IT project management: Does sustainability matter?

Upravljanje IT projektima: Je li održivost važna?

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Abstract. *Sustainability is important in many aspects of human life today, and this paper focuses on the sustainability of IT projects. IT projects face a dynamic environment and numerous challenges, raising the question of to what extent and how sustainability principles are considered.*
The paper reviews different types of sustainability in the IT sector, with a focus on IT projects. It analyzes the presence of sustainability topics in the literature, proposes their integration across the project life cycle, and presents an example of sustainability in an IT project. The paper lays the groundwork for further research on sustainability in IT projects.

Keywords. Sustainability, IT projects

Sažetak. *Održivost je pojam koji je u današnje vrijeme važan u raznim aspektima ljudskog života, a u ovom radu naglasak je na održivosti IT projekata. IT projekte karakterizira dinamično okruženje te brojni izazovi. Postavlja se pitanje u kojoj se mjeri i na koji način u IT projektima uvažavaju načela održivosti.*
Ovaj rad donosi pregled vrsta održivosti u IT sektoru općenito, s naglaskom na IT projekte. Rad obuhvaća analizu zastupljenosti tema održivosti u literaturi, donosi prijedlog održivosti kroz faze životnog ciklusa projekta te opisuje konkretan primjer održivosti u IT projektu. Rad pruža podlogu za daljnje istraživanje održivosti u konkretnim primjerima IT projekata.

Ključne riječi. Održivost, IT projekti

1 Introduction

The concept of sustainability and sustainable development is increasingly being mentioned in various areas of everyday life, including the IT sector. Although there is no universally accepted definition of sustainability, one of the most well-known definitions comes from the World Commission on Environment and Development, published in the 1987 report *Our Common Future*, which defines sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). Sustainability can be divided into several dimensions. For example, the World Commission on Environment and Development identifies three dimensions of sustainability: people, profit, and planet. These are also referred to as the economic, environmental, and social dimensions of

1 Uvod

Pojam održivosti i održivog razvoja sve se češće spominje u različitim područjima svakodnevnog života, pa tako i u IT sektoru. Iako ne postoji jedinstvena definicija održivosti, jedna od najpoznatijih definicija je ona Svjetske komisije za okoliš i razvoj, objavljena 1987. godine u izvještaju Our Common Future, prema kojoj je održivost „razvoj koji zadovoljava potrebe današnjice, a pritom ne ugrožava potrebe budućih generacija“ (Svjetska komisija za okoliš i razvoj, 1987). Održivost se može podijeliti na više dimenzija. Primjerice, Svjetska komisija za okoliš i razvoj dijeli održivost na tri dimenzije: ljudi, profit i planet. Te dimenzije još se nazivaju ekonomska, ekološka i društvena (socijalna) dimenzija. Pojedini autori uvode i dodatne dimenzije, kao što su tehnička, individualna, i kulturna održivost (Amri i Bellamine Ben Saoud, 2014; Moreira et al, 2023; Soini i Dessein, 2016; Swacha, 2022).

U ovom radu fokus je na održivosti u IT projektima. Upravljanje IT projektima samo je po sebi vrlo

sustainability. Some authors introduce additional dimensions, such as technical, individual, and cultural sustainability (Amri and Bellamine Ben Saoud, 2014; Moreira et al., 2023; Soini and Dessein, 2016; Swacha, 2022).

This paper focuses on sustainability in IT projects. Managing IT projects is, in itself, a highly dynamic and challenging field. In general, PMI defines project as "a temporary endeavor undertaken to create a unique product, service, or result" (Project Management Institute, 2013, p. 3), while IT projects "involve the use of hardware, software, and networks to create a product, service, or result" (Schwalbe, 2019, p. 3). By their nature, IT projects most often involve software development, in which case we refer to software project management (Peters, 2024); however, there are also infrastructure IT projects, consulting projects, upgrade projects, and others. One of the most frequently cited statistics related to IT projects is the percentage of projects that fail — meaning those that exceed their planned time and budget — which has remained consistently high since The Chaos Report (Standish Group, 1995), showing that only 16.2% of software projects were completed on time and within budget. The reason for this likely lies in the complexity of IT projects, which is reflected in the numerous elements that comprise the project ecosystem. These include project goals, scope, team size, number and interests of stakeholders, organizational and technological complexity, interdependencies among project elements, and many other factors (Morcov et al., 2021; Vidal and Marle, 2008). Given the rapid pace of technological advancement, IT projects can be considered a prime example of a VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) environment, whose characteristics significantly impact project (un)success (Moura et al., 2023). Considering the complexity of IT projects and the environment in which they operate, as well as the numerous factors influencing project success, it is not surprising that sustainability is often not a primary focus for project managers (Clinning and Marnewick, 2017).

