal za drugimi mesti. Pri vseh kazalnikih so bile med mesti velike razlike; na primer pri neto dohodku na prebivalca je razlika med mestom Székesfehérvár, ki je imelo najvišji dohodek (1,723.192 HUF), in mesti Baja in Salgótarján, ki sta imeli najnižji dohodek na prebivalca, znašala 600.000 do 700.000 HUF.

Pri 9. cilju trajnostnega razvoja (industrija, inovacije in infrastruktura) se je izkazalo, da imajo nekatera mesta pri več kazalnikih resne težave. Z nadpovprečnimi rezultati pri vseh kazalnikih pozitivno izstopa Gjur, ki je eno najbolj inovativnih in dinamičnih madžarskih mest, hkrati pa je pomembno izobraževalno središče. Pri petih izmed osmih kazalnikov se je najbolje odrezal Zalaegerszeg, ki pa je imel zelo slabe rezultate pri kazalnikih, ki se izrazito nanašajo na inovacije (npr. raziskave in razvoj ter patente). Razmere na tem področju bi lahko pomembno spremenilo odprtje nove Rheinmetallove tovarne za proizvodnjo Lynxovih pehotnih bojnih vozilv letu 2023. Érd izstopa pri štirih kazalnikih; pri raziskavah in razvoju ter inovacijah njegove rezultate močno zvišuje povprečje županije Pešta, poleg tega ima mesto čist zrak, saj v njem ni veliko industrije. Podpovprečne vrednosti pri večini kazalnikov pa sta imeli mesti Kaposvár in Debrecen.

Pri 11. cilju trajnostnega razvoja (trajnostna mesta in skupnosti), ki vsebuje največ kazalnikov (14), so med mesti največje razlike. Najbolj uravnotežene rezultate imajo Érd, Esztergom in Veszprém, najbolj negativne vrednosti kazalnikov pa sta dosegli mesti Nagykanizsa in Nyíregyháza. Pri količini emisij NO_2 so vrednosti vseh mest dokaj uravnotežene, pri povprečni ceni nepremičnin na kvadratni meter pa so med njimi precejšnje razlike. Najvišjo povprečno ceno ima Érd (več kot 720.000 HUF), najnižjo pa Salgótarján (198.000 HUF), razlika med njima je skoraj štirikratna. Cene so po navadi nižje na obrobjih mest. Pri kazalnikih zadovoljstva prebivalcev z družinskim finančnim položajem in bivalnim okoljem (na podlagi rezultatov ankete madžarskega centralnega statističnega urada) mesta dosegajo podobne rezultate; najvišje vrednosti imata Gjur in Sopron, najnižje pa Tatabánya, Nagykanizsa in Nyíregyháza, vendar standardni odklon med mesti ni velik.

4.2 Razvrščanje v skupine

Iz toplotnih prikazov so bili razvidni razlike med mesti in njihov položaj na vrhu ali dnu lestvice pri vsakem kazalniku. Avtorja sta domnevala, da lahko združita mesta s podobnimi značilnostmi in vrednostmi kazalnikov. Da bi preverila svojo hipotezo, sta uporabila metodo razvrščanja v skupine, katere cilj je oblikovati homogene skupine na podlagi vrednosti kazalnikov razmeroma heterogenih objektov (Anderberg, 1973). Odločala sta se med tem, ali naj mesta razdelita v tri, štiri ali pet skupin, na koncu pa sta se odločila za pet skupin, saj to omogoča boljšo interpretacijo rezultatov. Vrednosti sestavljenega indeksa za proučevana mesta, izračunane na podlagi kazalnikov za 8., 9. in 11. cilj trajnostnega razvoja, so navedene na sliki 1. Skupni rezultati posameznih mest so prikazani z vrednostmi, doseženimi pri posameznem cilju. Mesta sta razvrstila v pet skupin, pri čemer sta tista z doseženimi več kot 80 % vseh možnih točk uvrstila med najuspešnejše (tj. v prvo skupino), tista z manj kot 20 % točk pa med najmanj uspešne glede doseganja ciljev trajnostnega razvoja (tj. v zadnjo, peto skupino).

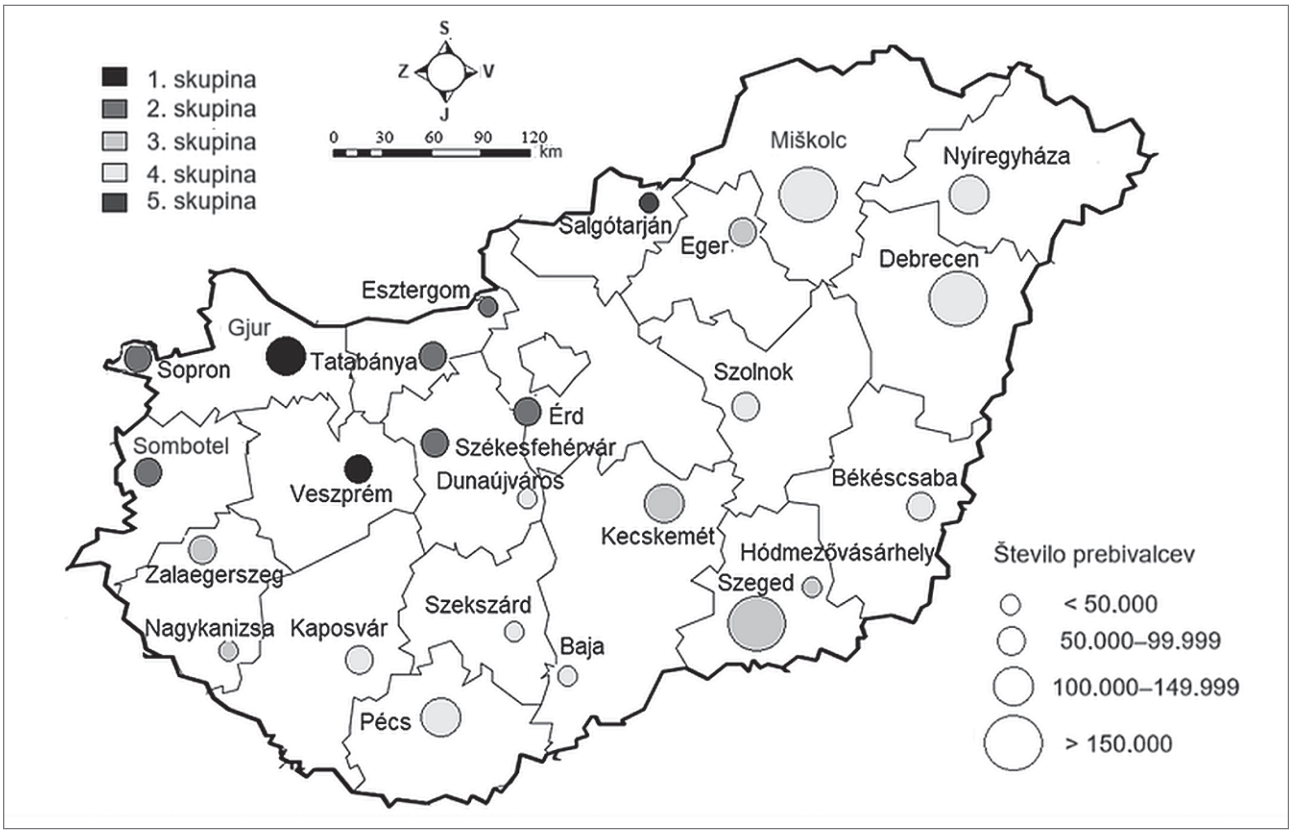
4.2.1 Prva skupina: najbolj dinamična in živahna madžarska mesta

Prva skupina je vključevala samo dve mesti, Gjur in Veszprém. Gjur je bil nekdaj mesto sejmov in trgovcev, danes pa je najbolj dinamično in inovativno središče županije. To je razvidno tudi iz rezultatov kazalnikov vseh treh proučevanih ciljev trajnostnega razvoja in iz najvišje vrednosti sestavljenega indeksa (65,44) med 25 analiziranimi mesti. Audijeva tovarna avtomobilov in z njo povezana mreža dobaviteljev (Józsa idr., 2017;

Skupina	Mesto	8	9	11	Sestavljeni indeks
1	Gjur	73,56	60,94	61,83	65,44
	Veszprém	60,65	64,72	69,20	64,86
2	Esztergom	59,02	63,13	60,24	60,79
	Érd	65,12	68,32	45,57	59,67
	Sopron	61,03	51,71	65,11	59,28
	Sombotel	60,96	53,83	59,94	58,24
	Tatabánya	69,26	53,80	48,19	57,08
	Székesfehérvár	54,81	58,90	54,40	56,04
3	Szeged	52,12	54,96	46,38	51,16
	Hódmezővásárhely	57,47	41,59	51,43	50,16
	Kecskemét	54,82	42,54	48,63	48,66
	Eger	33,78	47,36	62,09	47,74
	Zalaegerszeg	51,03	42,94	48,09	47,35
	Nagykanizsa	51,55	35,82	48,24	45,21
4	Nyíregyháza	55,15	35,22	42,94	44,44
	Pécs	31,59	42,18	58,75	44,17
	Szolnok	43,09	41,89	46,06	43,68
	Debrecen	45,50	28,74	56,09	43,44
	Dunaújváros	52,34	36,91	39,27	42,84
	Miškolc	30,52	39,88	56,32	42,24
	Békéscsaba	44,64	29,36	48,00	40,67
	Baja	32,02	37,60	45,67	38,43
	Kaposvár	33,86	29,63	46,53	36,67
	Szekszárd	28,10	41,10	39,40	36,20
5	Salgótarján	26,11	38,08	40,18	34,79

Slika 1: Skupine sestavljenega indeksa trajnostnega razvoja (ilustracija: avtorja)

Fekete, 2018) pomembno prispevata k dinamiki in trenutnemu razvoju mesta. Zaradi odličnih zaposlitvenih možnosti ima visok neto dohodek na prebivalca (1,662.287 HUF) in nizko stopnjo dolgotrajne brezposelnosti (4,0 %). Prebivalci so zadovoljstvo s finančnimi razmerami v mestu ocenili s 5,9 (na lestvici od 0 do 10), kar je med najvišjimi ocenami za madžarska mesta. Srednješolsko in visokošolsko izobraževanje v mestu sta visoke kakovosti, pri čemer ima ključno vlogo Univerza Széchenyija Istvána, ki je tesno povezana s podjetji v mestu, hkrati pa je tudi nosilka tamkajšnjega intelektualnega življenja. V Gjuru je poleg tega veliko zgodovinskih zgradb, ki močno vplivajo na zadovoljstvo prebivalcev z bivalnim okoljem (7,8 na lestvici od 0 do 10), k lepi podobi mesta pa prispeva tudi čisto okolje (20,4 % vseh odpadkov je zbranih ločeno). Po neto dohodku na prebivalca (1,616.214 HUF) je takoj za njim Veszprém, ki ima malce višjo stopnjo dolgotrajne brezposelnosti (6,4 %). Po padcu komunizma je težka industrija v mestu močno nazadovala, dinamika in inovativnost mesta pa sta se povečali s prihodom kapitalsko intenzivnih multinacionalk (npr. Continental Automotive Hungary, Valeo Auto-electric Hungary, Balluff-Elektronika, Valeo Simens eAutomotive Hungary, Lasselsberger-Knauf Építőipari, Bramac Betoncserépgyártó és Építőanyag itd.). Univerza ima še vedno pomembno vlogo v znanstvenem življenju mesta (delež izdatkov za raziskave in razvoj v bruto domačem proizvodu županije znaša 3,44 %). Zaradi starega mestnega jedra je Veszprém privlačen za bivanje, kar kaže tudi stopnja zadovoljstva prebivalcev z bivalnim okoljem (5,9), ki pa zaostaja za Gjurom. Veszprém je v proračunskem obdobju 2014–2020 prejel tretji najvišji znesek sredstev na prebivalca (tj. 2.590 HUF) iz evropskega operativnega programa EDIOP (za prijave projektov v zvezi z obnovljivimi viri energije). Na podlagi vrednosti kazalnikov obeh mest ima Gjur majhno prednost z vidika služb in inovacij, Veszprém pa je močnejši z vidika privlačnosti za bivanje in trajnostnosti, razlika v vrednosti sestavljenega indeksa med njima pa je samo 0,58 točke, kar je zanemarljivo. Prostorska porazdelitev vseh skupin je prikazana na sliki 2.



Slika 2: Prostorska porazdelitev skupin sestavljenega indeksa trajnostnega razvoja (ilustracija: avtorja)

4.2.2 Druga skupina: razvijajoča se in dinamična mesta, privlačna za bivanje

Na podlagi vrednosti sestavljenega indeksa druge skupine mest se zdi, da je skupina zelo heterogena, ob podrobnejši analizi pa se izkaže, da imajo značilnosti šestih mest v tej skupini bolj homogeno notranjo zgradbo. Glavni delodajalec v mestu Esztergom Magyar Suzuki Corporation in skupina podjetij, ki so z njim tesno povezana, prispevata k visokim rezultatom tega mesta. Ta podjetja ustvarjajo nova delovna mesta, zaradi česar je stopnja brezposelnosti v mestu nizka, stopnja zaposlenosti mladih diplomantov pa visoka (88,2 %). Število podeljenih patentov v Esztergomu (16,58) je skoraj dvakrat večje od tistega v sedežih županij (9,4). Prebivalci zadovoljstvo z bivalnim okoljem v mestu ocenjujejo s 7,7 (na lestvici od 0 do 10, razlogov za tako visoko oceno pa je več, med njimi tudi Donava in njena slikovita okolica ter čist zrak. Esztergom je zaradi mostu čez Donavo in potniškega terminala na Donavi tudi intermodalno vozlišče severno od metropolitanske aglomeracije Budimpešte, mednarodni prometni koridor iz Nitre na Slovaškem pa še krepi njegov položaj mednarodnega prometnega središča (Gauder idr., 2011). Drugo mesto v skupini glede na vrednost sestavljenega indeksa zaseda Érd, ki ima visok neto dohodek na prebivalca (1,562.145 HUF), nizko stopnjo dolgotrajne brezposelnosti (4,4 %), ugodno stopnjo zaposlenosti mladih diplomantov (85,9 %) in veliko patentov na milijon prebivalcev (29,76). Visoke vrednosti kazalnikov dosega tudi zaradi bližine Budimpešte, statusa spalnega naselja in socialne sestave. V njegovem predmestju skoraj ni industrijskih obratov, zaradi česar je zrak zelo čist. Ravni trdih prašnih delcev povečujeta gost promet (na avtocesti M7 in hitri cesti 7) in prah, ki se dviga z neasfaltiranih cest. Stopnja zadovoljstva prebivalcev z bivalnim okoljem je 6,8. Vrednost indeksa 11. cilja trajnostnega razvoja za Érd znaša samo 45,57, delni razlog za to pa je, da mesto ni prejelo niti centa za razvoj energetike iz programa EDIOP. Na drugem mestu v tej skupini je Sopron, mesto na meji z Avstrijo, znano po kulturnih spomenikih in šolah. Ker ustvarja veliko delovnih mest, je stopnja dolgotrajne brezposelnosti v njem zelo nizka (2,9 %), stopnja zaposlenosti mladih diplomantov pa je med vsemi 25 proučenimi mesti najvišja (91,2 %). Da je mesto privlačno za bivanje, potrjuje zadovoljstvo njegovih prebivalcev z bivalnim okoljem (7,8 na lestvici od 0 do 10), k njegovi privlačnosti pa prispeva tudi čist zrak (nizke emisije CO_2 in NO_2 na prebivalca). Tudi Sombotel ima veliko kulturnih spomenikov, saj mu je mestne pravice podelil že rimski cesar Klavdij. Od devetdesetih let 20. stoletja mesto doživlja temeljito preobrazbo. Nekdaj je v njem prevladovala lahka industrija (več deset tisoč ljudi je delalo v tovarnah čevljev Savaria in Marc, tovarni oblačil Styl in drugih podobnih obratih), z odprtjem tovarne avtomobilov Opel pa se je v mestu začel tudi razvoj avtomobilske industrije. Danes je razvoj mesta tesno povezan z avtomobilsko industrijo v Gjuru in Kecskemétu, kar se kaže tudi v nadpovprečnem dohodku na prebivalca (1,492.260 HUF). S prihodom sodobne tehnologije je mesto povečalo tudi izdatke za raziskave in razvoj, hkrati pa se je močno povečalo število podeljenih patentov (tj. 10,73 na milijon prebivalcev). Privlačnost mesta potrjujeta pozitivni selitveni prirast (0,6) ter visoka stopnja zadovoljstva prebivalcev z bivalnim okoljem (7,7) in družinskim finančnim stanjem (5,8 na lestvici od 0 do 10). Mesto ima bogato zgodovino, zato je v njem veliko kulturnih znamenitosti in muzejev (26,4 znamenitosti in 14,5 muzeja na 100.000 prebivalcev). Sombotel je privlačno mesto za bivanje, z bogato kulturno dediščino, zaradi česar je priljubljena destinacija za domače in tuje turiste. V Tatabányi, nekdanjem značilnem socialističnem mestu, je do leta 1987, ko se je zaprl še zadnji rudnik, prevladovalo rudarstvo. Preobrazba mesta je bila vse prej kot lahka, delovno aktivni prebivalci v njem pa so zaradi tega zelo trpeli. Stopnja zaposlenosti je bila višja od 25 %, kar so delno poskušali rešiti z uvedbo proizvodnih storitev (Gauder idr., 2011). Trenutna stopnja dolgotrajne brezposelnosti znaša 8,2 %, koeficient starostne odvisnosti starih pa je 28,7 %, kar pomeni, da je prebivalstvo v mestu razmeroma mlado. Število patentov na milijon prebivalcev znaša 16,83, kar kaže, da mesto krepi svoje inovacijske zmogljivosti. Po zaprtju rudnikov, termoelektrarne in cementarne je Tatabánya postala privlačno in čisto mesto, pri čemer je stopnja zadovoljstva prebivalcev z bivalnim okoljem 7,4. Tako kot Érd tudi Tatabánya dosega srednjo vrednost indeksa 11. cilja trajnostnega razvoja, delež ločeno zbranih odpadkov v mestu pa znaša samo 0,9 %, zaradi česar je pri tem kazalniku na zadnjem mestu. Zadnje mesto v drugi skupini zaseda Székesfehérvár, nekdanje versko središče države in kraljeva rezidenca, danes pa hitro razvijajoče se industrijsko mesto. Zagotavlja veliko možnosti za zaposlitev, zato ima podpovprečno stopnjo dolgotrajne brezposelnosti (7,5 %) in visoko stopnjo zaposlenosti mladih diplomantov (87,6 %). Med vsemi proučenimi mesti ima najvišji neto dohodek na prebivalca (1,723.197 HUF). Székesfehérvár je poleg tega med mesti, ki pri vseh treh ciljih trajnostnega razvoja dosegajo približno enake rezultate, vrednost sestavljenega indeksa pa je približno enaka povprečju indeksov vseh treh ciljev (56,04). Njegovi prebivalci so zadovoljni s kakovostjo bivalnega okolja (7,7), k čemur pripomore tudi čisto okolje (20,6 % vseh odpadkov je zbranih ločeno). Mesto je prejelo tudi precejšnja sredstva za razvoj obnovljivih virov energije (tj. 690,9 HUF na prebivalca iz programa EDIOP).

4.2.3 Tretja skupina: privlačna mesta, ki pa se počasi razvijajo

Mesta, uvrščena v tretjo skupino, imajo povprečne rezultate indeksov za proučevane tri cilje trajnostnega razvoja. Razdelimo jih lahko v dve podskupini: mesta na Veliki madžarski nižini, ki se počasi razvijajo (nekdanje svobodno kraljevo mesto Szeged ter nekdanji podeželski mesti Hódmezővárhely in Kecskemét), in mesta, ki za njimi razvojno zaostajajo in imajo slabše inovacijske zmogljivosti, a so še vedno vitalna (zgodovinsko mesto Eger, znano zlasti po šolah, ter mesti Zalaegerszeg in Nagykanizsa, ki se čedalje bolj industrializirata). Szeged je slavno univerzitetno mesto (Univerza v Szegedu) in znanstveno središče, v katerem deluje več mednarodno priznanih raziskovalnih inštitutov. Na znanstvenem področju dosega zavidljive rezultate: raziskavam in razvoju namenja 2,34% vseh izdatkov, s čimer je pri tem kazalniku na drugem mestu (takoj za Veszprémom), poleg tega ima 20,91 podeljenih patentov na prebivalca. Vseeno ima z vidika doseganja treh proučenih ciljev trajnostnega razvoja samo povprečne rezultate (neto dohodek na prebivalca znaša 1,353.578 HUF, delež zaposlenosti mladih diplomantov je 85,1 % itd.). Poleg tega velik delež prebivalcev (31,2 %) prejema finančno pomoč občine, kar je delno posledica pandemije COVID-19, zaradi katere je veliko ljudi izgubilo službo in se znašlo v zahtevnih razmerah. Prebivalci so zadovoljni z življenjem v mestu (stopnja zadovoljstva znaša 7,6 na lestvici od 0 do 10), ki skrbi za pestro kulturno dogajanje (Egedy idr., 2018). Hódmezővásárhely, nekdanje bogato podeželsko mesto z dolgo zgodovino, je danes tesno povezano s Szegedom. V petdesetih letih 20. stoletja je bilo celo sedež županije, tega so pozneje preselili v Szeged. Število prebivalcev Hódmezővásárhelyja razmeroma hitro narašča, zaradi česar se krepi njegov storitveni sektor, v katerem je danes zaposlenih največ ljudi (več kot 60 % vseh prebivalcev). Tudi to mesto namenja velik delež izdatkov raziskavam in razvoju (2,34 % bruto domačega proizvoda), zaradi bližine Szegeda pa ima tudi veliko patentov na prebivalca (20,91). Njegovi prebivalci so zadovoljni z bivalnim okoljem, kar potrjuje tudi visoka ocena lestvici od 0 do 10 (7,5). Tretje večje mesto v tej skupini je Kecskemét, prav tako nekdanje podeželsko mesto, ki je v petdesetih letih 20. stoletja postalo upravno središče županije Bács-Kiskun. Danes je pomembno središče madžarske avtomobilske industrije, saj tam obratuje tovarna korporacije Mercedes-Benz, ki spodbuja okolju prijazno in energijsko učinkovito proizvodnjo. S prihodom te tovarne so se močno izboljšale razmere na trgu dela (Józsa idr., 2017), vendar je stopnja dolgotrajne brezposelnosti v mestu še vedno visoka (13,0 %). Po drugi strani je število prijavljenih patentov na prebivalca skoraj dvakrat večje kot v drugih mestih (16,82). Eger je staro trgovsko mesto, bogato s kulturnimi spomeniki (ima 118,7 znamenitosti na 100.000 prebivalcev, kar je največ med vsemi mesti), njegovi prebivalci pa so zadovoljni s kakovostjo bivalnega okolja (ocena 7,1 na lestvici od 0 do 10). Po drugi strani mesto dosega slabe rezultate pri 8. in 9. cilju trajnostnega razvoja (33,78 oziroma 47,36), predvsem zaradi visoke stopnje dolgotrajne brezposelnosti (16,5 %), najvišjega koeficienta starostne odvisnosti starih med vsemi mesti (37,2 %) in zelo majhnega deleža izdatkov za raziskave in razvoj (0,54 %) v primerjavi s povprečjem drugih mest (0,9 %). Na zadnjem mestu v skupini sta Zalaegerszeg in Nagykanizsa, ki se razvijata zelo počasi, kar je razvidno zlasti pri rezultatu doseganja 9. cilja trajnostnega razvoja (Zalaegerszeg: 42,94, Nagykanizsa: 35,82). Mesti namenjata enak delež izdatkov za raziskave in razvoj (0,33 %) in imata enako število patentov na milijon prebivalcev (1,87).

4.2.4 Četrta skupina: mesta s cikličnim razvojem in povprečnimi razmerami

Mesta v tej skupini so se razvijala zelo različno, kar je jasno razvidno tudi iz vrednosti njihovih sestavljenih indeksov. Vključujejo tudi tri regionalna središča, ki so v hierarhiji mest takoj za Budimpešto: Debrecen, Miškolc in Pécs (vsa z več kot 100.000 prebivalci). V Miškolcu, nekdanjem središču težke industrije, se je po zatonu metalurške industrije močno povečala stopnja dolgotrajne brezposelnosti (ki zdaj znaša 19,5 %), podobno velja tudi za Dunaújváros, še eno značilno industrijsko mesto, v katerem stopnja brezposelnosti znaša 18,4 %. Za obe mesti je značilno staranje prebivalstva (koeficient starostne odvisnosti starih v Dunaújvárosu je 36,9 %, v Miškovcu pa 33,1 %); več starega prebivalstva ima samo še Szekszárd, kjer koeficient starostne odvisnosti starih znaša 37,4 %. Debrecen in Pécs izstopata po tem, da njuno vplivno območje sega prek meja županij, pri čemer se vsak dan vanju v šolo ali na delo vozi od 130.000 do 202.000 ljudi. Na Madžarskem veljata za podeželski mesti, ki pa imata vse pomembnejše ustanove in storitve (univerze, bolnišnice, znanstvene inštitute, sodišča itd.). Debrecen in Dunaújváros imata med vsemi mesti največ emisij CO_2 na prebivalca (51,7 oziroma 35,1 t), kar je v Debrecenu posledica obratovanja farmacevtskih obratov, v Dunaújvárosu pa obratovanja železarne. Po drugi strani ima Dunaújváros med vsemi proučenimi mesti najnižje koncentracije trdih prašnih delcev, čeprav je zaradi svoje lokacije središče prometno intenzivnih industrijskih dejavnosti (Gauder idr., 2011). Z vidika privlačnosti za bivanje mesta v tej skupini v primerjavi z drugimi dosegajo povprečne ali podpovprečne vrednosti (tj. 7,3 ali manj). Najnižjo vrednost sestavljenega indeksa v skupini (36,2) ima Szekszárd, kar je zlasti posledica slabih prometnih povezav, ki vplivajo na njegov gospodarski položaj, medtem ko se na primer Szolnok, Nyíregyháza in Békéscsaba bolje razvijajo zaradi dobrih železniških povezav. Mesta v tej skupini dosegajo povprečne vrednosti sestavljenega indeksa ciljev trajnostnega razvoja.

4.2.5 Peta skupina: propadajoče mesto, neprivlačno za bivanje

Slabi rezultati Salgótarjána v primerjavi z drugimi mesti so posledica njegove industrijske preteklosti, kar potrjujejo tudi izsledki raziskave dinamike madžarskega urbanega omrežja, ki sta jo opravila Beluszky in Sikos Tomay (2020). Med 346 mesti, ki sta jih proučevala, je Salgótarján zasedel 300. mesto. V raziskavi, predstavljeni v tem članku, je pri 8. cilju trajnostnega razvoja med vsemi mesti dosegel najnižjo vrednost (26,11). Mesto ima visoko stopnjo dolgotrajne brezposelnosti (več kot 33,0 %), pri čemer je brezposelna skoraj tretjina njegovih delovno aktivnih prebivalcev. Tudi njegov neto dohodek na prebivalca je najnižji med vsemi proučevanimi mesti (1,190.865 HUF). Nekdaj je bilo to pomembno industrijsko središče, danes pa ne najde prave strategije, da bi si gospodarsko opomoglo (Gauder idr., 2011). Njegove inovacijske zmogljivosti so majhne, saj ima samo 0,83 patenta na milijon prebivalcev, kar je zelo malo v primerjavi s povprečjem vseh proučevanih mest (tj. 9,4). Majhne emisije CO_2 v mestu so povezane tudi z upadom industrije, posledica česar sta po drugi strani tudi odseljevanje in posledično negativen selitveni prirast (−11,0 %), ta pa znižuje cene nepremičnin (198.994 HUF/m^2). Salgótarján ima med vsemi proučevanimi mesti najnižjo vrednost sestavljenega indeksa, kar ni čudno glede na rezultate pri posameznih kazalnikih. Nekdaj je bil paradni konj med socialističnimi mesti, danes pa v njem ni več industrije, poleg tega izgublja funkcionalnost (ljudje se na delo in v šolo vozijo v Budimpešto), zato močno zaostaja za drugimi madžarskimi mesti z županijskimi pravicami.

5 Razprava

Zaradi vplivov najrazličnejših socialnih, gospodarskih ali okoljskih pretresov (npr. pandemij, vojn in podnebnih sprememb) se čedalje bolj veča pomen trajnostnih in pametnih mest, kar je razvidno tudi iz čedalje več prispevkov o tej temi v literaturi. Avtorja sta v raziskavi, prestavljeni v tem članku, na podlagi ciljev trajnostnega razvoja in kazalnikov, ki jih je opredelil OZN, proučevala gospodarsko in okoljsko trajnostnost madžarskih mest z županijskimi pravicami, pri čemer sta se osredotočila na tri glavne cilje.

Metodologija, ki sta jo razvila, je primerna za analizo 8., 9. in 11. cilja trajnostnega razvoja. Proučevana mesta sta razdelila v pet homogenih skupin. Na podlagi vrednosti sestavljenih indeksov sta najbolj dinamični in vitalni madžarski mesti Gjur in Veszprém, tema sledita Esztergom in Érd. To pomeni, da so dinamična mesta na zahodu in severozahodu države hkrati tudi zelo trajnostna. Povsem na repu je Salgótarján, ki ima najslabše rezultate pri večini kazalnikov.

Opravljena pilotna raziskava madžarskega urbanega omrežja je pokazala, da so uporabljeni kazalniki primerni tudi za proučevanje drugih območij, raziskava pa se lahko tudi večkrat ponovi, na podlagi česar se lahko analizirajo trendi razvoja. Kazalniki in model, uporabljeni v tej raziskavi, se lahko zato uporabijo tudi pri proučevanju trajnostnosti v drugih državah, analiza pa se lahko razširi tudi na nižje mestne ali občinske ravni. Nekateri kazalniki so primerni za večino držav, nekateri pa se lahko na podlagi priporočil OZN in metodologije izračuna indeksa ciljev trajnostnega razvoja nadomestijo z drugimi, ki so za posamezno državo primernejši.

Predstavljena metoda in sestavljeni indeks trajnostnega razvoja imata seveda tudi nekatere omejitve in pomanjkljivosti, ki jih je treba upoštevati pri izračunih za druga območja ali obdobja. Največja omejitev so pomanjkljivi podatki, saj so nekateri na voljo samo za zadevna obdobja, ob tem se lahko vsebina kazalnikov sčasoma spremeni. Poleg tega so bili v analizo vključeni samo trije cilji trajnostnega razvoja, zato bi lahko v prihodnje pri analizah upoštevali tudi preostale cilje, ki jih je opredelil OZN.

6 Sklep

Rezultati raziskave so delno potrdili hipotezo avtorjev, da gospodarsko razvitejša mesta z višjimi dohodki (večinoma na zahodu in v osrednjem delu Madžarske) izstopajo tudi z vidika trajnostnega razvoja, pri čemer ni nujno, da so med njimi tudi največja mesta po številu prebivalcev. Od desetih največjih madžarskih mest po številu prebivalcev je samo eno, Gjur, med najbolj trajnostnimi (na vrhu lestvice), večina drugih mest pa je bila uvrščena v četrto skupino, za katero so bili značilni povprečni rezultati. Med mesti z manj kot 100.000 prebivalci sta bila samo Székesfehérvár in Sombotel med desetimi najbolj trajnostnimi madžarskimi mesti (uvrščena v drugo skupino). Posplošljivost hipoteze je nekoliko omejena, ker je bila Budimpešta izključena iz analize, čeprav ima sprejeto dolgoročno strategijo trajnostnega razvoja (do leta 2030), ki jo tudi izvaja. Če bi jo vključili, bi bila najverjetneje po trajnostnosti, številu prebivalcev in gospodarskem razvoju na prvem mestu.

Rezultati analize se delno ujemajo z rezultati primerjave držav, ki jo je opravil OZN in je pokazala, da so države srednje in vzhodne Evrope še daleč od tega, da bi dosegale vse cilje trajnostnega razvoja (Lafortune idr., 2022). Madžarska jih dosega 69,9-odstotno in je med članicami EU in EFTE na 23. mestu. Vseeno so iz analize treh izbranih ciljev razvidne pozitivne spremembe. Rezultati se ujemajo tudi z analizo evropskih mest, ki so jo opravili Lafortune in sodelavci (2019) ter je pokazala, da srednje- in vzhodnoevropska mesta po uspešnosti doseganja trajnostnih ciljev zasedajo mesta od osem (München) do 41 (Bukarešta) (Madžarska je na 37. mestu). Na splošno sta povsod, razen v nemških mestih, glavna izziva dostopnost in kakovost ključnih javnih storitev in infrastrukture.

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Zahvala

Raziskavo je financiral raziskovalni inštitut Eötvösa Józsefa madžarske nacionalne univerze za javno upravo.

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doi:10.5379/urbani-izziv-2023-34-02-04

Prejeto: 5. 5. 2023
Sprejeto: 25. 9. 2023

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Trajnostni promet v Prištini: kvalitativna raziskava izzivov in priložnosti, povezanih z izboljšavami urbane mobilnosti

Avtorja sta proučevala neučinkovitost, mogoče izboljšave, izzive in vplive trajnostnih prometnih rešitev v Prištini, da bi na podlagi izsledkov oblikovala strategije za razvoj tovrstnih rešitev v majhnih hitro urbanizirajočih se mestih in prispevala k znanju na področju trajnostnega prometa v majhnih državah v razvoju. Pri raziskavi trajnostnega prometa v Prištini sta uporabila kvalitativni pristop in polstrukturirane intervjuje z dvanajstimi anketiranci, njihove odgovore pa sta proučila s tematsko in prečno analizo. Izsledki raziskave so pokazali, da je prištinski prometni sistem zelo neučinkovit, kar je posledica zastarele infrastrukture in različnih pogledov deležnikov. S tematsko in prečno analizo sta avtorja opozorila na večplastne izzive pri uvedbi trajnostnega prometa v mestu. Njuna raziskava dopolnjuje literaturo s tega področja, saj daje vpogled v prometni sistem v Prištini in ponuja uporabne napotke za prometne načrtovalce. Z vidika družbe pa izsledki poudarjajo nujnost celostnega pristopa, ki bi združeval infrastrukturne izboljšave in spremembe v navadah ljudi ter tako omogočal vzpostavitev trajnostnega urbanega okolja v Prištini.

Ključne besede: načrtovanje trajnostne urbane mobilnosti, javni prevoz, infrastrukturne izboljšave, država v razvoju

1 Uvod

Družba dobro deluje, če ima dobro urejen prometni sistem. Prometni sektor poleg tega obsega pomemben delež BDP – 5 % v Evropi (Evropska komisija, 2022) oziroma 10 % v ZDA (Bureau of Transportation Statistics, 2021) – in zagotavlja ogromno priložnosti za zaposlitev. Po drugi strani promet ustvari kar 27 % vseh emisij toplogrednih plinov v Evropi (Evropska agencija za okolje, 2021), s čimer negativno vpliva na okolje, zlasti v mestih (Saidi in Hammami, 2017; Shafique idr., 2021). Vlade zato vlagajo sredstva v zmanjševanje emisij in negativnih posledic prometa za okolje (Eckelman idr., 2020).

Prometni sektor ima že od industrijske revolucije pomembno vlogo v svetovnem gospodarstvu. V njem je zaposlenih več kot 11 milijonov ljudi, poleg tega omogoča mednarodno trgovino (Maparu in Mazumder, 2017). Razvoj in čedalje večja uporaba napredne prometne infrastrukture pa povzročata precejšnjo okoljsko škodo. Promet ustvarja več kot 20,8 % emisij toplogrednih plinov v EU in je med povzročitelji emisij na drugem mestu (Andrés in Padilla, 2018). Poleg tega imajo lahko onesnaževala, ki jih v zrak izpuščajo motorji na notranje zgorevanje, ki jih poganjajo fosilna goriva, resne posledice za zdravje, saj lahko povzročajo srčna obolenja, astmo in raka. Glavni onesnaževalec je cestni promet, ta ustvarja 72,9 % vseh emisij v prometnem sektorju, letalski in ladijski promet pa jih ustvarita 13,3 % oziroma 12,8 % (Pallonetto, 2023).

Leta 2019 je mestna občina Priština v sodelovanju s svetovalnima podjetjema Grant Thornton in Mott MacDonald izdelala celostno prometno strategijo, pri kateri je upoštevala mnenja in povratne informacije, zbrane na javnih posvetovanjih. Strategija vsebuje sedem ključnih ciljev, ki se navezujejo na raznovrstne vidike trajnostnega prometa v Prištini, in izraža napreden pristop k izboljšanju prometnega sistema v mestu, ki se sklada s širšimi globalnimi prizadevanji za uvedbo trajnostne urbane mobilnosti.

Pandemija covida-19 je prizadela tudi prometni sektor in povzročila temeljite spremembe v potovalnih navadah ljudi. Uporaba javnega prevoza je močno upadla, ljudje pa so začeli več kolesariti in hoditi peš (Eisenmann idr., 2021). Avtomobili ostajajo najpogostejše prevozno sredstvo, zaradi česar bo zrak čedalje bolj onesnažen, trajnostnost prometnega sektorja pa bo čedalje manjša. Pandemija je kljub vsemu nakazala možnosti uporabe drugačnih pristopov, ki lahko zmanjšajo potrebe po prevozu. Ukrepi, kot sta fleksibilni delovni čas in hibridno delo, so se izkazali za uspešne, hkrati pa so zmanjšali pogostost potovanja na delo. Tudi tehnološko napredne rešitve, kot so električna in samovozeča vozila, lahko ublažijo škodljive vplive na okolje, vendar je treba za njihovo uspešno uporabo premostiti nekatere izzive, kot so omejitve z vidika dosega in varnosti, družbene in gospodarske ovire ter nerešena etična vprašanja (Staat, 2018; Generalni direktorat za komuniciranje, 2020; Figliozzi, 2020; Kopplin idr., 2021). Ključno je proučiti vplive tovrstnih inovacij in poiskati alternativne rešitve (Pallonetto, 2023).

Nadgradljivost naprednih mobilnostnih rešitev je velik globalni izziv, zlasti za države v razvoju, ki imajo slabše organizirane in usposobljene vladne organe in neustrezno infrastrukturo. Uvedba politik, ki bi omejile mobilnost prebivalcev, je ena izmed možnih rešitev in je bila že preizkušena med pandemijo, vendar ni združljiva s konceptom demokracije in svobode gibanja. Da so navedena vprašanja pomembna, je razvidno tudi iz raziskovalnega poročila, ki ga je lani objavila Evropska komisija (Bertoni idr., 2022). V njem so avtorji izpostavili vprašanja, ki bi jih oblikovalci politik morali obravnavati, da bi zagotovili trajnostna promet in mobilnost v prihodnosti.

1.1 Pregled literature

Za današnje prometne sisteme po svetu je značilen pomanjkljiv in neučinkovit javni prevoz (Novikov idr., 2022; Ali in Abdullah, 2023). Slabo razvit in neučinkovit prometni sistem močno ovira mobilnost ljudi (Żukowska idr., 2023), zlasti po pandemiji covida-19 pa se je pojavila potreba po reorganizaciji in preureditvi sistemov javnega prevoza po svetu (Giuffrida idr., 2021; Annunziata idr., 2022: Borchers in Figueirôa-Ferreira, 2022). Postkovidno obdobje je razkrilo šibkosti trenutnih prometnih sistemov, zaradi katerih so nujno potrebne izboljšave.

Kot druga mesta v jugovzhodni Evropi se tudi Priština spopada z izzivi, kot so nezadostne naložbe v javni prevoz, pomanjkanje ustreznega prometnega načrtovanja, prometni zamaški in pomanjkanje parkirišč (Mladenović, 2022). Podobno je v Podgorici, kjer tudi ni dovolj sredstev za naložbe, poleg tega ni politične podpore za uvedbo izboljšav in dovolj parkirišč (Vujadinović idr., 2021). Vodilno mesto v razvoju trajnostnega prometa v jugovzhodni Evropi zaseda Ljubljana, ki je znana po zavezanosti trajnostnemu razvoju in zelenim pobudam, prejela pa je tudi naziv zelene prestolnice Evrope, ki ga podeljuje Evropska komisija (Evropska agencija za okolje, 2017). Tudi Zagreb veliko vlaga v razvoj trajnostnega prometa, zlasti v električne tramvaje in avtobuse, načrtuje pa tudi uvedbo mestnih avtobusov na vodik (Iotkowska, 2021). V Atenah vlagajo v električne avtobuse ter ureditev kolesarskih stez, con za pešce in območij, prepovedanih za motorni promet (Kyriakidis idr., 2023). Na področju trajnostnega prometa se pričakuje, da se bo z razvojem čedalje večja podpora namenjala uvedbi električnih vozil ter da bodo v ospredju izvajanje projektov, povezanih s trajnostnim urbanim prometom, napredki v razvoju samovozečih vozil in alternativnih goriv, souporaba vozil, poudarjanje enakega dostopa do prometnih storitev in uvajanje trajnostnih oblik službenih potovanj (Caputo idr., 2023; Salo, 2023). Tudi Priština lahko doseže napredek v razvoju trajnostnega prometa, in sicer z izboljšanjem infrastrukture javnega prevoza, omogočanjem raznovrstnih oblik mobilnosti s poudarkom na kolesarjenju in pešačenju, uporabo inovativnih tehnologij za učinkovito upravljanje prometa in spodbujanjem trajnostnega življenjskega sloga med prebivalci s kampanjami ozaveščanja in političnimi pobudami.

Razvoj trajnostnega prometa se lahko okrepi samo z raziskavami, inovacijami in naložbami v sodobne prometne sisteme (Antunes idr., 2023). Za uvedbo trajnostne mobilnosti so poleg tega ključne izboljšave sistema javnega prevoza in digitalnih prometnih storitev (Hezam idr., 2023). V tem pogledu so nujne naložbe v kakovostne prevozne storitve in infrastrukturo, ki omogoča kolesarjenje in pešačenje (Szakonyi in Makó, 2023). Doseganje trajnostnosti v prometu je večplasten izziv, za njegovo reševanje pa so potrebni tehnološki napredki in spremembe politike.

Za trajnostna mesta je ključna uvedba trajnostnih oblik mobilnosti, kot so hibridna vozila, souporaba vozil, uporaba navadnih in električnih koles ter električnih skirojev (Pallonetto, 2023). Hibridna vozila porabijo manj energije (Habib idr., 2018), s souporabo vozil pa se občutno zmanjšajo emisije CO_2 (Nijland in van Meerkerk, 2017). Tudi mikromobilna prevozna sredstva v primerjavi s klasičnimi zmanjšajo emisije CO_2, in sicer za kar 40–70 % (Abduljabbar idr., 2021). K trajnostnemu prometu prispevajo strateško načrtovanje, kolesarjenje, posodobitev javnega prevoza in spremembe potovalnih navad. Za njegovo krepitev so potrebne izboljšave v javnem potniškem prometu, ob tem je treba vključiti različne načine prevoza, poudarjati trajnostnost in spodbujati trajnostne potovalne navade (Abu-Rayash in Dincer, 2021; Bi idr., 2023; Yaliniz idr., 2023). Raznovrstne oblike mobilnosti zmanjšujejo vpliv na okolje, hkrati pa uporabnikom omogočajo večjo prilagodljivost in praktičnost.

Zaradi infrastrukturnih in upravljavskih izzivov sta upravljanje okolja in ravnanje z okoljem v državah v razvoju pogosto neučinkovita, to pa močno otežuje tudi razvoj trajnostnega prometa. Zaradi neustrezne infrastrukture je več prometnih nesreč in umrlih, kar kaže na potrebo po boljšem prometnem načrtovanju in upravljanju infrastrukture (Pallonetto, 2023). Pomanjkanje potrebne prometne infrastrukture in načrtovanja poleg tega povzroča prometne zamaške in otežuje oblikovanje infrastrukture, ki bi lahko zadovoljila današnje potrebe (Kyriacou idr., 2019). Pri uvedbi trajnostnih prometnih sistemov je pomanjkanje finančnih sredstev lahko pomembna ovira. Poleg tega je upravljanje in vzdrževanje teh sistemov lahko dražje kot pri klasičnih sistemih, kar lahko vladam povzroča težave pri spodbujanju naložb v trajnostni promet (Sperling in Gordon, 2009; Mattioli idr., 2020). Finančne omejitve in upravljavski izzivi lahko zato močno ovirajo uvedbo trajnostnih prometnih rešitev. V prometnih načrtih številnih mest je kolesarjenje potisnjeno na stran, odsotnost ustrezne infrastrukture, nezadostna sredstva in slabo vodenje pa ovirajo sprejetje politik, naklonjenih kolesarjenju (Wang, 2018). Poleg tega lahko uvedba novih prevoznih sredstev, kot so električni skuterji, ogroža varnost drugih udeležencev v prometu, kar kaže na nujnost ustreznih upravljavskih praks in primerne infrastrukture (O'Keeffe, 2019; Gössling, 2020). Med glavnimi izzivi, s katerimi se spopadajo mesta, ki želijo uvesti trajnostne prometne sisteme, so torej pomanjkanje ustrezne infrastrukture, finančne omejitve, upravljavske in organizacijske ovire ter potovalne navade ljudi (Anagnostopoulou idr., 2020; Bouraima idr., 2023; Feldman, 2023). Raznovrstne težave, s katerimi se spopadajo države v razvoju, je mogoče premagati s pravilnimi strategijami, naložbami in mednarodnim sodelovanjem. Zaradi okoljskih in družbenih koristi bi moral biti trajnostni promet v prihodnosti med glavnimi prednostnimi nalogami.

Trajnostne oblike mobilnosti, kot je uporaba električnih in hibridnih vozil, občutno manj onesnažujejo okolje (Nijland in van Meerkerk, 2017). Aktivne oblike mobilnosti izboljšujejo zdravje mestnih prebivalcev (Saidla, 2018), zaradi uporabe trajnostnih prevoznih sredstev pa se izboljša tudi kakovost življenja na splošno (Steg in Gifford, 2005, 2007; Wey in Huang, 2018). Manj prometa, manjša onesnaženost, spodbujanje uporabe javnih prevoznih sredstev in aktivnih oblik mobilnosti ter boljše počutje mestnih prebivalcev so ključne koristi trajnostnega prometa (Elliott, 2023; Mohapatra idr., 2023; Molner idr., 2023). Trajnostni promet ima torej manjši vpliv na okolje, hkrati pa izboljša počutje mestnih prebivalcev.

1.2 Raziskovalna vprašanja

Iz pregledane literature je razvidno, da raziskovalci trajnostnim oblikam mobilnosti v majhnih državah v razvoju ne namenjajo veliko pozornosti. Zaradi majhnosti in hitre urbanizacije sta trgovina in mobilnost prebivalcev na Kosovu močno odvisni od cestnega prometa, ki pa hkrati povzroča težave, kot so onesnažen zrak in prometni zastoji (Malka idr., 2021). Glavno mesto Priština se na področju prometa spopada s precejšnjimi izzivi, na primer z omejenim javnim prevozom, omejeno infrastrukturo za pešce in kolesarje ter visoko stopnjo onesnaženosti zraka (Humolli idr., 2020). Na podlagi proučevanja prometnega sistema v Prištini se lahko oblikujejo strategije za izboljšanje mobilnosti, zmanjšanje emisij toplogrednih plinov in krepitev javnega zdravja v majhnih, hitro urbanizirajočih se mestih. V literaturi o trajnostnem prometu Kosovo ni bilo deležno velike pozornosti, zato je njegovo proučevanje še toliko pomembnejše. Poznavanje izzivov, s katerimi se spopada

Priština, je pomembno za razumevanje trajnostnega prometa v drugih majhnih državah v razvoju.
Na podlagi obsežnega pregleda literature sta avtorja oblikovala naslednja raziskovalna vprašanja in hipoteze:

Raziskovalno vprašanje 1 (RV1): Kateri vidiki prometa v Prištini trenutno veljajo za neučinkovite in netrajnostne?

Hipoteza 1 (H1): Neučinkovit prometni sistem v Prištini je posledica predvsem slabe pokritosti omrežja javnega prevoza, neučinkovitih avtobusnih voznih redov in slabo razvitih taksi storitev.

RV2: Katere izboljšave infrastrukture javnega prevoza v Prištini so ključne za zagotavljanje trajnostnega mestnega prometa?

H2: Za zagotavljanje trajnostnega mestnega prometa so odločilne izboljšave, kot so dodatne linije javnega potniškega prometa, sodobni avtobusi in boljše ceste.

RV3: Kaj so glavne ovire za uvedbo trajnostnega prometa v Prištini?

H3: Glavne ovire za uvedbo trajnostnega prometa v Prištini so neustrezna infrastruktura, finančne omejitve, spreminjanje miselnosti ljudi ter izzivi, povezani z realizacijo in upravljanjem sistema trajnostnega prometa.

RV4: Kako trajnostne oblike mobilnosti v Prištini vplivajo na mobilnost in kakovost življenja prebivalcev?

H4: Trajnostne oblike mobilnosti v Prištini lahko zmanjšajo prometne zamaške in onesnaženost ter izboljšajo mobilnost, kar posledično izboljša tudi kakovost življenja.

2 Raziskovalne metode

Avtorja sta izvedla kvalitativno raziskavo, v kateri sta opravila polstrukturirane intervjuje z dvanajstimi posamezniki. Intervjuje, ki so potekali v živo in trajali 30 minut, sta tudi posnela. Ker na Kosovu ni neodvisnega organa za etična vprašanja, je etično ustreznost raziskave proučila komisija za raziskovalno etiko na ESLG Collegeu, ki je avtorjema podelila dovoljenje za izvedbo raziskave št. 2124/2023.

Vprašanja v intervjujih so se osredotočala na trajnostni promet v Prištini. Prvo vprašanje se je nanašalo na neučinkovitost sistema javnega prevoza, drugo pa na ključne izboljšave, potrebne za zagotavljanje trajnostne mobilnosti. Pri tretjem vprašanju sta avtorja poizvedovala o glavnih izzivih, ki ovirajo uvedbo trajnostnega prometa, pri zadnjem, četrtem pa o vplivu trajnostnih oblik mobilnosti na mobilnost in kakovost življenja prebivalcev. Da bi avtorja navedene teme še podrobneje proučila, sta uporabila metodo veriženja s podvprašanji, v katerih sta intervjuvance spraševala o koristih in slabostih posameznih trajnostnih oblik mobilnosti, njihovih osebnih vrednotah in prepričanjih, povezanih s trajnostno mobilnostjo, in preferencah glede oblik mobilnosti. Metodo veriženja sta predlagala Reynolds in Gutman (1984), in sicer kot način preprečevanja raziskovalčeve pristranskosti v kvalitativnih raziskavah (Gutman, 1982).

Za anonimnost intervjuvancev sta avtorja poskrbela tako, da sta njihova imena kodirala. Izbrala sta jih s homogenim namenskim vzorčenjem, ki je ena izmed metod neverjetnostnega vzorčenja, uporabna zlasti, kadar želi raziskovalec izbrati vzorec posameznikov s skupnimi ali podobnimi lastnostmi (Saunders idr., 2012). Avtorja sta k sodelovanju v intervjujih povabila dvajset posameznikov s Kosova, ki so imeli ustrezna strokovna znanja s področja prometnega inženiringa, povabilo pa jih je sprejelo samo dvanajst.

Vzorec je bil dovolj velik, da je zagotovil nasičenost podatkov, ki se po navadi doseže pri šestem intervjuju, ko je pridobljenih že približnost 91 % vseh ključnih podatkov (Hennink idr., 2017). Sestava anketirancev je predstavljena v preglednici 1.

Avtorja sta polstrukturirane intervjuje posnela, nato pa sta vse posnetke dobesedno prepisala, s čimer sta pridobila besedilne podatke za analizo. Prepis vsakega intervjuja je bil dolg približno šest strani. Nato sta s tematsko analizo določila glavne zamisli anketirancev, pri čemer sta se osredotočila na besedne zveze, ki so jih uporabljali. Gradivo sta pregledala trikrat, na podlagi česar sta v skladu s priporočili avtoric Clarke in Braun (2017) določila glavne teme, jih kodirala in razdelila na tiste, ki se ponavljajo, in tiste, ki se pojavijo samo posamično. S programsko opremo NVivo sta teme sistematično kodirala in v 27 strani dolgem prepisu intervjujev določila skupne vzorce v razmišljanju anketirancev. Poleg tega sta s prečno analizo primerjala mnenja anketirancev. Tovrstna analiza omogoča določanje skupnih značilnosti, razlik in glavnih tem ter s tem boljše razumevanje podatkov. Avtorja sta z opisano metodo lahko odkrila morebitne nasprotujoče si odgovore in pridobila celovitejši pregled nad mnenji anketirancev. Podatke sta zbrala, razdrobila in ponovno združila z uporabo Yinove metodologije (Yin, 2011). Pri ponovnem sestavljanju podatkov sta dala prednost tematski ustreznosti pred pogostostjo, kot priporočata tudi avtorici Castleberry in Nolen (2018). Tako sta določila najpomembnejše teme, čeprav se niso pojavljale pogosto, s čimer sta lahko učinkovito obravnavala zastavljena raziskovalna vprašanja.

Preglednica 1: Sestava anketirancev

Šifra	Poklic	Izobrazba	Sektor	Starost	Spol
01	Prometni inženir	Doktorat	Zasebni	40–50	M
02	Arhitekt	Doktorat	Zasebni	30–40	M
03	Geograf	Doktorat	Zasebni	40–50	M
04	Urbanist	Diploma	Zasebni	20–30	Ž
05	Urbanist	Magisterij	Zasebni	20–30	M
06	Geograf	Doktorat	Zasebni	40–50	M
07	Prometni inženir	Doktorat	Zasebni	30–40	M
08	Inženir gradbeništva	Doktorat	Zasebni	30–40	M
09	Urbanistični in prometni načrtovalec	Doktorat	Zasebni	40–50	Ž
10	Vodja direkcije za javne službe, Občina Priština	Magisterij	Javni	50–60	M
11	Svetovalec za promet, Občina Priština	Diploma	Javni	40–50	M
12	Višji svetovalec za prometno signalizacijo, Občina Priština	Magisterij	Javni	30–40	M

3 Rezultati

3.1 Neučinkovitost prometa v Prištini in potreba po temeljitih spremembah

Tematska analiza odgovorov na vprašanja v intervjujih je pokazala, da promet v Prištini ni učinkovit in trajnosten, ključnih razlogov za to pa je več. Avtobusni prevozniki, večinoma zasebniki, imajo nezanesljive vozne rede. Avtobusi so zastareli, neučinkoviti in ne izpolnjujejo zahtevanih standardov za potniški promet. Poleg tega sta zaradi pomanjkanja ustrezne infrastrukture tudi kolesarjenje in pešačenje manj privlačna in varna. Izsledki tematske analize so potrdili hipotezo, da je neučinkovitost prometa v Prištini posledica slabe pokritosti omrežja javnega prevoza, neučinkovitih avtobusnih voznih redov, zastarelih avtobusov ter pomanjkanja infrastrukture za kolesarje in pešce. Da bi se zagotovil bolj trajnostni prometni sistem, so ključne izboljšave na omenjenih področjih.

Pri prečni analizi pa so se pri odgovorih pojavila nekatera nasprotja. Čeprav večina anketirancev ni bila zadovoljna s trenutno infrastrukturo in je predlagala, da bi bilo treba javni prevoz in kolesarsko infrastrukturo izboljšati, je manjšina poudarila sistemske težave, zaradi katerih so potrebni temeljite spremembe in ustrezni ukrepi. Nekateri se bojijo, da bi ti ukrepi nehote spodbudili še večjo uporabo avtomobilov, zato so predlagali rešitve, kot so kazni za povzročanje prometnih zastojev ali omejitve motornega prometa v središču mesta. Navedena raznovrstna mnenja potrjujejo zapletenost obravnavane problematike in poudarjajo potrebo po strokovnih razpravah, v katerih bi se predlagane rešitve ovrednotile in razvrstile po pomembnosti.

Obe analizi sta potrdili, da promet v Prištini ni učinkovit, in razkrili veliko potrebo po obsežnih naložbah, posodobitvi javnega prevoza, izboljšanju infrastrukture za kolesarje in uporabi uravnoteženega pristopa, ki bi zadostil raznovrstnim potrebam prebivalcev.

3.2 Ključne izboljšave za zagotavljanje trajnostnega prometa v Prištini

Izsledki analize potrjujejo hipotezo 2 in poudarjajo pomen izboljšanja prometne infrastrukture za zagotavljanje trajnostnega prometa v Prištini. Med glavnimi temami, izpostavljenimi v intervjujih, so izboljšave javnega prevoza, prenova infrastrukture, omogočanje bolj raznovrstnih oblik mobilnosti, spreminjanje miselnosti ljudi, konkretni ukrepi in celovit pristop k uvedbi alternativnih prometnih rešitev. Anketiranci so predlagali ukrepe, kot so umik starih avtobusov iz uporabe, spodbujanje kolesarjenja, vzpostavitev novih linij javnega prevoza, izboljšanje cestne infrastrukture in uvedba sistema enotnih vozovnic. Izpostavili so tudi potrebo po spremembi miselnosti in politike ter uporabi tehnologije za sledenje javnim prevozom in njihovo upravljanje.

Prečna analiza je razkrila različna mnenja o tem, kako bi bilo treba izboljšati prometni sistem v Prištini. Večina anketirancev se je strinjala, da bi bilo treba izboljšati sistem javnega prevoza, zlasti s posodobitvijo voznih parkov, poenostavitvijo vozovnic in boljšim načrtovanjem linij ter z boljšo infrastrukturo za kolesarje in pešce. Manjša skupina anketirancev je predlagala ureditev parkirišč na mestnem obrobju in uvedbo sistema enotnih vozovnic, kar bi vzpostavilo ravnovesje med zasebnim in javnim prevozom, drugi pa so svarili pred prevelikim zanašanjem na javni prevoz in kolesarjenje, saj bi to lahko postavilo v slabši položaj posameznike, ki so odvisni od prevoza z avtomobilom.

Z obema analizama se je potrdila potreba po izboljšanju prometne infrastrukture v Prištini in se je izpostavilo, kako pomemben je celosten pristop k omogočanju trajnostnega prometnega sistema v Prištini, ki bi vključeval spremembe tako v infrastrukturi kot navadah ljudi.

3.3 Glavne ovire za uvedbo trajnostnega prometa v Prištini

Tematska analiza odgovorov intervjuvancev je razkrila več izzivov, ki ovirajo uvedbo trajnostnega prometa, med drugim nezadostna sredstva, odpor uporabnikov in dejstvo, da zasebni prevozniki ne izpolnjujejo zahtevanih meril. Drugi izzivi vključujejo posodobitev avtobusnega voznega parka, določitev novih linij, poenostavitev upravnih postopkov ter izdelava in izvajanje načrta mobilnosti. Izpostavljeni sta bili tudi potrebi, da se ljudi spodbudi, da začnejo uporabljati tudi druge oblike mobilnosti, ne samo avtomobile, in da se sprejme boljša upravna ureditev mobilnosti v mestu. Trajnostno mobilnost ovirajo tudi prostorske omejitve, slabe povezave javnih prevozov in drage vozovnice. Analiza je tako potrdila hipotezo 3.

V prečni analizi so se pokazali različni pogledi na ovire pri uvedbi trajnostnega prometa v Prištini. Nekateri anketiranci so izpostavili nezadostna finančna sredstva, zastarelo infrastrukturo in potrebo po boljših avtobusih, drugi pa so se osredotočili na vedenjske in organizacijske vidike, kot so odpor ljudi do sprememb, nujnost upravne reforme in težave pri izvajanju raziskav na področju mobilnosti. Razlike v pogledih potrjujejo zahtevnost uvedbe trajnostnega prometa in kažejo, da je treba navedene raznovrstne izzive reševati celostno.

Z obema analizama se je razkrilo, da je uvedba trajnostnega prometa v Prištini zahtevna naloga, ob tem se je pokazalo, kako pomemben je celostni pristop k zagotavljanju trajnostnega prometnega sistema v Prištini, ki bi vključeval tako infrastrukturne izboljšave kot spremembe v navadah ljudi.

3.4 Vplivi trajnostnih oblik mobilnosti v Prištini na mobilnost in kakovost življenja prebivalcev

Tematska analiza je potrdila hipotezo 4 in razkrila, da imajo trajnostne oblike mobilnosti v Prištini pozitivne učinke. Med možnimi pozitivnimi vplivi so anketiranci izpostavili bolj tekoč in manj gost promet, manjšo onesnaženost in izboljšano infrastrukturo za kolesarje. Poleg tega so menili, da bi uvedba trajnostnih oblik mobilnosti lahko izboljšala mobilnost, zmanjšala prometne zamaške, spodbudila povezovanje mesta in podeželja ter izboljšala kakovost življenja prebivalcev.

S prečno analizo se je pokazalo precejšnje ujemanje v mnenjih anketirancev o pozitivnih vplivih trajnostnega prometa v Prištini, med katerimi so izpostavili manj gost promet, manjše onesnaženje, večjo učinkovitost prevoza in boljšo kakovost življenja. Pri tem so nekateri dali večji poudarek razvoju infrastrukture, kot so kolesarske poti in površine za pešce, drugi pa so poudarili potrebo po spremembi miselnosti glede javnega prevoza in po učinkovitem upravljanju prometa. Navedene razlike razkrivajo večplastnost obravnavane problematike in pomen celostnega pristopa k uvedbi trajnostnega prometa v Prištini.

Z obema analizama se je potrdilo, da imajo lahko trajnostne oblike mobilnosti pozitiven vpliv na mesto. Med anketiranci je prevladovalo mnenje, da so za to, da bi uvedba trajnostnega prometa v mestu vsem prinesla kar največje koristi, potrebna skupna prizadevanja, ki morajo vključevati izboljšave v infrastrukturi, kampanje za ozaveščanje ljudi in spremembe v politiki.

4 Razprava

Raziskava je pokazala, da promet v Prištini ni učinkovit in da so nujne bolj trajnostne rešitve. Tematska analiza je kot glavne težave izpostavila nezanesljive avtobusne storitve, zastarele vozne parke in pomanjkanje ustrezne infrastrukture za kolesarje in pešce. Anketiranci so predlagali izboljšave v sistemu javnega mestnega prevoza, vključno z zamenjavo starih avtobusov, vzpostavitvijo novih linij in uvedbo sistema enotnih vozovnic. Poudarili so tudi potrebo po boljši infrastrukturi za kolesarje in pešce. V prečni analizi pa so se pokazali različni pogledi glede najboljših pristopov k uvedbi trajnostnih rešitev, ki so razkrili večplastnost izzivov in pomen uravnotežene strategije, ki lahko zadosti raznovrstnim potrebam prebivalcev. Marans in Stimson (2011) ugotavljata, da je kakovost javnih prevoznih storitev odločilen dejavnik, ki vpliva na zadovoljstvo prebivalcev z mestnim potniškim prometom. Podobno Xiao idr. (2023) poudarjajo, da lahko posodobitev in preureditev infrastrukture javnega potniškega prometa izboljšata učinkovitost prevozov in zadovoljstvo uporabnikov. Po drugi strani Borowski in Stathopoulos (2020) navajata, da lahko tovrstne posodobitve povečajo stroške, zaradi česar je treba za povečanje uporabe javnega potniškega prometa in posledično zmanjšanje prometnih zamaškov uvesti ustrezne subvencije. Izsledki raziskave prometa v Prištini so pomembni za literaturo, prakso in družbo. Raziskava namreč dopolnjuje literaturo s področja celostnega prometnega načrtovanja, saj daje vpogled v razmere v Prištini ter je lahko podlaga za nadaljnje raziskave in analize. V praksi lahko prometni načrtovalci in oblikovalci politike izsledke raziskave uporabijo za odpravljanje neučinkovitosti ter izboljšanje sistema javnega prevoza in infrastrukture za kolesarje in pešce. Z vidika pomena za družbo lahko navedeni ukrepi zmanjšajo prometne zamaške in izboljšajo kakovost zraka ter mobilnost in dostopnost storitev za vse prebivalce, kar prispeva k bolj trajnostnemu okolju, ki je hkrati tudi bolj privlačno za bivanje.

Izsledki raziskave potrjujejo pomen izboljšanja prometne infrastrukture za zagotavljanje trajnostnega prometa v Prištini. Tematska analiza je potrdila hipotezo 2 in razkrila potrebne ukrepe, kot so izboljšanje sistema javnega prevoza, prenova infrastrukture, diverzifikacija storitev, sprememba miselnosti in celovit pristop k uvedbi bolj trajnostnih rešitev. S prečno analizo so se pokazala različna mnenja o najprimernejših strategijah. Večina anketirancev je podpirala izboljšanje sistema javnega prevoza, vključno z zamenjavo starih avtobusov in boljšim načrtovanjem avtobusnih linij, manjšina pa je poudarila potrebo po uvedbi parkirišč na obrobju mesta in sistema enotnih vozovnic. Nekateri so celo posvarili pred prevelikim poudarjanjem javnega prevoza in kolesarjenja, ker bi to lahko postavilo v slabši položaj posameznike, ki so odvisni od prevoza z avtomobilom. Izsledki se ujemajo s prejšnjimi raziskavami, zlasti z vidika poudarjanja izboljšav v javnem prevozu, infrastrukturnih reform in diverzifikacije načinov prevoza (prim. Sodiq idr., 2019; Anagnostopoulou idr., 2020; Abu-Rayash in Dincer, 2021; Pamucar idr., 2021; Bi idr., 2023; Yaliniz idr., 2023). Tudi prejšnje raziskave so izpostavile odločilno vlogo sprememb v miselnosti ljudi, konkretnih političnih ukrepov in alternativnih rešitev pri vzpostavljanju trajnostnega prometnega okolja. Izsledki raziskave, predstavljene v tem članku, dopolnjujejo literaturo o trajnostnem prometu v Prištini ter izboljšujejo razumevanje dejavnikov vpliva in ustreznih strategij za doseganje izboljšav. Pomembni so tudi za načrtovalsko prakso, saj poudarjajo pomen izboljšav v javnem prevozu in kolesarski infrastrukturi ter potrebo po zamenjavi starih avtobusov, spodbujanju uporabe tehnologije za sledenje in upravljanje prevozov ter upoštevanju mnenj o javnem in zasebnem prometu. Izsledki imajo tudi širši pomen za družbo, saj je bilo poudarjeno, da je treba spremeniti miselnost ljudi in politike, doseči dogovor in upoštevati nasprotujoča si mnenja.

Pregled izzivov pri uvedbi trajnostnih oblik mobilnosti v Prištini je razkril raznovrstne ovire, med drugim nezadostna finančna sredstva, odpor uporabnikov, neskladnost zasebnih prevoznikov z obveznimi standardi, izzive pri zamenjavi voznega parka in vzpostavitvi novih linij, slabo infrastrukturo, zapletene upravne postopke in težave pri izvajanju načrta mobilnosti. Navedeni izsledki potrjujejo hipotezo 3 in razkrivajo, da so glavne ovire pri uvedbi trajnostnega prometa v Prištini neustrezna infrastruktura, finančne omejitve, miselnost ljudi, vedenjski in organizacijski vidiki, kot sta odpor do sprememb in potreba po upravni reformi, in upravljavski izzivi. S prečno analizo so se pokazali različni pogledi anketirancev, poleg tega se je razkrila večplastnost izzivov. Poudarjeno je bilo, da je treba fizične ovire obravnavati skupaj z ovirami, povezanimi z navadami in mišljenjem ljudi. Glavne ovire, ki so jih anketiranci navedli, se ujemajo s tistimi, navedenimi v drugih raziskavah (Anagnostopoulou idr., 2020; Bouraima idr., 2023; Feldman, 2023). Izsledki dopolnjujejo literaturo o uvedbi trajnostnih oblik mobilnosti v Prištini in dajejo podlago za nadaljnje raziskave. Prometne načrtovalce in oblikovalce politike usmerjajo k temu, da prepoznane ovire odpravljajo s strateškim načrtovanjem, ustrezno zakonodajo in boljšo ureditvijo upravnih postopkov. Odprava tovrstnih ovir zagotavlja družbene koristi, kot je boljša kakovost zraka in življenja prebivalcev, za to pa so potrebni politična volja, sodelovanje deležnikov, razumevanje tako fizičnih kot vedenjskih izzivov ter angažiranost javnosti.

Analiza anketnih odgovorov je potrdila hipotezo 4, saj so anketiranci menili, da imajo trajnostne oblike mobilnosti v Prištini pozitivne vplive (npr. bolj tekoč in manj gost promet, manjša onesnaženost in boljša kolesarska infrastruktura). Uvedba bolj trajnostnih oblik mobilnosti naj bi izboljšala mobilnost, zmanjšala prometne zamaške in izboljšala kakovost življenja na splošno. Odgovori anketirancev glede pričakovanih koristi trajnostne mobilnosti so se precej ujemali, močno pa so se razlikovali glede tega, katerim ukrepom so dajali večji pomen. Prednosti trajnostnega prometa so proučevali že mnogi raziskovalci, a nikoli v povezavi s Prištino. Prejšnje raziskave (npr. Elliott, 2023; Mohapatra idr., 2023; Molner idr., 2023) so med koristmi uvedbe trajnostnega prometa izpostavile zlasti zmanjšanje prometnih zastojev in boljšo kakovost storitev. Izsledki raziskave, predstavljene v tem članku, se ujemajo s temi ugotovitvami in dopolnjujejo literaturo o trajnostnem prometu v Prištini. Prometne načrtovalce in oblikovalce politike usmerjajo k upoštevanju pozitivnih vplivov trajnostnih oblik mobilnosti pri izdelavi prometnih načrtov in izvajanju celostnih prometnih strategij, pri čemer poudarjajo zlasti pomen infrastrukturnih izboljšav, kampanj ozaveščanja in sprememb politike.

5 Sklep

Raziskava omogoča večplastno razumevanje trajnostnega prometa v Prištini, pri čemer s proučevanjem izzivov in morebitnih koristi v tem mestu zapolnjuje pomembno vrzel v literaturi. Izsledki opravljenih tematskih in prečnih analiz poudarjajo raznovrstnost izzivov v mobilnosti in raznovrstne poglede na morebitne rešitve. Novost te raziskave je podrobna proučitev prometne krajine v Prištini, ki je bila v znanstveni literaturi do zdaj slabo raziskana. Raziskava ima tudi nekatere omejitve. Ker temelji na odgovorih anketirancev, so njeni izsledki lahko pristranski, z osredotočanjem na Prištino pa je omejena tudi njena posplošljivost na druga mesta. V prihodnjih raziskavah bi se lahko obravnavalo širše geografsko območje, uporabile bi se mešane metode, ki omogočajo celovitejše razumevanje obravnavane problematike, in proučevali bi se dolgoročni vplivi predlaganih celostnih prometnih strategij v Prištini in podobnih urbanih okoljih.

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UDK: 711.433: 502.131.1 (560.11)
doi:10.5379/urbani-izziv-2023-34-02-05

Prejeto: 29. 8. 2023
Sprejeto: 7. 11. 2023

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Proučevanje trajnostnosti turških provinc z uporabo mehke logike

Trajnostnost se nanaša na ravnovesje socialnih, gospodarskih in okoljskih dejavnikov, cilj tega koncepta pa je življenje v sožitju z naravo. Trajnostni razvoj se po drugi strani nanaša na doseganje urbanih ciljev za prihodnost ter na hkratno povečevanje blaginje in učinkovito prenašanje virov na naslednje generacije. Za oblikovanje politike in spremljanje napredka na tem področju se uporabljajo kazalniki trajnostnosti, ki jih oblikujejo razne ustanove in se razlikujejo glede na državo. V gospodarstvih v razvoju, kot je Turčija, je bilo do zdaj opravljenih malo raziskav o merjenju trajnostnosti. Avtorici sta v članku proučili ravni trajnostnosti turških mest z uporabo mehke logike, pri čemer sta oblikovali tudi merljiv in ponovljiv številski model za analizo njihove trajnostnosti. Za merjenje trajnostnosti sta uporabili 27 kazalnikov v okviru glavnih komponent ekologije, gospodarstva in socialnih vidikov, trajnostnost mest pa sta ocenili z mehkimi pravili. Na podlagi rezultatov sta vseh 81 turških provinc razdelili na kvantilne razrede in jih kartirali. Uporabljeni analitični pristop je lahko uporaben za urbaniste, oblikovalce politik in odločevalce, raziskava, predstavljena v tem članku, pa prispeva k boljšemu poznavanju in razumevanju trajnostnosti.

Ključne besede: trajnostnost, trajnostna mesta, mehka logika, Turčija

1 Uvod

Posledice pandemije covida-19, rasti prebivalstva, podnebnih sprememb, razvrednotenja okolja, pomanjkanja stanovanj ter negotove oskrbe z vodo, hrano in energijo so predmet intenzivnih razprav med akademiki, urbanisti in oblikovalci politik (Dumane idr., 2019; Son idr., 2023)artificial intelligence (AI. Vse od industrijske revolucije se zaradi urbanizacije naravni viri hitro porabljajo. Do leta 2050 naj bi že približno 70 % vseh prebivalcev na Zemlji (tj. 6,9 milijarde ljudi) živelo v mestih (UNDP, 2020; Ramesh, 2022). Za zagotavljanje trajnostnosti mest in blaginje za prihodnje generacije je treba naravne vire modro uporabljati. Poleg reševanja vprašanj, kot so segrevanje ozračja, tanjšanje ozonske plasti in pomanjkanje stanovanj, ter zdravstvenih in še drugih okoljskih vprašanj bi se morali oblikovalci politik zavzemati tudi za trajnostni razvoj mest (Dumane idr., 2019).

Trajnostnost se lahko pojmuje kot temeljni cilj človeka, ki živi v sožitju z naravo (Robati in Rezaei, 2022). Na splošno gre za iskanje ustreznega ravnovesja med socialnimi, gospodarskimi in okoljskimi dejavniki (Dumane idr., 2019). Etimološko pojem trajnostnosti izvira iz latinske besede *sustinere* 'prenesti, prestati' (Alptekin in Saraç, 2017). Proučuje se v daljšem obdobju (Kusakci idr., 2022), pomemben pa je tako za zasebni kot javni sektor. Z vidika podjetij se nanaša na prilagodljivost trgu in doseganje konkurenčne prednosti, v javnem sektorju pa na doseganje ciljev, kot so stroškovna učinkovitost, pozitivni vplivi na okolje, uporaba trajnostnih tehnologij ter ozaveščanje potrošnikov o okoljskih in ekoloških vprašanjih (Akçakaya, 2016).

Trajnostni razvoj je opredeljen kot trajnostna gospodarska rast in trajnostno obnavljanje okolja. Pojem je v ospredju urbanističnih razprav, katerih cilj je ustvariti privlačno urbano prihodnost. Nanaša se na doseganje ciljev, povezanih z mesti, brez škodljivega vpliva na družbeno blaginjo, kakovost življenja in okolje (Son idr., 2023). Kazalniki trajnostnega razvoja zagotavljajo informacije za oblikovanje strateških dokumentov in razvojnih programov. Uporabni so za določanje prednostnih nalog, spremljanje uspešnosti reševanja težav ter merjenje uspešnosti posegov, povezanih z okoljskimi, socialnimi in gospodarskimi vprašanji. Cilj je oblikovati, izbrati in proučiti kazalnike s sodelovanjem javnosti in s tem javnost vključiti v odločanje (Michalina idr., 2021). Kazalniki zagotavljajo informacije javnosti, znanstvenikom in oblikovalcem politik.

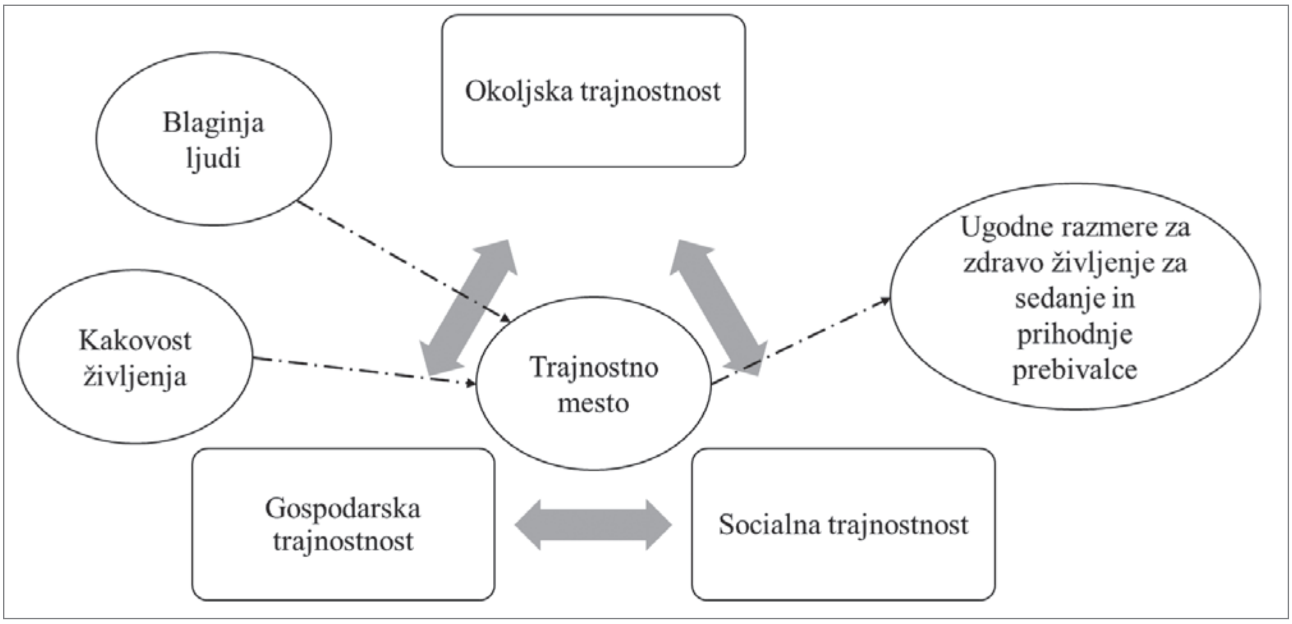
Ena od metod merjenja trajnostnosti mest je mehka logika, s katero se izjave v naravnem jeziku pretvorijo v matematične pojme in oblikuje logična struktura, prilagojena posameznemu problemu (Robati in Rezaei, 2022). Ta zmanjša negotovost in kompleksnost sistema in zagotavlja jasnejše rezultate. Z metodo mehke logike lahko raven trajnostnega razvoja mest predstavimo z vmesnimi vrednostmi, ne z ostrimi, dvovrednostnimi izjavami, kot na primer »dobro ali slabo«. Avtorici sta postavili hipotezo, da je mehka logika lahko učinkovito orodje za ocenjevanje ravni trajnostnega razvoja mest, pri kateri se za merjenje uporabijo razne komponente in kazalniki. Hipoteza temelji na zmožnosti razvrščanja turških mest v kvartilne razrede glede na trajnostnost z uporabo metode mehke logike. Cilj raziskave, predstavljene v tem članku, je omogočiti merjenje trajnostnosti z modelom, ki se lahko uporablja tudi drugje, je ponovljiv in temelji na številskih podatkih. Izsledki raziskave so lahko v pomoč mestnim načrtovalcem, oblikovalcem politik in odločevalcem pri ustvarjanju bolj trajnostnih mest. V nadaljevanju je naprej predstavljeno teoretično ozadje na podlagi pregleda literature, nato pa se avtorici osredotočita na trajnostnost turških mest in mehko logiko. V poglavju Metode predstavita model, ki sta ga izdelali za raziskavo, na koncu pa povzameta izsledke in glavna opažanja.

2 Ozadje

2.1 Pojem trajnostnega mesta in spremljanje trajnostnosti mest

Pri današnjih prizadevanjih za ustvarjanje trajnostnega sveta je ključno upravljanje mest, ki imajo lokalni in mednarodni vpliv na naravne vire in ekološko ravnovesje ter upravljanje sprememb in preobrazb v tovrstnih mestih. Za celosten razvoj trajnostnih mest, ki upošteva gospodarske, socialne in okoljske dejavnike, imajo veliko odgovornost lokalne uprave, saj so to javne ustanove, ki so najbližje mestnim skupnostim. Pomembno vlogo imajo na primer pri oblikovanju politike trajnostnega razvoja mest in merjenju njihove trajnostnosti (Akçakaya, 2016). Trajnostost mest se lahko obravnava kot del trajnostnega razvoja, ki poudarja ravnovesje med okoljsko, gospodarsko in socialno trajnostnostjo ter se osredotoča na izboljšanje človekove blaginje in kakovosti življenja (Robati in Rezaei, 2022). Mednarodna organizacija ICLEI pa ob tem navaja, da si trajnostna mesta prizadevajo zagotavljati okoljsko, socialno in gospodarsko zdrave in prilagodljive življenjske razmere za sedanje prebivalce, ne da bi ogrožala možnosti prihodnjih generacij, da imajo enako izkušnjo (slika 1). Kljub vsemu bi morale pristojne ustanove v mestih obravnavati številna vprašanja in jih, če je le mogoče, tudi rešiti (Michalina idr., 2021).

Pojem trajnostnosti mest je bil obravnavan na drugi konferenci Organizacije združenih narodov o človekovih naseljih (Habitat II), ki je leta 1996 potekala v Istanbulu (Alptekin in Saraç, 2017). Izhaja iz zamisli, da morajo mesta skrbno in



Slika 1: Definicije trajnostnosti mest (ilustracija: avtorici)

učinkovito izkoriščati naravne vire, da bi zadostila potrebam sedanjih in prihodnjih generacij ter vključujoče podpirala ljudi. Za trajnostna mesta je značilno, da izvajajo ukrepe za spodbujanje okoljske trajnostnosti, kot so ohranjanje okolja, učinkovita raba energije in vode, zmanjševanje ogljičnega odtisa, ohranjanje zelenih površin ter ustrezno ravnanje z odpadki in njihovo recikliranje (Pınarcıoğlu in Kanbak, 2020). Za doseganje gospodarske trajnostnosti morajo mesta spodbujati gospodarsko rast, hkrati pa povečevati možnosti za zaposlitev, zmanjševati neenakosti in preprečevati revščino. Socialna trajnostnost mest pa se nanaša na to, da imajo vse skupnosti, ki živijo v mestih, enake možnosti, dostopen prevoz ter lahek dostop do izobraževanja, zdravstva, stanovanj in drugih osnovnih storitev (slika 2). Poleg tega so za doseganje socialne trajnostnosti pomembni ohranjanje kulturne raznovrstnosti, spodbujanje sodelovanja skupnosti in krepitev demokratičnih procesov (Michalina idr., 2021).

Cilji trajnostnega razvoja (CTR), ki jih je Organizacija združenih narodov leta 2015 sprejela, da bi okrepila trajnostni razvoj vseh držav sveta do leta 2030, vključujejo 17 ciljev in 169 podciljev (OZN, 2015). Njihov namen je ustvariti bolj trajnosten in enakopraven svet ob upoštevanju tako mestnih kot podeželskih območij. Poskušajo doseči tisto, kar se ni doseglo z razvojnimi cilji novega tisočletja, in dajejo prednost ravnovesju treh vidikov trajnostnega razvoja: gospodarskega, socialnega in okoljskega. Trajnostna mesta imajo med cilji trajnostnega razvoja pomembno mesto. Za razvoj vseh držav po svetu je nujno, da tudi večina prebivalstva, ki živi v mestih, postane trajnostna. 6. cilj trajnostnega razvoja (čista voda in sanitarna ureditev) vsebuje podcilje, ki se nanašajo na trajnostno gospodarjenje z vodnimi viri, zagotavljanje dostopa do

Slika 2: Razsežnosti trajnostnosti mest (ilustracija: avtorici)

čiste vode in odvajanje odpadne vode na mestnih območjih. 11. cilj (trajnostna mesta in skupnosti) se nanaša neposredno na trajnostnost mest ter dejavnike, kot so trajnostna infrastruktura, prometni sistemi, raba energije in urbanistično načrtovanje, ki naj bi prispevali k bolj trajnostnim mestom, privlačnejšim za bivanje. 7. cilj (cenovno dostopna in čista energija) spodbuja uporabo obnovljivih virov energije na mestnih območjih. 8. cilj (dostojno delo in gospodarska rast) spodbuja trajnostno in vključujočo rast ter poudarja gospodarsko vlogo, ki jo morajo prevzeti mesta (npr. ustvarjanje delovnih mest in spodbujanje gospodarske rasti). Na 3. cilj (zdravje in dobro počutje) močno vpliva urbanistično načrtovanje. Čisto okolje, zelene površine in dobro načrtovana mesta lahko prispevajo k bolj zdravemu življenju ljudi. 10. cilj (zmanjšanje neenakosti) pa je pomemben z vidika zagotavljanja socialne trajnostnosti v mestih. Ključni cilj je zmanjšanje neenakosti v mestih na področjih, kot so prihodki, izobraževanje in življenjski standard.