Therefore, the main goal of this paper is to provide a more detailed analysis of current research in the field of sustainability related to IT projects and to propose various types of sustainable actions throughout the phases of the project life cycle.

2 Types of sustainability

To better understand sustainability in the context of IT projects, this chapter first describes the fundamental dimensions of sustainability.

The economic dimension of sustainability refers to the sustainability of an organization's business operations. Economically sustainable business

dinamično i izazovno područje. Općenito, projekt se definira kao „privremeni pothvat poduzet radi stvaranja jedinstvenog proizvoda, usluge ili rezultata" (Project Management Institute, 2013, p. 3), dok IT projekti „uključuju korištenje hardvera, softvera i mreža za stvaranje proizvoda, usluge ili rezultata" (Schwalbe, 2019, p.3). Po svojoj prirodi, IT projekti najčešće uključuju razvoj softvera, pri čemu se govori o upravljanju projektima softverskih proizvoda (engl. *software project management*) (Peters, 2024), no također postoje i infrastrukturni IT projekti, konzultantski projekti, projekti nadogradnje itd. Jedna od najčešćih statistika koja se veže uz IT projekte jest postotak neuspješno završenih projekata, odnosno projekata koji su završili prekoračenjem planiranog vremena i budžeta, a koji je kontinuirano vrlo visok, još od The Chaos Reporta (Standish Group, 1995) koji pokazuje da samo je samo 16.2% softverskih projekata završeno na vrijeme i u okviru budžeta. Razlog tome sigurno leži u kompleksnosti IT projekata koja se ogleda u raznim elementima koji čine ekosustav projekta, a koji obuhvaćaju ciljeve projekta, opseg projekta, veličinu projektnog tima, broj i interese dionika, organizacijsku kompleksnost, tehnološku kompleksnost, međuovisnosti između projektnih elemenata i mnoge druge faktore (Morcov i sur., 2021; Vidal i Marle, 2008). Uzme li se u obzir brzi napredak tehnologije, može se zaključiti da IT projekti predstavljaju pravi primjer VUCA (engl. *Volatility, Uncertainty, Complexity, and Ambiguity*) okruženja koje karakteriziraju volatilnost, nesigurnost, kompleksnost i dvoznačnost, pri čemu karakteristike takvog okruženja zasigurno utječu na (ne)uspjeh projekta (Moura i sur., 2023). Uzevši u obzir kompleksnost IT projekata i okruženja u kojem djeluju, te brojne faktore koji utječu na uspjeh projekt, nije neobično da održivost nije u fokusu voditelja upravljanja projektima (Clinning i Marnewick, 2017).

Stoga je glavni cilj ovog rada detaljnije analizirati trenutna istraživanja u području održivosti vezane uz IT projekte te predložiti različite vrste održivih akcija kroz faze životnog ciklusa projekta.

2 Vrste održivosti

Radi boljeg razumijevanja održivosti u kontekstu IT projekata, ovo poglavlje najprije donosi opis osnovnih dimenzija održivosti.

Ekonomska dimenzija održivosti odnosi se na održivost poslovanja organizacije. Ekonomski održivo poslovanje znači ostvarivanje prihoda koji su veći od troškova, odnosno poslovanje s profitom. Ova dimenzija održivosti također uključuje sve ono što doprinosi povećanju prihoda organizacije, kao što je povećanje kvalitete proizvoda i usluga. Clinning i Marnewick (2017) ističu kako je upravo ekonomska dimenzija još uvijek najvažnija dimenzija održivosti, osobito za profitne organizacije. Naime, organizacija koja zanemari ekološku ili socijalnu dimenziju i dalje

means generating revenue that exceeds costs — in other words, operating at a profit. This dimension of sustainability also encompasses everything that contributes to increasing an organisation's revenue, such as enhancing the quality of products and services. Clinning and Marnewick (2017) emphasize that the economic dimension remains the most important aspect of sustainability, especially for for-profit organizations. An organization that neglects its environmental or social dimension may continue to operate, but a profit-oriented organization that operates at a loss cannot survive (Clinning and Marnewick, 2017). Economic sustainability is reflected in the rational management of financial resources, investment in quality to generate higher profits, and cost reduction (Doane and MacGillivray, 2001).

Environmental sustainability is often the first association that comes to mind when the term "sustainability" is mentioned. It refers to the protection of the environment to minimise negative environmental impacts. Among other things, environmental sustainability includes the rational use of resources, efficient energy consumption, the use of renewable energy sources, reduction of CO2 emissions, extending product life cycles, repairing instead of replacing products, reducing waste, recycling, and disposing of waste in an environmentally friendly manner (Sutton, 2024).

Social sustainability refers to the well-being of all community members in which an individual or organisation operates. Social sustainability encompasses communication, safety, transparency, mutual honesty, and trust between individuals and groups, as well as the inclusion of diverse social groups in decision-making processes, the acceptance of diversity, and equal opportunities for all (Clinning and Marnewick, 2017; Moreira et al., 2023).

Technical sustainability refers to the properties and performance of a technological product. It encompasses the durability, adaptability, resilience, modularity, and safety of hardware and software. A technically sustainable product should be functional (performing its intended purpose) and operate without errors. It should also be safe, reliable, and adaptable to the user's needs. A technically sustainable product should be modular, meaning that one component of the product can be replaced without the need to purchase an entirely new product and discard the old one (Moreira et al., 2023). In the context of IT projects, the concept of technical debt is well known. According to Gartner, technical debt represents "a deviation of a system from any of its non-functional requirements" (Williams, 2025). As such, technical debt negatively impacts sustainability by reducing the long-term adaptability of systems to new technologies, increasing maintenance costs, and

može poslovati, ali profitna organizacija koja posluje s gubitkom ne može opstati (Clinning i Marnewick, 2017). Ekonomska održivost očituje se u racionalnom upravljanju financijskim sredstvima, ulaganju u kvalitetu kako bi se ostvario veći profit te smanjenju troškova (Doane i MacGillivray, 2001).

Ekološka održivost mnogima je prva asocijacija na spomen održivosti. Označava zaštitu okoliša uz nastojanje da se smanji negativan utjecaj na okoliš. Između ostalog, ekološka održivost uključuje racionalno korištenje resursa, racionalnu potrošnju energije, korištenje energije iz obnovljivih izvora, smanjenje emisija CO2, produljenje životnog vijeka proizvoda, popravak proizvoda umjesto zamjene, smanjenje količine otpada, recikliranje te zbrinjavanje otpada na ekološki prihvatljiv način (Sutton, 2024).
Društvena održivost odnosi se na dobrobit svih pripadnika zajednice u kojoj djeluje pojedinac ili organizacija. Društvena održivost uključuje komunikaciju, sigurnost, transparentnost, međusobnu iskrenost i povjerenje između pojedinaca i skupina, uključivanje različitih društvenih skupina u donošenje odluka, prihvaćanje različitosti i jednake prilike za sve (Clinning i Marnewick, 2017; Moreira i sur., 2023).

Tehnička održivost odnosi se na svojstva i performanse tehnološkog proizvoda. Označava dugotrajnost, prilagodljivost, otpornost, modularnost i sigurnost korištenja hardvera ili softvera. Tehnički održiv proizvod trebao bi biti funkcionalan (raditi ono čemu je namijenjen) te raditi bez grešaka. Također, trebao bi biti siguran za korištenje, pouzdan i prilagodljiv prema potrebi korisnika. Tehnički održiv proizvod trebao bi biti modularan, što znači da se jedna komponenta proizvoda može zamijeniti bez potrebe da se nabavlja cijeli novi proizvod, a stari se baca (Moreira i sur., 2023). U kontekstu IT projekata poznat je pojam tzv. tehničkog duga (engl. technical debt) koji, prema Gartneru, predstavlja „odstupanje sustava od bilo kojeg od njegovih nefunkcionalnih zahtjeva" (Williams, 2025). Kao takav, tehnički dug negativno utječe na održivost obzirom da smanjuje dugoročnu prilagodljivost sustava novih tehnologijama, povećava troškove održavanja i općenito uključuje negativne prakse koje utječu na održivost.

Neki autori dodatno navode individualnu i kulturnu dimenziju održivosti. Obje su usko vezane uz društvenu održivost. Individualna održivost više je fokusirana na dobrobit svakog pojedinca, za razliku od društvene održivost koja označava dobrobit društva u cjelini. Primjer individualne održivosti je dobrobit svakog zaposlenika u nekoj organizaciji – količina posla, primjerenost radnih zadataka, plaća, radni uvjeti, potrebna znanja i vještine (Amri i Bellamine Ben Saoud, 2014). Kulturna održivost se odnosi na očuvanje kulturne baštine, običaja i tradicije (Soini i Dessein, 2016).