Trajnostna urbanizacija velja za eno ključnih prvin trajnostne rasti, zato je merjenje trajnostnosti mest pomembno za ugotavljanje uspešnosti doseganja ciljev, povezanih z rastjo. Za to se uporabljajo kazalniki trajnostnega razvoja mest, ki vključujejo okoljske, gospodarske in socialne vidike (Pınarcıoğlu in Kanbak, 2020). Za spremljanje trajnostnega razvoja mest morajo oblikovalci politik izbrati ustrezne tematske kategorije in kazalnike, kar je lahko izziv. Izbor kategorij in kazalnikov temelji na izpolnjevanju točno določenih meril in zahtev. Celoten proces mora biti pregleden, metodološko pravilen in jasno utemeljen. V večini primerov je težko odpraviti subjektivnost tega procesa, saj izbira kategorij in kazalnikov ni vrednostno nevtralna, ampak izraža pristranskost, napake, namere, domneve in svetovne nazore njegovih izvajalcev (Michalina idr., 2021).

V poročilu Evropske komisije iz leta 2018 z naslovom *Indicators for Sustainable Cities* (Kazalniki trajnostnih mest) je obravnavana funkcija kazalnikov pri merjenju trajnostnosti. S tovrstnimi kazalniki lahko urbanisti, lokalni upravitelji in oblikovalci politik merijo uspešnost mest pri doseganju socialne, gospodarske in okoljske trajnostnosti. Kazalniki, ki omogočajo merjenje tovrstne uspešnosti mest na področjih, kot so urbanistično oblikovanje, infrastrukturne storitve, mestna politika, ravnanje z odpadki, onesnaževanje in dostop do storitev, pomagajo odkriti težave in področja, ki jih je mogoče izboljšati z dobrim upravljanjem in raziskavami (Akçakaya, 2016; Evropska komisija, 2018). Ker so med mesti precejšnje razlike z vidika razpoložljivih virov, števila prebivalcev in procesov urbanega metabolizma, je koristno, da imamo na razpolago čim več raznovrstnih trajnostnih kazalnikov, hkrati pa je morda zelo težko izbrati najustreznejše (Evropska komisija, 2018). Znani so merljivi in razumljivi gospodarski, socialni in okoljski kazalniki, ki omogočajo primerjave med geografskimi območji in obdobji, na podlagi katerih lahko ugotovimo, ali se mesta razvijajo trajnostno in kako zavzeto (Çolakoğlu, 2019). Kazalniki trajnostnega razvoja dokazano spodbujajo trajnostni razvoj mest, znanih pa je na stotine tovrstnih kazalnikov. V okviru programa OZN za naselja (UN-HABITAT), programa OZN za trajnostni razvoj mest (*Sustainable Cities Program*), priročnika CityStrength Diagnostic, ki ga je izdala Svetovna banka, indeksa trajnostnega razvoja mest (*Sustainability Index for Cities*) in natečaja za najbolj trajnostna evropska mesta (*European Sustainable Cities Award*) so bili oblikovani kazalniki za merjenje trajnostnega razvoja mest (Evropska komisija, 2018). S tovrstnimi kazalniki lahko mestni načrtovalci in oblikovalci politik proučijo gospodarske, socialne in okoljske vplive izvedenih urbanističnih načrtov na razvoj infrastrukture, politike, onesnaženje in dostop prebivalcev do storitev (Robati in Rezaei, 2022). Na splošno ni enotnih ali skupnih kazalnikov za opredelitev temeljnih prvin, ki jih mesto potrebuje, da bi doseglo cilje trajnostnega razvoja (Pires idr., 2014).

2.2 Trajnostnost turških mest

O uspešnosti doseganja trajnostnega razvoja mest v razvitih državah je bilo opravljenih že mnogo raziskav, le malo pa se jih je osredotočalo na države v razvoju, kot je Turčija, kar je verjetno posledica dejstva, da je pristop, ki temelji na uporabi kazalnikov, tam šele v začetni fazi razvoja (Kusakci idr., 2022). Turška mesta so v zadnjih 50 letih močno zrasla, v njih pa živi približno 75 % vseh prebivalcev v državi. Spopadajo se z raznovrstnimi okoljskimi in socialnimi izzivi, zaradi katerih je treba uvesti najrazličnejše trajnostne ukrepe. Iz 10. razvojnega načrta države je razvidno, da so trenutno najbolj pereči izzivi pomanjkanje stanovanj, prometni zamaški, slaba varnost, pomanjkljiva infrastruktura, slaba socialna kohezija, migracije in razvrednotenost okolja (Kusakci idr., 2022). Trajnostni razvoj Turčije s finančno pomočjo podpira tudi Svetovna banka v okviru projekta Sustainable Cities Project (Projekt trajnostnih mest). Njegov cilj je izboljšati gospodarsko, okoljsko in socialno trajnostnost mest z zagotavljanjem finančnih sredstev za prednostne naložbe, za katera lahko zaprosijo občine (Svetovna banka, 2019). Na žalost skupnih kazalnikov za merjenje trajnostnega razvoja turških mest še ni.

Kot članica OZN je tudi Turčija leta 2021 podpisala Pariški sporazum o podnebnih spremembah in s tem pokazala, da si čedalje bolj prizadeva reševati vprašanje podnebnih sprememb. Iz pregleda raziskav trajnostnosti turških mest je razvidno, da raziskovalci uporabljajo številne analitične metode. Gülcan in Aldemir (2008) sta primerjala gospodarske in socialno-kulturne dejavnike v dveh provincah v egejski pokrajini (Aydın in Denizli). Ugotovila sta, da za proučevanje trajnostnega razvoja mest niso dovolj samo gospodarski dejavniki in da je treba v analizo vključiti tudi druge dejavnike, kot so kulturne vrednote in socialne mreže (Kusakci idr., 2022). Leta 2011 je istanbulska univerza Boğaziçi skupaj z družbo MasterCard izvedla raziskavo trajnostnosti turških mest, ki je temeljila tako na objektivnih kot subjektivnih podatkih. Objektivni podatki so bili pridobljeni s kazalniki, oblikovanimi za izračun indeksov trajnostnega razvoja in kakovosti življenja v vseh 81 turških provincah, subjektivni podatki pa z anketo, opravljeno z direktorji podjetij v 29 provincah, ki so vključevale 26 regij na ravni NUTS 2 in 16 metropolitanskih občin (MasterCard Worldwide in Boğaziçi Üniversitesi, 2011).

Gazibey idr. (2014) so analizirali trajnostnost 81 turških provinc, za kar so uporabili socialne, gospodarske in okoljske kazalnike ter metodo TOPSIS (Technique for Order Preference by Similarity to Ideal Solution). Navedeno metodo sta leta 1981 razvila Hwang in Yoon, uporablja pa se za razvrščanje alternativ pri večkriterijskem odločanju (Hwang in Yoon, 1981). Z njo se določijo alternative, ki so najbližje pozitivni idealni rešitvi in hkrati najbolj oddaljene od negativne idealne rešitve. Pozitivna idealna rešitev je rešitev, ki zagotavlja največje koristi in najnižje stroške, negativna idealna rešitev pa je povezana z najmanjšimi koristmi in najvišjimi stroški. Posledično se alternative razvrstijo v padajočem vrstnem redu glede na njihovo relativno bližino do idealnih rešitev (Gazibey idr., 2014). Izsledki raziskave so pokazali, da so najbolj trajnostna mesta Kocaeli, Istanbul in Ankara. Raziskovalci so poudarili, da so lahko njihovi izsledki v pomoč pri oblikovanju novih javnih politik in doseganju ravnovesja med stroški in koristmi pri deležnikih. Izpostavili so tudi potrebo po novih kazalnikih za proučevanje trajnostnega razvoja turških provinc in zbiranju potrebnih podatkov zanje (Alptekin in Saraç, 2017).

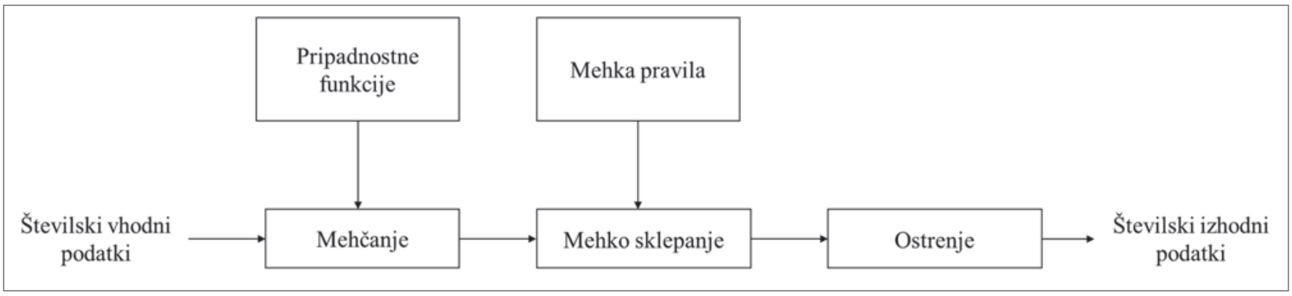
Yıldırım in sodelavci (2017) so proučevali mnenja zaposlenih v javni upravi v Istanbulu o orodjih, ki spodbujajo okoljsko trajnostnost, pri čemer so analizirali kazalnike iz lokalne agende 21, vključno z družbenimi aktivnostmi, projekti, ki se nanašajo na obnovljivo energijo in učinkovito rabo energije, zelenim prevozom in ravnanjem z odpadki. Ugotovili so, da so prakse, ki temeljijo na strategijah (npr. trajnostno načrtovanje in participativne politike), uspešnejše od tistih, ki temeljijo na projektih (Kusakci idr., 2022). Alptekin in Saraç (2017) sta z entropijsko metodo uteževanja določila uteži (pomembnost) spremenljivk v nizu kazalnikov, ki omogočajo merjenje trajnostnega razvoja. Poleg tega sta uporabila metodo sive relacijske analize, s katero sta turške province razvrstila glede na doseženo stopnjo trajnostnosti. V raziskavi iz leta 2022 so Kuşakçı in sodelavci z metodo IT2D-AHP ugotovili, da se raven trajnostnega razvoja 30 turških velemest razlikuje glede na gospodarski, socialni, okoljski in institucionalni vidik (Kusakci idr., 2022). Cilj vseh navedenih raziskav je ozaveščati o pomenu trajnostnih mest, zagotoviti gradivo oblikovalcem politik, ki temelji na podatkih in lahko pomaga pri njihovem odločanju, ter ponuditi orodje za merjenje in izboljšanje trajnostnosti mest.

Trajnostni razvoj mest je težko opredeliti zgolj kvantitativno, v zadnjih nekaj desetletjih tudi raziskovalci opozarjajo na negotovo in dvoumno naravo določanja kazalnikov z raznimi metodami zbiranja podatkov (Hincu, 2011). Rezultati so nezanesljivi tako pri kvalitativnih kot matematičnih analizah trajnostnega razvoja. Z uporabo mehke logike se lahko oblikuje model za ocenjevanje trajnostnosti mest, ki združuje različne podsisteme trajnostnosti (Jaderi idr., 2014). Trajnostni razvoj je pojem, ki se nanaša na gospodarske, socialne in okoljske razsežnosti. Andriantiatsaholiniaina in sodelavci (2004) so razvili model SAFE (Sustainability Assessment by Fuzzy Evaluation), ki se lahko pojasni z mehko logiko in za merjenje trajnostnega razvoja uporablja kazalnike okoljske celovitosti, gospodarske učinkovitosti in socialne solidarnosti. Avtorji so model razvili za grška in ameriška gospodarstva, pri čemer so opozorili, da ne obstaja samo en način učinkovitega odločanja o trajnostnih vprašanjih, in podprli uporabo različnih kazalnikov za različne države (Alptekin in Saraç, 2017).

2.3 Mehka logika

Metodo mehke logike je leta 1965 razvil Lotfi A. Zadeh. Gre za matematični pristop k modeliranju in nadziranju sistemov, za katere so značilni negotovost, to, da ni natančnih meja, in prehodi med posameznimi vrednostmi (Robati in Rezaei, 2022). Uporablja se za odpravo negotovosti, ki se pogosto pojavljajo v kompleksnih scenarijih iz resničnega življenja. Na podlagi mehke logike naprave pridobijo sposobnost človeškega razmišljanja in sklepanja z uporabo nenatančnih izjav, izraženih v naravnem jeziku (Phillis idr., 2017). Uporablja se na področjih, kot so med drugim nadzorni sistemi, umetna inteligenca, robotika, obdelava slik, strojno učenje, obdelava naravnega jezika, ekonomija in finance, ravnanje z okoljem, upravljanje energije, zdravstvo, upravljanje prometa, industrija, kmetijstvo. Z mehko logiko se lahko uspešno premagajo izzivi pri merjenju trajnostnega razvoja. V analizah trajnostnosti mest se pogosto uporablja za oblikovanje sestavljenih indeksov za razvrščanje in oceno trajnostnosti, ocenjevanje projektov urbane prenove in primerjavo enot na lokalni ravni, kot so mesta, po vsem svetu (Buzási idr., 2022).

V nasprotju z običajno, binarno logiko mehka logika omogoča vrednotenje neskončnih možnosti v intervalu 0–1, saj nima strogih binarnih pragov. Uporablja se lahko za modeliranje in analizo negotovih in kompleksnih sistemov (Hincu, 2011). Pomaga zmanjšati negotovost podatkov in bolje razumeti sistem, poleg tega omogoča vključitev mnenj in izkušenj strokovnjakov. Opisuje proces, pri katerem so številski podatki najprej ovrednoteni opisno, na koncu pa so spet izraženi številsko (glej sliko 3). Metoda se začne s postopkom mehčanja, pri katerem se številski podatki pretvorijo v mehke, opisne izjave. Za vsak vhodni podatek se oblikujejo funkcije pripadnosti, ki so lahko različnih oblik (npr. trikotna, trapezna ali Gaussova funkcija) in se opredelijo z izrazi, kot so »nizka,« »srednja« ali »visoka«. Sledi faza mehkega sklepanja, pri katerem se izhodna izja-



Slika 3: Mehka logika (ilustracija: avtorici)

va določi na podlagi odnosov med pripadnostnimi funkcijami. Pravila v tej fazi so izražena v obliki stavkov »če ..., potem ...«. S tem se na podlagi odnosov med vhodnimi podatki oblikujejo izhodne izjave. V zadnji fazi, imenovani ostrenje, pa se izhodna izjava pretvori v ostro ali številsko vrednost (slika 3).

3 Metoda

Avtorici sta v raziskavi uporabili model, ki vključuje metodo mehke logike in temelji na izboru kazalnikov, ki omogočajo merjenje trajnostnosti vseh turških mest. Trajnostnost sta proučevali na podlagi številskih podatkov in izbranih podkomponent v okviru treh glavnih komponent analize: ekologije, gospodarstva in socialnih vidikov. Komponenta ekologija vključuje podkomponente zrak, voda, tla in energija. Zrak, vodo in energijo sta proučevali z dvema kazalnikoma, tla pa s tremi. Komponenta gospodarstvo vključuje podkomponenti delo in življenjske razmere, pri čemer sta avtorici vsako proučili s tremi kazalniki. Komponenta socialni vidiki vključuje podkomponente prebivalstvo, izobraževanje, zdravstvo in stanovanja. Avtorica sta prebivalstvo proučevali z dvema kazalnikoma, izobraževanje s štirimi, zdravstvo in stanovanja pa s tremi. Rezultate za glavne komponente sta pridobili tako, da sta kazalnike ovrednotili z mehkimi pravili, na koncu pa sta ta pravila uporabili še za pridobljene podatke in tako izračunali raven trajnostnega razvoja za vsako turško mesto posebej.

Avtorici sta v raziskavi veliko pozornost namenili temu, da so bili za vsak izbrani kazalnik za merjenje trajnostnosti podatki na voljo na ravni provinc. Izbrani kazalniki so bili že uporabljeni v prejšnjih raziskavah v Turčiji, povezanih s to temo. Uporabljena referenčna literatura in vpliv mehkih pravil (pozitiven ali negativen) sta podrobneje predstavljena v preglednici 1. Omejitve raziskave so povezane z dostopnostjo podatkov na ravni provinc in letom razpoložljivih referenčnih podatkov, ki je moralo biti enako ali najbližje proučevanemu. Večina podatkov je bila pridobljena od turškega statističnega inštituta (TSI, 2020, 2021, 2022), nekateri pa so bili pridobljeni tudi od drugih virov. Podatki o podjetjih so bili tako pridobljeni od turške zveze zbornic in blagovnih borz (UCCE, 2022), podatki o vrednosti znižanja davka na nepremičnine so bili pridobljeni na spletnem mestu podjetja Endeksa (2022), podatki o gozdovih od turškega generalnega direktorata za gozdove (General, 2021), podatki o elektriki pa od turške uprave za energetski trg (EMRA, 2022).

Ker so bile vrednosti kazalnikov izražene v različnih merskih enotah, so bili podatki normalizirani, obseg njihovih vrednosti pa je bil spremenjen v interval med 0 in 1. Z normalizacijo podatkov sta avtorici omogočili primerljivost mest. Postopek normalizacije je temeljil na največjih in najmanjših vrednostih podatkovnih nizov posameznih kazalnikov, pri čemer sta avtorici uporabili naslednjo enačbo:

$$x_{norm} = \frac{x - x_{min}}{x_{maks} - x_{min}},$$

kjer je x_{norm} normalizirana vrednost, x je realna vrednost, x_{min} je najmanjša vrednost in x_{maks} je največja vrednost v podatkovnem nizu.

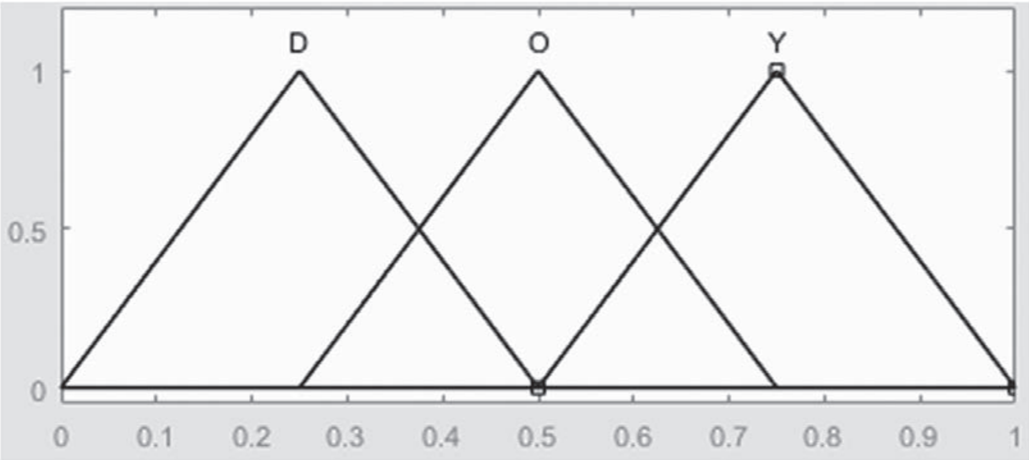
Izhodišče modela so kazalniki, končni rezultat pa je stopnja trajnostnosti. Avtorici sta uporabili trikotne pripadnostne funkcije, saj so te najustreznejše in se tudi v literaturi najpogosteje uporabljajo (slika 4). V vseh fazah so bile enakomerno porazdeljene. V prvi fazi modela sta avtorici pripadnostne funkcije kazalnikov opredelili kot nizke (N), srednje (S) in visoke (V). Mejne vrednosti ali oglišča trikotnikov so v preglednici na sliki 4 navedene kot P1, P2 in P3, pri čemer so navedene tudi meje osnovnih kazalnikov, podkomponent in glavnih komponent.

Avtorici sta oblikovali mehka pravila za odnose med kazalniki in podkomponentami, pri čemer sta vse komponente obravnavali z enako pomembnostjo (v skladu z mnenji strokovnjakov) ter upoštevali njihove pozitivne in negativne vplive. S programom MATLAB sta pridobili podatke za podkomponente z vrednostmi v razponu od 0 do 1. V naslednji fazi sta za podkomponente oblikovali pripadnostne funkcije, vrednost katerih sta opisali z izjavami »nizka« (N), »srednja« (S) in »visoka« (V). Mehka pravila sta oblikovali tudi za odnose med podkomponentami in glavnimi komponentami, pri čemer sta v programu MATLAB pridobili rezultate za komponente v razponu od 0 do 1. V zadnji fazi sta zanje oblikovali še pri-

Preglednica 1: Kazalniki modela trajnostnosti

	Kazalnik		Literatura	Vpliv
Gospodarstvo	Delo			
		Stopnja brezposelnosti	Gazibey idr., 2014; OZN, 2015 (CTR 8); Alptekin in Saraç, 2017	Negativen
		Delovna sila	Gazibey idr., 2014; Alptekin in Saraç, 2017	Pozitiven
		Podjetja	Alptekin in Saraç, 2017	Pozitiven
	Življenjske razmere			
		Koeficient GINI	OZN, 2015 (CTR 4)	Negativen
		Stopnja regionalne revščine	OZN, 2015 (CTR 10)	Negativen
		BDP	OZN, 2015 (CTR 8); Alptekin in Saraç, 2017; Kuşakçı idr., 2022	Pozitiven
Ekologija	Kakovost zraka			
		Letne ravni delcev PM10	MasterCard, 2011; Gazibey idr., 2014; OZN, 2015 (CTR 11); Alptekin in Saraç, 2017	Negativen
		Število avtomobilov na tisoč prebivalcev	Kuşakçı idr., 2022	Pozitiven
	Voda			
		Pitna voda	MasterCard, 2011; Gazibey idr., 2014; OZN, 2015 (CTR 6); Kuşakçı idr., 2022	Pozitiven
		Kanalizacijsko omrežje	MasterCard, 2011; Gazibey idr., 2014; OZN, 2015 (CTR 6); Kuşakçı idr., 2022	Pozitiven
	Tla			
		Zazidane površine, namenjene javni rabi	OZN, 2015 (CTR)	Pozitiven
		Površina gozdov	MasterCard, 2011; OZN, 2015 (CTR 15)	Pozitiven
		Zbiranje in obdelava komunalnih odpadkov	MasterCard, 2011; OZN, 2015 (CTR 11); Kuşakçı idr., 2022	Pozitiven
	Energija			
		Poraba elektrike	MasterCard, 2011	Negativen
		Obnovljiva energija	Alptekin in Saraç, 2017; Kuşakçı idr., 2022	Pozitiven
Socialne zadeve	Prebivalstvo			
		Gostota	MasterCard, 2011; Gazibey idr., 2014; Alptekin in Saraç, 2017; Kuşakçı idr., 2022	Negativen
		Selitveni prirast	Kuşakçı idr., 2022	Negativen
	Izobraževanje			
		Pismenost	MasteCcard, 2011; Alptekin in Saraç, 2017; Kuşakçı idr., 2022	Pozitiven
		Vpis v osnovno šolo	OZN, 2015 (CTR 4); Alptekin in Saraç, 2017; Kuşakçı idr., 2022	Pozitiven
		Vpis v nižjo srednjo šolo	OZN, 2015 (CTR 4); Alptekin in Saraç, 2017; Kuşakçı idr., 2022	Pozitiven
		Vpis v višjo srednjo šolo	OZN, 2015 (CTR 4); Alptekin in Saraç, 2017; Kuşakçı idr., 2022	Pozitiven
	Zdravstvo			
		Stopnja umrljivosti otrok, mlajših od 5 let	Gazibey idr., 2014; OZN, 2015 (CTR 3); Alptekin in Saraç, 2017; Kuşakçı idr., 2022	Negativen
		Št. zdravnikov na tisoč prebivalcev	MasterCard, 2011; Gazibey idr., 2014; OZN, 2015 (CTR 3); Alptekin in Saraç, 2017; Kuşakçı idr., 2022	Pozitiven
		Pričakovana življenjska doba	Kuşakçı idr., 2022	Pozitiven
	Stanovanja			
		Znesek znižanja davka zaradi vzdrževanja	OZN, 2015 (CTR 11)	Negativen
		Število prodanih stanovanj	Alptekin in Saraç, 2017; Kuşakçı idr., 2022	Pozitiven
		Število stavb na gradbeno dovoljenje	Kuşakçı idr., 2022	Pozitiven

Vir: avtorici



	Osnovni kazalniki			Podkomponente, komponente in trajnostnost		
	N	S	V	N	S	V
P1	0,00	0,25	0,50	0,00	0,20	0,50
P2	0,25	0,50	0,75	0,20	0,50	0,80
P3	0,50	0,75	1,00	0,50	0,80	1,00

Slika 4: Pripadnostne funkcije in meje (ilustracija: avtorici)

padnostne funkcije z istimi opisi vrednostmi kot za podkomponente. Mehka pravila sta na koncu oblikovali še za odnose med glavnimi komponentami in trajnostnostjo, pri čemer sta z uporabljenim modelom pridobili vrednosti trajnostnosti v razponu od 0 do 1 (slika 5).

Avtorici sta v raziskavi uporabili Mamdanijevo metodo mehkega sklepanja, ki vključuje štiri faze: mehčanje vhodnih spremenljivk, oceno pravil, združevanje posledic pravil in ostrenje. V fazi mehčanja se številskim vrednostim vhodnih podatkov pripiše stopnja pripadnosti ustreznim pripadnostnim funkcijam. V fazi ocenjevanja pravil se določijo vrednosti izhodnih podatkov na podlagi stopnje pripadnosti vhodnih spremenljivk, pri čemer se poiščejo pripadajoče vrednosti pripadnostnih funkcij izhodnih spremenljivk. Vrednosti vhodnih podatkov se uporabijo za vsa oblikovana pravila, pripadnostne funkcije izhodnih spremenljivk pa se združijo. V tej fazi se seštejejo vse posledice pravil. V fazi ostrenja pa se dobljene mehke vrednosti pretvorijo v številske vrednosti. Avtorici sta za to uporabili težiščno metodo (ang. *centroid method*), pri kateri se težišče (ang. *center of gravity* ali *COG*) izhodne mehke množice izračuna z naslednjo enačbo:

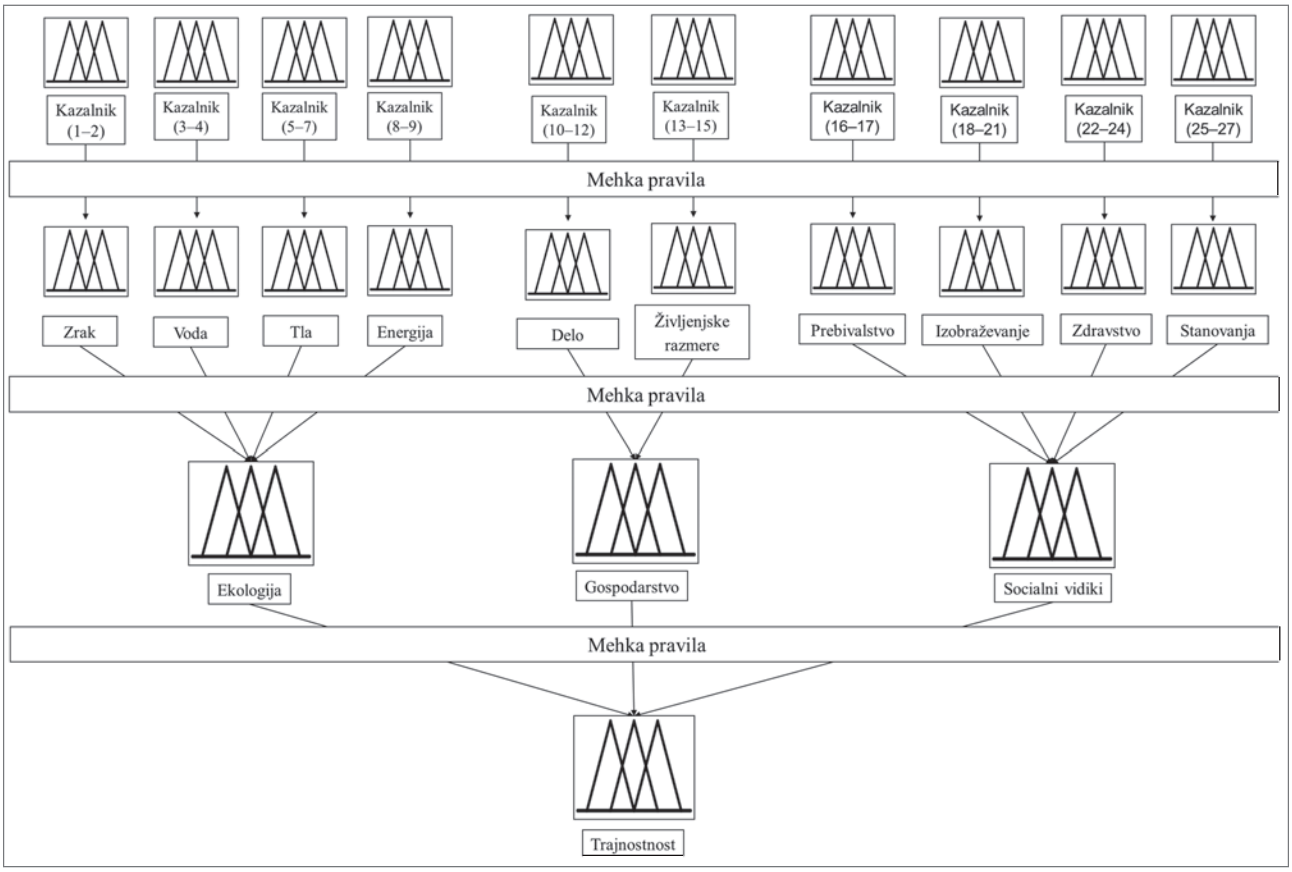
$$COG = \frac{\int_a^b \mu_{(x)} \cdot x \cdot dx}{\int_a^b \mu_{(x)} \cdot dx}$$

kjer je *μ_((x))* stopnja pripadnosti, *x* pa je vrednost te stopnje pripadnosti v izhodni funkciji.

S temi vrednostmi se izračuna težišče v mejah *a* in *b*, s čimer se pridobi številska vrednost izhodne funkcije. Računalniško orodje MATLAB Fuzzy Toolbox za računanje vrednosti trajnostnosti mest je predstavljeno na sliki 6. Številski podatki, ki se nanašajo na ekološko, gospodarsko in socialno komponento posameznega mesta, se sekajo s pripadnostnimi funkcijami v pravilih. Te vrednosti ustrezajo izhodnim mehkim množicam. Avtorici sta postopek uporabili za vsa pravila, vse izhodne množice pa sta združili. Nato sta izračunali težišče končne, združene množice in indeks trajnostnosti za posamezno mesto.

4 Rezultati

Avtorici sta rezultate za vsako od 81 turških provinc razdelili v pet kvantilnih razredov, pri čemer sta 16 mest uvrstili v prvi razred, 16 v drugi razred, 17 v tretji razred, 16 v četrti razred in 16 v peti razred. Nato sta mesta, urejena po vrstnem redu od najnižje do najvišje ravni trajnostnosti, tudi kartirali. Po istem sistemu sta razvrstili in kartirali tudi rezultate za glavne komponente mest (ekologijo, gospodarstvo in socialne vidike). Pri opisih rezultatov analize glavnih komponent so vsakokrat posebej izpostavljeni rezultati treh turških mest z največ prebivalci: Istanbula, Ankare in Izmirja.



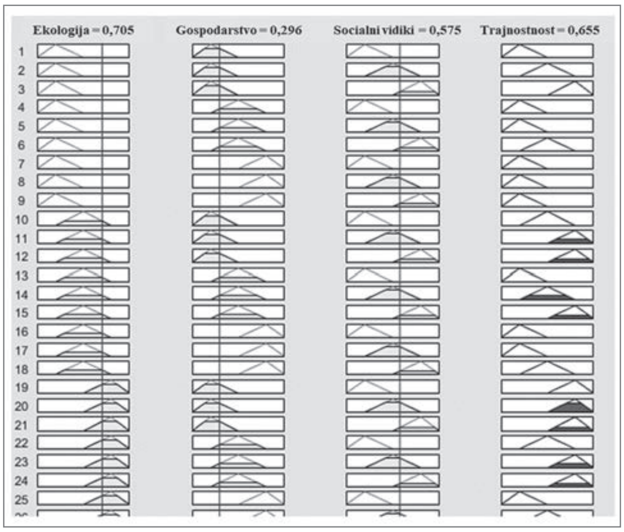
Slika 5: Model trajnostnosti (ilustracija: avtorici)

4.1 Ekologija

Pri glavni komponenti ekologija sta avtorici v okviru štirih podkomponent proučili devet kazalnikov. Rezultati so pokazali, da najnižjo stopnjo ekološke trajnostnosti dosega Malatya (uvrščena v prvi razred). Sledijo ji province Hakkari, Batman, Hatay in Burdur. Najvišjo stopnjo dosega Karaman, ki mu sledijo province Erzurum, Sakarya, Gaziantep in Ankara (uvrščene v zadnji, peti razred). V preglednici 1 so prikazani vrednosti stopenj ekološke trajnostnosti za vsa proučevana mesta in razredi, ki jim pripadajo. Ankara v primerjavi z Istanbulom in Izmirjem dosega višjo stopnjo ekološke trajnostnosti, saj je v petem razredu (Istanbul je v drugem, Izmir pa v tretjem).

4.2 Gospodarstvo

Pri glavni komponenti gospodarstvo sta avtorici v okviru dveh podkomponent proučili šest kazalnikov. Dobljene vrednosti so bile nižje kot pri drugih glavnih komponentah. Najnižjo gospodarsko trajnostnost dosega Mardin, najvišjo pa Bursa. Izmir je v tretjem razredu, Istanbul in Ankara pa sta v četrtem razredu. Po visoki gospodarski trajnostnosti izstopata pokrajini Egej in Jugovzhodna Anatolija.



Slika 6: Orodje MATLAB Fuzzy Toolbox (ilustracija: avtorici)

4.3 Socialni vidiki

Glavna komponenta socialni vidiki je vključevala največ kazalnikov (12), te sta avtorici proučevali v okviru štirih podkomponent. Najnižjo socialno trajnostnost dosega Sinop, sledijo pa Ağrı, Şanlıurfa, Afyonkarahisar in Gaziantep. Najvišjo stopnjo trajnosti na socialnem področju dosega Istanbul, sledijo pa mu Antalya, Aydın, Ankara in Artvin. Izmir, Ankara in Istanbul so vsi v najvišjem, petem razredu.

Preglednica 2: Ekološka trajnostnost

Razred	Province
1. (najnižji)	Malatya (0,293), Hakkari (0,295), Batman (0,297), Hatay (0,3), Burdur (0,308), Kırşehir (0,421), Amasya (0,423), Tokat (0,424), Muğla (0,44), Rize (0,442), Aydın (0,45), Ardahan (0,463), Zonguldak (0,475), Ordu (0,475), Bilecik (0,481), Adıyaman (0,483)
2. (nizek)	Erzincan (0,486), Sinop (0,490), Bitlis (0,495), Tunceli (0,498), Uşak (0,499), Mardin (0,501), Kahramanmaraş (0,503), Osmaniye (0,508), Bayburt (0,509), Düzce (0,509), Kırıkkale (0,510), Istanbul (0,519), Kırklareli (0,519), Gümüşhane (0,528), Aksaray (0,529), Bartın (0,532)
3. (srednji)	Van (0,533), Kütahya (0,536), Samsun (0,536), Çorum (0,543), Bursa (0,545), Tekirdağ (0,55), Giresun (0,556), Edirne (0,57), Antalya (0,573), Nevşehir (0,577), Izmir (0,578), Niğde (0,580), Karabük (0,585), Elazığ (0,593), Trabzon (0,593), Konya (0,595), Kars (0,597)
4. (visok)	Denizli (0,652), Eskişehir (0,614), Yozgat (0,630), Şırnak (0,657), Manisa (0,616), Afyonkarahisar (0,547), Çanakkale (0,636), Siirt (0,651), Kocaeli (0,635), Diyarbakır (0,562), Çankırı (0,602), Kilis (0,609), Kastamonu (0,579), Şanlıurfa (0,507), Balıkesir (0,599), Artvin (0,640)
5. (zelo visok)	Muş (0,645), Isparta (0,631), Kayseri (0,644), Bolu (0,647), Mersin (0,653), Adana (0,655), Bingöl (0,647), Iğdır (0,656), Yalova (0,629), Ağrı (0,567), Sivas (0,662), Ankara (0,660), Gaziantep (0,561), Erzurum (0,660), Karaman (0,665), Sakarya (0,614)

Vir: avtorici

Preglednica 3: Gospodarska trajnostnost

Razred	Province
1. (najnižji)	Mardin (0,284), Kahramanmaraş (0,286), Osmaniye (0,286), Şırnak (0,286), Siirt (0,290), Kırşehir (0,292), Nevşehir (0,292), Niğde (0,292), Batman (0,293), Sivas (0,293), Yozgat (0,294), Şanlıurfa (0,297), Hatay (0,300), Sinop (0,30), Ardahan (0,303), Kars (0,303), Iğdır (0,303)
2. (nizek)	Diyarbakır (0,319), Hakkari (0,364), Aksaray (0,365), Kırıkkale (0,381), Edirne (0,385), Amasya (0,387), Çorum (0,387), Karaman (0,389), Kastamonu (0,391), Tokat (0,391), Konya (0,392), Kayseri (0,395), Muş (0,399), Bitlis (0,400), Çankırı (0,407) Samsun (0,414)
3. (srednji)	Izmir (0,419), Gaziantep (0,420), Adıyaman (0,424), Bartın (0,424), Karabük (0,424), Kilis (0,424), Van (0,424), Zonguldak (0,424), Ağrı (0,424), Kırklareli (0,429), Erzurum (0,432), Bayburt (0,437), Mersin (0,466), Adana (0,476), Çanakkale (0,482), Balıkesir (0,484)
4. (visok)	Erzincan (0,492), Gümüşhane (0,492), Ordu (0,492), Giresun (0,492), Trabzon (0,493), Rize (0,493), Ankara (0,499), Istanbul (0,500), Afyonkarahisar (0,531), Tekirdağ (0,557), Aydın (0,558), Düzce (0,562), Sakarya (0,564), Isparta (0,570), Bolu (0,576), Yalova (0.582)
5. (zelo visok)	Kocaeli (0,583), Kütahya (0,588), Artvin (0,592), Burdur (0,598), Manisa (0,604), Uşak (0,609), Malatya (0,609), Bingöl (0,610), Elazığ (0,610), Tunceli (0,610), Denizli (0,669), Muğla (0,672), Antalya (0,677), Bilecik (0,691), Eskişehir (0,696), Bursa (0,703)

Vir: avtorici

4.4 Stopnja dosežene skupne trajnostnosti

Iz analize skupne trajnostnosti na podlagi podatkov iz leta 2022 je razvidno, da najnižje stopnje dosegajo province Bilecik, Malatya, Bursa, Burdur in Uşak, najvišje pa Erzurum, Karaman, Kahramanmaraş, Osmaniye, Sivas in Istanbul (preglednica 4). Vidne so razlike v posameznih pokrajinah, višje stopnje trajnostnosti pa so značilne za mesta v osrednji Turčiji. Poleg tega so opazne tudi precejšnje razlike med provincami.

5 Razprava

Avtorici sta v raziskavi z modelom mehke logike proučili stopnjo trajnostnosti turških mest. Uporabljeni model je vključeval tri glavne komponente (tj. gospodarstvo, ekologijo in socialne vidike) in 27 kazalnikov. Rezultati raziskave so pokazali, da turška mesta dosegajo različne stopnje trajnostnosti. Pri njihovi primerjavi z rezultati prejšnjih raziskav so razvidne nekatere razlike in podobnosti.