U Tablici 1 sažeto su navedene i opisane dimenzije održivosti te autori koji spominju ove dimenzije u svojim radovima.

generally involving practices that harm sustainability.

Some authors additionally mention individual and cultural dimensions of sustainability. Both are closely related to social sustainability. Individual sustainability focuses more on the well-being of each individual, as opposed to social sustainability, which refers to the overall well-being of society. An example of individual sustainability is the well-being of each employee in an organization — workload, appropriateness of tasks, salary, working conditions, required knowledge, and skills (Amri and Bellamine Ben Saoud, 2014). Cultural sustainability refers to the preservation of cultural heritage, customs, and traditions (Soini and Dessein, 2016).

Table 1 summarizes and describes the dimensions of sustainability as well as the authors who mention these dimensions in their works.

Table 1. Sustainability dimensions (source: authors)

Sustainability dimension	Description	Authors
Economic sustainability	Refers to the sustainability of an organization's business operations. It includes increasing revenue, reducing costs, and operating profitably.	Amri & Bellamine Ben Saoud (2014), Clinning & Marnewick (2017), Doane & MacGillivray (2001), Santarius & Wagner (2023)
Environmental sustainability	Refers to reducing negative impacts on the environment. It involves rational energy consumption, ecological waste management, and the use of environmentally friendly materials.	Amri & Bellamine Ben Saoud (2014), Clinning & Marnewick (2017), Santarius & Wagner (2023), Sutton (2024)
Social sustainability	Refers to the well-being of all members of society. It includes communication, transparency, cooperation, and various social aspects.	Amri & Bellamine Ben Saoud (2014), Clinning & Marnewick (2017), Moreira et al. (2023), Santarius & Wagner (2023)

Tablica 1. Dimenzije održivosti (izvor: autori)

Dimenzija održivosti	Opis	Autori
Ekonomska održivost	Odnosi se na održivost poslovanja organizacije. Uključuje povećanje prihoda, smanjenje troškova te poslovanje s profitom.	Amri i Bellamine Ben Saoud (2014), Clinning i Marnewick (2017), Doane i MacGillivray (2001), Santarius i Wagner (2023)
Ekološka održivost	Odnosi se na smanjenje negativnog utjecaja na okoliš. Uključuje racionalnu potrošnju energije, ekološko zbrinjavanje otpada i korištenje ekološki prihvatljivih materijala	Amri i Bellamine Ben Saoud (2014), Clinning i Marnewick (2017), Santarius i Wagner (2023), Sutton (2024)
Društvena (socijalna) održivost	Odnosi se na dobrobit svih pripadnika društva. Uključuje komunikaciju, transparentnost, suradnju i različite društvene aspekte.	Amri i Bellamine Ben Saoud (2014), Clinning i Marnewick (2017), Moreira et al. (2023), Santarius i Wagner (2023)
Tehnička održivost	Odnosi se na karakteristike tehnološkog proizvoda.	Moreira et al. (2023), Swacha (2022)
Individualna održivost	Usko vezana uz društvenu održivost. Odnosi se na dobrobit pojedinca.	Amri i Bellamine Ben Saoud (2014), Moreira et al. (2023), Swacha (2022)
Kulturna održivost	Odnosi se na održavanje određene kulture, baštine i običaja.	Soini i Dessein (2016),

3 Održivost u IT sektoru

Kad se govori o održivosti u IT projektima i IT sektoru općenito, potrebno je razlikovati „održivi IT“ i „IT za održivost“. „Održivi IT“ označava informacijsko-komunikacijske tehnologije (IKT) koje su same po sebi održive. To može značiti da su ekološki prihvatljivije od drugih tehnologija – primjerice, troše manje energije ili su napravljene od materijala koji se može reciklirati (Swacha, 2022). S druge strane, „IT za održivost“ predstavlja tehnologije koje doprinose postizanju ciljeva održivosti u širem smislu To mogu biti

Technical sustainability	Refers to the characteristics of a technological product.	Moreira et al. (2023), Swacha (2022)
Individual sustainability	Closely linked to social sustainability. Refers to the well-being of the individual.	Amri & Bellamine Ben Saoud (2014), Moreira et al. (2023), Swacha (2022)
Cultural sustainability	Refers to the preservation of a specific culture, heritage, and customs.	Soini & Dessein (2016),

3 Sustainability in the IT Sector

When discussing sustainability in IT projects and the IT sector in general, it is important to distinguish between "sustainable IT" and "IT for sustainability." "Sustainable IT" refers to information and communication technologies (ICT) that are sustainable in themselves. This can mean that they are more environmentally friendly than other technologies—for example, they consume less energy or are made from recyclable materials (Swacha, 2022). On the other hand, "IT for sustainability" represents technologies that contribute to achieving sustainability goals in a broader sense. These can be technologies that digitise processes previously performed on paper, thereby enabling a reduction in paper waste. Another example is the use of technologies that optimise production processes, resulting in resource savings (Santarius and Wagner, 2023). It is important to acknowledge that, in addition to their positive impact, ICT can also have negative effects on sustainability, particularly in the environmental dimension. This is most evident in electricity consumption (both in the production and use of devices) and the disposal of devices that are no longer in use (Santarius and Wagner, 2023).

IT projects can also be divided into "sustainable projects" and "projects for sustainability." A "sustainable project" is one in which sustainable practices are implemented in all phases of the project execution. In contrast, a "project for sustainability" is a project whose outcome contributes in some way to one of the dimensions of sustainability (Soares, Fernandes, and Santos, 2024).

An organization striving for sustainability should introduce as many sustainable practices as possible into its projects. However, this is not always easy, as there are contradictions between project management and sustainability. While tehnologije koje digitaliziraju određene procese za koje se prije koristio papir te na taj način omogućavaju smanjenje količina papirnatog otpada. Drugi primjer su tehnologije za optimizaciju procesa u proizvodnji, koje doprinose uštedi resursa (Santarius i Wagner, 2023). Važno je napomenuti da IKT osim pozitivnog, mogu imati i negativni utjecaj na održivost, osobito ekološku dimenziju. To se najviše očituje u potrošnji električne energije (kod proizvodnje i korištenja uređaja) te zbrinjavanju uređaja koji se više ne koriste (Santarius i Wagner, 2023).

IT projekti također se mogu podijeliti na „održive projekte“ i „projekte za održivost“. „Održivi projekt“ je onaj u kojem su održive prakse implementirane u sve faze provođenja projekta, dok je „projekt za održivost“ onaj projekt čiji rezultat na neki način doprinosi nekoj od dimenzija održivosti (Soares, Fernandes i Santos, 2024).

Organizacija koja teži održivosti idealno bi trebala uvesti što više održivih praksi u svoje projekte. Međutim, to nije uvijek jednostavno, jer postoje kontradikcije između upravljanja projektima i održivosti. Dok su projekti jedinstveni, s jasno određenim trajanjem, početkom i krajem, održivi razvoj nema početak ni kraj. Održivost podrazumijeva pogled u budućnost, koja može biti bliža i dalja, i traženje dugoročnih rješenja. U projektu je cilj provesti sve planirane aktivnosti i doći do rezultata, nakon čega projekt završava. Održivi razvoj nema kraja – ako je cilj da nešto bude održivo, cilj je da traje što je dulje moguće. Projekt ima definiran tim, voditelja, ciljnu skupinu i druge zainteresirane skupine – u projekt je obično uključen manji broj ljudi. S druge strane, održivost se odnosi na društvo u cjelini, i to ne samo na sadašnje, već i buduće generacije. Nije moguće jednim projektom ostvariti sve ciljeve čovječanstva vezane uz održivost, no zato se manjim projektima mogu ostvariti specifični ciljevi manjih zajednica (Clinning i Marnewick, 2017).

4 Održivost u IT projektima u literaturi

Kako bi se dobio detaljniji uvid u zastupljenost održivosti u kontekstu IT projekata u znanstvenoj literaturi, napravljena je jednostavnija bibliometrijska analiza u bazi Web of Science (WoS). Upit na bazu TI=((IT OR "Information technology") AND project AND manag*) rezultirao je s ukupno 502 rada, a analiza prema ključnim riječima napravljena je korištenjem alata VOSWiever (2025). Identificirano je ukupno 1433 ključnih riječi, od kojih njih 75 ima više od 5 pojavljivanja, međutim među njima se nijednom ne pojavljuje ključna riječ „sustainability“.