Preglednica 4: Socialna trajnostnost

Razred	Province
1. (najnižji)	Sinop (0,297), Ağrı (0,301), Şanlıurfa (0,350), Afyonkarahisar (0,398), Gaziantep (0,402), Kırşehir (0,404), Bitlis (0,405), Van (0,413), Niğde (0,438), Tekirdağ (0,442), Diyarbakır (0,451), Sakarya (0,456), Kütahya (0,459), Kastamonu (0,460), Mardin (0,461), Balıkesir (0,465)
2. (nizek)	Bartın (0,472), Uşak (0,473), Yalova (0,474), Kars (0,475), Manisa (0,476), Yozgat (0,477), Batman (0,485), Bursa (0,490), Hatay (0,492), Kocaeli (0,493), Çankırı (0,495), Nevşehir (0,496), Kırıkkale (0,498), Gümüşhane (0,500), Sivas (0,500), Siirt (0,501)
3. (srednji)	Muş (0,501), Bilecik (0,502), Aksaray (0,507), Tunceli (0,507), Kahramanmaraş (0,514), Düzce (0,515), Osmaniye (0,521), Adıyaman (0,527), Hakkari (0,535), Malatya (0,536), Zonguldak (0,537), Kayseri (0,538), Burdur (0,539), Konya (0,539), Çorum (0,540), Karaman (0,540), Kilis (0,540)
4. (visok)	Mersin (0,540), Amasya (0,540), Şırnak (0,542), Bolu (0,544), Karabük (0,546), Elazığ (0,552), Erzurum (0,556), Çanakkale (0,559), Denizli (0,560), Kırklareli (0,561), Adana (0,575), Iğdır (0,590), Rize (0,590), Bingöl (0,594), Samsun (0,601), Muğla (0,620)
5. (zelo visok)	Tokat (0,623), Giresun (0,626), Bayburt (0,629), Erzincan (0,638), Ardahan (0,641), Trabzon (0,642), Ordu (0,647), Isparta (0,649), Edirne (0,651), Eskişehir (0,654), Izmir (0,671), Artvin (0,686), Ankara (0,688), Aydın (0,702), Antalya (0,704), Istanbul (0,711)

Vir: avtorici

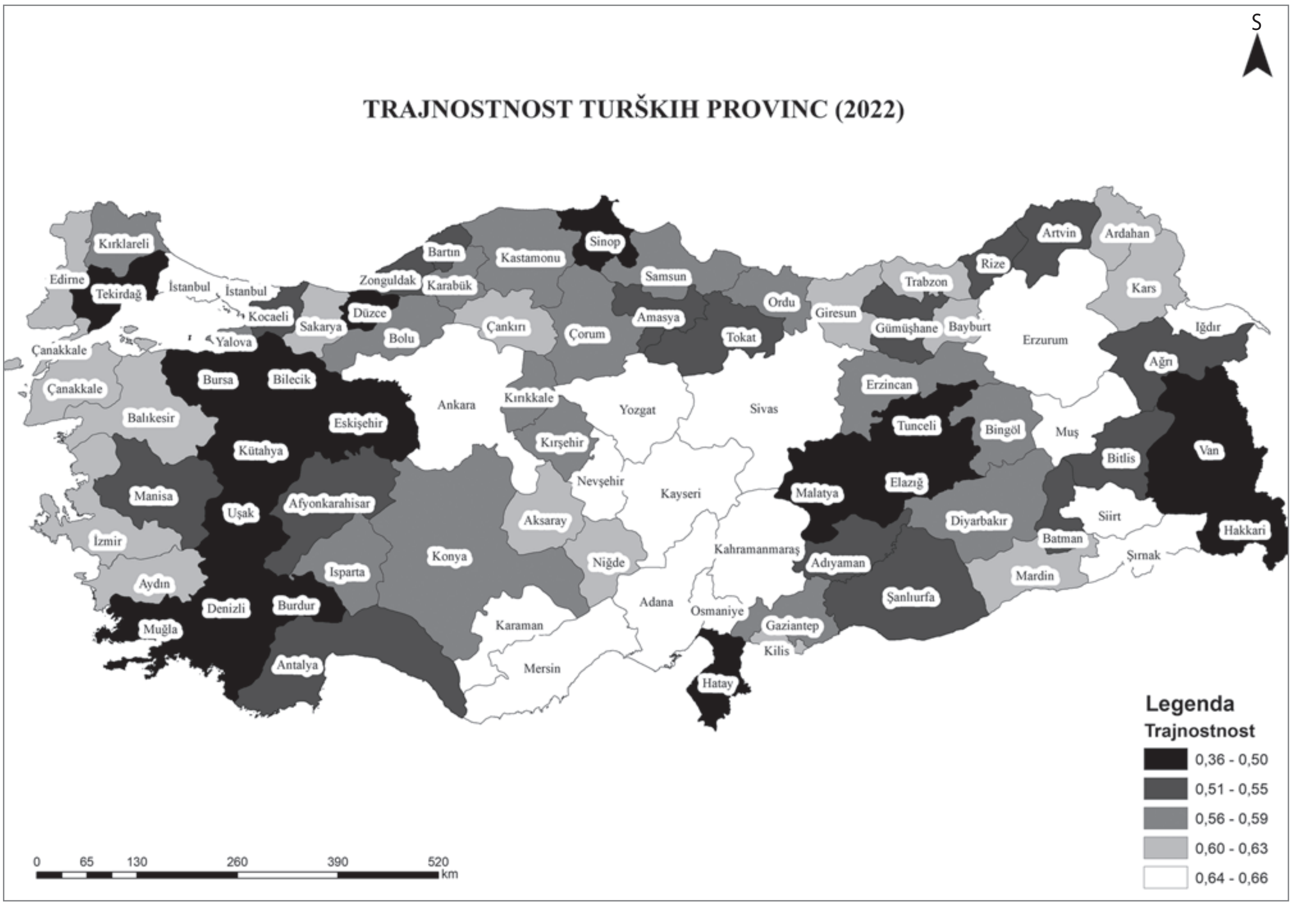
Preglednica 5: Skupna stopnja dosežene trajnostnosti

Razred	Province
1. (najnižji)	Bilecik (0,359), Malatya (0,386), Bursa (0,394), Burdur (0,396), Uşak (0,417), Tunceli (0,423), Denizli (0,460), Hakkari (0,460), Kütahya (0,463), Düzce (0,464), Muğla (0,472), Eskişehir (0,478), Elazığ (0,490), Van (0,493), Tekirdağ (0,494), Sinop (0,497)
2. (nizek)	Hatay (0,500), Batman (0,50), Bitlis (0,503), Manisa (0,508), Ağrı (0,509), Afyonkarahisar (0,511), Antalya (0,516), Rize (0,522), Amasya (0,523), Gümüşhane (0,523), Tokat (0,529), Kocaeli (0,532), Şanlıurfa (0,532), Bartın (0,535), Zonguldak (0,538), Adıyaman (0,544)
3. (srednji)	Artvin (0,554), Kırklareli (0,556), Bingöl (0,558), Isparta (0,560), Karabük (0,566), Kırşehir (0,567), Gaziantep (0,571), Bolu (0,574), Diyarbakır (0,577), Samsun (0,577), Yalova (0,577), Kastamonu (0,580), Konya (0,581), Çorum (0,585), Ordu (0,586), Kırıkkale (0,588), Erzincan (0,590)
4. (visok)	Çanakkale (0,591), Aydın (0,593), Niğde (0,594), Balıkesir (0,594), Giresun (0,594), Ardahan (0,596), Bayburt (0,597), Sakarya (0,599), Aksaray (0,601), Çankırı (0,603), Trabzon (0,606), Kilis (0,610), Edirne (0,613), Kars (0,621), Mardin (0,622), Yozgat (0,627), Izmir (0,627)
5. (zelo visok)	Muş (0,645), Kayseri (0,646), Mersin (0,649), Siirt (0,651), Nevşehir (0,653), Adana (0,655), Iğdır (0,655), Ankara (0,658), Şırnak (0,658), Karaman (0,660), Istanbul (0,661), Sivas (0,662), Osmaniye (0,664), Kahramanmaraş (0,664), Erzurum (0,665)

Vir: avtorici

V raziskavi, ki jo je izvedla družba MasterCard (2011), je bilo uporabljenih 69 kazalnikov v okviru gospodarske, socialne in okoljske komponente, njeni rezultati pa so pokazali, da so zahodne turške pokrajine bolj trajnostne, vzhodne in jugovzhodne pa manj. Gazibey in sodelavci (2014) so uporabili 52 kazalnikov in za najbolj trajnostna mesta določili Kocaeli, Istanbul, Ankaro, Izmir in Canakkale, za manj trajnostna pa Adiyaman, Mardin, Şanlıurfo, Kilis in Hakkari. Navedeni rezultati potrjujejo hipotezo, da je zahodna Turčija bolj trajnostna, jugovzhodne turške pokrajine pa so dosegajo nižjo stopnjo trajnostnega razvoja. Alptekin in Saraç (2017) sta proučila 51 kazalnikov v okviru gospodarske, socialne in okoljske komponente. Na podlagi podatkov iz leta 2013 sta med najbolj trajnostna turška mesta uvrstila Istanbul, Ankaro, Antalyo, Kocaeli in Izmir, med manj trajnostna pa Kilis, Duzce, Sinop, Bartin in Kastamonu. Tudi njuni izsledki kažejo, da je zahodna Turčija bolj trajnostna, mesta ob Črnem morju in v jugovzhodni Anatoliji pa so manj trajnostna.

Raziskava, ki so jo opravili Kusakci in sodelavci (2022), je temeljila na 53 kazalnikih v okviru gospodarske, okoljske,



Slika 7: Trajnostnost turških provinc (ilustracija: avtorici)

socialne in institucionalne komponente, a se je osredotočala samo na 30 največjih turških mest. Med najbolj trajnostna mesta so bili uvrščeni Antalya, Mugla, Eskisehir, Ankara in Kocaeli, med manj trajnostna pa Van, Mardin, Ordu, Diyarbakir in Şanlıurfa. Podobno kot druge raziskave je tudi ta potrdila, da so jugovzhodne turške province manj trajnostne, v nasprotju z drugimi raziskavami pa je pokazala, da osrednja Anatolija in sredozemske pokrajine dosegajo visoko stopnjo trajnostnosti. To je verjetno posledica uporabe drugačnega modela in metodologije ter vplivov pandemije v letu, ko so se zbirali podatki (slika 7).

V vseh raziskavah trajnostnosti turških mest so bila primerjana tri največja mesta po številu prebivalcev: Istanbul, glavno mesto Ankara in Izmir. V raziskavi, predstavljeni v tem članku, sta avtorici na podlagi uporabljenega analitičnega modela ugotovili, da je med njimi najbolj trajnosten Istanbul, Ankara je na drugem mestu, Izmir pa na tretjem. Njuni izsledki se ujemajo s podobnimi raziskavami v literaturi, ki kažejo, da so mesta z večjim številom prebivalcev, kot so tista na velikih metropolitanskih območjih, po navadi bolj trajnostna od manjših. Izsledki njune raziskave so pokazali še, da so lahko manjša mesta po doseženi stopnji trajnostnosti konkurenčna večjim mestom, kar kaže potrebo po boljšem izkoriščanju trajnostnega potenciala manjših naselij. Za najbolj trajnostno provinco se je izkazal Erzurum, kar lahko pripišemo pravilom in prožnosti metode mehke logike. Hkrati je treba opozoriti, da ima tudi njuna raziskava nekatere omejitve. Dve izmed teh sta, da se uporabljeni podatki nanašajo samo na izbrano obdobje in da so bile za izbor kazalnikov uporabljene enake uteži. V prihodnjih raziskavah bi se zato lahko proučili učinki uporabe raznih kazalnikov in uteži.

6 Sklep

Mesta so že od nekdaj pomembna središča družbenega, gospodarskega in kulturnega razvoja. S pospešeno urbanizacijo, čedalje večjo rastjo prebivalstva in naraščajočimi vplivi na okolje je trajnostnost zanje postala pomembno vprašanje. Trajnostna mesta na podlagi načrtovanja, upravljanja in tehnologije zagotavljajo dolgoročno privlačnost za bivanje in dolgotrajno blaginjo prebivalcev z okoljskega, gospodarskega in socialnega vidika. Prizadevajo si doseči cilje trajnostnega razvoja ter s tem ustvariti zdravo in privlačno bivalno okolje za prihodnje rodove. Oblikovalcem politike, lokalnim upravam, urbanistom in akademikom so na voljo zelo raznovrstni kazalniki trajnostnega razvoja.

Avtorici sta v raziskavi, predstavljeni v tem članku, merili trajnostnost turških mest z metodo mehke logike, pri čemer sta kot glavne komponente analize proučevali gospodarstvo, ekologijo in socialne vidike. Mesta sta na podlagi dosežene stopnje trajnostnosti razdelili v kvantilne razrede. Izsledki raziskave lahko pomagajo ugotoviti, katera področja trajnostnega razvoja v mestih bi bilo treba izboljšati. Mehka logika velja za pomembno analitično orodje na področju merjenja trajnostnosti, saj lahko zmanjša negotovosti in kompleksnosti. Z modelom, uporabljenim v tej raziskavi, bodo lahko urbanisti, oblikovalci politik in odločevalci lažje razvili strategije in politike za ustvarjanje bolj trajnostnih mest, ki bodo tudi privlačnejša za bivanje. Predstavljeni model je ponovljiv in prilagodljiv, omogoča primerjave na podlagi številskih rezultatov in prispeva k literaturi na področju merjenja trajnostnosti mest. V nadaljnjih raziskavah bi se lahko uporabil za podatke, ki se nanašajo na druga leta, primerjavo rezultatov in odkrivanje sprememb v trajnostnosti mest v daljšem obdobju.

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Opomba

Članek je bil napisan na podlagi doktorske disertacije z naslovom Proučevanje trajnostnosti mest in naselij v Turčiji z uporabo pristopa mehke logike in modela pametnih ekoloških stanovanjskih območij avtorice Ece Özmen, študentke doktorskega programa Urbanizem in regionalno načrtovanje na Inštitutu za podiplomske študije Tehnične univerze v Istanbulu.

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UDC: 711.4:004.8:005.52 (497.115)
doi:10.5379/urbani-izziv-en-2023-34-02-01

Received: 4 April 2023
Accepted: 16 June 2023

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A study of components predicting smart governance in Prishtina, Kosovo

This research pinpoints key drivers of smart governance in Prishtina, Kosovo, using a quantitative approach. A self-report survey with 1,536 respondents, selected through stratified probability sampling, provided the necessary data. Principal component analysis was applied to assess the questionnaire's internal structure, and regression analysis helped reveal smart governance predictors. Two pivotal findings emerged concerning Prishtina's smart governance. Smart city management and smart collaboration were the most significant determinants, with the former demonstrating a slightly stronger correlation. These results underscore the role of effective city management practices and stakeholder collaboration in directing governance outcomes in smart cities. In light of this, policymakers are advised to emphasize stakeholder collaboration in smart city initiatives. For Prishtina, this translates into increased cooperation, transparency, accessibility to data in management practices, and a focus on infrastructure and public services to enhance smart city governance.

Keywords: smart city management, smart collaboration, smart governance, Prishtina, Kosovo

1 Introduction

Effective implementation of smart city projects requires strong governance mechanisms that integrate multiple stakeholders (Ruhlandt, 2018). Information and communications technology (ICT) can improve general governance, leading to efficient resource allocation, collaboration, communication of rules and policies, and social innovations, referred to as smart governance (Backus, 2001; O'Reilly, 2011). Smart governance involves the interaction of technologies, people, policies, practices, resources, social norms, and information that foster city governance efforts (Chourabi et al., 2012). It encompasses government-to-citizen (G2C), government-to-business (G2B), and government-to-government (G2G) governance (cf. Bernardo, 2017; Anindra et al., 2018). Smart governance consists of three core components: stakeholder involvement, ICT services, and network-oriented connections, such as collaborations or partnerships (Gil-Garcia et al., 2015).

Components of smart governance encapsulate stakeholder roles and duties, frameworks, and institutions that regulate the interplay and alliances among stakeholders, and procedures associated with sharing information, collaboration, formulating decisions, and execution. In addition, they incorporate technologies and data that facilitate competent governance, along with policy and legislative structures to address challenges related to smart cities (Bolivar & Meijer, 2016; Meijer, 2016; Chelvachandran et al., 2020; El-Ghalayini & Al-Kandari, 2020; Razmjoo et al., 2021). Outcomes of smart governance and their corresponding metrics include wellbeing, social and digital inclusion, amenities delivered, public involvement, funding allocated for smart governance endeavours, economic expansion, and job opportunities (Castelnovo et al., 2016; Ruhlandt, 2018; Herdiyanti et al., 2019; Alsaid, 2021). Situational elements such as the level of autonomy enjoyed by smart cities or local circumstances also predict smart governance outcomes and components (Bolívar & Meijer, 2016; Meijer, 2016; Ruhlandt, 2018).

Smart city governance is a collaborative hybrid model involving public administration, the private sector, and citizen participation (Sancino & Ve Hudson, 2020). Rather than purely being a tech-driven initiative, it incorporates strategic use of administrative organizations, governance-oriented policies, and information resources (Nam & Pardo, 2011). ICT-based governance (Chourabi et al., 2012) extends beyond technology, combining social norms and information resources, thereby enhancing city management and streamlining decision-making. Notably, the evolution of smart city governance creates new dynamics in stakeholder relationships. According to Shelton et al. (2015), data-driven governance projects lead to the formation of extra-regional networks among key actors and institutions, thereby shaping urban futures through targeted plan financing and implementation. Angelidou (2015) further posits that active participation and stakeholder coordination form the bedrock of smart governance. In essence, smart city governance hinges on technological integration, strategic partnerships, and active stakeholder involvement, heralding a shift toward data-driven, citizen-centric urban management.

The use of different dimensions to enhance the city's smart governance system requires strategic prioritization and innovative financing mechanisms to support the development of smart city infrastructure and service improvement, particularly in developing countries with large informal economies. Therefore, the research gap identified involves studying which dimensions of smart governance most significantly affect the implementation of smart governance in an understudied region such as Kosovo. Kosovo, as a developing country, has budgetary restrictions that make it challenging to meet all the city government needs. The findings of this study could help different city government structures in various developing countries that face similar financing and other challenges. They will better understand how to set strategic priorities in enhancing their smart governance system.

Based on the definition of the smart city concept, Prishtina is not considered a smart city in the global context (Nimani, 2014). One of the primary challenges that Prishtina faces in achieving smart governance involves leveraging innovation and technology to efficiently use resources. It also needs to ensure citizen participation through e-participation and e-governance, which are vital for addressing issues and enhancing the quality of life for residents (Ubo Consulting, 2020). Even though 97% of the population has internet access, along with a thriving ICT industry and a young population of millennial entrepreneurs and professionals with a disruptive vision, it remains uncertain whether Prishtina is effectively using these resources to move toward becoming a sustainable and digital city (Musliu, 2021). In light of this, it is crucial to prioritize smart governance, not only for Prishtina but also for other cities in Kosovo, based on smart city indicators to ensure their long-term success (Pallaska, 2020). Consequently, city policymakers need to propose measures to promote smart development.

To fill the research gaps identified in global literature and in a rapidly urbanizing city such as Prishtina, this study identifies the most important predictors of smart governance in Prishtina. This will contribute to the literature in this field, especially by prioritizing the most important dimensions influencing smart governance.

1.1 Literature review

The review of previous research reveals varying perspectives on what constitutes a smart city. Some sources view the smart city as smart governance, whereas others equate the smart city with innovative manners of decision making, innovative management, and innovative forms of cooperation (Meijer & Bolívar, 2016). One form of innovative management in smart developed countries is data-driven decision-making (Ahvenniemi et al., 2017), which requires an integrated approach to management, in which various stakeholders collaborate to achieve common goals (Spence, 2017). This can involve the use of innovative forms of cooperation such as co-creation, co-design, and co-production, which emphasize the involvement of residents and other stakeholders in planning and implementing smart city initiatives (Ahvenniemi et al., 2017).

Smart city management relies on integrating and optimizing infrastructure, including transportation, energy, waste management, and public services. Recent studies suggest several approaches to improving the sustainability and efficiency of urban infrastructure. Liu et al. (2017) proposed an integrated model for transportation, energy, and communication systems. However, implementing smart city infrastructure requires significant resources, and the presence of large informal economies can complicate the realization of smart city ideals (Allam & Dhunny, 2019). A strategic approach that prioritizes innovative financing mechanisms and technology can help address these challenges and facilitate the integration of smart technologies into urban areas. By doing so, governments can create more efficient and sustainable cities, resulting in enhanced quality of life for residents (Caragliu et al., 2011). Access to public services is also a crucial aspect of smart city management. Technology and innovation can improve the city's service delivery (Atthahara, 2018), and stakeholder collaboration, including businesses and community groups, is essential to city transformation (Ziozias & Anthopoulos, 2022). According to Bibri and Krogstie (2020), there has been an emerging trend of data-driven smart city management by employing innovative solutions in Barcelona, including artificial intelligence (Rijab & Melloulli, 2018). There have been improvements in smart city management, especially with respect to the digitalization of public transportation in Barcelona through electronic ticket booking and validation self-service (Chiscano & Darcy, 2022), and a unified ticketing system (Smith & Martin, 2021). Overall, community engagement is crucial to achieving effective strategic planning and successful city transformation.

City managers should pay attention to residents' and stakeholders' concerns and include them in governance (Lopes 2017; Vrabie & Tirziu, 2021). Data accessibility through digitalization of towns can be used to improve decision-making and cities' e-governance (Deakin & Waer, 2011). Data transparency about decision-making helps cities achieve more legitimacy in the public eye (de Fine Licht & de Fine Licht, 2020). Data accessibility, decision-making transparency, and citizen participation in information about city decisions enhances a city's governance and decision-making structure (Jurado-Zambrano et al., 2023). Transparency creates greater trust and, as a consequence, makes possible clearer decision-making within city structures (Jacobs et al., 2022). In turn, data accessibility helps individuals and communities engage more in decision-making within a city with respect to issues that concern their lives. Data accessibility not only increases transparency and trust in the public eye but also leads to smart initiatives by residents, which overall enhances a city's decision-making and governance system. Data accessibility also has great potential to nurture digital culture among residents and a city's governance structures (Kaluarachchi, 2022). ICT-enabled systems create possibilities for individuals and businesses to be better informed about city decisions (Demirel & Mülazımoğlu, 2022).

In young democracies, smart city governance enhances residents' life quality through data-driven policymaking, partnerships, and citizen participation, as suggested by Pereira et al. (2018). This approach, underscored by the principles of collaborative governance (Angelidou, 2015; Grossi et al., 2020), focuses on infrastructural upgrades, IT literacy enhancement, and addressing socio-economic disparities, which are key to the development of a young democracy such as Kosovo (Dzihic, 2019; Domagala, 2020; Mustafa, 2020). This young democracy strongly emphasizes the involvement of residents in decision-making (Lombardi et al., 2012; Bifulco et al., 2017), facilitated by tools such as the e-Kosova platform (E-Kosova Platform, 2023) for smart governance. Furthermore, trust, better coordination, security, and transparency are fostered through multi-stakeholder collaboration (Parenti et al., 2022), a vital aspect considering Kosovo's conflict history (Pallaska, 2020). The transition to collaborative governance harnesses Kosovo's unique strengths, including its youthful population and burgeoning tech sector (Angelidou, 2015), fuelling an inclusive, resilient, and sustainable urban future (Domagala, 2020; UNDP Kosovo, 2023).

Smart collaboration allows the participation of various stakeholders in decision-making, facilitating collaboration and transforming the way cities are managed (Oschinsky et al., 2022). Citizen input is essential in city decision-making, and e-participation is an effective way to achieve a user/citizen-centric approach to smart governance (Lim & Yigitcanlar, 2022). The involvement of residents leads to both smart city initiatives and their better implementation, enhancing the effectiveness of multiple stakeholder collaboration (Bastos et al., 2022; Parenti et al., 2022). Effective collaboration between stakeholders is crucial to building trust, ensuring better coordination, upholding security, and promoting transparency among parties involved in the implementation of smart city initiatives (Parenti et al., 2022). By ensuring the participation of various stakeholders in planning and decision-making, governance mechanisms become critical to smart city governance (Ruhlandt, 2018).

Smart governance, also referred to as e-governance or e-democracy, involves using modern communication channels to engage residents in decision-making. This concept places emphasis on the transparency of administrative systems and the availability of public services to facilitate citizen participation (Lombardi et al., 2012; Vanolo, 2014). The level of smart governance in the city is measured by the principles of transparency, cooperation, participation, and partnership, including city government accountability, which in turn positively affects residents' quality of life (Demirel & Mülazımoğlu, 2022). Public trust in city decisions allows better and clearer decision-making, consequently affecting city governance. Transparency fosters greater trust and, as a consequence, allows more precise decision-making for city structures (Jacobs et al., 2022). The responsiveness of local government reduces residents' concerns and enhances the value of citizen input (Guo et al., 2022). The city government's responsiveness to residents' concerns heightens residents' perception of local government effectiveness, contributing to smart governance (Wolf et al., 2020).

Based on a thorough literature review, this study addressed the following research question: Which components predict smart governance in Prishtina?

2 Methodology

The study adopts a quantitative research methodology, specifically using the correlational research method to investigate the statistical measure of relationships between variables. This method was chosen due to its ability to provide information about the strength and direction of a relation between two variables, as argued by Burns and Grove (2005) and Leedy and Omrod (2010). Principal component analysis is employed to account for the highest proportion of overall variance (not just common variance) within a correlation matrix by transforming the original variables into a set of linear components (Field, 2017). In this case, items are grouped into components based on their loadings or correlations with each other. This study used multiple regression to examine the predictors of smart governance.

2.1 Research design

This study uses a two-section questionnaire, as suggested by Grum and Temeljotov Salaj (2011). The first section of the questionnaire is composed of three questions aimed at gathering demographic information on sex, age, and education status. The second section contains twelve items related to the study variables, including smart city management, smart decision-making, smart collaboration, and smart governance, with each response on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The questionnaire was composed of questions related to the following items: 1) access to city infrastructure (transportation, energy, and waste management), 2) access to public services (healthcare, education, and public safety, 3) technology use in service improvement of the city, 4) decision-making transparency, 5) data accessibility, 6) information about city decisions, 7) contribution of residents to city decision-making, 8) stakeholder collaboration with city government, 9) effectiveness of city government in addressing multiple stakeholder concerns, 10) accountability of city government, 11) public trust in city decisions, and 12) city response to residents' concerns and needs.

The study used stratified random sampling to select participants, ensuring the representativeness of Prishtina's population in the study sample, as suggested by Jonker and Pennink (2010). The sample comprises 1,536 respondents from Prishtina. The stratification of respondents based on sex, age, education, employment, and job type was conducted in a proportional manner based on the data on sex, age, and education from the 2011 census for Prishtina. A sample of 1,807 participants was randomly selected through Facebook, designed to mirror the proportional stratification, as shown in Table 1. The response rate was 85%, or 1,536 respondents.

Table 1 shows the distribution of respondents according to their sex, age, and education. The strata used in this study are identical to the population strata of Kosovo for the 18 to 65 age group per the latest census (Kosovo Agency of Statistics, 2011).

The age groups from 18 to 65 represent 67% of the total population of Prishtina. The population from 0 to 18 and from 65 to 85 was excluded from the sample. In terms of education status, the active population belonging to the age group from 18 to 65 was taken into consideration for calculating the number of respondents in each stratum.

Given that the total population of Prishtina belonging to the age groups from 18 to 65 is 133,909 (Kosovo Agency of Statistics, 2011), the sample size of 1,536 respondents achieves a margin of error of 2.44%, which is an acceptable level of margin of error in the social sciences, which ranges from 3% to 7%, as suggested by Cochran (1977).

Table 1: Respondent structure.

Respondent type/category	Respondents		Prishtina population, 18–65	
	n	%	n	%
Prishtina	1,536	100.00	133,909	100.00
Sex				
Male	766	49.90	66,821	49.90
Female	770	50.10	67,088	50.10
Total	1,536	100.00	133,909	100.00
Age				
18 to 35	722	47.00	62,893	47.00
36 to 55	583	38.00	51,127	38.00
56 to 65	231	15.00	19,889	15.00
Total	1,536	100.00	133,909	100.00
Education				
Primary school	291	19.00	24,792	19.00
Secondary school	614	40.00	54,682	40.00
Bachelor's degree	552	36.00	48,004	36.00
Master's or doctoral degree	79	5.00	6,431	5.00
Total	1,536	100.00	133,909	100.00

2.2 Research procedure

The questionnaire was distributed to respondents via email through a Google Forms link. An introduction of the study and instructions were included in the form to ensure clarity. The authors selected a web-based survey due to its potential global reach, convenience, flexibility, and ease of data entry, as suggested by Evans and Mathur (2005), who argue that one of the significant strengths of online survey research is that lack of representativeness is no longer an issue because most societies now have internet access and are internet-savvy. Given the high internet penetration rate in Kosovo of 96% (Kosovo ICT Association, 2019), the web-based survey did not impinge on the credibility of the research instrument. The web-based survey was distributed through Facebook, bearing in mind that the number of Facebook users in Kosovo is 932,000 (Digital Kosovo, 2023), and in Prishtina the number of Facebook users is 170,000 (Hallakate, 2020), representing 86% of the total population of Prishtina.

2.3 Statistical analysis

The study used IBM SPSS 23.0 to analyse the quantitative study model to answer the research question. The study employed principal component analysis to explore the internal structure of the questionnaire and the emerging components from a set of items. Principal component analysis (PCA) was used as the initial extraction method. After the initial extraction of components, the study used the oblique rotation method (promax), assuming that the components were correlated. Rotation was employed to achieve a simpler and more interpretable component structure. Finally, the study used multiple regression analysis to examine the relationship between independent and dependent variables.

3 Results

To begin the quantitative study, a reliability analysis was conducted in IBM SPSS 23.0 to evaluate the consistency of twelve variables related to smart city management, smart decision-making, smart collaboration, and smart governance. First, a sampling adequacy test and the Bartlett sphericity test were performed. The KMO measure of 0.835 demonstrates that the chosen sample is sufficient. Bastič (2006) suggests that, for the sample to be adequately representative, the KMO value should exceed 0.5. The sphericity test score of 3927.751 points to a highly significant presence of dimensions that predict the perception of respondents in Prishtina with respect to smart governance. From an inter-item correlation matrix,[1] it became evident that the inter-item correlations were solid, and so the study could not exclude any of the items from the model, as suggested by Field (2017).

Further, an initial analysis was conducted to secure eigenvalues for every component within the data set. Three components surpassed Kaiser's criterion of 1 as suggested by Field (2017), and in combination accounted for 51.53% of the variance. Further, the study retained three components because of the large

Table 2: Component loadings of the smart city governance questionnaire.

	Component		
	1	2	3
Access to city infrastructure (transportation, energy, waste management)	.619	.028	–.073
Access to public services (healthcare, education, public safety)	.831	–.038	–.199
Technology use in service improvement	.708	–.224	.144
City decision-making transparency	.500	.198	.201
Data accessibility	.483	.310	.029
Information about city decisions	.228	.482	.118
Contribution to city decision-making	–.063	–.041	.679
Stakeholder cooperation with city government (businesses, community groups, interest groups)	.086	–.086	.766
Effectiveness of addressing multiple stakeholder concerns	–.050	–.022	.777
City government accountability	–.161	.447	.414
Public trust in city decisions	–.065	.901	–.109
City response to residents' concerns and needs	–.047	.804	–.073

Note: Extraction method = principal component analysis; rotation method = promax with Kaiser normalization,

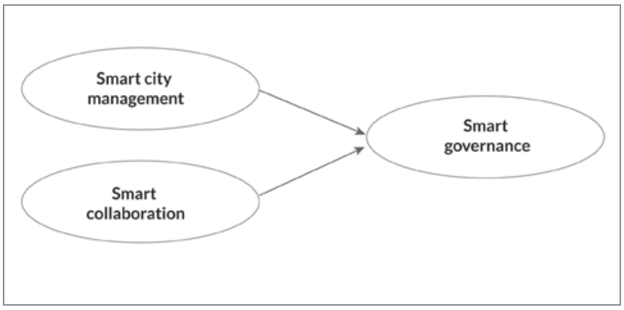

Figure 1: Hypothesized smart city governance model (illustration: authors).

sample size and the convergence of the scree plot and Kaiser's criterion on this value. Because the questions measure different aspects of smart city management, decision-making, collaboration, and governance, there could be an overlap or correlation between items. Therefore, an oblique rotation (promax) was used to extract component loadings. The rotated component loadings are shown in Table 2.

The items that load onto the same components use the criterion of component loadings of higher than 0.5, as suggested by Field (2017). Hence it is possible to establish the following three components:

- Component 1: Smart city management measured by the following five items: access to city infrastructure, access to public services, technology use in service improvement, transparency, and data accessibility,
- Component 2: Smart governance measured by the following four items: information about city decisions, city government accountability, public trust in city decisions, and the city's response to residents' needs and concerns;
- Component 3: Smart collaboration measured by the following three items: residents' contribution to city decision-making, stakeholder cooperation, and effectiveness of addressing the concerns of multiple stakeholders;

From the loaded items and established components, the design shown in Figure 1 can be established.

Components are often more reliable measures of complex phenomena compared to individual questions. To ensure reliability, Cronbach's alpha was calculated for three components in quantitative research (component one = 0.84, component two = 0.85, component three = 0.78). The results showed that all three components had values greater than 0.69, as recommended by Nunnally (1978). Given the high values, the study used linear regression with components one and three as independent variables and component two as the dependent variable.

Next, multiple regression analysis was used to predict smart governance as a dependent variable. The regression results indicate that the value of R^2 is 0.346, which indicates that 34.6% of smart governance is accounted for by component one (smart city management) and component three (smart collaboration), whereas the remaining amount ($1 - R^2$, or 65.4%) is explained by other dimensions that were not incorporated into the regression model. The regression results indicate that the components of smart city management and smart collaboration explain a significant amount of variance of smart governance with the following values ($F(2, 1532) = 405.91$, $p < 0.001$, $R^2 = 0.59$, $R^2_{adj} = 0.35$).

Table 3: Linear regression coefficients.

Model	Unstandardized coefficients		Standardized coefficients: beta	95% confidence interval for B	
	B	SE		Lower bound	Upper bound
(Constant)	1.005	.084		.841	1.169
Smart city management	.375*	.023	.365	.330	.419
Smart collaboration*	.332*	.021	.350	.291	.374

* $p < 0.001$

Finally, the regression coefficients are presented in Table 3, which indicate that both independent components have significant positive correlations with the dependent component. The standardized coefficients indicate that smart city management has a slightly stronger correlation with smart governance than smart collaboration.

4 Discussion

The findings of the study indicate that both smart city management and smart collaboration have a strong correlation with smart governance. Nevertheless, smart city management seems to have a slightly stronger correlation with smart governance than smart collaboration. The findings show that smart city management is the strongest predictor of smart governance in Prishtina. This is in line with previous research showing a strong relationship between the two components. Bakici et al. (2013) argue that smart city-management practices can enhance governance efficacy and effectiveness. This finding underscores the importance of investing in smart city management practices and offers a promising path for cities to elevate governance quality standards, encourage active involvement of residents, and bolster sustainability.

With respect to practical implications, city authorities and decision-makers should focus their efforts on financing technologies and adopting strategies that allow for effective control of city infrastructure and services while underscoring transparency, accountability, and residents' involvement to drive effective smart city governance. Moreover, future research could explore the specific instruments through which smart city management affects smart governance, as well as investigate the possible moderating effects of contextual elements on this relationship. Nonetheless, funding city-management initiatives such as access to city infrastructure, access to public services, technology use in service improvement, transparency, and data accessibility has significant financial implications for Prishtina as the capital of a developing country. This could represent a challenge for the city government and policymakers, who may need to strike a balance during prioritization between contending demands for limited resources. In addition, transparency and accountability in making these investments are another challenge. The focus on transparency and resident involvement indicates a necessity for open communication and collaboration between the government and residents to ensure that these investments are aligned with the city's best interests.

Smart collaboration is also a strong predictor of smart governance in Prishtina. The strong relationship between smart collaboration and smart governance has relevance for both theory and practice. This finding offers an understanding of the components that are essential for successfully implementing smart city initiatives in this region. Furthermore, this finding can be informative for policymakers in enhancing smart city governance in Prishtina. Collaboration is an essential component of effective smart governance, as argued by various scholars (Marsal-Llacuna, 2016; Bifulco et al., 2017; Ruhlandt, 2018). Stakeholder collaboration, including collaboration between residents, businesses, and government, plays a pivotal role in the successful implementation of smart city initiatives and projects (Caragliu et al., 2011; Lombardi et al., 2012). Various scholars such as Nam and Pardo (2011), Bifulco et al. (2017), and Lombardi et al. (2012) underscore the vital role that stakeholder collaboration has in creating and promoting smart city initiatives. This finding has relevance for both research and society. First, the finding adds relevance to the smart city governance literature. Second, it also offers a foundation for future research on successful collaboration. Finally, these research findings can guide city managers and policymakers in prioritizing collaboration for ensuring effective implementation of smart city initiatives. This insight can also be used to develop training programs and resources to enhance smart city collaboration, which can ultimately improve the implementation of smart city governance initiatives in Prishtina and elsewhere. However, there are various challenges that may arise during the implementation of such collaboration in a developing country like Kosovo. For example, building trust and cooperation among various stakeholders, especially in a context where residents' trust in government institutions is low, may be challenging. Furthermore, ensuring effective communication among stakeholders that may have different interests, goals, and expectations may also present a challenge. It is therefore essential for policymakers to consider these challenges and develop strategies to overcome them when promoting collaboration in smart city governance.

Based on the findings discussed above, the strategic implication for Prishtina would be to prioritize smart collaboration and smart city management practices in efforts toward smart city governance. The fact that these two components are the strongest predictors of smart governance suggests that Prishtina should focus on improving collaboration among stakeholders and developing transparent, data-accessible, and technology-driven smart city management practices focused on the improvement of infrastructure and public services. Policymakers, practitioners, and researchers in Prishtina should work toward improving collaboration and city management as a means of achieving more effective and efficient smart city governance.

5 Conclusion

The findings of this study can provide guidance to policymakers in prioritizing collaboration among stakeholders and implementing transparent, tech-driven smart city management in Prishtina, particularly with a focus on infrastructure and public services, aiming for more efficient governance. This study introduces a novel focus on smart collaboration as a key predictor of smart governance, making a significant contribution to smart city governance literature. It suggests that enhancing decision-making can foster better governance outcomes in smart cities and underscores the role of smart city management practices, particularly in developing contexts like Kosovo.

However, there are limitations to the study's correlation-based methodology, which precludes drawing cause-and-effect conclusions. The data, which are self-reported and derived from a single instrument, may suffer from bias and measurement errors. The findings, based on a potentially non-representative sample, may not apply universally, but rather primarily to contexts similar to Prishtina. Future research avenues include understanding the influence of smart city management practices on governance, identifying effective collaboration barriers, and evaluating the cost-effectiveness of various strategies and technologies. These avenues can provide more insight into management strategies, building trust and cooperation, and communication strategies amid conflicting interests. The findings reflect the democratic state of Kosovo, where residents' expectations mirror developed societies, but institutional trust is weaker due to centralized decision-making. Consequently, collaboration emerges as the most viable solution for cities like Prishtina.

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Notes

[1] The inter-item correlation matrix is available to readers upon request as supplementary material.

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UDC: 349.414:332.142.6 (560.11)
doi:10.5379/urbani-izziv-en-2023-34-02-02

Received: 27 March 2023
Accepted: 19 June 2023

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Multifactor sensitivity assessment for spatial planning in Izmir, Turkey

Sensitivity assessment produces data to guide spatial planning by determining areas that need to be protected. Izmir, the study area of this article, is a city with rich ecological values but rapidly changing spatiality. This study determines ecologically sensitive areas of Izmir and reveals the relationship between ecologically sensitive areas and spatial planning decisions. To achieve this goal, ecologically sensitive areas are defined by the Analytical Hierarchy Process (AHP) and overlapped with planning decisions. The study evaluates ecological factors and processes using nine main parameters and twenty-one sub-parameters. Each of the parameters selected was divided into ecological sensitivity levels. The result of the analysis found 16.8% of the area to have very high sensitivity, 18.5% high sensitivity, 22.7% average sensitivity, 28.5% low sensitivity, and 13.5% very low sensitivity. A comparison of these areas with the 1:100,000 Environmental Regulation Plan decisions showed that the planning decisions are not compatible with the ecological sensitivities of the study area. As a result, the study provides an ecological sensitivity assessment model that can contribute to improving decision-making processes in urban plans.

Keywords: ecological sensitivity assessment, analytic hierarchy process, GIS, spatial planning, Izmir

1 Introduction

Today, the exploitation of resources and uncontrolled human activities are causing the rapid transformation or disappearance of ecologically sensitive areas (IPBES, 2019; Powers & Jetz, 2019; Almond et al., 2020). This destruction is leading to the loss of habitats and a decrease in biological diversity, also causing the loss of ecosystems, which are essential for human life (McPhearson et al., 2015; Ritchie & Roser, 2021). To prevent these losses, it is necessary to integrate decision-making processes with ecological sensitivities in the planning process. Many different assessment tools and methodologies have been developed that integrate decision-making processes with environmentally sound perspectives (Singh et al., 2012; Dizdaroglu & Yiğitcanlar, 2016). In this context, ecological sensitivity assessment is a tool for obtaining reliable information about the area from an ecological point of view and making appropriate planning decisions (Dai et al., 2012; Liang & Li, 2012; Xie et al., 2015; Leman et al., 2016; Niu et al., 2020).

Ecologically sensitive areas are areas that contain various ecosystems that are necessary for the long-term management of soil, water, and other natural resources, especially biodiversity. They include forests, wetlands, steep slopes, and agricultural land (Ndubisi et al., 1995; Steiner et al., 2000). Although there are many studies that define ecologically sensitive areas using different approaches (Jennings & Reganold, 1991; Steiner et al., 2000; Hong et al., 2017), ecologically sensitive areas are generally defined as the level of response and/or adaptability of an area to environmental changes caused by internal and external factors (Mingwu et al., 2010; Liang & Li, 2012). In particular, external interventions cause natural areas to undergo spatial change processes, such as perforation, dissection, fragmentation, shrinkage, or attrition (Forman, 1995). One of the main reasons for these changes is due to the development of spatially inappropriate land-use decisions (Dai et al., 2012). In the last three decades, ecological sensitivity analysis has become a cutting-edge field of research, especially in ecological and environmental assessment, in terms of evaluating and defining ecologically sensitive areas to help guide spatial planning (Liang & Li, 2012).

Many approaches and methods are used in ecological sensitivity analysis (Steiner et al., 2000; Xie et al., 2015; Leman et al., 2016). Whereas early studies focused more on the environmental problems of a single species or event (Liang & Li, 2012), later research focused on specific issues, such as erosion susceptibility, desertification, and soil salinization (Leman et al., 2016). In recent years, the scope of the subject has been expanded, and studies that deal with multiple factors at the same time have used different spatial scales. Some of these studies focus on a specific area, such as wetlands and river basins (Steiner et al., 2000; Mingwu et al., 2010; Butt et al., 2019; Chi et al., 2019), or nature reserves (Liang & Li, 2012; Düzgüneş & Demirel, 2016) and parklands (Deng & Hu, 2012), and other studies on spatial scales have been expanded with evaluations made at the urban (Zhang et al., 2011; Pan et al., 2012; Niu et al., 2020; Yilmaz et al., 2020) and regional scale (Dai et al., 2012; Xie et al., 2015; Leman et al., 2016; Hong et al., 2017; Tsou et al., 2017).