Dodavanje ključne riječi „sustain*“ u temu rada (TI=((IT OR "Information technology") AND project AND manag*) AND TS=sustain*) rezultiralo je sa samo 13 radova. Od njih, samo su tri rada zapravo

projects are unique, with clearly defined durations, beginnings, and endings, sustainable development has no start or finish. Sustainability implies a forward-looking perspective, which can be near-term or long-term, and seeks solutions that address long-term needs. The goal of a project is to carry out all planned activities and achieve the desired results, after which the project concludes. Sustainable development, on the other hand, has no end — if the goal is for something to be sustainable, the aim is for it to last as long as possible. A project has a defined team, a project manager, a target group, and other stakeholders — usually involving a smaller number of people. Sustainability, on the other hand, refers to society as a whole, including not only current but also future generations. It is not possible to achieve all humanity's sustainability goals with a single project; however, smaller projects can achieve specific goals for smaller communities (Clinning and Marnewick, 2017).

4 Sustainability in IT projects in the literature

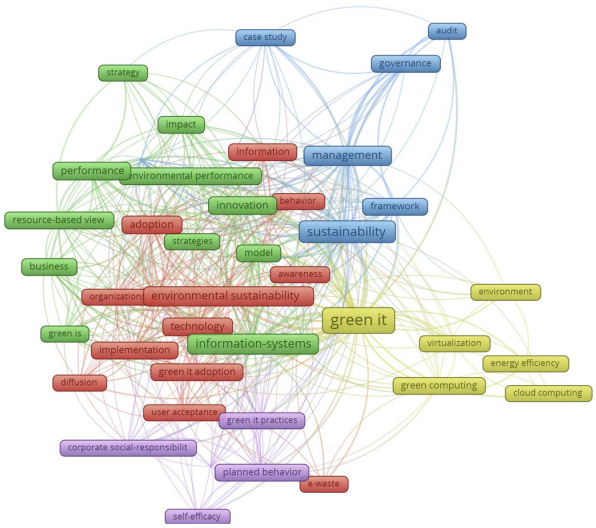
In order to get a more detailed insight into the representation of sustainability in the context of IT projects in the scientific literature, a simpler bibliometric analysis was made in the Web of Science (WoS) database. The query to the database TI=((IT OR "Information technology") AND project AND manag*) resulted in a total of 502 works, and the analysis according to keywords was done using the VOSWiever tool (2025). A total of 1433 keywords were identified, of which 75 have more than 5 occurrences, but the keyword "sustainability" does not appear among them.

Adding the keyword "sustain*" to the topic of the paper (TI=((IT OR "Information technology") AND project AND manag*) AND TS=sustain*) resulted in only 13 papers. Of these, only three papers are actually focused on sustainability in IT projects. Pantović et al. (2024) emphasize that ensuring sustainability in IT project management is an ongoing challenge and propose a new approach focused on data-driven strategies to improve sustainability and excellence in IT project management. Woźniak (2021) proposes and verifies the concept of a sustainable approach to IT project management by involving the client in the selection of project management methodology. Another sustainable approach in terms of the role of stakeholders in project management, and especially in IT service management projects, was presented by Zaleski and Michalski (2021), who tried to identify the success factors of an IT service project, including both traditional and agile approaches and taking into account sustainable development.

As mentioned in the introduction, IT projects are most often software development projects, so an additional search was made in order to investigate usmjerena na održivost u IT projektima. Pantović i sur. (2024.) naglašavaju da je osiguranje održivosti u upravljanju IT projektima stalni izazov i predlažu novi pristup usmjeren na strategije utemeljene na podacima kako bi se poboljšala održivost i izvrsnost u upravljanju IT projektima. Woźniak (2021.) predlaže i provjerava koncept održivog pristupa upravljanju IT projektima uključivanjem klijenta u odabir metodologije upravljanja projektima. Drugi održivi pristup u smislu uloge dionika u upravljanju projektima, a posebice u projektima upravljanja IT uslugama, predstavili su Zaleski i Michalski (2021.), koji su pokušali identificirati čimbenike uspjeha projekta IT usluga, uključujući i tradicionalne i agilne pristupe te uzimajući u obzir održivi razvoj.

Kao što je uvodno bilo spomenuto, IT projekti najčešće su projekti razvoj softvera pa je stoga napravljena dodatna pretraga kako bi se detaljnije istražilo spominje li se i u kojoj mjeri održivost vezana konkretnije uz razvoj softvera. Pojmovi koji se spominju u literaturi su „green IT" i „green software engineering", stoga je upit uključio navedene ključne riječi: TI=("green software" OR "green IT") i rezultirao s 302 rada, među kojima su detektirane 52 ključne riječi s više od 5 pojavljivanja i 22 ključne riječi s više od 10 pojavljivanja.