These studies, which aim to identify ecologically sensitive areas, are generally carried out using geographic information systems (GIS) and remote sensing techniques. Integrated methods offered by GIS, such as analysis, synthesis, spatial query, quantitative measurements, and data management, are used to identify sensitive areas. Among these integrated methods, there are studies using the Analytical Hierarchy Process (Huang et al., 2010; Mingwu et al., 2010; Leman et al., 2016), the Fuzzy Logic method (Zhang et al., 2011), and the weighting method with various approaches (Hong et al., 2017; Butt et al., 2019), and studies using a combination of some of these methods (Niu et al.; 2020). In particular, these methods evaluate the sensitivity of areas through parameters such as soil conditions, atmospheric conditions, biodiversity, and hydrological structure, and the study area is levelled within the determined parameters (Xie et al., 2015). In most studies, ecological sensitivity is addressed at four or five levels on a scale from extreme to non-sensitive (Zhang et al., 2011; Dai et al., 2012; Liang & Li, 2012; Pan et al., 2012; Niu et al., 2020).

It has been emphasized by many studies that inappropriate decisions about land use damage the functionality of ecologically sensitive areas (Su et al., 2011; Dai et al., 2012; Butt et al., 2019; Niu et al., 2020). Nowadays, spatial planning is expected to include new approaches presented by ecological sensitivity analysis to reduce the destructive effect of human activities (Steiner et al., 2000; Liang & Li, 2012; Leman et al., 2016). However, as a result of neoliberal policies, the real estate and construction sectors have become one of the critical sectors behind economic growth since the 2000s in Turkey (Balaban, 2012). As a result, the planning process has become one of the most critical tools that guide the public sector to implement this growth model in cities (Öktem Ünsal, 2023). In this respect, the planning system in Turkey has established a balance between the market and the public interest (Salata et al., 2022). Nevertheless, this growth model – which is supported by planning as well as other factors, such as authority confusion in planning and plan revisions – has given rise to urban sprawl and environmental degradation, and it has ignored areas with ecological sensitivity in cities.

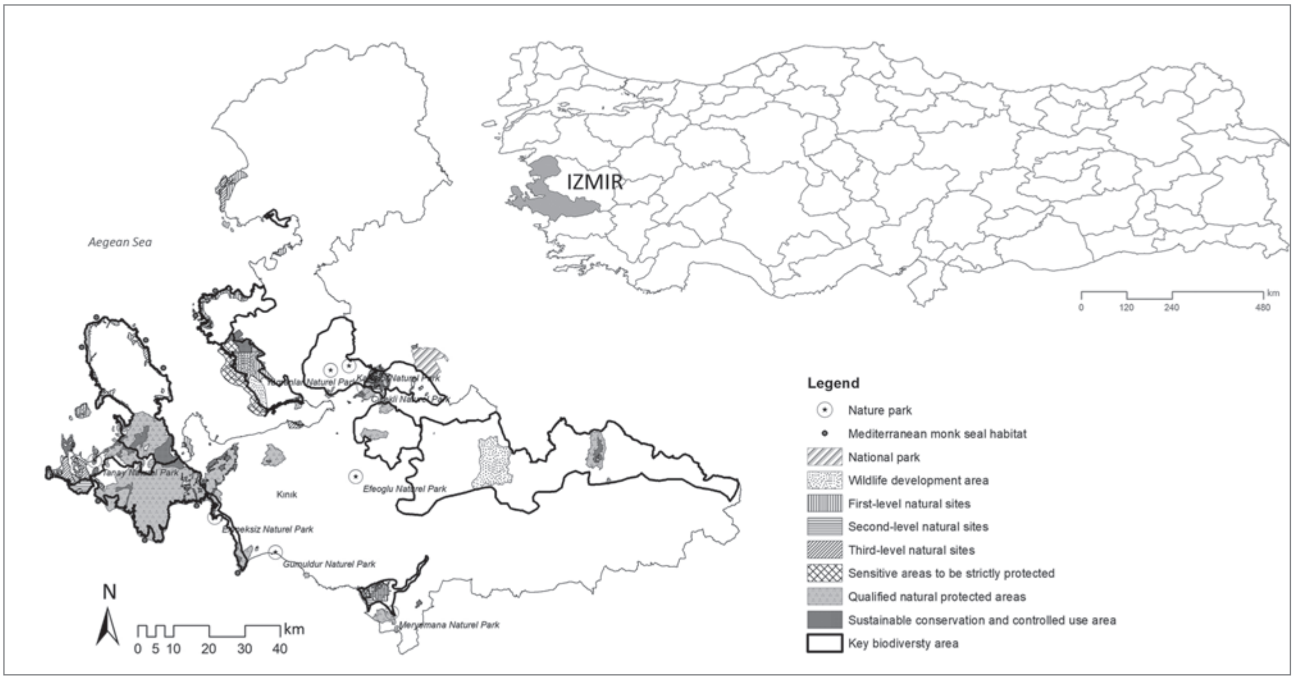

Figure 1: Location of the study area, regulated nature conservation areas, and key biodiversity areas (illustration: author).

This study determines areas of ecological sensitivity and compares them with the Environmental Regulation Plan (ERP) to reveal contradictions between planning decisions and ecological sensitivity, and to offer an ecological sensitivity analysis model that can assist decision-making processes for planning.

2 Materials and methods

2.1 Description of the study area

Izmir, which is the third-largest city in Turkey by population and urbanization rate, was examined as the study area (Figure 1). The morphological structure of the city, which covers 12,012 km^2, plays an important role in the formation of the natural and built environment.

The area has many different ecosystems, including terrestrial and aquatic ecosystems. However, Izmir has been affected by the migration waves experienced in Turkey since the 1950s, and it began to urbanize rapidly in the 1960s, which has led to increased pressures, especially on its ecosystems. Due to the wide ecological diversity of Izmir, conservation areas with various statuses (wildlife development areas, nature parks, natural monuments, Ramsar areas, special environmental protection areas, and natural protected areas of different levels) were created within the legal administrative framework. In addition, these areas are evaluated within the scope of the plans implemented in Turkey.

In Turkey, there are plans at different scales and scopes in the planning hierarchy. National development plans at the highest scale are followed by the national spatial strategy plan and ERP at scales of 1:100,000 or 1:25,000 prepared by the Ministry of Climate Change, Environment, and Urbanism. In addition, metropolitan municipalities prepare 1:25,000 and 1:5,000 master development plans, and district municipalities prepare 1:1,000 implementation plans. With regard to the plans and decisions guiding the spatial development of the city, many different plans were produced soon after 1923, but the 1:25,000 master plan for Izmir was approved in 1973. In this planning period, which was in force between 1973 and 2002, many different revisions of planning decisions at the 1:5,000 and 1:1,000 scales were also implemented. In 2007, the 1:100,000 ERP, which included the Izmir, Manisa, and Kütahya regions and was prepared by the central government, remained in effect until it was cancelled in 2011. In 2012, Izmir was designated a metropolitan municipality by law no. 6360, and in 2014 the entire provincial area became a metropolitan municipality. In 2013, the Metropolitan Municipality of Izmir implemented the 1:25,000 Izmir Metropolitan Whole Environmental Regulation Plan.

The new ERP, which covers the Izmir and Manisa regions, was prepared and implemented in 2014, and it is still in effect with revisions made at various dates. It received criticism from the public because this plan was not prepared using the current data for the area, and the process of creating the plan was also criticized (TMMOB, 2020; Salata et al., 2022). This plan is at the top of the planning hierarchy. Ignoring ecological sensitivities is one of the most significant problems of the plan.

2.2 Methods

2.2.1 Establishment of ecological sensitivity evaluation units

The method used in this study consists of five stages. In the first stage, the research area was divided into ecological units in accordance with the evaluation level of the inventory data. In the literature research, two different techniques are used for ecological units. The first of these is based on overlapping areas within the scope of each specified parameter according to the evaluation scale, and it is a technique in which vector data are mainly used (Mingwu et al., 2010; Zhang et al., 2011; Yilmaz et al., 2020). The second is the division of the area into cell units of certain sizes. This technique is mostly used in studies in which raster data alone are used, or raster data and vector data are used together (Dai et al., 2012; Leman et al., 2016; Hong et al., 2017; Butt et al., 2019; Niu et al., 2020). Within this study, the cell unit technique was used and all of Izmir was divided into a 500 × 500 m grid system, after which evaluations were made. The main reason for choosing this technique in this study was to obtain a data set that is compatible with the scale of the plan to be compared.

2.2.2 Selecting evaluation parameters

The second step is the selection of ecological sensitivity evaluation parameters. To objectively evaluate ecologically sensitive areas, the selection of appropriate evaluation parameters and determination of evaluation levels are of great importance for the accuracy of the study (Zhang et al., 2011; Leman et al., 2016). In addition, each parameter that plays a major role in determining ecological sensitivity should be selected based on the characteristics of the study area and the scale of the study (Hong et al., 2017).

Each parameter used for the research was determined to include ecological factors and processes, considering previous studies and the characteristics of the area (Table 1). Within the scope of the evaluation, two principal evaluation categories – ecological factors and processes – were applied to the study area. Ecological factors in the study are defined as features (topography, soil, microclimate, etc.) that determine the sensitivity of an area. In addition, the distance to industrial areas affects the ecological sensitivity of that area. Therefore, distance to industrial areas is considered a factor in this study. Ecological processes, which are not static, but instead have a dynamic structure, are defined as the ecological cycles that take place within an area. In addition, ecological processes are directly affected by the ecological characteristics of the area.

There are numerous processes in an area, including water infiltration into the soil, soil transport, and the carbon cycle. This study examines water infiltration and soil transport. In this context, the two evaluation categories were evaluated based on nine parameters and twenty-one sub-parameters. Five reference values were determined, ranging from 1 to 5 as follows: 1 = very low sensitivity, 2 = low, 3 = average, 4 = high, and 5 = very high. Reference values for all parameters were determined according to the relevant literature (Mingwu et al., 2010; Zhang et al., 2011; Dai et al., 2012; Deng & Hu, 2012; Pan et al., 2012; Düzgüneş & Demirel, 2016; Leman et al., 2016; Özhancı & Yılmaz, 2018; Alphan & Çoşkun Hepcan, 2019; Karadağ & Şenik, 2019; Niu et al., 2020; Yilmaz et al., 2020) and characteristics of the area.

The slope was the first sub-parameter analysed. The greater the slope, the less suitable an environment is for life. In particular, the slope degrees that make soil formation difficult adversely affect the growth of plant species. Aspect, as the second sub-parameter studied, impacts plant sensitivity, especially because it affects temperature and humidity. The northern sides of hills, which are shaded, have a denser plant texture and therefore are less ecologically sensitive due to the higher soil moisture content and higher organic matter content of the soil. On the other hand, the hotter and drier southern sides of hills lead to plants growing less frequently and therefore to being more sensitive against internal and external factors (Sternberg & Shoshany, 2001). In the elevation sub-parameter, the sensitivity levels especially for plants increase depending on the temperature as the elevation increases (Odum & Barrett, 2008). For the land capability sub-parameter, reference values are assigned according to the sensitivity levels of the land capability classification of the area. Class I–II soils are suitable for agriculture and have high sensitivity levels, whereas Class VII–VIII soils have low sensitivity levels. The soil groups sub-parameter was evaluated in terms of the properties of individual soil types and their sensitivity to internal and external factors.

To determine the ecological sensitivity of microclimate parameters, the data produced in the moderately optimistic climate scenarios (RCP 4.5) for Izmir in the book *A Framework for Climate Change Resistant Cities: A Green Oriented Adaptation Guide* are used (Alphan & Çoşkun Hepcan, 2019). The increase in the change in the average precipitation leads to an increase in the sensitivity. The average temperature sub-parameter was created according to the RCP 4.5 scenario, taking into account the geographical features of the areas where the annual average temperature changes decrease and increase.

Table 1: Evaluation parameters.

Parameter	Sub-parameter	Sensitivity				
		Very low	Low	Average	High	Very high
Factors						
Topography	Slope (%)	0–5	5–10	10–20	20–30	> 30
	Aspect	N	NE–NW	W–E	SE–SW	S
	Elevation (m)	0–100	100–200	200–500	500–1000	> 1,000
Soil	Land capability	VII–VIII	VI	V–IV	III	II–I
	Soil groups	—	Hydro-morphic soils, Regosols	Brown, chestnut, limeless brown forest, limeless brown, red Mediterranean, red brown Mediterranean, reddish chestnut, Rendzina, Vertisols	Brown forest, colluvial, reddish brown, organic soils	Alluvial soils
Microclimate	Avg. precipitation (mm)	—	—	50–150	150–200	> 200
	Avg. temperature	—	—	0.5 and 1	0.5 and –1	–2 and –1
Hydrology	Drinking water and basin conservation zone	—	Long-range	Medium-range	Short-range	Present and absolute
	Streams	—	—	—	—	Present
	Flood areas	—	—	—	—	Present
Habitat	Nature reserves (m)	—	—	500–1,000	500	Present
	NDVI	0.02 low	0.02–0.2	0.2–0.3	0.3–0.5	> 0.5
	Species diversity	—	—	—	—	Presence
	Forest canopy cover	Very low	Low	Average	High	Very high
Land use	Land cover	Urban-rural settlement	Arable land	Maquis, heather	Forest	Wetland
	Distance to city (m)	—	5,000	1,000–2,000	500–1,000	500
	Distance to village (m)	—	—	—	500–1,000	500
	Roads	—	—	—	—	Present
	Distance to cultural and archaeological site (m)	—	—	500–100	500	Present
Distance to industrial areas	Industrial zones	—	—	—	Small industrial and storage areas	Organized industry, waste-treatment facilities, mine sites, petrol stations
	Wind farms	—	—	—	—	Present
Processess						
Water infiltration		Very low	Low	Average	High	Very high
Soil protection		Very low	Low	Average	High	Very high

The drinking water conservation zone sub-parameter was evaluated in terms of the sensitivity level of the areas where dams and ponds are located, and their legal protection zones. Due to the study scale, the stream sub-parameter was evaluated only in the area where streams are located at the highest sensitivity level. With regard to the nature reserves sub-parameter, all the natural areas with legal protection status and the areas within 500- and 1,000-meter buffer zones were evaluated. The plant density of the area was determined by using the 2020 Landsat satellite image for the Normalized Difference Vegetation Index (NDVI) sub-parameter. As the value of the index becomes closer to 1, ecological sensitivity increases. One of the sub-evaluation criteria of the habitat parameter is species diversity. Within the study, only the species diversity data of the forest areas and key biodiversity areas (Eken et al., 2006) of Izmir were obtained. Because there are no data on the species diversity of the entire study area, only the regions where nature reserve areas are located were determined to be areas with very high sensitivity in the species diversity sub-parameter. In the forest canopy cover sub-parameter, the ecological sensitivity of the area was evaluated according to the extent of soil covered by crowns of trees. The land cover sub-parameter was determined within the scope of the use of the area.

The sub-parameters distance to a city, distance to a village, and distance to a cultural and archaeological site were evaluated in terms of distance to the built environment. Sensitivity of an area increases the closer it is to the built environment. Similarly for the road sub-parameter, the presence of roads increases ecological sensitivities in the area. The most important reason for this is that roads directly affect ecological flows. In the sub-parameter distance to an industrial area, the presence of industrial zones and wind farms was determined to be ecologically sensitive because it has a direct impact on the ecology. The sub-parameter water infiltration was evaluated in terms of the infiltration of water into the soil. Finally, in the soil conservation sub-parameter, places where erosion was high were determined to be ecologically sensitive areas. Based on the scoring system, the mapping process was carried out using the ArcGIS 10.4 program.

2.2.3 Weight scoring

The most commonly used method in determining weights is AHP (Dai et al., 2012; Liang & Li, 2012; Wang et al., 2014). AHP establishes a hierarchy based on a pairwise comparison between parameters by decision-makers or experts. The weight score of each parameter is obtained by determining the relative importance of the parameters evaluated with respect to each other (Saaty, 1990). A comparison is made according to the importance rating ranging from one to nine (1 = equally important, 9 = most important), and the score for the rating is taken as a basis. The weight coefficient of each parameter is calculated according to the number of parameters used. Accordingly, AHP was applied to determine the ecological sensitivity areas and to define weight scores for all parameters in this study. A pairwise comparison of the parameters was established by two expert decision-makers working on the Izmir Urban Transformation Roadmap Project. In this study, the WLC method, which is the most frequently used method in the literature, was used. This method weights the parameters and sums them according to the weighted average.

$$WLC = \sum_{i=1}^{n} w_i x_i$$

where WLC is the total sensitivity score, w_i is the weight score of parameter i, x_i is the score of parameter i, and n is the number of parameters.

2.2.4 Evaluation of integrated sensitivity areas

In the fourth stage of the study, the weight coefficients specified in Table 2 were used to obtain the integrated ecological sensitivity areas for Izmir.

2.2.5 Comparison of ecological sensitivity areas and the 1:100,000 ERP

The last methodological step in the study included a comparison of the integrated ecological sensitivity areas with the 1:100,000 ERP. Among the spatial decisions determined in the plan, six fundamental decisions that directly guide urban spatial development include housing development areas, industrial areas, organized industrial zones, logistics centre areas, public institution areas requiring a lot of space, and tourism areas. The data obtained were evaluated quantitatively on a provincial basis and then on a district basis. Although the legal boundaries do not overlap with the natural systems, the study compares the plan and ecological sensitivity area within the boundaries of a district to spatially evaluate the decisions. Areas with the highest conflict between the ecological sensitivity areas and the plan were determined at the district level. Based on these data, three regions with the highest conflict between ecological sensitivity and the plan (i.e., focus regions) were selected. In determining the focus regions, the geographical locations of the districts, their relations with the city centre, and the effect of planning decisions on spatial development dynamics were also taken into account. The focus regions are especially important because they make it possible to more effectively establish whether the plan decisions are appropriate in terms of the ecological sensitivity of space.

3 Results and discussion

3.1 Spatial distribution of Izmir's integrated ecological sensitivity areas

The study weighted the two main evaluation categories, ecological factors, and ecological processes, according to AHP. The consistency rate in the study for AHP carried out on ecological factors was determined to be 0.10, and this value meets the threshold consistency value determined by Saaty (1990).

Table 2: Weight coefficients of parameters used in the study.

Category, weight	Parameter	Weight	Sub-parameter	Weight
Ecological factors, 0.6	Topography	0.07	Slope	0.70
			Aspect	0.05
			Elevation	0.23
	Soil	0.15	Land capability	0.33
			Soil groups	0.66
	Microclimate	0.06	Avg. precipitation	0.50
			Avg. temperature	0.50
	Hydrology	0.26	Drinking water and basins	0.38
			Streams	0.44
			Flood areas	0.16
	Habitat	0.35	Nature reserves	0.46
			NDVI	0.14
			Species diversity	0.31
			Forest canopy cover	0.07
	Land use	0.04	Land cover	0.07
			Distance to city	0.50
			Distance to village	0.19
			Roads	0.50
			Distance to cultural and archaeological site	0.07
	Distance to industrial areas	0.01	Industrial zones	0.50
			Wind farms	0.50
Ecological processes, 0.4	Water infiltration	0.50		
	Soil conservation	0.50		

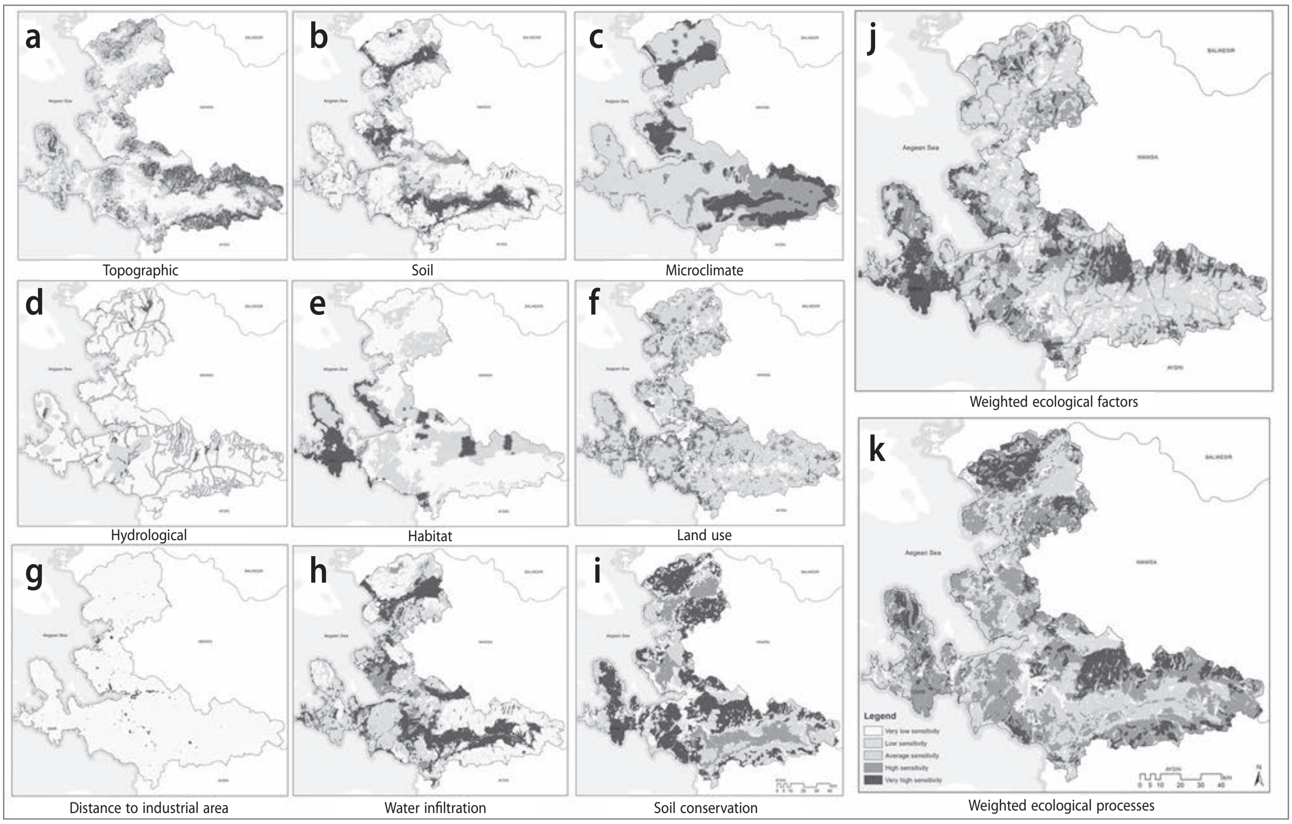

Figure 2: Ecological factors and process sensitivity: a) topography, b) soil, c) microclimate, d) hydrology, e) habitat, f) land use, g) distance to industrial area, h) water infiltration, i) soil conservation, j) weighted ecological factors, and k) weighted ecological processes (illustration: author).

Table 3: Ecological sensitivities of evaluation parameters by area (hectares) and percentage.

		Sensitivity									
Evaluation category	Parameter	Very low		Low		Average		High		Very high	
		Area	%	Area	%	Area	%	Area	%	Area	%
Ecological factors	Topography	362,070	30.4	299,400	25.1	199,100	16.7	227,175	19.1	103,550	8.7
	Soil	595,350	50.0	180,350	15.1	126,650	10.6	153,500	12.9	135,400	11.4
	Microclimate	642,650	53.9	127,000	10.7	87,725	7.4	193,825	16.3	140,100	11.8
	Hydrology	747,100	62.7	159,250	13.4	171,900	14.4	98,975	8.3	14,075	1.2
	Habitat	596,325	50.1	182,200	15.3	245,575	20.6	48,025	4.0	119,175	10.0
	Land use	136,350	11.4	309,650	26.0	460,525	38.7	216,650	18.2	68,125	5.7
	Distance to industrial area	1,181,050	99.1	—	—	—	—	1,125	0.1	9,125	0.8
Ecological processes	Water infiltration	355,714	29.9	295,073	24.8	140,162	11.8	130,862	11.0	267,806	22.5
	Soil conservation	170,706	14.3	150,088	12.6	272,559	22.9	164,309	13.8	433,566	36.4

Table 4: Levels of ecological sensitivity in Izmir Province by area (hectares) and percentage.

Sensitivity levels	Area	%
Very high	197,931	16.8
High	218,365	18.5
Average	268,310	22.7
Low	336,810	28.5
Very low	160,075	13.5

The parameters in the second evaluation category were determined based on the general characteristics of the study area and other studies in the literature (Dai et al., 2012; Deng & Hu, 2012; Leman et al., 2016; Mingwu et al., 2010; Niu et al., 2020). Using the method applied in the study, the areas that varied in ecological sensitivity for each parameter were determined and mapped (Figure 2, Table 3).

An integrated ecological sensitivity map was obtained after the weighted maps of the two main assessment categories were overlapped (Figure 3). The sensitivity levels established for all of Izmir Province are presented in Table 4. Examining the spatial distribution of the sensitivity levels on a district basis, the districts with very high sensitivity were Urla (62.2%), Çiğli (43.6%), and Bayındır (34.3%), and districts with high sensitivity included Karaburun (39.2%), Karabağlar (31.1%), and Çiğli (27.9%). Urla (74.6%), Çiğli (71.5%), and Karaburun (62.3%) districts stand out in terms of having very high and highly sensitive areas. Whereas some of these districts (Urla, Karaburun, Karabağlar, Çiğli) contain protected areas of various statuses, some of them (Bayındır) make significant contributions to the water cycle.

The size of areas with an average ecological sensitivity level in all of Izmir is 268,310 hectares, covering 22.7% of the entire province. Although the areas with this sensitivity level are distributed throughout the province, they are concentrated in the districts of Kınık (47.1%), Balçova (35.9%), and Menderes (33.3%). Areas with this level of sensitivity have average index values within the framework of the parameters selected due to a relatively uniform relationship between ecological values and environmental problems. However, the spatial decisions made in these areas (such as industrial areas, housing development areas, organized industrial zones, and tourism areas) have an effect on the sensitivity of the area. Accordingly, it is vital that the spatial decisions made in the future for these areas aim at nature conservation and that the principles of site selection be adopted by considering the balance of conservation and use.

Areas with low sensitivity are concentrated in northern and southwestern Izmir. Low sensitivity levels are concentrated in the Dikili (47.9%) and Bergama (38.8%) districts in the north, and also in the Beydağ (54.7%) and Kiraz (41.4%) districts in the south. Most areas have very low soil and habitat sensitivity, and most have low and very low sensitivity levels in terms of ecological processes. This shows that the planning decisions in these areas should be regulated by considering the sensitivity

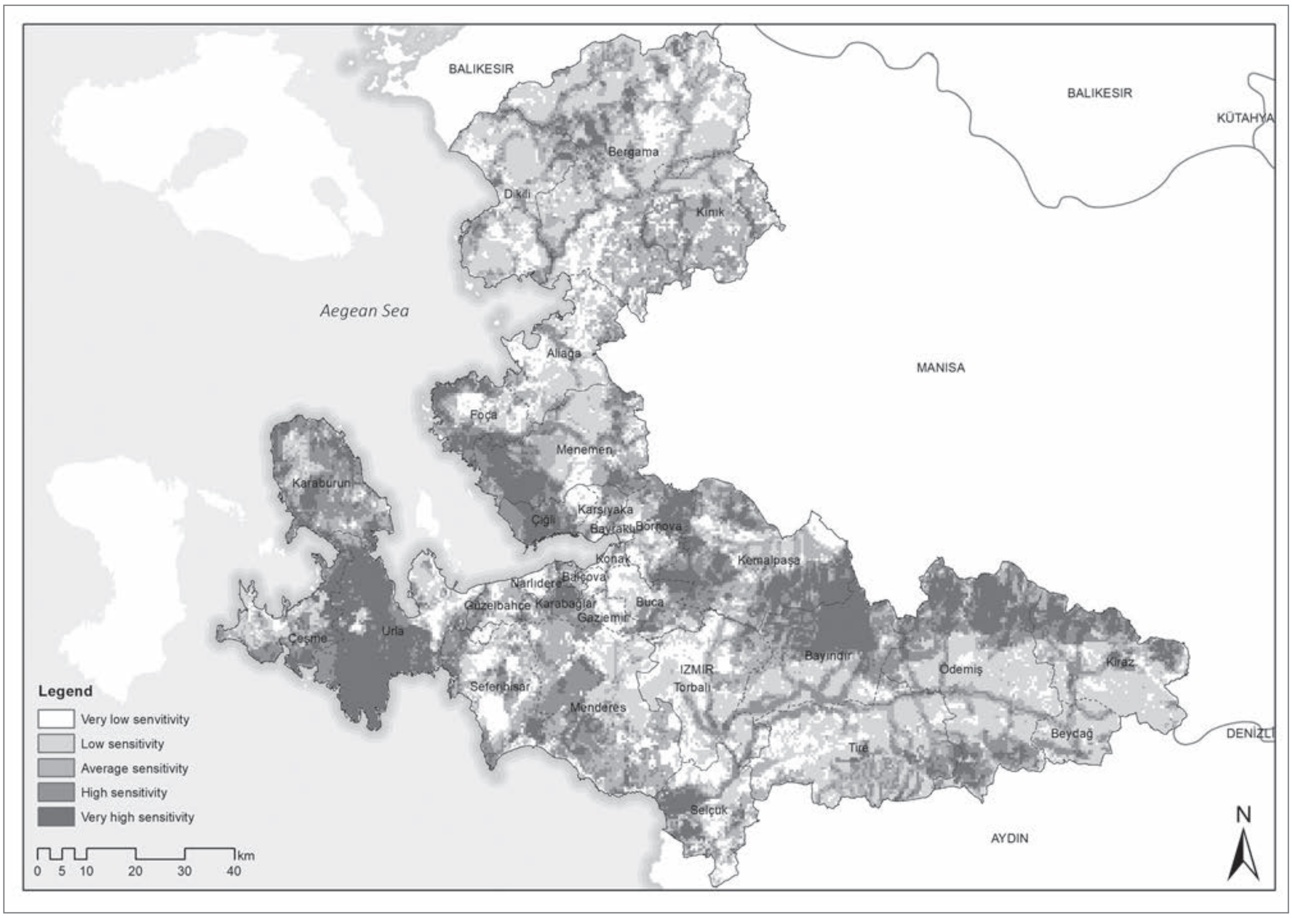

Figure 3: Integrated ecological sensitivity map of Izmir Province (illustration: author).

levels of the area. Accordingly, these areas should be studied in greater detail at sub-scales, and planning decisions should be made to improve their environmental characteristics.

The areas with very low ecological sensitivity in Izmir Province are concentrated in the Konak (45.4%), Narlıdere (44.3%), and Gaziemir (38.4%) districts. With regard to spatial distribution, these areas do not play a major role in terms of ecological processes and do not have legal protection status, especially in regions where the built environment predominates. Although these areas are suitable for construction, external interventions should be better managed by suitable spatial decisions and, due to the scale of this study, these areas require a more detailed analysis in terms of the parameters selected.

3.2 Comparison with the 1:100,000 ERP

The integrated ecological sensitivity map obtained in the study and the decisions determined in the 1:100,000 ERP were overlapped in the ArcGIS 10.4 program (Figure 4). Very high and high ecological sensitivity levels were compared against the 1:100,000 plan. It was determined that 69.6% of public institution areas requiring a lot of space, 10.3% of housing development areas, 48.6% of logistics centre areas, 19.6% of organized industrial zones, 8% of industrial areas, and 27.8% of tourism areas had a very high or high sensitivity level (Figure 5).

In this context, these values were reconsidered on a district basis. Accordingly, the districts that come to the fore in the entire province were evaluated in three focus regions within the scope of geographical location, relationship with the city centre, and the effect of planning decisions in terms of spatial development dynamics. The first focus region defined was the Northern Izmir focus region (covering the Aliağa and Menemen districts), the second was the Central Izmir focus region (covering the Çiğli district), and the third was the Peninsula focus region (covering the Çeşme, Karaburun, and Urla districts).

The Northern Izmir focus region has the most extensive industrial zone in Izmir Province. In the 1:100,000 plan, industrial area decisions were made by transferring the industrial areas from sub-scale plans (master and implementation zoning plan) to the plan. In addition, the surroundings of the existing industrial area have been expanded to serve industry. In this context, it is seen that the industrial site decisions in the area are made without paying attention to its ecological sensitivities. As a

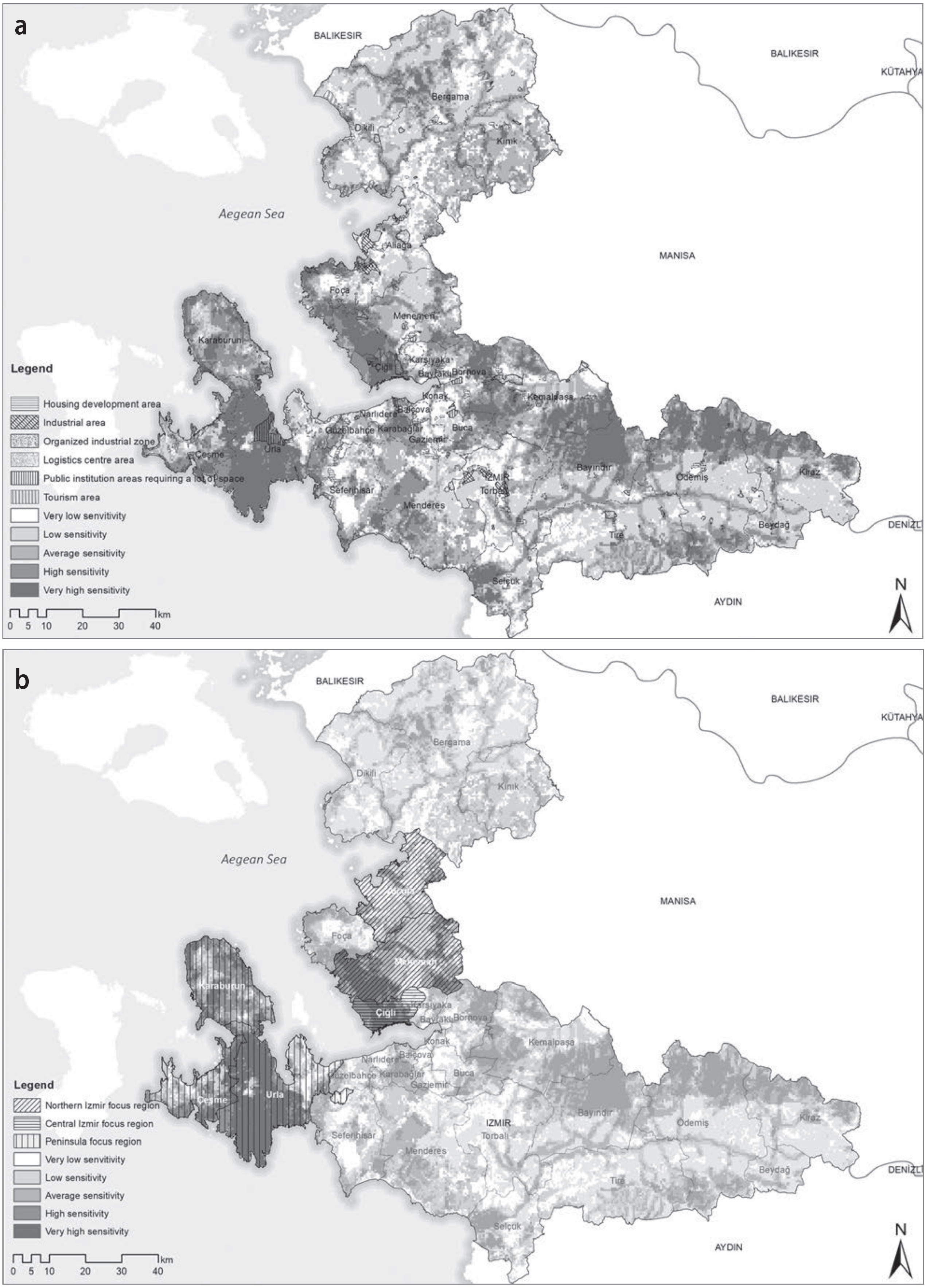

Figure 4: a) 1:100,000 planning decisions and ecological sensitivity map overlap, b) focus regions (illustration: author).

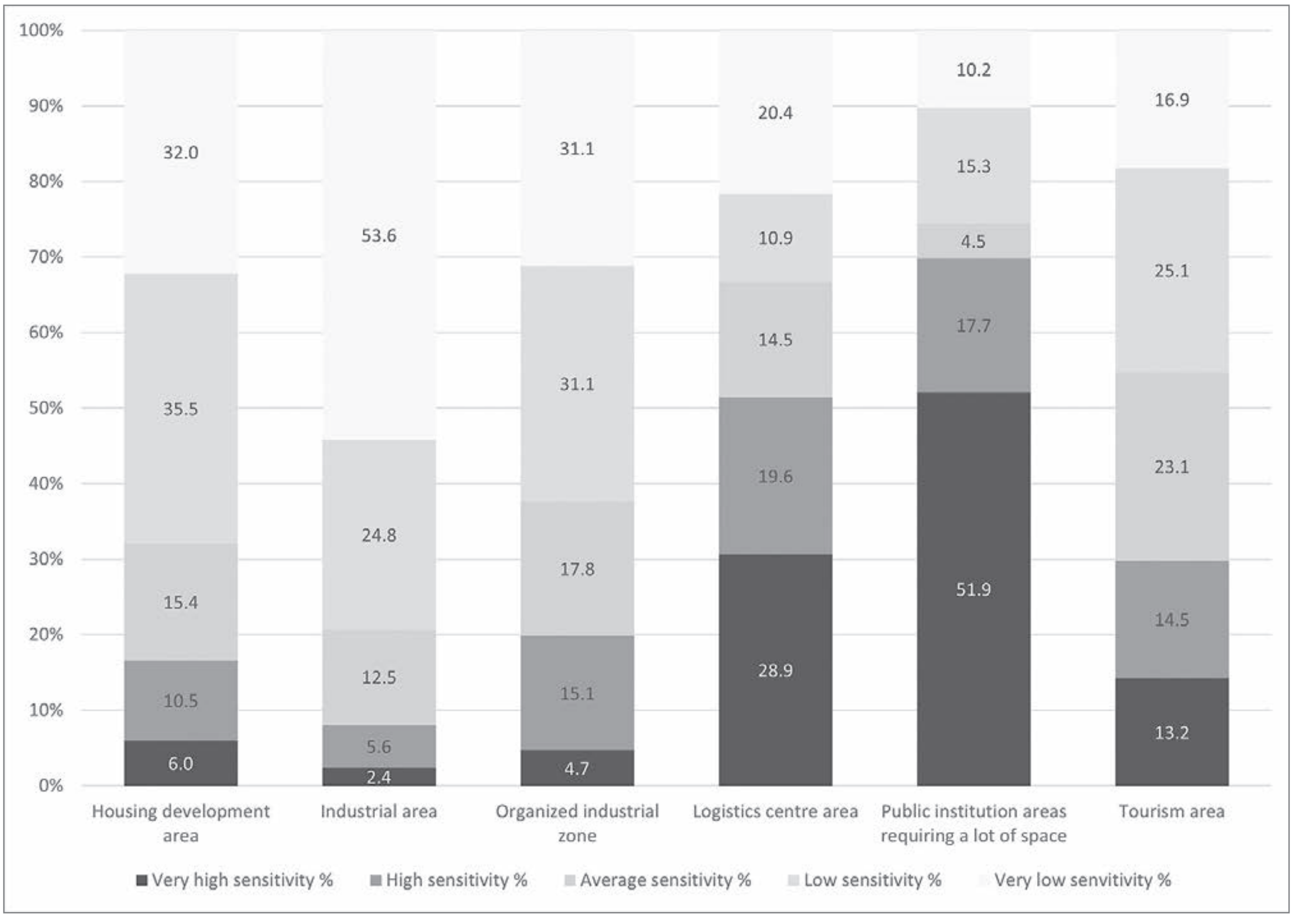

Figure 5: Comparison of 1:100,000 planning decisions with ecological sensitivity levels (illustration: author).

result, almost half of the industrial areas located in areas with very high and high sensitivity in Izmir are found in this region.

With regard to logistics centres, 48.6% of the logistics centre areas throughout the province are planned in areas with a very high or high level of sensitivity. Altogether, 27.2% of these are within the Northern Izmir focus region. Because this focus region is located particularly close to the city centre, many housing development areas and logistics centres are planned there. However, these planning decisions are not in conformity with the ecological sensitivity levels. This lack of conformity shows that the criteria prioritized by the plan do not follow an ecological point of view.

Housing development areas, logistics centre areas, organized industrial zones, and industrial areas come to the fore in terms of planning decisions in the Central Izmir focus region. The main reason for this is the aim of shifting the industrial and new residential areas to the north axis in the plan. Although this focus region, located just north of Izmir's city centre, covers the borders of a single district, many decisions that directly guide spatial development are made in a single district with an ecologically very high and high sensitivity level. Even though the region has important ecosystems and has a legal protection status, there is intense urbanization pressure on areas outside the region. The natural areas with legal protection status within this pressure area, which is also supported by the planning decisions, are under threat in terms of ecological functionality. The areas with very high or high ecological sensitivity are defined as housing development areas, logistics centre areas, organized industrial zones, and industrial areas in the ERP. This shows that areas with high ecological sensitivity outside the protected zones should be carefully planned and that the legal status of protected areas should not be changed in any way.

With regard to the planning decisions in the Peninsula focus region, tourism and public institution areas requiring a lot of space come to the fore. In particular, the location of public development projects that require a lot of space in areas with very high and high ecological sensitivity is a critical problem in terms of the ecological functionality of the region. Moreover, the Peninsula focus region has high ecological sensitivity, especially in areas without a conservation status that are under pressure from intense tourism and secondary housing development. This is particularly true for areas without a conservation status but with high ecological sensitivity that are defined as development areas in the 1:100,000 plan, and the changes made to the natural site levels within the scope of law no.

2863 are an indicator of the pressure of the construction sector in the area. In addition, the Culture and Tourism Protection and Development Region decision made for part of the area, apart from the ERP, similarly paves the way for construction even in the protected areas in the region.

In this context, it is necessary to protect areas with high ecological sensitivity to ensure the sustainability of such protected areas. In addition, planning is expected to direct development toward less sensitive areas. Accordingly, the level of sensitivity is critical, requiring planning decisions to be made correctly and effectively. If the ecological sensitivity map is used correctly, it can also provide an opportunity for development. Ecological sensitivities can be protected by detailing the planning decisions (such as tourism areas or housing development areas) in the planning notes. At this point, the ecological sensitivity map can be used to protect ecological sensitivities, as well as to produce planning decisions according to the ecological sensitivities defined. As a result, the planning decisions defined in the ERP should be revised for the three focus regions. For example, organized industrial zones and industrial areas should be planned in areas with low ecological sensitivity, and tourism and housing areas should be developed in line with their sensitivity levels.

Although currently only 10.95% of Izmir Province has legal conservation status, the share of areas with ecologically very high (16.8%) and high sensitivity (18.5%) was determined to be much higher than that. This includes natural areas protected by different legal statuses, as well as areas that are not protected by legal status but are of great importance in terms of ecological functionality. These areas with rich biological diversity are key in terms of ecological values and serve the system in terms of ecological functionality, but they are vulnerable to deterioration that may occur due to external interventions, especially human activities, and planning decisions that pose a threat to them. After the 1:100,000 ERP decisions were compared with the areas with ecologically very high and high sensitivity, it was determined that the plan's decisions are not suitable for the ecological characteristics of these areas. Moreover, the real sensitivities of the areas were not considered sufficiently during planning. It is therefore necessary to analyse multiple parameters with a holistic perspective on the study area to make planning decisions that take into account ecological sensitivities. The integrated ecological sensitivity map provides opportunities for revising the current 1:100,000 ERP and 1:25,000 Metropolitan Whole Environmental Regulation Plan.

4 Conclusion

This study examined the conflicts between the planning decisions made as part of the ERP and the sensitivities of ecosystems in the case of Izmir. A well-structured relationship between the plan content and real urban dynamics creates more sustainable living spaces. However, after the 2000s, neo-liberal policies in Turkey paved the way for a construction-oriented growth model. In addition, the ERP does not use the necessary methodological approaches to protect the environmental characteristics. The only limitation in the legislation is the legally determined conservation status. Nevertheless, in areas with high ecological sensitivity that are not protected, inappropriate spatial decisions can be regulated within the scope of the ERP. Considering the functions of ecological systems, grading in ecological sensitivity areas can be a tool to guide spatial development. This highlights the relationship between spatial development and ecological sensitivities while emphasizing the areas that need protection.

This study determined the sensitivity levels of the planning area and revealed the importance of making planning decisions according to these sensitivity levels. It shows that it is essential to adopt a more sustainable growth approach, such as green growth models, rather than construction-based growth models. In addition, the use of analysis for a holistic understanding of the ecological characteristics of an area, such as ecological sensitivity analysis, is another critical issue. Accordingly, an approach can be used for making planning decisions consistent with ecologically sensitive areas. In this respect, the research presents a new ecological sensitivity assessment model that will contribute to better decision-making in planning studies, especially in developing countries and distinct geographies.

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Acknowledgments

This study was produced as part of the study Ecological Loss, Hazard, & Risk, which is one of the main topics addressed in the Izmir Urban Transformation Roadmap Project jointly carried out by the Ministry of Environment, Urbanization, and Climate Change, and the Urban Renewal Centre.

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UDC: 502.131.1:711.433(439)
doi:10.5379/urbani-izziv-en-2023-34-02-03

Received: 21 June 2023
Accepted: 22 September 2023

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Analysing economic and environmental sustainability in Hungary: How cities with county rights perform in SDGs

Cities are the most important hubs of economic activity worldwide due to their concentration of population, businesses, trade, and stock markets. Nowadays, rapidly changing conditions resulting from factors such as globalization, industry 4.0, artificial intelligence, pandemics, and the Russian–Ukrainian war are raising new challenges for cities, which require innovative and smart solutions to maintain sustainability and competitiveness. This study analyses the performance of Hungarian cities with county rights in terms of their smartness level, with a special focus on the pillars of environmental and economic sustainability. Our hypothesis is that economically more developed cities (in terms of per capita income) are likely to be more sustainable due to the financial and professional resources available, but their ranking may not necessarily reflect the more populous group of cities due to, among other things, economies of scale and liveability. We analysed three elements of the seventeen UN Sustainable Development Goals (SDGs) and selected a set of indicators suggested by the Hungarian Central Statistical Office and the UN, adapted to the specific features of the Hungarian urban network, using min-max normalization and average calculation to construct the SDG pillars and a complex sustainability index. The cities were sorted into five cluster groups, which mainly differ in their development dynamics and liveability. The resulting clusters reflect the spatial characteristics of the Hungarian urban network, with the dynamic cities of the western and northwestern parts of the country showing outstanding sustainability performance.

Keywords: Hungarian cities, SDGs, sustainability, economic pillar, smart cities

1 Introduction

The United Nations Environment Programme (UNEP, 2018) estimates that the use of raw materials associated with the activity of cities will increase to ninety billion tonnes by 2050, up from forty billion tonnes in 2010. Mitigating global climate change and reducing its negative impacts on the environment has become one of the greatest challenges of life today (Yigitcanlar & Kamruzzaman, 2018). Policymakers promote sustainability as a key priority of urban development, as reflected in the UN's Sustainable Development Goal (SDG) 11, which emphasizes making cities inclusive, safe, resilient, and sustainable (UN, 2018).

Generally, there are three main pillars of sustainability, which also play a key role in the development of cities. These three pillars are the environmental, economic, and social dimensions of sustainability (Lehtonen, 2004). The environmental pillar is essentially concerned with environmental aspects (the natural environment: flora and fauna, and energy production). The social dimension represents equity, people's wellbeing, and the satisfaction of basic human needs, and the economic dimension can be understood as the economic competitiveness and diversity of urban areas (Toli & Murtagh, 2020).

As a result, a new concept has emerged in the literature – the *sustainable smart city* – and the terms *resilience*, *sustainability*, and *smartness* are applied simultaneously in its definition. Our study addresses how the twenty-five Hungarian cities with county rights are performing in some of the SDG index's priority dimensions. Our research hypothesis is that economically more developed cities (e.g., in terms of per capita income) are likely to be more sustainable due to the financial and professional resources available, but their ranking may not necessarily reflect the more populous group of cities, due to, among other things, economies of scale and liveability. Using this analysis, a complex sustainability ranking of the Hungarian cities can be drawn up based on economic and environmental aspects, which is comparable with the traditional urban network analyses carried out for the hierarchy of Hungarian cities.

2 Theoretical background: The concept of smart and sustainable cities

The term *smart city* became popular in the early 1990s and has changed several times since then, but even today there is no single agreed-on definition. Initially, most definitions focused on the technological aspect of smart urban development. One of the most frequently cited concepts in technocratic approaches is that of Harrison et al. (2010), emphasizing that smart and appropriate use of ICT (information and communication technologies) can lead to smart, institutionalized, and connected cities. Later, increasingly more researchers integrated soft elements such as knowledge, innovation, creativity, human capital, or sustainability into the definitions to create complex definitions (Szendi, 2021; Wataya & Shaw, 2022). According to the new definitions, a smart city consists of two main characteristics: technology and the creation of added value for stakeholders. It aims to ensure high quality of life and to increase competitiveness in a defined geographical area (Glasmeier & Christopherson, 2015). Therefore, the common feature of the concepts is that they aim to improve the living conditions of residents while emphasizing the role of sustainability, innovation, and knowledge. With the incorporation of soft elements, the concept of smart cities has become increasingly complex, and the measurability of their performance is a growing challenge for researchers. One of the most frequently used models is the six-component model developed by Giffinger et al. (2007; economy, people, governance, mobility, environment, and living conditions), which uses over eighty indicators to rank cities.

According to the European Parliament's (2014) studies (based on a sample of 599 cities), the environmental dimension is the most important pillar of European smart cities, accounting for 33% of the total list, and the economic dimension, for example, is the main priority axis in only 11% of cities (García Fernandez & Peek, 2020). Research indicates that the most dynamic segment of smart cities will be the smart governance and smart energy dimensions by 2025, which will further evolve until 2030 (Angelidou et al., 2022), meaning that the focus on the sustainability dimension is expected to grow further. The sustainable smart city includes all the basic elements of smart cities, complemented by indicators of the optimal management of limited resources (environment, waste and water management, green energy, etc.; Ahvenniemi et al., 2017). A sustainable smart city is a city that, with the support of ICT, meets the needs of its current inhabitants without compromising the ability of other people or future generations to meet their needs, thus not exceeding environmental limits (Höjer & Wangel, 2014).

This study measures the economic and sustainability performance of Hungarian cities, for which the UN Sustainable Development Indicators provide a good basis as a comprehensive set of indicators in sustainable development. Although there are several studies on the measurability of smart cities (e.g., Giffinger et al., 2007; Cohen, 2014), there are few comprehensive studies on Hungarian cities so far. SDG measurement in Hungary has only been carried out at the county level under the supervision of the Hungarian Central Statistical Office

(HCSO), with only Budapest as an urban example analysed by the Sustainable Development Solutions Network (SDSN) and the Brabant Centre for Sustainable Development (Telos). The Hungarian capital ranked thirty-seventh overall among the forty-five European cities analysed, with an overall score of 55.4 (moderate performance). In terms of SDGs, the city still faces significant challenges in five of the fifteen SDGs, seven others indicate crucial problems, and two (clean water and sanitation, and reduced inequalities) are only slightly behind the targets (one dimension is missing; Lafortune et al., 2019). We decided to exclude the capital city from the analysis because in many cases its outlier values would distort the results of the analysis (mainly through the standardization process) and would indicate unrealistic differences in the urban network.

Previously, European and US cities were also analysed using the SDG indices, and both analyses highlighted the problems of data availability and comparability. The first SDG index for US cities was produced in 2017. The index ranks the hundred most populous US cities along with metropolitan regions based on their performance on the SDGs. The results show that all US cities, even those at the top of the index (the San Jose–Sunnyvale–Santa Clara metropolitan region in California), need to make significant strides to achieve the SDGs (Sustainable Development Solutions Network, 2017). In Europe, the report compares the performance of the European Union (EU) and European Free Trade Association (EFTA) capitals and some other metropolitan areas on the seventeen SDGs. In this first prototype version, the results for forty-five European cities are presented using fifty-six indicators. Oslo is ranked first with a score of 74.8 before Stockholm and Helsinki. This means that Oslo has a 74.8% achievement rate of the SDGs according to the indicators used in the index. However, even for these best-performing cities, significant challenges remain to achieve all the goals (Lafortune et al., 2019). In 2022, a sustainability analysis was carried out for seventeen of Kazakhstan's largest cities. In their analysis, the authors developed a sustainable urban development index and clustered the cities. The study used a similar normalization method as the analysis presented here; however, its components included standard economic and social factors, not focusing specifically on SDGs (Nyussupova et al. 2022).

This article therefore calculates the SDG index of Hungarian cities with county rights by focusing on economic and sustainability aspects, and to characterize the city network in terms of SDG performance.

3 Methodology and data

In September 2000, the United Nations adopted the Millennium Development Goals, committing its members to a new global partnership focused on the problems of developing countries. Therefore, eight targets were set for the period up to 2015 (HCSO, 2022). Despite the achievements of the MDGs, by the mid-2010s there were significant disparities between the poorest and richest regions, and between urban and rural areas (UN, 2015). Therefore, taking the basic idea a step further, at the UN Sustainable Development Summit on 25–26 September 2015, world leaders adopted "Transforming Our World: the 2030 Agenda for Sustainable Development", which included seventeen global SDGs and 169 targets (European Environment Agency, 2020). The 2030 agenda, in addition to the previous focus areas, also considers developed countries' perspectives, while placing special emphasis on the environmental dimension. In the development of indicators, in 2020 the UN reached the goal of all indicators having a clear methodology (HCSO, 2022). Among the seventeen SDGs set by the UN, we have focused our analysis on three sustainability goals measuring the sustainability and smart economy of cities. They include two economic objectives – SDG 8 (decent work and economic growth) and SDG 9 (industry, innovation, and infrastructure) – and a social objective, SDG 11 (sustainable cities and communities).

The aim of the study was to show that, although national governments have adopted the SDG targets, it is also clear that regions and cities are playing a crucial role in achieving them (Lafortune et al., 2019). Based on this idea, we performed SDG index calculations by focusing on three SDGs. Among the SDGs, there are several that focus on economic sustainability in addition to environmental sustainability. In selecting SDGs 8, 9, and 11, our main research question was whether the most economically developed cities are sustainable in environmental, economic, and social terms. We selected the SDGs where this approach is emphasized, where data are available for a range of cities, and where the results provide relevant information for the Hungarian cities. In addition to these SDGs, we also analysed some indicators from SDG 12 (ensure sustainable consumption and production patterns) with data on waste management and financial support. In selecting the indicators, we chose data series supported by Hungarian and international literature. The data sources were the TEIR (National Regional Development and Spatial Planning Information System) database, the HCSO Dissemination Database, and the Hungarian Attractions Inventory. Twenty-seven variables were included in the baseline database after cleaning the database two times (in the first step, five variables were removed, and then one more) because of multicollinearity.

Table 1: List of indicators used for each SDG.

SDG	Indicator	Correlation with SDGs (+/–)
8. Decent work and economic growth	Net disposable income per capita (HUF)	+
	Long-term unemployment rate (more than 180 days; %)	–
	Old-age dependency ratio (65+ / 15–64 years)	–
	Proportion of self-employed persons in business (%)	–
	Employment rate of recent graduates (20–34 years; %)	+
9. Industry, innovation, and infrastructure	R&D expenditure as percentage of GDP (county level)	+
	Internet connections per 1,000 inhabitants	+
	Number of patents per 1 million inhabitants (county level)	+
	Length of national roads per 100 km^2 (county level)	+
	Per capita CO_2 emission (tons)	–
	Inward migration balance (permanent and temporary) per 1,000 inhabitants, 2020	+
	Commuters as share of locally employed persons, 2011	–
	Budapest access time by road (fastest, min)	–
11. Sustainable cities and communities	PM10 (particulate matter particle diameter below 10 microns), annual average (μg/m^3)	–
	NO_2 emissions per capita (kg/year)	–
	Average property price per square metre	–
	Satisfaction with household's financial situation (scale of 0 to 10)	+
	Satisfaction with quality of living environment (scale of 0 to 10)	+
	Aid (number of people receiving municipal aid as percentage of population)	–
	Number of local bus trips per inhabitant	+
	Number of cultural institutions per 100,000 inhabitants	+
	Number of attractions per 100,000 inhabitants	+
	Number of museums per 100,000 inhabitants	+
	Secondary utility gap (difference between proportion of dwellings connected to public drinking water network and proportion of dwellings connected to public sewerage)	–
	Waste generated per capita (kg)	–
	Separately collected waste in total waste collection (%)	+
	EDIOP support per capita for renewable energy development (HUF)	+

Note: The indicators used are about an 80% fit to the original version of SDG studies because of the available city database. Some variables that are not computed for the Hungarian city network were excluded (e.g., Community design applications, recharging stations, groundwater of good chemical status) and some were replaced with a suitable one.

Source: authors, based on data from HCSO, Eurostat, OKIR–LAIR, ingatlannet.hu, Google maps, palyazat.gov.hu.

When compiling the database used for the analysis, an important aspect was comparability and the possible addition of a data series to create a complex index. Accordingly, in an initial step, specific data were calculated, mostly using values per 1,000 or 10,000 persons, or using a percentage distribution. Because the data did not have the same units of measurement even after the specific values had been calculated, it was necessary to use standardization (Freudenberg, 2003) to calculate the components. By transforming or scaling the data (in our case, with min-max normalization), we achieved comparability of the indicators. The following formula was used for standardization:

$$x = \frac{x_i - x_{min}}{x_{max} - x_{min}} * 100$$

The main advantages of the method are that, while preserving the original context, it is possible to aggregate series of data in different units (e.g., kg, %, m^2, etc.), and it does not cause data loss or bias (Giffinger et al., 2007; Cohen, 2014). For those indicators for which a higher value had a more negative meaning (e.g., number of jobseekers, or various measures of air pollution), the reciprocal of the values was calculated using the following formula:

$$x_{corr} = \frac{x_i - x_{max}}{x_{min} - x_{max}} * 100$$

Complex components of the indicators were then formed using a simple arithmetic mean (because after standardization there is no outlier value in the database; Das & Imon, 2014) to produce the SDG 8, SDG 9, and SDG 11 indices and the resulting complex sustainability index. The twenty-seven indicators shown in Table 1 were used for the analysis.

After developing the final indicator structure, we reviewed the distribution using heatmaps and performed a cluster analysis based on literature recommendations (e.g., Bellantuono et al., 2022) to interpret the results.

4 Results

4.1 Heatmaps

The heatmap shows how the cities perform for each indicator or component (Dorofeev, 2022). It is a "two-dimensional visualization of data using colour to represent magnitude" (Cui & Zwick, 2016, p. 2). The values per column show the goodness or weakness of the area's position along a given variable. The values per row indicate the positive or negative values of the indicators for the cities (HCSO, 2015). For comparability among the datasets, standardized values were used, and each territorial unit was ranked on a scale from 0 to 100 in line with the literature (Arbatli & Johansen, 2017).

The SDG 8 (decent work and economic growth) heat map shows large heterogeneity in the performance of the cities studied. Esztergom, Győr, Tatabánya, and Veszprém showed the most stable positive performance in the more economic-focused indicators of SDG 8. The worst performers are Salgótarján and Szekszárd, as shown by several indicators. In Salgótarján, all components except self-employment are in the bottom third of the scale, whereas Szekszárd has positive performance in income and unemployment, but a significant lag in the other indicators. For all indicators, there is wide variation in the performance of the cities studied; for example, in per capita net income, the difference between the best-performing city of Székesfehérvár (HUF 1,723,192) and the worst-performing cities of Baja and Salgótarján is HUF 600,000 to 700,000.

In SDG 9 (industry, innovation and infrastructure), some cities have serious problems with several indicators. Győr stands out for its overall performance, with above-average scores for all dimensions. Győr is one of the most innovative and dynamic cities in the country, underpinned by its excellent educational background. Zalaegerszeg is the best cluster member in terms of five out of eight indicators, with a very low weight of "hard" innovation indicators, such as R&D and patents, which can only be significantly changed by the construction of Rheinmetall's new Lynx infantry fighting vehicle plant (in 2023), which will bring several new innovations to the city. Érd is outstanding in four out of eight indicators; its R&D and patenting performance is significantly improved by the application of Pest County's average, and because the city has no major industry it has clean air. Most of the below-average values, on the other hand, can be found in the Kaposvár and Debrecen areas.

SDG 11 (sustainable cities and communities) contains the most indicators, fourteen in total, and the cities' performance in this group is the most heterogeneous. Érd, Esztergom, and Veszprém show the most balanced performance, whereas Nagykanizsa and Nyíregyháza have the most negative indicators. Apart from these values, the dispersion of the cities' values is balanced, especially for NO_2. However, there is a significant difference in the average price per square metre of real estate. The difference between the highest price in Érd (more than HUF 720,000) and the lowest in Salgótarján (HUF 198,000) is almost four times. Prices mostly reflect the distribution of geographical peripheries. In the dimensions of satisfaction (based on the HCSO survey), the situation of the cities is similar in terms of their financial situation and living environment, with Győr and Sopron showing the most favourable values and Tatabánya, Nagykanizsa, and Nyíregyháza the least favourable, but the standard deviation of values among the cities is not significant.

4.2 Cluster analysis

The heat maps also highlighted the differences between the cities and the position of cities at the top and bottom of the list for each factor. It was assumed that cities with similar features and indicator values can be grouped together. To verify this, we used cluster analysis, which tries to form homogeneous groups from indicators of relatively heterogeneous objects (Anderberg, 1973). For the cluster analysis, we considered several possible solutions, including three, four, and five clusters. The three- and four-cluster versions over-aggregated the city types, making the results difficult to interpret. In the end, the five-cluster solution was chosen because of the interpretability of the results. The complex index values for the given cities, calculated from the indicators of SDGs 8, 9, and 11, are summarized in Figure 1. We have indicated the status of target achievement by the values of the components. For the five-cluster solution, we set thresholds of 20%, whereby cities

Cluster	City	8	9	11	Complex
1	Győr	73.56	60.94	61.83	65.44
	Veszprém	60.65	64.72	69.20	64.86
2	Esztergom	59.02	63.13	60.24	60.79
	Érd	65.12	68.32	45.57	59.67
	Sopron	61.03	51.71	65.11	59.28
	Szombathely	60.96	53.83	59.94	58.24
	Tatabánya	69.26	53.80	48.19	57.08
	Székesfehérvár	54.81	58.90	54.40	56.04
3	Szeged	52.12	54.96	46.38	51.16
	Hódmezővásárhely	57.47	41.59	51.43	50.16
	Kecskemét	54.82	42.54	48.63	48.66
	Eger	33.78	47.36	62.09	47.74
	Zalaegerszeg	51.03	42.94	48.09	47.35
	Nagykanizsa	51.55	35.82	48.24	45.21
4	Nyíregyháza	55.15	35.22	42.94	44.44
	Pécs	31.59	42.18	58.75	44.17
	Szolnok	43.09	41.89	46.06	43.68
	Debrecen	45.50	28.74	56.09	43.44
	Dunaújváros	52.34	36.91	39.27	42.84
	Miskolc	30.52	39.88	56.32	42.24
	Békéscsaba	44.64	29.36	48.00	40.67
	Baja	32.02	37.60	45.67	38.43
	Kaposvár	33.86	29.63	46.53	36.67
	Szekszárd	28.10	41.10	39.40	36.20
5	Salgótarján	26.11	38.08	40.18	34.79

Figure 1: Clusters of the complex sustainability index (illustration: authors).

with scores above 80% were given the highest ranking and cities below 20% of the average face serious challenges.

4.2.1 Cluster 1: The most dynamic and vibrant cities in the country

The first cluster included only two municipalities, Győr and Veszprém. Győr, formerly a city of trade fairs and merchants, is now the most dynamic and innovative county seat. This is reflected in the results of the indicators for SDG 8 (decent work and economic growth), SDG 9 (industry, innovation, and infrastructure), and SDG 11 (sustainable cities and communities), with the highest complex index value among the twenty-five cities studied (65.44). The Audi car plant and its related supplier network (Józsa et al., 2017; Fekete, 2018) significantly contribute to the dynamics and current development process of Győr. Thanks to excellent job opportunities, the city has a high net income per capita of HUF 1,662,287 and a low long-term unemployment rate of only 4.0%. Residents' satisfaction with their financial situation in the city is 5.9 (on a scale of 0 to 10), which is in the highest category. The city's secondary and higher education is high quality, and Széchenyi István University is a key player in the city's life, closely linked to the city's economy and a catalyst for the city's intellectual life. Győr's atmosphere is also enhanced by many historical buildings, which have a significant impact on residents' satisfaction with their living environment, which is 7.8 (on a scale of 0 to 10). In addition, the clean environment (20.4% of waste collected separately as a percentage of total waste generated) also enhances the image of the city. Veszprém is directly behind Győr in terms of net income per inhabitant (HUF 1,616,214), but the long-term unemployment rate is slightly higher (6.4%). After the collapse of communism, the city's economy suffered from the decline of heavy industry, and only the relocation of capital-intensive multinationals to the city has helped increase the city's dynamism and innovation capacity (Continental Automotive Hungary, Valeo Auto-electric Hungary, Balluff-Elektronika, Valeo Simens eAutomotive Hungary, Lasselsberger-Knauf Építőipari, Bramac Betoncserépgyártó és Építőanyag, etc.). The university still plays a major role in the city's scientific life (R&D expenditure as percentage of GDP, county level value of 3.44%). Veszprém is a truly liveable city thanks to its historic town, as shown by the satisfaction of its inhabitants with their living environment, which at 5.9 is behind that of Győr. The city of Veszprém received the third-highest amount of funding per capita among the towns in the EDIOP (Eco-

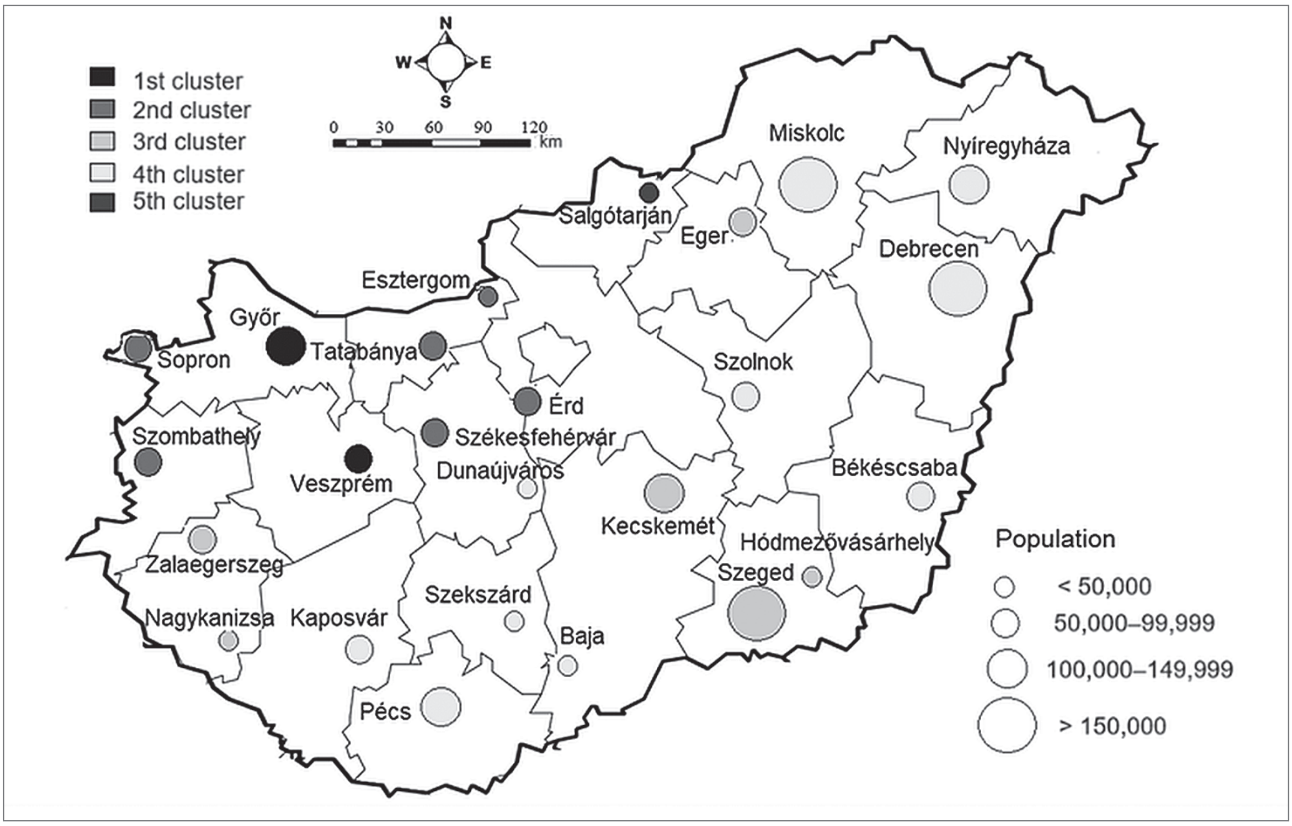

Figure 2: Spatial distribution of the clusters of the Complex Sustainability Index (illustration: authors).

nomic Development and Innovation Operational Programme of Hungary in the 2014–2020 EU support period) renewable energy applications, at HUF 2,590. Based on the indices obtained for the two cities, Győr is slightly stronger in jobs and innovation, but Veszprém is more powerful in liveability and sustainability, with a difference of just 0.58 points in the complex indices between the cities, which can be considered marginal. The spatial distribution of the clusters is illustrated in Figure 2.

4.2.2 Cluster 2: Emerging, dynamic, and liveable cities

The values of the complex index of the second, six-element cluster result in a seemingly heterogeneous group. However, when analysed in depth and individually, the characteristics of the cities in the cluster show a more homogeneous internal structure. Esztergom's main employer, Magyar Suzuki Corporation, and the group of satellite companies closely linked to it contribute to the outstanding scores of this city. These companies create job opportunities, resulting in a low unemployment rate and a favourable job prospect for recent graduates (88.2%). The number of patents registered in Esztergom is almost twice as high (16.58) as in the county seats (9.4). The city's liveability and living environment is rated by the residents as 7.7 (on a scale of 0 to 10). This high score can be explained by several factors: the historic character of the city, the picturesque surroundings of the Danube, and the clean air of the city. The city's position is reinforced by the fact that Esztergom is the northern intermodal hub of the metropolitan agglomeration thanks to the Danube bridge and the passenger terminal. In addition, the international transport corridor from Nitra (Slovakia) strengthens the city's position as an international hub (Gauder et al., 2011). The second city in the cluster based on the complex index is Érd, whose inclusion in the cluster is due to its high net income per capita (HUF 1,562,145), low long-term unemployment rate (4.4%), favourable employment rate of recent graduates (85.9%), and very high number of patents per million inhabitants (29.76). Érd's outstanding scores are also linked to its proximity to Budapest, its status as a dormitory city, and its social composition. The suburb is almost free of industrial enterprises, and because of this its air is very clean. However, road congestion (the M7 freeway and Expressway 7) and gravel dust pollution from unpaved roads increase particulate matter concentrations. For this reason, the city's residents have an average level of satisfaction with their living environment of 6.8 (on a scale of 0 to 10). The index for SDG 11 for Érd is only 45.57, which is partly because the city has not received a single cent of funding for energy development in the EDIOP programme among the cities studied. The next city in the cluster, Sopron, is known as a border town, monument town, and school town. Due to the city's favourable job creation potential, the long-term unemployment rate is extremely low (2.9%), and the employment rate of recent graduates is high (91.2%), the highest among the twenty-five cities studied. The city's liveability is reflected in its residents' satisfaction with the living environment (7.8 on a scale of 0 to 10), which is also supported by the city's clean air (low CO_2 and NO_2 emissions per capita). Szombathely is also rich in monuments, having received its city status from Roman Emperor Claudius. Since the 1990s it has undergone a major transformation. The city's industry used to be dominated by light industry (tens of thousands of people worked for the Savaria shoe factory and then at the Marc shoe factory, Latex, Styl Garment Factory, and similar plants), but the launch of the Opel motor factory marked the start of a new industry, the automotive industry. Today, the development of the city is linked to the car industry in Győr and Kecskemét, which is reflected in the higher-than-average per capita income (HUF 1,492,260). The arrival of modern technology has led to an increase in R&D expenditure and a significant increase in the number of patents in Szombathely (10.73 patents per million inhabitants). The city's liveability is reflected in the inward migration balance of 0.6, the high satisfaction of city residents with their living environment of 7.7, and the satisfaction with the financial situation of households of 5.8 (on a scale of 0 to 10). Due to its long history, the city is rich in monuments, cultural attractions, and museums (26.4 attractions and 14.5 museums per 100,000 inhabitants). Szombathely is a truly liveable border city with rich cultural assets, making it a popular destination for both domestic and foreign tourism. In Tatabánya, a former "socialist" town, coal mining was the dominant industry until 1987, when the last mine was closed. The transformation process was far from easy, and the city's active working-age population suffered significantly from the change, with unemployment rates higher than 25%, which was partly addressed by the introduction of manufacturing services (Gauder et al., 2011). Currently, the long-term unemployment rate is 8.2%. The age structure of the population is relatively young, with a 28.7% old-age dependency ratio. The number of patents per million inhabitants (16.83) is an indication of the city's renewed capacity for innovation. After the closure of the mines, the coal-fired power plant, and the cement plant, Tatabánya has become a liveable, clean environment, with a satisfaction index of 7.4. Tatabánya, like Érd, has a medium score (48.19) on the SDG 11 index, with a very low rate of separate waste collection of 0.9%, ranking it last among the cities studied. The last city in the cluster is Székesfehérvár, the former religious centre of the country, a royal city, and today a dynamically developing industrial city. The labour market offers a wide range of opportunities, which is why the city has a below-average long-term unemployment rate (7.5%) and a favourable employment rate for recent graduates (87.6%). It has the highest net income per capita of all the cities studied, at HUF 1,723,197. Székesfehérvár is one of the cities with a balanced performance on SDGs 8, 9 and 11, with a complex index around the previous three targets' average (56.04). The residents of the city are satisfied with the quality of their living environment (positive, 7.7), which is also helped by the cleanliness of the environment (20.6% of waste collected separately as a percentage of total waste generated). The city has received a significant amount of funding for renewable energy (HUF 690.9 per capita for renewable energy development in the EDIOP grant).

4.2.3 Cluster 3: Liveable cities on a slow growth path

The cluster cities' contribution to SDGs 8, 9, and 11 is average. Within the cluster, there are two groups of cities: the cities of the Great Plain with slow dynamics (Szeged with its free royal city past and Hódmezővárhely and Kecskemét with their rural town past) and the group of cities that are catching up, with lower innovation capacity, but still viable (the school and historic town of Eger and industrializing Zalaegerszeg and Nagykanizsa). Szeged is a famous school town (University of Szeged) and a centre of scientific life with internationally recognized research centres. The city has an outstanding record in science (its R&D expenditure as percentage of GDP is 2.34, ranking it second after Veszprém, and the number of patents per capita is 20.91). However, its contribution to SDGs 8, 9 and 11 is only average (net income per capita HUF 1,353,578, employment rate of recent graduates 85.1%, etc.). The parameters of the city's performance are worsened by the level of aid (31.2% of people receive municipal aid). The high level of municipal aid is partly due to the coronavirus pandemic, which has led to many people losing their jobs and finding themselves in a desperate situation. People living in Szeged are satisfied with their living environment and the comfort of the city (7.6 on a scale of 0 to 10), which has a lively cultural life (Egedy et al., 2018). Hódmezővásárhely, a rich former rural town with a long history, now has strong links to Szeged. In the 1950s it also had the function of a county seat, which was later transferred to Szeged. Hódmezővásárhely's relatively rapid population growth has led to a multiplication of services in the city. This sector is now the largest employer, accounting for over 60% of the total. Vásárhely also has a significant R&D expenditure of 2.34% of GDP and the number of patents per million inhabitants is 20.91 thanks to the attraction of Szeged. The people of Hódmezővásárhely are satisfied with their living environment, as shown by the high value of the index (7.5 on a scale of 0 to 10). The third major city in the cluster is Kecskemét, which has a rural past and became the administrative centre of Bács-Kiskun county in the 1950s. Today, it is an important automotive bastion of the country, home to Mercedes-Benz Manufacturing, which strives to develop environmentally friendly and energy-efficient production. The labour market structure of Kecskemét has been significantly improved by the operation of the Mercedes factory (Józsa et al., 2017), but the long-term unemployment rate is still 13.0%, while the number of patents per million inhabitants is almost twice the average of the other cities studied (16.82). Eger has a long history of trade and commerce, is very rich in monuments, and has the highest number of attractions per 100,000 inhabitants (118.7). The inhabitants of Eger are satisfied with their city's environment and its liveability (7.1 on a scale of 0 to 10). In contrast, the city is performing poorly in terms of development objectives for SDGs 8 (33.78) and 9 (47.36). This is due to the high long-term unemployment rate (16.5%), the highest old-age dependency ratio (37.2%), and the very low R&D expenditure as percentage of GDP: 0.54 (average 0.9). The last two cluster elements, Zalaegerszeg and Nagykanizsa, are on a slow growth path, especially regarding SDG 9 (Zalaegerszeg at 42.94 and Nagykanizsa at 35.82). The two cities have the same values for R&D expenditure as percentage of GDP (0.33%) and for the number of patents per million inhabitants (1.87). The cities in the cluster have average values for the SDGs.

4.2.4 Cluster 4: Cities with cyclical development and average conditions

The cities in the ten-item cluster have followed and are following very different development paths, which is clearly reflected in the evolution of their complex index values. The cluster also includes three cities with a regional role, immediately following Budapest in the city hierarchy: Debrecen, Miskolc, and Pécs (population over 100,000). The fluctuating performance of these cities is due to changes in their socioeconomic situation. Miskolc, formerly a stronghold of heavy industry, has seen a significant increase in unemployment (19.5% of the long-term rate) following the decline of the metallurgical industry. Dunaújváros, another typical industrial city, also had a high unemployment rate (18.4%), also due to the decline of the metallurgical industry. The population of these two cities has an ageing age structure (the old-age dependency ratio is 36.9% in Dunaújváros and 33.1% in Miskolc), with a worse rate for the elderly population only in Szekszárd, at 37.4%. Debrecen and Pécs stand out from the cluster, with an area of operation extending beyond the county boundaries and a catchment area of around 130,000 to 202,000 inhabitants. They are "rural cities" (in Hungarian terms) with corresponding institutions, as well as residential and business services (universities, clinics, scientific institutes, courts, etc.). Among the cities studied, Debrecen and Dunaújváros have the highest CO_2 emissions per capita (51.7 tonnes per capita in Debrecen and 35.1 tonnes per capita in Dunaújváros) due to the pharmaceutical factories in Debrecen and ISD Dunaferr in Dunaújváros. Dunaújváros has the lowest concentration of particulate matter among the cities studied, despite being a centre of transport-intensive industries due to its location and logistics (Gauder et al., 2011). In terms of liveability, the cities in the cluster are around average (7.3) or below average compared to the other cities studied. The most disadvantaged municipality in the cluster, Szekszárd, has a complex index of 36.2. Its transport situation contributes to this low value because low-capacity traffic connections affect it, which has led to a decline in its economic position, whereas the development of Szolnok, Nyíregyháza, and Békéscsaba, for example, has been supported by the railways.

4.2.5 Cluster 5: A declining and hardly liveable city

The modest ranking of Salgótarján among the cities studied is connected with its industrial past, which is also supported by a previous study on the dynamics of the Hungarian urban network conducted by Beluszky and Sikos Tomay (2020). Salgótarján was among the 346 cities they studied, ranking three hundredth. Based on the indicators examined in our analysis, it also scored only 26.11 on SDG 8, which is the weakest in terms of the indicators of "decent work and economic growth". The city has a high long-term unemployment rate, over 33.0%, and almost a third of the active jobseekers are unemployed. Salgótarján is not much better among the cities studied in terms of net per capita income (in last position at HUF 1,190,865). Formerly a highly ranked industrial centre, now it cannot find a strategy to recover from economic decline (Gauder et al., 2011). In terms of SDG 9, the county's innovation capacity is low, with the number of patents per million inhabitants in the city at 0.83, compared to the average of 9.4 for the cities studied. The low CO_2 emissions of the city are also linked to the decline of industry, a consequence of which is its high migration balance at −11.0%, which has also had a negative impact on property prices (198,994 HUF/m^2). Salgótarján's complex index (36.2) is the worst among all the cities examined, which is not surprising given the scores above. We can conclude that, as one of the former socialist flagships, but now abandoned by industry and lacking new elements of urbanization and functionality, it is lagging significantly behind the other cities with county rights.

5 Discussion

Today, the importance of sustainable and smart cities is increasing due to the impact of various social, economic, or environmental shocks (e.g., pandemics, military conflicts, and climate change), as shown by the growing literature on the subject. Our study assessed the economic and environmental sustainability of Hungarian cities with county rights, using the SDG methodology and set of indicators developed by the United Nations along three main dimensions.

Our attempt to measure sustainability in the context of county seats resulted in five clusters, which can be considered homogeneous and clearly explained. The methodology we developed for the analysis is suitable for the analysis of three SDGs (SDG 8: decent work and economic growth, SDG 9: industry, innovation, and infrastructure, and SDG 11: sustainable cities and communities). The resulting complex indices confirm that the most dynamic and vibrant cities in the country are Győr and Veszprém, followed by Esztergom and Érd. In other words, the dynamic cities of the western and northwestern parts of the country are also outstanding in terms of sustainability. Salgótarján closes the list, which is the most disadvantaged cluster member in most aspects.

In our opinion, the most important implications of this pilot study for the Hungarian city network are that the indicators included in the study allow the method to be applied to other model areas and the studies to be repeated at different times to analyse trends. The indicators used and the framework of the model can therefore be applied to other countries in sustainability calculations, but the analysis can also be extended to smaller urban or municipal levels. A specific feature of some indicators is that they are mostly available in all countries with similar content or can be substituted on a country-specific basis thanks to the UN recommendations and the SDG calculation methodology.

Of course, our method and complex sustainability index may have some limitations and shortcomings, which we must consider by calculating it for other territories or different time horizons. The greatest limitation is the data constraints because these kinds of indicators cannot be reproduced in any possible time; some data are available only for shorter terms. Regarding the data constraints, another issue might be that the content of indicators can change over time. In addition, the analysis contains only the performance of three SDGs, and so sustainable performance and the ranking of the cities could be modified by accounting for the other pillars of the UN methodology.

6 Conclusion

Our results thus partially support our initial hypothesis that economically more developed higher-income cities (mostly located in western and central Hungary) also stand out from a sustainability point of view, but this is not necessarily consistent with the ranking of the most populous cities. Out of the ten most populous cities in Hungary, only one, Győr, can be classified as the most sustainable (topping the list), but the other cities with a population of over 100,000 are mostly in the fourth cluster of cities with average conditions. Out of the top ten, only Székesfehérvár and Szombathely, with populations below 100,000, can be classified in the more sustainable second cluster. The generalizability of our hypothesis is somewhat distorted by the fact that the Hungarian capital Budapest was excluded from the analysis due to bias, although it has a long-term sustainability strategy (until 2030), which is currently being implemented. Thus, it is likely to top the list in terms of sustainability, population, and economic development.