Slika 1. prikazuje najučestalije ključne riječi s više od 5 pojavljivanja, pri čemu se može zaključiti da tri najveća klastera obuhvaćaju teme koje se odnose na 1) energetsku učinkovitost i održivi razvoj softvera, 2) teme koje obuhvaćaju inovacije i prihvaćanje „green IT" te 3) svjesnost, ponašanje i ekološku održivost. Iako bi za konkretnije zaključke trebalo provesti detaljnju analizu detektiranih radova, iz navedenog se može zaključiti da raznici oblici održivosti kroz faze životnog ciklusa projekta u dosadašnjoj literaturi nisu zastupljeni u većoj mjeri.



Slika 1. Najučestalije ključne riječi u radovima u bazi WoS vezanima uz "Green software" i "Green IT", izvor: autori, korištenjem WoS baze i VOSviewer alata

in more detail whether and to what extent sustainability is mentioned more specifically related to software development. The terms mentioned in the literature are "green IT" and "green software engineering", so the query included the specified keywords: TI=("green software" OR "green IT") and resulted in 302 papers, among which 52 keywords with more than 5 occurrences and 22 keywords with more than 10 occurrences were detected.

Fig. 1 shows the most frequent keywords with more than 5 occurrences, whereby it can be concluded that the three largest clusters include topics related to 1) energy efficiency and sustainable software development, 2) topics covering innovation and adoption of "green IT", and 3) awareness, behaviour and environmental sustainability. Although more specific conclusions would require a detailed analysis of the analysed papers, it can be concluded from the above that various forms of sustainability across the project life cycle phases are not represented to a greater extent in the literature to date.

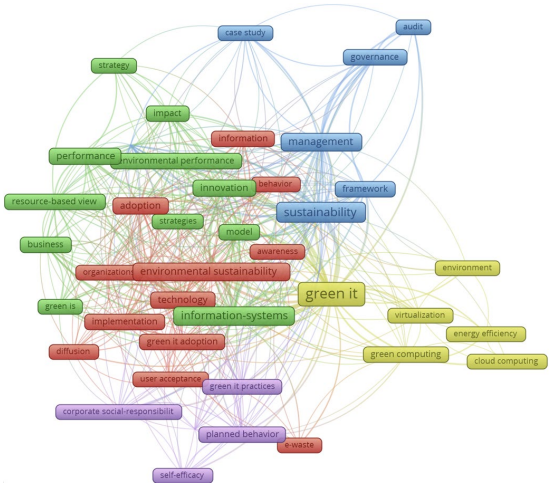


Figure 1. Most frequent keywords in papers in the WoS database related to “Green software” and “Green IT”, source: authors, using WoS database and VOSviewer

The importance of sustainability research in IT projects is supported by the fact that a conference called *ICT for Sustainability (ICT4S)* has been held once a year for more than 10 years. It brings together ICT experts, industry representatives and public administration representatives (ICT4S, 2025). According to Rugeviciute, Courboulay and Hilty (2023), the mapping of research communities according to the ICTS4S model indicates various aspects of sustainability in IT that are intertwined - *Green ICT, Green IS* and *Environmental Informatics* study the impact of ICT on the environment; *Sustainable Software Engineering (SSE)* and *Sustainable Human-Computer Interaction* study the impact of ICT on the

U prilog važnosti istraživanja održivosti u IT projektima ide činjenica da da se već više od 10 godina jednom godišnje održava konferencija naziva *ICT for Sustainability (ICT4S).* Ona okuplja stručnjake iz područja IKT-a, predstavnike industrije te predstavnike javne uprave (ICT4S, 2025). Prema Rugeviciute, Courboulay i Hilty (2023), mapiranje istraživačkih zajednica prema ICTS4S modelu ukazuje na razne aspekte održivosti u IT-ju koji se međusobno isprepliću - *Green ICT, Green IS* i *Environmental Informatics* proučavaju utjecaj IKT na okoliš; *Sustainable Software Engineering (SSE)* i *Sustainable Human-Computer Interactio*n proučavaju utjecaj IKT na okoliš i društvo; *ICT for Development* također istražuje utjecaj tehnologije na društvo, s fokusom na zemlje u razvoju; zajednica *Corporate Digital Sustainability* bavi se odgovornim donošenjem odluka u organizacijama, a *ICT & Ethics* pitanjima etike u IT sektoru.