The results reflect the results of the country-level comparisons of the UN to some extent because the countries of central and eastern Europe are far from achieving the SDGs (Lafortune et al., 2022). Hungary is twenty-third among the EU + EFTA member states, with a total of 69.9% goal achievement. However, it is promising that the tendencies show positive changes in the three goals analysed. The results also agree with the city-level analysis of Lafortune et al. (2019), in which the performance of central and eastern European cities ranges from Munich ranked eighth to Bucharest ranked forty-first (with Budapest at thirty-seventh). Except for cities in Germany, access and the quality of key public services and infrastructure are the greatest challenges.

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Acknowledgement

This study was supported by the Eötvös József Research Centre of the National University of Public Service.

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UDC: 656:502.131.1(497.115)
doi:10.5379/urbani-izziv-en-2023-34-02-04

Received: 5 May 2023
Accepted: 25 September 2023

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Sustainable transportation in Prishtina, Kosovo: A qualitative investigation of challenges and opportunities for urban mobility improvements

This study examines inefficiencies, possible improvements, challenges, and impacts of sustainable transportation alternatives in Prishtina with the goal of creating evidence-based strategies for small rapidly urbanizing cities and contributing to the knowledge about sustainable transportation in small and developing countries. The study uses a qualitative approach and semi-structured interviews with twelve participants to explore sustainable transportation in Prishtina, with thematic analysis and cross-case analysis to analyse the responses. The findings underscore significant inefficiencies in Prishtina's transportation system, rooted in outdated infrastructure and varied stakeholder views. Through thematic and cross-case analyses, the study sheds light on the multifaceted challenges of implementing sustainable transportation. This study adds to the literature with insights into Prishtina's context, offering actionable guidance for transportation planning specialists. For society, the results emphasize the imperative of a comprehensive approach, blending infrastructure enhancements with behavioural adaptations, to cultivate a sustainable urban milieu in Prishtina.

Keywords: sustainable urban mobility planning, public transport, infrastructure improvement, developing country

1 Introduction

The functionality of society relies on a well-organized transportation system. The transportation sector contributes to GDP (5% in Europe according to the European Commission, 2022, and 10% in the US according to the Bureau of Transportation Statistics, 2021) and it provides vast employment opportunities. However, transportation emissions contribute to 27% of greenhouse gas emissions in Europe (European Environment Agency, 2021), posing a threat to the environment, especially in cities (Saidi & Hammami, 2017; Shafique et al., 2021). Governments are investing resources to reduce emissions and address environmental damage (Eckelman et al., 2020).

The transportation sector has played a significant role in the world's economy since the Industrial Revolution. It employs over eleven million people, making possible international trade (Maparu & Mazumder, 2017). However, the growth of advanced transport infrastructure has come at a considerable environmental cost. Accounting for over 20.8% of greenhouse gas (GHG) emissions, the transport sector is the EU's second-largest emissions contributor (Andrés & Padilla, 2018). In addition, pollutants emitted from internal combustion engines powered by fossil fuels can result in severe health consequences, including heart disease, asthma, and cancer. In the transportation sector, road transport is the leading emitter, responsible for 72.9% of emissions. In contrast, the aviation and maritime sectors contribute 13.3% and 12.8%, respectively (Pallonetto, 2023).

In 2019, the Municipality of Prishtina, in partnership with the consultancy firms Grant Thornton and Mott MacDonald, crafted a sustainable urban mobility plan, integrating insights from public hearings and feedback. The plan outlines seven key objectives targeting diverse aspects of sustainable transportation in Prishtina. This action highlights the city's forward-thinking approach to bolstering its transportation framework, resonating with the wider global push for sustainable urban mobility.

The COVID-19 pandemic disrupted the transportation sector, causing a radical shift in travel behaviour. Public transport usage dropped significantly, and there was a slight increase in cycling and walking (Eisenmann et al., 2021). Cars remain the preferred mode of travel, which could lead to increased air pollution, reducing the sustainability of the sector. Nonetheless, the pandemic has presented opportunities for alternative approaches to decrease transportation demand. Measures such as blended, flexible, and hybrid work have emerged as viable options, and a new essential travel baseline has been established. Technological advancements in transportation, such as electric vehicles and autonomous vehicles, hold the potential to mitigate environmental impacts. However, challenges including range and safety limitations, social and economic barriers, and unanswered ethical questions need to be addressed for their successful adoption (Staat, 2018; Directorate-General for Communication, 2020; Figliozzi, 2020; Kopplin et al., 2021). Evaluating the impact of these innovations and exploring alternative solutions is crucial (Pallonetto, 2023).

The scalability of advanced mobility solutions is a significant global challenge, especially for developing countries with less structured and skilled governmental bodies and insufficient infrastructure. Establishing policies that limit the population's mobility may be a possible alternative tested during the pandemic, but it is incompatible with the concept of democracy and freedom of movement. The significance of these concerns is underscored in a policy report recently published by the European Commission (Bertoni et al., 2022), and it underlines the related policy questions that policymakers must address to ensure sustainable transportation and mobility in the future.

1.1 Literature review

The global transportation system is currently characterized by insufficient and inefficient public transportation systems (Novikov et al., 2022; Ali & Abdullah, 2023). A poorly developed and inefficient transport system is a significant hindrance to mobility (Żukowska et al., 2023). Especially after COVID-19, the need for reorganization and restructuring of the public transportation system has arisen (Giuffrida et al., 2021; Annunziata et al., 2022; Borchers & Figueirôa-Ferreira, 2022). The post-pandemic era has highlighted the vulnerabilities in current transportation systems, emphasizing the urgency for improvements.

Like other cities in southeastern Europe, Prishtina faces similar challenges, such as lack of investment in public transportation, lack of adequate transportation planning, congestion, and parking problems (Mladenović, 2022). Podgorica faces similar problems as Prishtina, such as insufficient funds, lack of political support, and parking issues (Vujadinović et al., 2021). The leader in sustainable transportation in southeastern Europe is Ljubljana, which has been noted for its commitment to sustainability and green initiatives, which include a comprehensive focus on sustainable transportation, and was named the European Green Capital by the European Commission (European Environment Agency, 2017). Zagreb has also been investing in sustainable transportation, particularly electric trams and buses, including plans to use hydrogen-powered buses (Iotkowska, 2021). Similarly, Athens has invested in electric buses, cycle paths, pedestrianized zones, and restrictions on car use in the city centre (Kyriakidis et al., 2023). The expected trends in sustainable transportation are increased support for electric vehicles, sustainable urban transportation projects, advancements in autonomous vehicles and alternative fuels, shared mobility services, emphasis on transportation equity, and sustainability efforts in corporate travel (Caputo et al., 2023; Salo, 2023). Therefore, the potential for development and the way forward for sustainable transportation in Prishtina lies in improving public transportation infrastructure, diversifying transportation options with a focus on cycling and pedestrian paths, utilizing innovative technologies for efficient traffic management, and fostering a culture of sustainability among residents through educational campaigns and policy initiatives.

Sustainable transportation can only be strengthened and implemented through research, innovation, and investment in modern transportation systems (Antunes et al., 2023). Furthermore, improvement of public transportation system and digital transportation services under the umbrella of sustainability are key to implementing sustainable mobility (Hezam et al., 2023). To this end, investment in high-quality transit services and in walking and cycling infrastructure is key to achieving sustainable transportation (Szakonyi & Makó, 2023). Sustainability in transportation is a multifaceted challenge requiring both technological advancements and policy shifts.

Integrating mobility alternatives such as hybrid vehicles, car sharing, cycling, and electric bikes or scooters is crucial for sustainable cities (Pallonetto, 2023). Hybrid vehicles offer lower energy consumption costs (Habib et al., 2018), and car sharing significantly reduces CO_2 emissions (Nijland & van Meerkerk, 2017). Micromobility alternatives cut carbon emissions by 40% to 70% compared to conventional modes (Abduljabbar et al., 2021). Strategic planning, cycling, modernizing public transportation, and changing travel behaviour contribute to sustainable transport. Enhancing sustainable transportation requires improving public transportation, integrating modes, prioritizing sustainability, and fostering a sustainable travel culture (Abu-Rayash & Dincer, 2021; Bi et al., 2023; Yaliniz et al., 2023). Diverse mobility options not only reduce environmental impact but also offer flexibility and convenience to users.

Infrastructure and management challenges in developing countries often lead to inefficient governance and environmental management, making it extremely challenging for them to pursue sustainable transportation. Poor infrastructure contributes to a high number of accidents and higher mortality rates, indicating the need for better transportation planning and infrastructure management (Pallonetto, 2023). In addition, the lack of necessary transport infrastructure and planning leads to high traffic congestion, making it difficult to design infrastructure that can meet current needs (Kyriacou et al., 2019). Nevertheless, financial constraints can be a substantial barrier in implementing sustainable transportation systems. In addition, the operation and maintenance costs of sustainable transportation systems can exceed those of conventional systems, which creates challenges for governments when prioritizing sustainable transport investments (Sperling & Gordon, 2009; Mattioli et al., 2020). In this regard, financial constraints and other management challenges can pose substantial obstacles to implementing sustainable transportation solutions. Cycling, for example, has been marginalized in many cities' transport planning systems, and the absence of infrastructure, funding, and leadership has impeded the adoption of pro-cycling policies (Wang, 2018). Further, introducing new transportation modes such as electric scooters can result in encounters related to space, speed, and safety, underscoring the significance of proper management practices and absence of physical infrastructure (O'Keeffe, 2019; Gössling, 2020). In conclusion, absence of physical infrastructure, financial constraints, management and organizational obstacles, and travel attitudes and behaviour are some of the concerns and challenges that must be tackled by cities pursuing sustainable transportation agendas (Anagnostopoulou et al., 2020; Bouraima et al., 2023; Feldman, 2023). The challenges faced by developing countries in implementing sustainable transportation are multifaceted, but these challenges can be overcome with the right strategies, investments, and international cooperation. The benefits of sustainable transportation, both environmental and social, make it a priority for the future.

Sustainable transportation alternatives such as electric and hybrid vehicles significantly lower pollution (Nijland & van Meerkerk, 2017). According to Saidla (2018), promoting active transportation leads to higher levels of health of the city's population. Finally, sustainable transportation alternatives lead to improved quality of life (Steg & Gifford, 2005, 2007; Wey & Huang, 2018). Reducing traffic and pollution, promoting public transportation and active transportation, and improving the overall wellbeing of a city's residents are key benefits of sustainable transportation (Elliott, 2023; Mohapatra et al., 2023; Molner et al., 2023). Embracing sustainable transportation not only addresses environmental concerns but also significantly increases the overall wellbeing of urban populations.

1.2 Research questions

From the reviewed literature, a lack of attention to sustainable transportation alternatives in the context of small and developing countries and small and rapidly urbanizing cities was identified as a research gap. Kosovo heavily relies on road transportation for trade and mobility due to its small size and rapid urbanization, leading to issues such as air pollution and traffic congestion (Malka et al., 2021). Prishtina, the capital, faces significant transportation challenges, including limited

public transportation, limited infrastructure for pedestrians and cyclists, and high levels of air pollution (Humolli et al., 2020). Studying Prishtina's transportation system can help develop evidence-based strategies to improve mobility, reduce greenhouse gas emissions, and promote public health in small, rapidly urbanizing cities. Kosovo has received limited attention in the literature on sustainable transportation, making studying this region important. Understanding Prishtina's challenges can contribute to knowledge about sustainable transportation in other small and developing countries.
Based on an extensive literature review, this study poses the following research questions and hypotheses:

RQ1: What are the specific aspects of transportation in Prishtina that are currently deemed inefficient and unsustainable?

Hypothesis 1 (H1): The inefficiencies in Prishtina's transportation system are largely attributed to inadequate public transportation coverage, inefficient bus schedules, and poor taxi services.

RQ2: What specific improvements in Prishtina's transportation infrastructure are perceived as key to achieving sustainable transportation?

Hypothesis 2 (H2): Improvements in Prishtina's transportation infrastructure, such as expanding public transportation routes, introducing modern buses, and enhancing road conditions, are perceived as critical for achieving sustainable transportation.

RQ3: What are the perceived major challenges to implementing sustainable transportation alternatives in Prishtina?

Hypothesis 3 (H3): Infrastructure inadequacies, financial constraints, mindset changes, and implementation and management challenges are major obstacles to implementing sustainable transportation alternatives in Prishtina.

RQ4: How are sustainable transportation alternatives in Prishtina perceived to impact residents' mobility and quality of life?

Hypothesis 4 (H4): Sustainable transportation alternatives in Prishtina have the potential to reduce traffic congestion, decrease pollution, and enhance mobility, ultimately leading to improved quality of life.

2 Methods

This qualitative research employed semi-structured interviews with twelve participants to gain insights. The interviews lasted thirty minutes and they were conducted in person and recorded. Ethical considerations were reviewed by the Human Research Ethics Committee of ESLG College, granting authorization no. 2124/2023 due to the absence of an independent ethics review body in Kosovo.

The interview questions focused on sustainable transportation in Prishtina. The first question asked about current inefficiencies in the transportation system, and the second question inquired about key improvements for achieving sustainable transportation. The third question delved into how perceived major challenges relate to implementing sustainable transportation. Finally, the fourth question explored how sustainable transportation alternatives could affect mobility and quality of life. To further explore these topics, laddering technique sub-questions were used, asking participants about the benefits and drawbacks of each transportation alternative, their personal values and beliefs around sustainable transportation, and their preferences for transportation modes. The laddering technique is suggested by Reynolds and Gutman (1984) to avoid biases that originate from qualitative research, as suggested by Gutman (1982).

This study ensured participant anonymity through coding. Utilizing purposive sampling, a nonprobability technique, qualitative interviews were conducted. Homogenous purposive sampling, selected for shared road transportation experiences, was employed following Saunders et al. (2012), who highlight its use when common characteristics are found within the sample. From across Kosovo, twenty individuals with significant transportation and traffic engineering expertise were invited for interviews. However, only twelve responded.

In line with Hennink et al. (2017), this study adopted a sample size of twelve respondents per population to ensure code and meaning saturation, which typically occurs around the sixth interview, accounting for about 91% of vital information. The structure of respondents is presented in Table 1.

The semi-structured interviews were recorded, transcribed, and transformed into textual data for analysis. Verbatim transcription generated approximately six pages of data per interview. Thematic analysis was conducted to discern underlying and overt ideas, with emphasis on phrases. The material was reviewed three times to establish patterns, develop codes, and organize them into recurrent and non-recurrent themes, following the recommendations of Clarke and Braun (2017). NVivo software systematically coded themes and identified patterns across seventy-two pages of data. The study also used cross-case analysis to juxtapose different cases, allowing for a deeper understanding of the data by identifying commonalities, differences, and overarching themes. This method enriched the

Table 1: Structure of respondents

Code	Profession	Education	Sector	Age	Sex
01	Transportation engineer	PhD, transport engineering	Private	40–50	M
02	Architect	PhD, architecture	Private	30–40	M
03	Geographer	PhD, geography and planning	Private	40–50	M
04	Urban planner	BSc, urban planning	Private	20–30	F
05	Urban planner	MSc, urban planning	Private	20–30	M
06	Geographer	PhD, geography	Private	40–50	M
07	Traffic engineer	PhD, transport engineering	Private	30–40	M
08	Civil engineer	PhD, transport engineering	Private	30–40	M
09	Urban and transportation planner	PhD, transport engineering	Private	40–50	F
10	Head of public services sector, Municipality of Prishtina	MSc, transport and civil engineering	Public	50–60	M
11	Transportation officer, Municipality of Prishtina	BSc, transport engineering	Public	40–50	M
12	Senior officer for traffic signalling, Municipality of Prishtina	MSc, transport engineering	Public	30–40	M

analysis by addressing any conflicting responses and providing a more comprehensive view of the participants' perspectives. Adopting Yin's (2011) methodology, the researchers compiled, disassembled, and reassembled data. During reassembly, following Castleberry and Nolen (2018), thematic relevance to the research questions took precedence over frequency. This strategy allowed the identification of pertinent themes, even if infrequent, effectively addressing the research inquiries.

3 Results

3.1 Prishtina's transportation inefficiencies and the need for comprehensive changes

The thematic analysis of the interview responses revealed that transportation in Prishtina is inefficient and unsustainable due to several key factors. Bus operators, mostly private, have inconsistent schedules, resulting in unreliable service. The bus fleet is outdated and insufficient, not meeting required standards for passenger transport. In addition, the absence of cycling and pedestrian infrastructure undermines the attractiveness and safety of alternative modes of transportation. The thematic analysis thus supported the hypothesis that Prishtina's transportation inefficiencies stem from inadequate public transportation coverage, inefficient bus schedules, an outdated bus fleet, and a lack of cycling and pedestrian infrastructure. Improvement in these areas is crucial for a more sustainable transportation system.

Conversely, in analysing Prishtina's transportation issues by means of cross-case analysis, conflicts emerge. Although most respondents express dissatisfaction with the current infrastructure and suggest improving public transit and cycling, a minority emphasize systemic problems requiring comprehensive change. However, some fear that these measures may inadvertently encourage more driving into the city, and they therefore propose solutions such as congestion charges or driving restrictions in the city centre. These varied viewpoints underscore the complexity of the issue, emphasizing the need for expert discussions to evaluate and prioritize proposed solutions.

Both analyses underscored Prishtina's transportation inefficiencies, highlighting the urgent need for broad improvements, modernizing public transport, bolstering cycling facilities, and advocating a balanced approach catering to the population's diverse needs.

3.2 Key improvements for achieving sustainable transportation in Prishtina

The thematic analysis supported Hypothesis 2, highlighting the importance of improving Prishtina's transportation infrastructure for sustainable transportation. The themes identified included improving public transportation, infrastructure reform, diversifying transportation options, a mindset shift and concrete actions, and an integrated approach to alternative solutions. Respondents suggested measures such as eliminating old buses, promoting cycling, creating new public transport lines, improving road infrastructure, and implementing integrated ticket systems. They also emphasized the need for mindset shifts, policy changes, and the use of technology for tracking and managing transportation.

The cross-case analysis revealed conflicting perspectives on improving Prishtina's transportation. The majority of interviewees favoured public transport enhancements, including bus fleet upgrades, simplified ticket transfers, and better route planning, coupled with improved cycling and pedestrian infrastructure. A smaller group advocated city fringe parking lots and integrated ticketing to balance public and private transport, whereas others cautioned against overreliance on public transportation and cycling, fearing this may disadvantage car-dependent individuals.

Both analyses affirmed the need to enhance Prishtina's transportation infrastructure for sustainability, highlighting the importance of a holistic approach, considering both infrastructure and behavioural changes, to achieve a sustainable transportation system in Prishtina.

3.3 Perceived major challenges to implementing sustainable transportation alternatives in Prishtina

The thematic analysis of the interview answers regarding challenges to implementing sustainable transportation alternatives in Prishtina revealed various obstacles. These included insufficient funds, resistance from users, and the need for private operators to meet specific criteria. Challenges further involve changing the bus fleet, determining routes, simplifying administrative procedures, and implementing the mobility plan. Encouraging people to shift from private vehicles and addressing administrative organization were highlighted. Limited space, connectivity, and high costs contribute to the difficulties. The analysis validated Hypothesis 3, confirming the identified obstacles of infrastructure inadequacies, financial constraints, mindset changes, and implementation and management challenges in implementing sustainable transportation alternatives in Prishtina.

The cross-case analysis showed varied viewpoints on the challenges of implementing sustainable transportation in Prishtina. Some respondents highlighted tangible barriers such as inadequate funding, outdated infrastructure, and the need for better buses. Others focused on behavioural and organizational aspects such as resistance to change, the necessity for administrative overhaul, and the difficulty of conducting mobility studies. These differing perspectives underscore the complexity of implementing sustainable transportation, suggesting that a multifaceted approach is needed to overcome these diverse challenges.

Both analyses illuminated the complexities of sustainable transportation implementation in Prishtina, emphasizing the importance of a holistic approach, considering both infrastructure and behavioural changes.

3.4 The perceived impact of sustainable transportation alternatives on mobility and quality of life in Prishtina

Thematic analysis of the interview answers supported Hypothesis 4, showing that sustainable transportation alternatives in Prishtina are believed to have positive effects. Respondents highlighted improved circulation, reduced traffic, decreased pollution, and enhanced cycling infrastructure as potential outcomes. Implementing sustainable transportation alternatives is expected to improve mobility, reduce pollution and congestion, and promote urban and rural integration, ultimately leading to improved quality of life in Prishtina.

The cross-case analysis of the responses demonstrated broad agreement on the perceived positive impacts of sustainable transportation in Prishtina: reduced traffic and pollution, increased efficiency, and enhanced quality of life. However, some respondents placed more emphasis on infrastructure development such as bike and pedestrian paths, whereas others stressed the need for changing public mindsets about public transportation and efficient traffic management. The discrepancies do not create conflicts but instead present different facets of the issue, implying that a comprehensive approach is necessary for successfully implementing sustainable transportation in Prishtina.

Both analyses affirmed the potential of sustainable transportation to positively transform Prishtina. The overarching sentiment is that a combined effort, encompassing infrastructure upgrades, public awareness campaigns, and policy adjustments, is required to truly realize the benefits of sustainable transportation in Prishtina.

4 Discussion

The research findings highlight Prishtina's transportation inefficiencies and the pressing need for sustainable solutions. The thematic analysis highlighted primary issues, including inconsistent bus services, aging vehicle fleets, and a lack of suitable facilities for cyclists and pedestrians. Respondents uniformly recommended enhancements in public transportation, encompassing the replacement of aging buses, new transit routes, and unified ticketing mechanisms. Moreover, there was a pronounced demand for improving infrastructure for cyclists and pedestrians. However, the cross-case analysis brought to light varied viewpoints on the best approaches, emphasizing the multifaceted nature of the challenges and the importance of a balanced strategy that addresses the diverse needs of the population. Marans and Stimson (2011) identified the quality of public transportation services as a pivotal factor influencing residents' satisfaction with their city's transportation system. Similarly, Xiao et al. (2023) emphasized that modernizing and reorganizing transportation infrastructure can enhance efficiency and user satisfaction. However, as Borowski and Stathopoulos (2020) noted, such modernization can increase costs, necessitating appropriate subsidization to boost ridership and alleviate traffic congestion. The research findings on Prishtina's transportation inefficiencies have significant implications for the literature, practice, and society. In the literature, the research contributes to existing knowledge by offering specific insights related to Prishtina, serving as a foundation for further research and analysis in sustainable transportation planning. In practice, transportation planners and policymakers can utilize the findings to address the inefficiencies identified, prioritize upgrades in public transport, and advocate for enhanced cycling and pedestrian infrastructure. From the perspective of society, implementing these measures can result in reduced traffic congestion, better air quality, and improved accessibility and mobility for all residents, which contributes to a more sustainable and liveable environment.

The research findings underscore the significance of enhancing Prishtina's transportation infrastructure for sustainable transportation. The analysis supported Hypothesis 2 and revealed themes linked to public transportation enhancement, infrastructure reformation, transportation diversification, mindset change, concrete actions, and an integrated approach to alternative solutions. It also emphasized the importance of technology in tracking and managing transportation. In turn, the cross-case analysis revealed conflicting viewpoints on optimal strategies. While a majority advocated for public transport enhancements, including bus fleet upgrades and better route planning, a smaller group emphasized the need for city fringe parking lots and integrated ticketing. Some even caution against an overreliance on public transportation and cycling, suggesting potential disadvantages for car-dependent individuals. The findings from our research resonate with prior academic investigations specifically focusing on Prishtina's transportation landscape. This alignment is evident in the emphasis on enhancing public transportation, infrastructure reforms, and diversifying transportation methods, as highlighted by Sodiq et al. (2019), Anagnostopoulou et al. (2020), Abu-Rayash and Dincer (2021), Pamucar et al. (2021), Bi et al. (2023), and Yaliniz et al. (2023). These studies, like ours, have highlighted the critical role of mindset shifts, concrete policy actions, and the integration of alternative solutions in fostering a sustainable transportation environment. The present research results contribute to the literature on sustainable transportation in Prishtina, providing an understanding about the influencing variables and enhancement strategies. It has implications for transportation planning practice, highlighting the relevance of improvements in public transportation and cycling infrastructure, and the need for eliminating old buses, promoting technology in tracking and managing transportation, and considering the diverse opinions on public versus private transport. These results have wider social implications, including reduced congestion, improved air quality, and enhanced accessibility. They underscore the necessity for mindset change, policy shifts, consensus-building, and careful reflection on conflicting viewpoints.

The examination of challenges in implementing sustainable transportation alternatives in Prishtina reveals various obstacles, including insufficient funds, user resistance, the need for private operators to meet specific criteria, challenges with changing the bus fleet, route determination, poor infrastructure, administrative procedures, and implementing the mobility plan. These results validate Hypothesis 3, underscoring the significance of infrastructure inadequacies, financial limitations, mindset shifts, and behavioural and organizational aspects such as resistance to change and the necessity for administrative overhaul, and addressing management challenges. The diverse perspectives highlighted in the cross-case analysis emphasize the multifaceted nature of these challenges, suggesting that both tangible barriers and behavioural aspects need to be addressed in tandem. The key impediments to implementing sustainable transportation alternatives identified agree with those established by Anagnostopoulou et al. (2020), Bouraima et al. (2023), and Feldman (2023). The research findings broaden the literature on implementing sustainable transportation alternatives in Prishtina, offering a foundation for additional research. It directs transportation planners and policymakers toward addressing barriers through strategic planning, legislation, and improved administrative organization. Overcoming these barriers can result in social benefits, including improved air quality and quality of life, and this requires political will, stakeholder collaboration, a comprehensive understanding of both physical and behavioural challenges, and effective public commitment.

The analysis of interview responses supported Hypothesis 4, indicating that sustainable transportation alternatives in Prishtina are believed to have positive effects. Potential outcomes mentioned by respondents included improved circulation, reduced traffic, decreased pollution, and enhanced cycling infrastructure. Implementation is expected to improve mobility, reduce congestion, and enhance the overall quality of life. Although there is broad agreement on the benefits, respondents' emphasis varies, suggesting that a multifaceted approach is essential for Prishtina's transportation future. Although many scholars have delved into the advantages of sustainable transportation, our research offers nuanced insights specific to Prishtina. Prior studies, such as those by Elliott

(2023), Mohapatra et al. (2023), and Molner et al. (2023), have underscored benefits such as reduced congestion and enhanced service quality. Our findings resonate with these works and enrich the literature on sustainable transportation in Prishtina. They guide transportation planners and policymakers to consider these positive impacts when formulating transportation plans and implementing strategies, especially emphasizing infrastructure upgrades, public awareness campaigns, and policy adjustments.

5 Conclusion

This research offers a nuanced understanding of sustainable transportation in Prishtina, bridging a gap in the literature by delving into the specific challenges and potential benefits within this urban context. The study's findings, particularly those of the thematic and cross-case analyses, contribute to the academic discourse by highlighting the multifaceted nature of transportation challenges and the diverse perspectives on potential solutions. The novelty lies in its detailed exploration of Prishtina's transportation landscape, a topic previously underrepresented in scholarly literature. However, the research is not without limitations. The reliance on interview responses might introduce biases, and the study's focus on Prishtina might limit its generalizability to other urban settings. Future research could expand the geographical scope, employ mixed methods for a more comprehensive understanding, and explore the long-term impacts of the proposed sustainable transportation strategies in Prishtina and similar urban environments.

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UDC: 711.433: 502.131.1 (560.11)
doi:10.5379/urbani-izziv-en-2023-34-02-05

Received: 29 August 2023
Accepted: 7 November 2023

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Evaluating the sustainability performance of Turkish provinces with fuzzy logic

Sustainability is the balance of social, economic, and environmental factors. Evolving from history to the present, the goal of this concept is for humanity to live in harmony with nature. Sustainable development, on the other hand, encompasses achieving urban goals for the future while increasing prosperity and efficiently passing resources to future generations. Sustainability indicators are utilized to guide policymaking and monitor progress. Indicators introduced by various institutions vary by country. In developing economies like Turkey, which this study focuses on, there are a limited number of works on measuring sustainability performance. Hence, this study evaluates urban sustainability levels using the fuzzy logic method. Another objective is to develop a measurable and replicable numerical model to analyse the sustainability performance of cities in Turkey. The study employs a measurement set consisting of twenty-seven indicators from the main ecological, economic, and social components, and it assesses the sustainability levels of cities using fuzzy logic rules. Based on the results obtained, all eighty-one provinces of Turkey are classified into quantile groups and mapped. This analytical approach can guide urban planners, policymakers, and decision-makers. This study contributes to enhancing knowledge and understanding sustainability.

Keywords: sustainability, sustainable cities, fuzzy logic, Turkey

1 Introduction

In today's world, the effects of COVID-19, population growth, climate change, environmental degradation, inadequate housing, and uncertainties related to the nexus of water, food, and energy are subjects of intense debate among academics, urban planners, and policymakers (Dumane et al., 2019; Son et al., 2023). The urbanization dynamic experienced since the Industrial Revolution has led to the rapid consumption of global resources by the human population. It is projected that by 2050 approximately 70% of the world's population, or 6.9 billion people, will live in cities (UNDP, 2020; Bharani & Ramesh, 2022). Ensuring the sustainability of life and cities and providing wellbeing for future generations require wise utilization of natural resources today. Alongside issues such as global warming, ozone layer depletion, housing, health, and the environment, policymakers need to strive for sustainable development in cities (Dumane et al., 2019).

Sustainability can be thought of as the fundamental goal of people living in harmony with nature (Robati & Rezaei, 2022). Sustainability, in a general sense, involves striking an appropriate balance among social, economic, and environmental factors (Dumane et al., 2019). The concept of sustainability has evolved from the past to the present with increasing inclusivity and continuous development. Etymologically, it comes from Latin *sustinere* 'to stand, endure' (Alptekin & Saraç, 2017). Sustainability is a long-term concept (Kusakci et al., 2022). It holds significant implications for both the private and public sectors. For businesses, it signifies adaptability to the competitive market and gaining a competitive advantage, whereas in the public sector it serves objectives such as cost efficiency, positive environmental outputs, directing the private sector toward sustainable technologies, and fostering consumer awareness about environmental and ecological issues (Akçakaya, 2016).

Sustainable development is defined as sustainable economic growth and ecological renewal. The concept of sustainable development has been pushed to the forefront of urban policy debates with the hope of constructing a desirable urban future It promises to achieve urban goals without compromising the welfare of society, quality of life, and the environment (Son et al., 2023). Sustainable development indicators are used as a source of information for crafting strategic documents and development programs. They aid in setting priorities, monitoring the success of solutions to problems, and gauging the success or failure of interventions related to environmental, social, and economic issues. The aim is to integrate the public into the decision-making process by designing, selecting, and evaluating indicators collaboratively (Michalina et al., 2021). Indicators provide information to the public, researchers, and policymakers.

One method that can be employed to measure the sustainability performance of cities is the fuzzy logic method. Fuzzy logic converts expressions conveyed in natural language into mathematical concepts, and it constructs a logical structure tailored to a specific problem (Robati & Rezaei, 2022). This structure reduces uncertainty and complexity within the system and provides clearer results. The fuzzy logic method allows for the representation of a city's sustainability level not in sharp terms such as good or bad, but in degrees of goodness or badness. The hypothesis of this study is "The fuzzy logic method can serve as an effective tool for evaluating the sustainability levels of cities using a measurement set encompassing various sustainability components and indicators." This hypothesis is based on the ability to categorize cities in Turkey according to their sustainability performance levels into quartile groups using the fuzzy logic method. The aim of the study is to make sustainability performance measurable with a model that is applicable, repeatable, and based on numerical data. The measurement set developed for this study to measure the sustainability performance of cities is approached with the fuzzy logic method. The results obtained have the potential to serve as a guide for city planners, policymakers, and decision-makers to create more sustainable cities. The study starts by providing background information from the literature, followed by information about the sustainability of cities in Turkey and fuzzy logic. Then, the method section explains the model created for this study. Finally, the findings are presented and evaluations are made.

2 Background

2.1 The concept of the sustainable city and monitoring the sustainability of cities

In today's context of creating a sustainable world, it is of great importance to manage cities, which have local and global impacts on natural resources and ecological balance, as well as changes and transformations in these cities. Referred to as "urban sustainability" or the "sustainable city", the integrated development of cities with economic, social, and environmental sensitivities entails significant responsibilities for local governments, which are the closest public institutions to urban communities. The functions of local governments are manifested in areas such as producing urban sustainable policies and measuring urban sustainability performance (Akçakaya, 2016). Urban sustainability can be considered the part of sustainable development that emphasizes the balance between environmental, economic, and social sustainability, highlighting the improvement of human wellbeing and quality of life (Robati & Rezaei, 2022). On the other hand, the international organization ICLEI (Local Governments for Sustainability) states that "sustainable cities work towards providing environmentally,

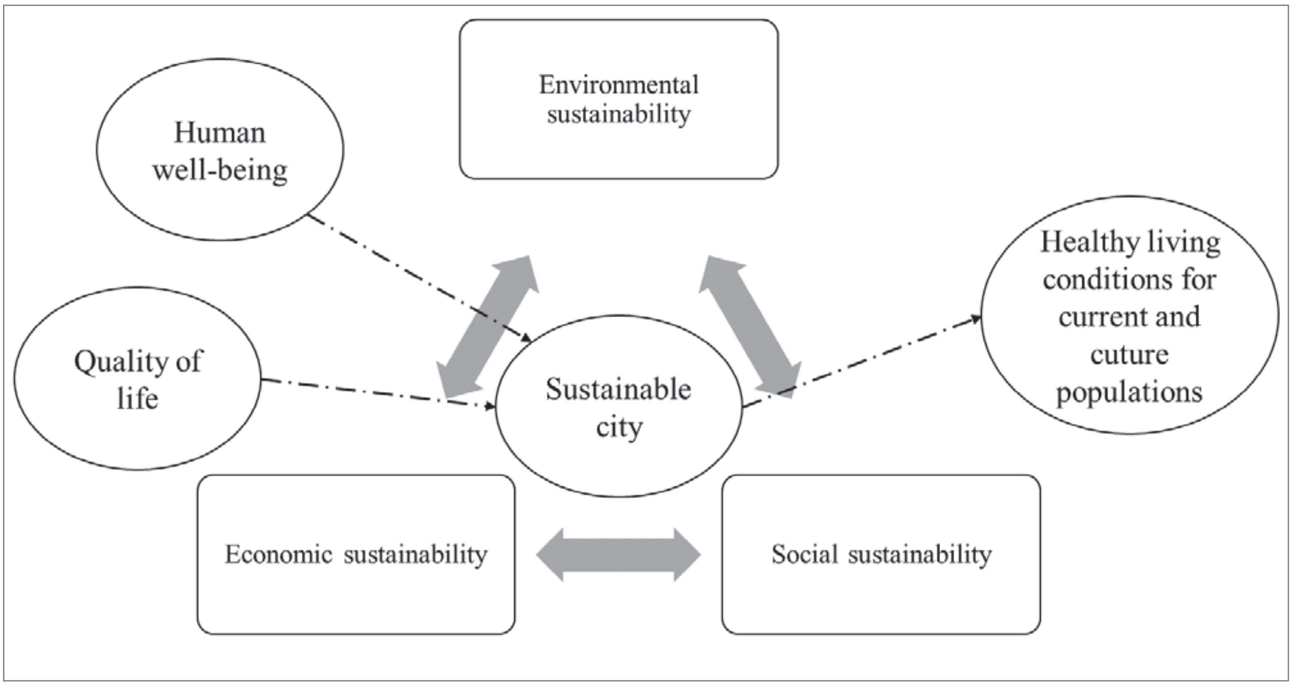


Figure 1: Definitions of urban sustainability (illustration: authors).

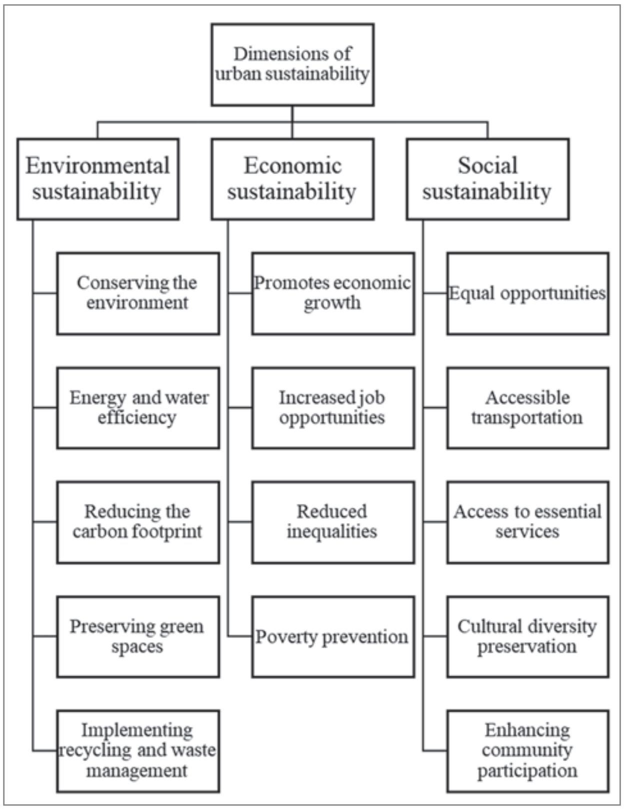


Figure 2: Dimensions of urban sustainability (illustration: authors).

socially, and economically healthy and flexible living conditions for current populations, without compromising the ability of future generations to have the same experience" (Figure 1). However, many issues in cities require responsible institutions to address and ideally resolve them (Michalina et al., 2021).

The concept of urban sustainability was addressed during the United Nations Habitat II Conference on Human Settlements, also known as the City Summit, held in Istanbul in 1996 (Alptekin & Saraç, 2017). This concept emerged from the idea that cities need to carefully and effectively utilize natural resources to meet the needs of current and future generations, as well as to inclusively support people. Sustainable cities are characterized by environmental sustainability measures such as conserving the environment, energy and water efficiency, reducing carbon footprints, preserving green spaces, and implementing recycling and waste management (Pınarcıoğlu & Kanbak, 2020). Economic sustainability implies that cities should promote economic growth while increasing job opportunities, reducing inequalities, and preventing poverty. Social sustainability, on the other hand, means that all communities living in cities have equal opportunities, accessible transportation, and easy access to education, health, housing, and other essential services (Figure 2). Furthermore, preserving cultural diversity, enhancing community participation, and strengthening democratic processes are also important for social sustainability (Michalina et al., 2021).

The Sustainable Development Goals (SDGs) consist of seventeen goals and 169 targets adopted by the United Nations in 2015 with the aim of promoting sustainable development globally by 2030 (UN, 2015). These goals aspire to build a more sustainable and equitable world, addressing both urban and rural areas. The Sustainable Development Goals, which seek to complete what the Millennium Development Goals could not achieve, prioritize the balance between the three dimensions of sustainable development: economic, social, and environmental. Urban sustainability holds a significant place within the Sustainable Development Goals. For global development, it is imperative that the majority of the population living in cities also become sustainable. For example, the goal Clean Water and Sanitation (SDG 6) comprises targets related to sustainable water resource utilization, clean water provision, and wastewater disposal within urban areas. Sustainable Cities and Communities (SDG 11) is a goal directly related to urban sustainability. It expects factors such as sustainable infrastructure, transportation systems, energy usage, and urban planning to contribute to the liveability and sustainability of cities. Clean Energy (SDG 7) is a goal that encourages the promotion of renewable energy in urban areas. Good Jobs and Economic Growth (SDG 8) aim for sustainable and inclusive growth. It describes the economic role that cities need to assume, such as job creation and promoting economic growth. Health and Wellbeing (SDG 3) is greatly impacted by urban planning. A clean environment, green spaces, and well-planned cities can contribute to people living healthier lives. Reducing Inequalities (SDG 10) is significant for social sustainability in cities. Decreasing inequalities in areas such as income, education, and living standards within urban areas is a key target.

Sustainable urbanization is considered one of the key elements of sustainable growth. Therefore, measuring the sustainability of cities and evaluating their performance are thought to be responses to achieving growth goals. As a result, urban sustainability indicators, designed as a framework comprising environmental, economic, and social aspects, are used as tools to assess the sustainability performance of cities (Pınarcıoğlu & Kanbak, 2020). Monitoring sustainable urban development poses a challenge for policymakers in terms of selecting relevant thematic categories and indicators. The selection of categories and indicators is carried out based on meeting specific criteria and requirements. The entire process of selecting categories and indicators must be transparent, methodologically accurate, and clearly justified. In most cases, eliminating the subjective nature of this process is difficult because the selection of categories and indicators is not value-neutral; rather, it reflects the biases, failures, intentions, assumptions, and worldviews of the framers of the framework (Michalina et al., 2021).

The European Commission's 2018 report *Indicators for Sustainable Cities* discusses the function of performance indicators in measuring sustainability performance. In this context, urban sustainability indicators can provide urban planners, local administrators, and policymakers with the ability to measure the socioeconomic and environmental performance of the city. Urban sustainability indicators that assist in measuring the city's performance in areas such as urban design, infrastructure services, policies, waste disposal systems, pollution, and accessibility to services not only aid in identifying issues but also help identify areas of improvement through good governance and research (Akçakaya, 2016; European Commission, 2018). Due to the significant variations in terms of available resources, population size, and urban metabolic processes among cities, the richness of sustainability indicators is beneficial. However, selecting appropriate sustainability indicators can be challenging (European Commission, 2018). There are measurable and comprehensible economic, social, and environmental indicators that allow for comparisons between different geographical regions and times to determine whether sustainable development is taking place in cities and to what extent (Çolakoğlu, 2019). Sustainability indicators are a proven method to promote sustainable urban development, and there are hundreds of different sets and frameworks available. The United Nations Human Settlements Programme (UN-Habitat), the UN Sustainable Cities Program, the World Bank's City Strength Diagnostic, the Sustainability Index for Cities, and the European Sustainable Cities Award have all introduced various indicators to measure the sustainability of cities (European Commission, 2018). Urban sustainability indices allow city planners and policymakers to assess the economic, social, and environmental impacts of applied urban plans on infrastructure development, policies, pollution, and citizens' access to services (Robati & Rezaei, 2022). Generally, there is no clear consensus on the methodology or standards in indicator sets that define the fundamental elements a city needs to ensure its sustainability (Pires et al., 2014).

2.2 Sustainability of cities in Turkey

There are a considerable number of studies on the sustainability performance of cities in developed countries, but there are relatively few studies focusing on emerging economies such as Turkey, mainly due to the incipient stage of the indicator-based approach (Kusakci et al., 2022). Cities in Turkey, which have experienced significant urban growth in the past fifty years, are home to approximately 75% of the total population. Cities in Turkey face diverse environmental and social challenges that require a variety of sustainable measures. According to Turkey's Tenth Development Plan, the most critical urban issues are inadequate housing units, traffic congestion, security and infrastructure deficiencies, social cohesion, migration, and environmental degradation (Kusakci et al., 2022). Moreover, the World Bank Group has supported sustainable development in Turkey through the Sustainable Cities Project by expanding financing. The program aims to improve the economic, environmental, and social sustainability of cities by enabling municipalities to access funds for priority investments (World Bank, 2019). Unfortunately, a shared set of sustainability measurement indicators for all provinces in Turkey is not yet available.

As a member of the United Nations, Turkey also signed the Paris Agreement in 2021, indicating its increased efforts in addressing climate change. When examining the studies conducted on the sustainability of cities in Turkey up to this point, it is evident that various analysis methods have been used. Gülcan and Aldemir (2008) compared two provinces in the Aegean Region (Aydın and Denizli) in terms of economic and sociocultural factors. They stated that economic factors alone are not sufficient to evaluate sustainability. Therefore, other factors such as cities' cultural values and networks must also be included (Kusakci et al., 2022). The Sustainability Study of Turkey's Cities, conducted in 2011 in collaboration between Boğaziçi University and MasterCard, was examined. This study used both objective and subjective data. Objective data involved using indicators published at the province level to calculate sustainability and quality of life indices covering all eighty-one provinces in Turkey. In addition to objective assessment, a survey was conducted with business managers in twenty-nine provinces, including twenty-six regions at the NUTS 2 level and sixteen metropolitan municipalities for subjective evaluation (MasterCard Worldwide & Boğaziçi Üniversitesi, 2011).

Gazibey et al. (2014) analysed the sustainability performance of the eighty-one provinces in Turkey using social, economic, and environmental indicators and the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method. The TOPSIS method is a technique for determining the preference ranking of alternatives in multi-criteria decision problems (Hwang & Yoon, 1981). The TOPSIS method aims to simultaneously identify alternatives that are closest to the "positive ideal solution" and farthest from the "negative ideal solution". The positive ideal point has the highest benefit and the lowest cost, and the negative ideal point is associated with the lowest benefit and the highest cost. Consequently, the ranking of alternatives is established in descending order based on their relative proximity values to the ideal solutions (Gazibey et al., 2014). The results indicated that Kocaeli, Istanbul, and Ankara were the top three sustainable cities. It was emphasized that the results from this study could assist in making decisions during the creation of new public policies and help achieve a balance between costs and benefits among stakeholders. The need for new indicators and the necessity of data collection related to these new indicators for evaluating the sustainability of provinces in the country were highlighted (Alptekin & Saraç, 2017).

Yıldırım et al. (2017) focused on examining the perception levels of local government personnel in Istanbul regarding environmental sustainability tools by evaluating indicators of Local Agenda 21, including social activities, renewable energy projects, energy efficiency projects, green transportation, and waste management. The results indicated that strategy-based practices such as sustainable planning and participatory policies were more successful than project-based applications (Kusakci et al., 2022). Alptekin and Saraç (2017) used the entropy weight determination method for determining the importance levels (or weights) of each variable in the indicator set that assists in measuring sustainable development. They also employed the grey relational analysis technique, a multi-criteria decision-making method, to establish rankings for sustainable development among provinces in Turkey (Alptekin & Saraç, 2017). Finally, in their study conducted in 2022, Kuşakçı et al. used the IT2D-AHP method to reveal that the level of urban sustainability in the thirty metropolitan cities in Turkey varied in economic, social, environmental, and institutional dimensions through the Sustainable Cities Index (Kusakci et al., 2022). The aim of all these studies is to raise awareness about urban sustainability, provide data-based contributions to policymakers' decision-making processes, and offer a roadmap for measuring and improving the performance of cities in terms of sustainability.

Defining urban sustainable development in purely quantitative terms is difficult, and over the past decades researchers have acknowledged the inherently uncertain and ambiguous nature of defining and addressing indicators related to the efficient and effective use of resources through various data collection methods (Hincu, 2011). The outcomes of sustainable development are uncertain in both qualitative and mathematical sustainability assessments. To obtain a sustainable model for a city system, the sustainability of subsystems can be integrated using fuzzy logic (Jaderi et al., 2014). Sustainable development is a concept that simultaneously meets the needs of economic, social, and environmental dimensions. Andriantiatsaholiniaina et al. (2004) developed the SAFE (Sustainability Assessment by Fuzzy Evaluation) model, which can be explained by fuzzy logic and uses basic, environmental integrity, economic efficiency, and social solidarity indicators to measure sustainable development. They proposed this model for the Greek and American economies and argued that there is no single way to make effective sustainable decisions, advocating the use of different indicators for each country (Alptekin & Saraç, 2017).

2.3 Fuzzy logic

Fuzzy logic is a method that was introduced by Lotfi A. Zadeh in 1965. Fuzzy logic is a mathematical approach used to model and control systems that involve uncertainty, lack of precise boundaries, or transitions between specific values (Robati & Rezaei, 2022). This method is designed to handle uncertainties commonly encountered in complex and real-world scenarios. Fuzzy logic aims to equip machines with the ability to think and make conclusions like humans, using imprecise terms expressed in natural language (Phillis et al., 2017). The

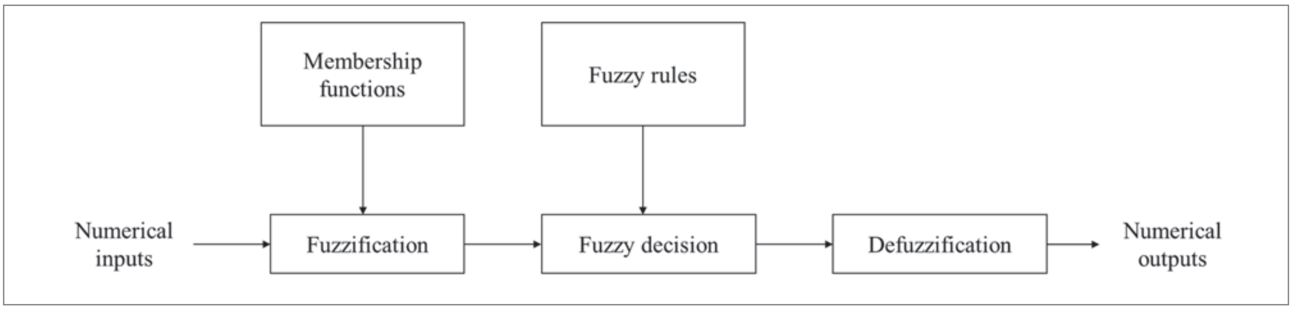


Figure 3: Fuzzy logic (illustration: authors).

applications of fuzzy logic are quite extensive, including control systems, artificial intelligence, robotics, image processing, machine learning, natural language processing, economics and finance, and environmental and energy management. In addition, fuzzy logic is used in various sectors such as healthcare, traffic management, industrial processes, and agriculture. Fuzzy methodologies can address assessment challenges in sustainability evaluations. As an appropriate method, in urban sustainability analysis, it is often used for purposes such as developing composite indices to rank and assess urban sustainability performances, evaluating urban renewal projects, and comparing local-scale units or cities from around the world (Buzási et al., 2022).

Unlike traditional binary logic, fuzzy logic evaluates the infinite possibility range within the interval (0–1) because it does not have strict binary thresholds. Fuzzy logic can be employed as a method to model and analyse uncertain and complex systems (Hincu, 2011). This method helps reduce uncertainty in the data, aiding in better understanding the system. The method also allows for the incorporation of expert opinions and experiences. The fuzzy logic method describes a process in which numerical data are first evaluated verbally and then expressed numerically again at the output. The fuzzy logic process is summarized in Figure 3. The method starts with the fuzzification process, in which numerical data are transformed into verbal expressions. For each input datum, membership functions are created in various shapes such as triangles, Gaussian curves, or trapezoids. These membership functions are defined using verbal expressions such as low, medium, and high. The second stage of the method is called the fuzzy decision-making process, in which the output expression is defined based on the relationship between membership functions. The rules in this stage are expressed as "if . . . and/or . . . then . . ." rules. In this way, a verbal output is obtained based on the relationship between different inputs. In the final stage of the method, the numerical counterpart of the verbal output expression obtained is calculated, and this stage is referred to as defuzzification (Figure 3).

3 Method

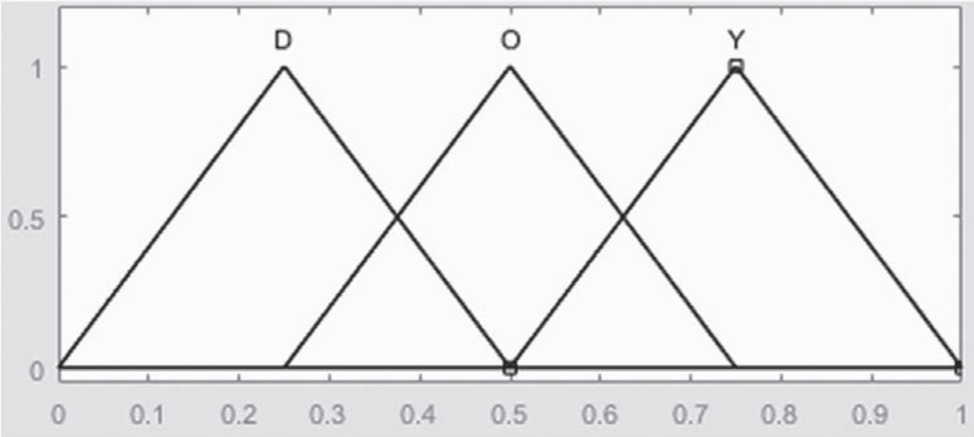
This study employs the fuzzy logic method within a model based on an indicator set to monitor the sustainability performance of all cities in Turkey. The sustainability performance of a city is addressed based on numerical data along with sub-components defined within the main ecological, economic, and social components. The ecological component includes subcomponents of air, water, soil, and energy. Two indicators are used for air, two for water, three for soil, and two for energy. The economic component includes subcomponents of work life and livelihood, with three indicators used for each. For the social component, the subcomponents are defined as population, education, health, and housing. Population is examined through two indicators, education through four, health through three, and housing through three. The results were obtained for the main components by applying fuzzy logic rules to the indicators. By applying these fuzzy logic rules again to the data obtained, the sustainability levels of all cities in Turkey were calculated individually.

In this study, careful attention has been given to whether each selected indicator for determining the sustainability performance of provinces has a counterpart at the provincial level. The indicators utilized in the study have also been employed in previous research related to this subject in Turkey. Detailed explanations regarding the data, the reference study for the data, and the impact of the fuzzy logic rules (positive/negative) are provided in Table 1. The limitations of this study include accessing data at the provincial level and selecting the same or the nearest available year as the reference year. Although data in Turkey are recorded by the Turkish Statistical Institute (TSI, 2020, 2021, 2022), some data were obtained from other sources. Data related to commercial establishments were obtained from the Union of Chambers and Commodity Exchanges of Turkey (UCCE, 2022), housing depreciation data from the Endeksa website (Endeksa, 2022), forest assets from the General Directorate of Forestry (2021), and electricity-related data from the Energy Market Regulatory Authority (EMRA, 2022).

Table 1: Sustainability performance model indicators.

	Indicator		References	Impact
Economic	Work life			
		Unemployment rate	Gazibey et al., 2014; UN, 2015 (SDG 8); Alptekin & Saraç , 2017	Negative
		Labour force	Gazibey et al., 2014; Alptekin & Saraç , 2017	Positive
		Companies	Alptekin & Saraç , 2017	Positive
	Livelihood			
		GINI coefficient	UN, 2015 (SDG 4)	Negative
		Regional poverty	UN, 2015 (SDG 10)	Negative
		GDP	UN, 2015 (SDG 8); Alptekin & Saraç , 2017; Kuşakçı et al., 2022	Positive
Ecological	Air quality			
		Annual PM10 levels	MasterCard, 2011; Gazibey et al., 2014; UN, 2015 (SDG11); Alptekin & Saraç , 2017	Negative
		Cars per capita	Kuşakçı et al., 2022	Positive
	Water			
		Access to potable water	MasterCard, 2011; Gazibey et al., 2014; UN, 2015 (SDG 6); Kuşakçı et al., 2022	Positive
		Access to sewerage network	MasterCard, 2011; Gazibey et al., 2014; SDG 6; Kuşakçı et al., 2022	Positive
	Soil			
		Built-up areas open for public use	UN, 2015 (SDG 11)	Positive
		Forest area	MasterCard, 2011; UN, 2015 (SDG 15)	Positive
		Municipal waste collection and treatment	MasterCard, 2011; UN, 2015 (SDG 11); Kuşakçı et al., 2022	Positive
	Energy			
		Electricity consumption	MasterCard, 2011	Negative
		Renewable energy	Alptekin & Saraç , 2017; Kuşakçı et al., 2022	Positive
Social	Population			
		Population density	MasterCard, 2011; Gazibey et al., 2014; Alptekin & Saraç , 2017; Kuşakçı et al., 2022	Negative
		Net migration	Kuşakçı et al., 2022	Negative
	Education			
		Literacy	MasterCard, 2011; Alptekin & Saraç , 2017; Kuşakçı et al., 2022	Positive
		Primary school enrolment	UN, 2015 (SDG 4); Alptekin & Saraç , 2017; Kuşakçı et al., 2022	Positive
		Junior high school enrolment	UN, 2015 (SDG 4); Alptekin & Saraç , 2017; Kuşakçı et al., 2022	Positive
		High school enrolment	UN, 2015 (SDG 4); Alptekin & Saraç , 2017; Kuşakçı et al., 2022	Positive
	Health			
		Under-5 mortality rate	Gazibey et al., 2014; SDG 3; Alptekin & Saraç , 2017; Kuşakçı et al., 2022	Negative
		Physicians per capita	MasterCard, 2011; Gazibey et al., 2014; UN, 2015 (SDG 3); Alptekin & Saraç , 2017; Kuşakçı et al., 2022	Positive
		Life expectancy	Kuşakçı et al., 2022	Positive
	Housing			
		Depreciation (rent)	UN, 2015 (SDG 11)	Negative
		House sales	Alptekin & Saraç , 2017; Kuşakçı et al., 2022	Positive
		Buildings with building permit	Kuşakçı et al., 2022	Positive

Source: Authors.



	Basic indicators			Sub-components, components, and sustainability		
	L	M	H	L	M	H
P1	0,00	0,25	0,50	0,00	0,20	0,50
P2	0,25	0,50	0,75	0,20	0,50	0,80
P3	0,50	0,75	1,00	0,50	0,80	1,00

Figure 4: Membership functions and limits (illustration: authors).

The data have been normalized within their value ranges and scaled to a range of 0 to 1. Normalization has been applied to the data in the study because the indicators are expressed in different measurement units. This ensures that cities can be compared. The normalization process has been performed based on the minimum and maximum values in the data sets related to the indicators, using the following formula:

$$x_{norm} = \frac{x - x_{min}}{x_{max} - x_{min}}$$

where x_{norm} is the normalized value, x is the real value, x_{min} is the minimum value, and x_{max} is the maximum value in the data set.

This model starts from the indicators and ultimately reaches the sustainability performance degree. All membership functions have been chosen in the form of a triangle due to their convenience and frequent preference in the literature (Figure 4). Membership functions at all stages have been uniformly and evenly distributed. In the first stage of the model, membership functions for the indicators have been defined as Low (L), Medium (M), and High (H) in triplets. The boundary values used to create these triangles are provided in the table as P1, P2, and P3. The basic indicator, sub-component, component, and sustainability limits in the study are given in Figure 4.

Rules were written for the relationships between indicators and sub-components. In writing these rules, all components were treated with equal weight in line with expert opinions. The positive effects of some components and negative effects of others were considered in writing the rules. By running the MATLAB program, data in the range of 0 to 1 for sub-components were obtained. In the second stage, triplet membership functions were created for sub-components using Low (L), Medium (M), and High (H) expressions based on the data related to sub-components. Rules were written for the relationships between sub-components and components. By running the MATLAB program, results in the range of 0 to 1 for components were obtained. In the final stage, membership functions for components were created as Low (L), Medium (M), and High (H) expressions in triplets. Rules were written for the relationships between components and sustainability, and the sustainability performance values were obtained in the range of 0 to 1 as a result of the model (Figure 5).

In this study, the Mamdani fuzzy inference method was applied. The Mamdani method consists of four stages: fuzzification of input variables, evaluation of rules, aggregation of rule outputs, and defuzzification. In the fuzzification stage, numerical values of the inputs are associated with membership degrees in their corresponding membership functions. The evaluation of rules determines the output based on the membership degrees of the inputs, finding the corresponding output function values. The values of the inputs are applied to all written rules, and the output functions are aggregated.

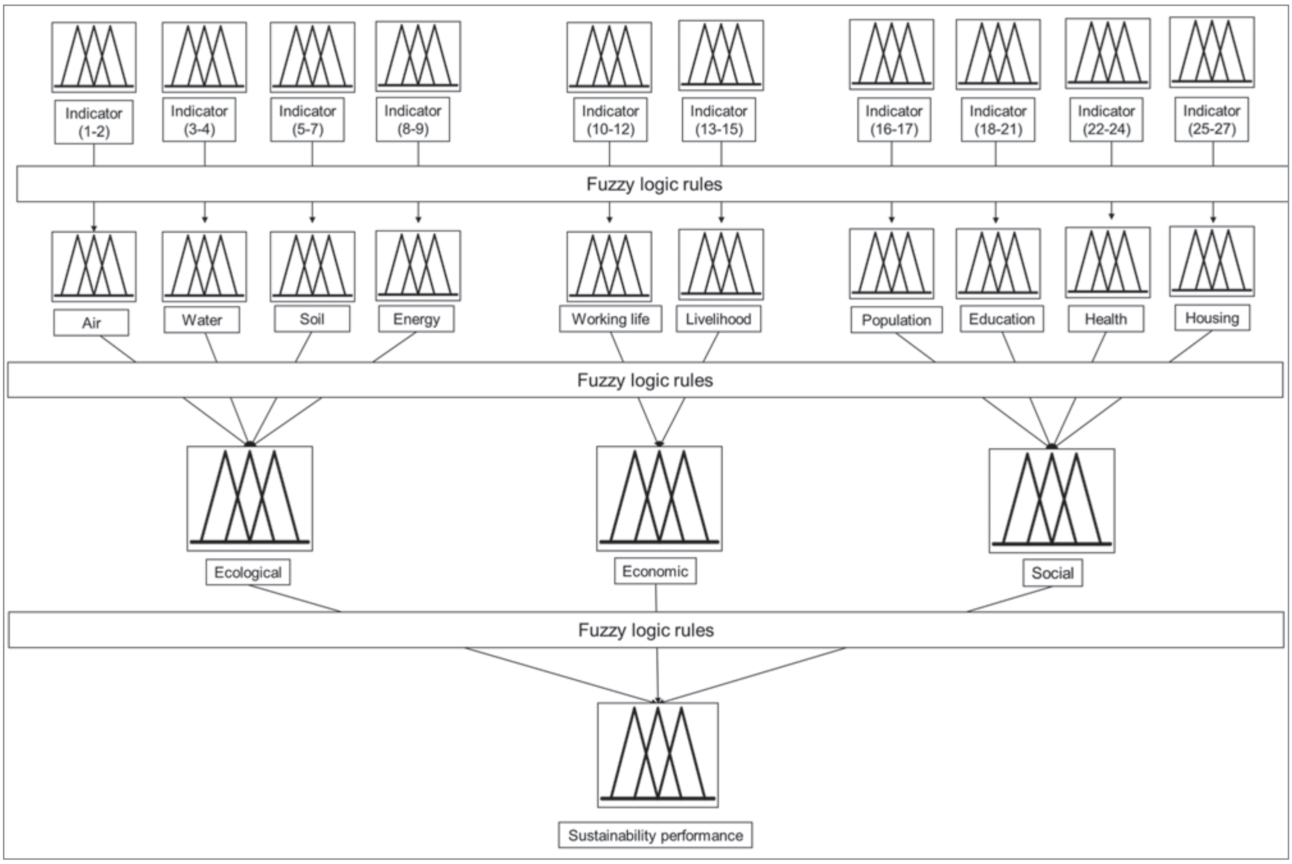


Figure 5: Sustainability performance model (illustration: authors).

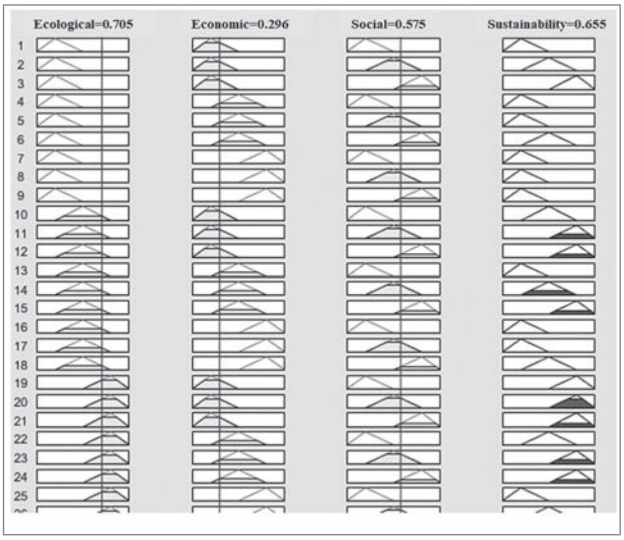


Figure 6: The MATLAB Fuzzy Toolbox interface (illustration: authors).

This stage involves the summation of all rule outputs. The final stage, defuzzification, expresses the obtained fuzzy set result as a single number. For this purpose, the centroid technique was used. In the centroid technique, the centre of gravity of the output fuzzy set is calculated. The formula used for this is:

$$x_{norm} = \frac{x - x_{min}}{x_{max} - x_{min}}$$

The COG (centre of gravity) formula represents the centroid of the output fuzzy set. $\mu_{(x)}$ denotes the membership degree, and x represents the value of this membership degree in the output function. Using these values, the centroid is calculated within the boundaries of a and b, providing the numerical value of the output function. The MATLAB Fuzzy Toolbox interface for calculating sustainability values is provided in Figure 6. Numerical data related to the ecological, economic, and social components of the city for which the calculation will be performed intersect with the membership functions in the rules. These values correspond to fuzzy sets obtained in the sustainability output. This process is applied to all rules, and all sustainability output sets are aggregated. The centroid of the aggregated set is calculated, and the sustainability index for that city is computed.

4 Results

The results obtained for each of the eighty-one provinces in Turkey were divided into five quantile (twenty-percentile) groups. The cities were ranked as follows: sixteen cities in

Table 2: Ecological performance.

Ecological level	Provinces
Level 1: lowest	Malatya (0.293), Hakkari (0.295), Batman (0.297), Hatay (0.3), Burdur (0.308), Kırşehir (0.421), Amasya (0.423), Tokat (0.424), Muğla (0.44), Rize (0.442), Aydın (0.45), Ardahan (0.463), Zonguldak (0.475), Ordu (0.475), Bilecik (0.481), Adıyaman (0.483)
Level 2: low	Erzincan (0.486), Sinop (0.490), Bitlis (0.495), Tunceli (0.498), Uşak (0.499), Mardin (0.501), Kahramanmaraş (0.503), Osmaniye (0.508), Bayburt (0.509), Düzce (0.509), Kırıkkale (0.510), Istanbul (0.519), Kırklareli (0.519), Gümüşhane (0.528), Aksaray (0.529), Bartın (0.532)
Level 3: medium	Van (0.533), Kütahya (0.536), Samsun (0.536), Çorum (0.543), Bursa (0.545), Tekirdağ (0.55), Giresun (0.556), Edirne (0.57), Antalya (0.573), Nevşehir (0.577), Izmir (0.578), Niğde (0.580), Karabük (0.585), Elazığ (0.593), Trabzon (0.593), Konya (0.595), Kars (0.597)
Level 4: high	Denizli (0.652), Eskişehir (0.614), Yozgat (0.630), Şırnak (0.657), Manisa (0.616), Afyonkarahisar (0.547), Çanakkale (0.636), Siirt (0.651), Kocaeli (0.635), Diyarbakır (0.562), Çankırı (0.602), Kilis (0.609), Kastamonu (0.579), Şanlıurfa (0.507), Balıkesir (0.599), Artvin (0.640)
Level 5: very high	Muş (0.645), Isparta (0.631), Kayseri (0.644), Bolu (0.647), Mersin (0.653), Adana (0.655), Bingöl (0.647), Iğdır (0.656), Yalova (0.629), Ağrı (0.567), Sivas (0.662), Ankara (0.660), Gaziantep (0.561), Erzurum (0.660), Karaman (0.665), Sakarya (0.614)

Source: Authors.

Table 3: Economic performance.

Economic level	Provinces
Level 1: lowest	Mardin (0.284), Kahramanmaraş (0.286), Osmaniye (0.286), Şırnak (0.286), Siirt (0.290), Kırşehir (0.292), Nevşehir (0.292), Niğde (0.292), Batman (0.293), Sivas (0.293), Yozgat (0.294), Şanlıurfa (0.297), Hatay (0.300), Sinop (0.30), Ardahan (0.303), Kars (0.303), Iğdır (0.303)
Level 2: low	Diyarbakır (0.319), Hakkari (0.364), Aksaray (0.365), Kırıkkale (0.381), Edirne (0.385), Amasya (0.387), Çorum (0.387), Karaman (0.389), Kastamonu (0.391), Tokat (0.391), Konya (0.392), Kayseri (0.395), Muş (0.399), Bitlis (0.400), Çankırı (0.407) Samsun (0.414)
Level 3: medium	İzmir (0.419), Gaziantep (0.420), Adıyaman (0.424), Bartın (0.424), Karabük (0.424), Kilis (0.424), Van (0.424), Zonguldak (0.424), Ağrı (0.424), Kırklareli (0.429), Erzurum (0.432), Bayburt (0.437), Mersin (0.466), Adana (0.476), Çanakkale (0.482), Balıkesir (0.484)
Level 4: high	Erzincan (0.492), Gümüşhane (0.492), Ordu (0.492), Giresun (0.492), Trabzon (0.493), Rize (0.493), Ankara (0.499), İstanbul (0.500), Afyonkarahisar (0.531), Tekirdağ (0.557), Aydın (0.558), Düzce (0,562), Sakarya (0,564), Isparta (0.570), Bolu (0.576), Yalova (0.582)
Level 5: very high	Kocaeli (0.583), Kütahya (0.588), Artvin (0.592), Burdur (0.598), Manisa (0.604), Uşak (0.609), Malatya (0.609), Bingöl (0.610), Elazığ (0.610), Tunceli (0.610), Denizli (0.669), Muğla (0.672), Antalya (0.677), Bilecik (0.691), Eskişehir (0.696), Bursa (0.703)

Source: Authors.

the first group, sixteen in the second group, seventeen in the third group, sixteen in the fourth group, and sixteen in the last group. The cities, sorted from the lowest to the highest degree, were mapped. The outputs obtained from the ecological, economic, and societal main components of the cities grouped according to sustainability performance were also classified and mapped using the same system. The most populous cities in Turkey (Istanbul, Ankara, and Izmir) were evaluated under each main component.

4.1 Ecological main component

Within the ecological main component, nine different indicators were evaluated within four sub-components. According to the evaluation results, the province with the lowest ecological performance level, in the first group, is Malatya. After Malatya, the provinces with the lowest performance are Hakkari, Batman, Hatay, and Burdur. The province with the highest performance in the last group is Karaman. The Erzurum, Sakarya

Table 4: Social performance.

Social level	Provinces
Level 1: lowest	Sinop (0.297), Ağrı (0.301), Şanlıurfa (0.350), Afyonkarahisar (0.398), Gaziantep (0.402), Kırşehir (0.404), Bitlis (0.405), Van (0.413), Niğde (0.438), Tekirdağ (0.442), Diyarbakır (0.451), Sakarya (0.456), Kütahya (0.459), Kastamonu (0.460), Mardin (0.461), Balıkesir (0.465)
Level 2: low	Bartın (0.472), Uşak (0.473), Yalova (0.474), Kars (0.475), Manisa (0.476), Yozgat (0.477), Batman (0.485), Bursa (0.490), Hatay (0.492), Kocaeli (0.493), Çankırı (0.495), Nevşehir (0.496), Kırıkkale (0.498), Gümüşhane (0.500), Sivas (0.500), Siirt (0.501)
Level 3: medium	Muş (0.501), Bilecik (0.502), Aksaray (0.507), Tunceli (0.507), Kahramanmaraş (0.514), Düzce (0.515), Osmaniye (0.521), Adıyaman (0.527), Hakkari (0.535), Malatya (0.536), Zonguldak (0.537), Kayseri (0.538), Burdur (0.539), Konya (0.539), Çorum (0.540), Karaman (0.540), Kilis (0.540)
Level 4: high	Mersin (0.540), Amasya (0.540), Şırnak (0.542), Bolu (0.544), Karabük (0.546), Elazığ (0.552), Erzurum (0.556), Çanakkale (0.559), Denizli (0.560), Kırklareli (0.561), Adana (0.575), Iğdır (0.590), Rize (0.590), Bingöl (0.594), Samsun (0.601), Muğla (0.620)
Level 5: very high	Tokat (0.623), Giresun (0.626), Bayburt (0.629), Erzincan (0.638), Ardahan (0.641), Trabzon (0.642), Ordu (0.647), Isparta (0.649), Edirne (0.651), Eskişehir (0.654), Izmir (0.671), Artvin (0.686), Ankara (0.688), Aydın (0.702), Antalya (0.704), Istanbul (0.711)

Source: Authors.

Table 5: Sustainability performance.

Sustainability level groups	Provinces
Level 1: lowest	Bilecik (0.359), Malatya (0.386), Bursa (0.394), Burdur (0.396), Uşak (0.417), Tunceli (0.423), Denizli (0.460), Hakkari (0.460), Kütahya (0.463), Düzce (0.464), Muğla (0.472), Eskişehir (0.478), Elazığ (0.490), Van (0.493), Tekirdağ (0.494), Sinop (0.497)
Level 2: low	Hatay (0.500), Batman (0.503), Bitlis (0.503), Manisa (0.508), Ağrı (0.509), Afyonkarahisar (0.511), Antalya (0.516), Rize (0.522), Amasya (0.523), Gümüşhane (0.523), Tokat (0.529), Kocaeli (0.532), Şanlıurfa (0.532), Bartın (0.535), Zonguldak (0.538), Adıyaman (0.544)
Level 3: medium	Artvin (0.554), Kırklareli (0.556), Bingöl (0.558), Isparta (0.560), Karabük (0.566), Kırşehir (0.567), Gaziantep (0.571), Bolu (0.574), Diyarbakır (0.577), Samsun (0.577), Yalova (0.577), Kastamonu (0.580),Konya (0.581), Çorum (0.585), Ordu (0.586), Kırıkkale (0.588), Erzincan (0.590)
Level 4: high	Çanakkale (0.591), Aydın (0.593), Niğde (0.594), Balıkesir (0.594), Giresun (0.594), Ardahan (0.596), Bayburt (0.597), Sakarya (0.599), Aksaray (0.601), Çankırı (0.603), Trabzon (0.606), Kilis (0.610), Edirne (0.613), Kars (0.621), Mardin (0.622), Yozgat (0,627), İzmir (0.627),
Level 5: very high	Muş (0.645), Kayseri (0,646), Mersin (0.649), Siirt (0.651), Nevşehir (0.653), Adana (0.655), Iğdır (0.655), Ankara (0.658), Şırnak (0.658), Karaman (0.660), İstanbul (0.661), Sivas (0.662), Osmaniye (0.664), Kahramanmaraş (0.664), Erzurum (0.665)

Source: Authors.

Gaziantep, and Ankara provinces reached the highest values after Karaman. Table 2 shows the distribution of performance values for all cities and the groups they belong to. In terms of ecological performance, the Ankara province has a higher value compared to Istanbul and Izmir. Istanbul is in the second group and Izmir is in the third group, whereas Ankara is in the best group, which is the fifth group.

4.2 Economic main component

The economic main component consists of two sub-components and a total of six indicators. The values obtained in the economic component were lower than the values observed in all other main components. Mardin had the lowest economic performance, and Bursa showed the highest performance.

Izmir is in the third group, and Ankara and Istanbul are in the fourth group. Table 3 shows that the Aegean region and the Southeast Anatolia region stand out economically.

4.3 Social main component

The social main component has more indicators than the economic and ecological components. Within the social component, consisting of a total of twelve indicators, there are four sub-components. As a result of the evaluation, it can be seen that the Sinop province has the lowest performance. The Ağrı, Şanlıurfa, Afyonkarahisar, and Gaziantep provinces have the lowest performance after Sinop. The province with the highest performance is Istanbul. Antalya, Aydın, Ankara, and Artvin are other provinces in this group. The Izmir, Ankara, and Istanbul provinces are all in the highest level, which is the fifth group. Table 4 shows the results of the social main component.

4.4 Sustainability performance

When the results of the sustainability performance ratings are evaluated based on the 2022 data, it is observed that Bilecik, Malatya, Bursa, Burdur, and Uşak are the lowest-ranking provinces. The provinces showing the highest sustainability performance are Erzurum, Karaman, Kahramanmaraş, Osmaniye, Sivas, and Istanbul (Table 5). With differentiation in each region, higher sustainability performance in cities located in the middle of Turkey is evident. According to the analysis results, there are significant differences in sustainability levels among provinces.

5 Discussion

This study was conducted using a fuzzy model with the aim of assessing the sustainability performance of cities in Turkey. This model takes into account three main components – namely, the economy, ecology, and society – and encompasses a total of twenty-seven indicators. Based on the research findings, it is observed that different cities in Turkey exhibit varying levels of sustainability performance. When comparing the results of this study to those of previous research, various differences and similarities are observed.

The study conducted by MasterCard (2011) utilized sixty-nine indicators under the categories of economic, social, and environmental components, and it demonstrated that the western regions of Turkey are more sustainable, whereas the eastern and southeastern regions are less sustainable. Another study by Gazibey et al. (2014) employed a total of fifty-two indicators and identified Kocaeli, Istanbul, Ankara, Izmir, and Canakkale as the most sustainable cities, while ranking Adiyaman, Mardin, Sanliurfa, Kilis, and Hakkari as less sustainable. These results support the thesis that western Turkey is more sustainable and the southeastern regions less so. A study by Alptekin and Saraç (2017) examined fifty-one indicators under the categories of economic, social, and environmental components. According to data from 2013, they ranked Istanbul, Ankara, Antalya, Kocaeli, and Izmir as the most sustainable cities and identified Kilis, Duzce, Sinop, Bartin, and Kastamonu as less sustainable. These results also indicate that western Turkey is more sustainable, with cities in the Black Sea and Southeast Anatolia regions being less sustainable.

Finally, a study by Kusakci et al. (2022) considered fifty-three indicators under the categories of economic, environmental, social, and institutional components, but only examined three major cities. In this study, they designated Antalya, Mugla, Eskisehir, Ankara, and Kocaeli as the most sustainable cities while ranking Van, Mardin, Ordu, Diyarbakir, and Sanliurfa as less sustainable. Similar to other studies, this study found that the sustainability performance in the southeastern provinces of Turkey is lower, but, uniquely, it observed that the central Anatolian and Mediterranean regions of Turkey exhibited higher sustainability performance, possibly due to differences in the model framework, the methodology, and the pandemic effects specific to the year when the data were collected (Figure 7).

In all the studies conducted on the sustainability of cities in Turkey, it is observed that the cities with the highest population – namely, Istanbul, the capital Ankara, and Izmir – are evaluated among themselves. When the sustainability performance of these cities is assessed using the model employed in this study, the ranking is as follows: Istanbul, Ankara, and Izmir. This result is consistent with similar studies in the literature, in which cities with higher populations, typically large metropolitan areas, tend to exhibit higher sustainability performance compared to smaller cities. The results obtained in this study indicate that smaller cities can compete with larger cities in terms of sustainability performance, emphasizing the need to harness the potential of smaller settlements in terms of sustainability. For instance, in this study, the Erzurum province emerged as having the highest sustainability performance, which can be attributed to the rule-based and flexible nature of the fuzzy logic method. However, it is important to note that this study, like others, has certain limitations. One limitation is that the data used are specific to a particular period. In addition, the use of equal weights for indicators and their selection represents other limitations. Future studies could examine the effects of using different indicators and adjusting the weights of indicators.

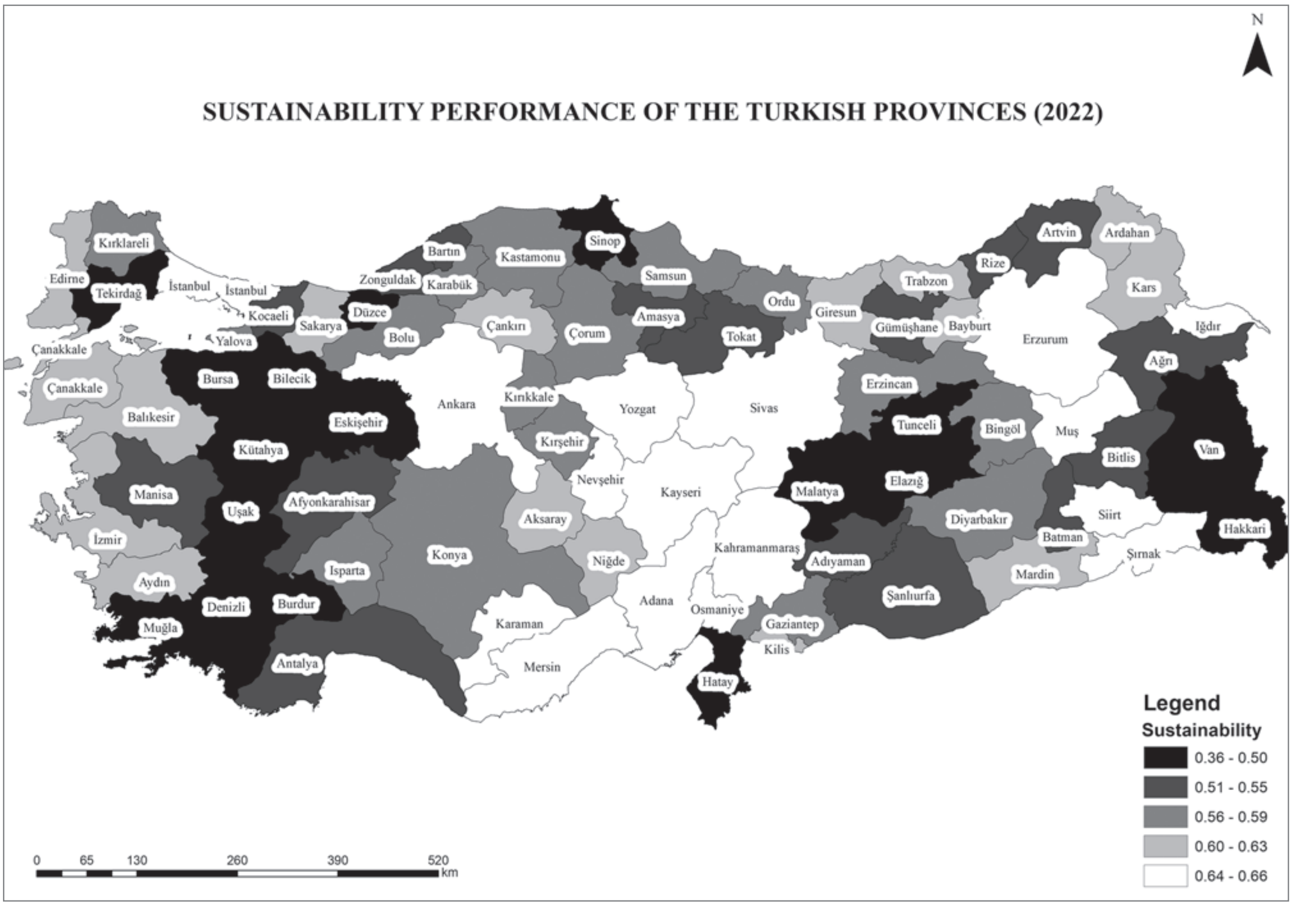


Figure 7: Sustainability performance of Turkish provinces (illustration: authors).

6 Conclusion

Cities have been important centres for the social, economic, and cultural development of humanity throughout history. However, with the increasing pace of urbanization, population growth, and environmental impacts, the concept of sustainability has become a significant issue for cities. Sustainable cities combine planning, management, and technological perspectives to ensure long-term liveability and wellbeing from environmental, economic, and social perspectives. These cities work toward achieving sustainability goals to create a healthy and liveable environment for future generations. Policymakers, local governments, urban planners, and academics today face a wide variety of existing sustainability indicator frameworks.

This study measured the sustainability performances of cities in Turkey through the application of the fuzzy logic method, considering economic, ecological, and social components. The cities were divided into quantiles (twenty-percentile) groups based on their achieved sustainability levels. The performance results will serve as a guide for identifying areas where more work needs to be done in terms of specific sustainability components in cities. The fuzzy logic method has been shown to be an important analytical tool in the field of sustainability due to its ability to address uncertainties and complexities. It is believed that this model will provide urban planners, policymakers, and decision-makers with better opportunities to develop strategies and policies for creating more sustainable and liveable cities. This model, which is repeatable, adaptable, and allows for comparisons based on numerical results, is expected to contribute to the literature. Future studies will repeat this model for data from different years, compare the results, and observe changes in cities' sustainability levels over time.

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Notes

This article is based on the doctoral dissertation *Evaluation of Sustainable City and Settlement Performance in Turkey through a Fuzzy Logic Approach and Smart-Ecological Housing Area Model* by Ece Özmen, a student in the doctoral programme in city and regional planning at the Institute of Graduate Studies at Istanbul Technical University.

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