Autori Santarius i Wagner (2023) analizirali su ukupno 211 radova s ICT4S konferencija, objavljenih u razdoblju od 2013. do 2019. godine. Podijelili su radove u tri razine, prema načinu na koji pristupaju održivosti. Autori definiraju razine na sljedeći način:

- Prva razina odnosi se na održivost tehnološkog proizvoda - materijal od kojeg je sastavljen, energiju potrošenu za proizvodnju, energiju koju troši proizvod dok se koristi te resurse potrebne za recikliranje i zbrinjavanje nakon korištenja proizvoda
- Druga razina odnosi se na doprinos tehnologije održivosti
- Treća razina odnosi se na strukturalne promjene koje nastaju od utjecajem tehnologije, a vezane su uz održivost (npr. promjene zakona ili društvenih normi)

Dodatno, isti autori utvrdili su da se većina radova s ICT4S konferencija, njih 111 od 211, bavi drugom razinom održivosti. Nešto manje radova, njih 66, bavi se prvom razinom. Tek 34 rada bave se trećom razinom održivosti (Santarius i Wagner, 2023). To pokazuje da su istraživanja u području održivosti u IT-ju uglavnom fokusirana na načine na koje digitalne tehnologije mogu doprinijeti održivosti u drugim područjima.

5 Održivost kroz faze IT projekta

Sukladno životnom ciklusu projekta (Project Management Institute, 2013), i IT projekte karakterizira 5 osnovnih faza životnog ciklusa: pokretanje projekta (inicijacija), planiranje projekta, provedba, zatvaranje te kontinuirano nadgledanje i kontrola. Prethodna istraživanja već ukazuju na održive prakse prema fazama upravljanja projektima (Soares et al., 2024), a u nastavku ovog rada slijedi prijedlog održivih akcija te pitanja o kojima je važno promisliti u kontekstu životnog ciklusa IT projekta.

environment and society; *ICT for Development* also explores the impact of technology on society, with a focus on developing countries; the *Corporate Digital Sustainability* community deals with responsible decision-making in organizations, and *ICT & Ethics* deals with ethical issues in the IT sector.

Authors Santarius and Wagner (2023) analysed a total of 211 papers from ICT4S conferences, published between 2013 and 2019. They divided the papers into three levels based on their approach to sustainability. The authors define the levels as follows:

- The first level refers to the sustainability of the technological product - the material from which it is composed, the energy consumed in production, the energy consumed by the product while in use, and the resources needed for recycling and disposal after use of the product
- The second level refers to the contribution of technology to sustainability
- The third level refers to the structural changes that arise from the impact of technology, and are related to sustainability (e.g. changes in laws or social norms).

Additionaly, based on their analysis, Santarius and Wagner (2023) found that the majority of papers from ICT4S conferences, 111 out of 211, deal with the second level of sustainability. Slightly fewer papers, 66, deal with the first level. Only 34 papers deal with the third level of sustainability. This indicates that research in the field of sustainability in IT primarily focuses on how digital technologies can contribute to sustainability in other areas.

5 Sustainability through IT project phases

According to the project life cycle (Project Management Institute, 2013), IT projects are also characterized by 5 basic phases of the life cycle: project initiation, project planning, implementation, closure, and continuous monitoring and control. Previous research has already proposed sustainable practices according to project management phases (Soares et al., 2024). In continuation of this work, a proposal of sustainable actions and questions that are important to consider in the context of an IT project's life cycle follows.

5.1 Project initiation

Sustainability can be an integral part of a project from the very first phase, project initiation. Before implementing a project, its financial viability is usually examined, which is an element of the

5.1 Pokretanje projekta

Održivost može biti sastavni dio projekta već od prve faze, pokretanja projekta. Prije provođenja projekta obično se ispituje njegova financijska isplativost, što je element ekonomske dimenzije održivosti (Soares et al., 2024). Prilikom ispitivanja izvodljivosti projekta na isti način mogu se razmotriti ostale dimenzije održivosti. Primjerice, može se ispitati kakav će utjecaj projekt imati na okoliš. Ovo je posebno važno ako se u sklopu projekta razvija hardver, odnosno neki fizički proizvod. Ako organizacija želi da taj proizvod bude ekološki održiv, može razmisliti o korištenju ekološki prihvatljivih materijala u proizvodnji te o ekološkom zbrinjavanju proizvoda na kraju njegova životnog vijeka. Također, treba sagledati utjecaj projekta na društvo. Tim koji pokreće projekt treba se zapitati koje će pozitivne i negativne učinke projekt imati prvo na sve koji su direktno uključeni, a zatim i na širu zajednicu. Tehnička održivost osobito je važna u IT projektima i već u fazi pokretanja dobro je razmisliti o tome hoće li finalni proizvod (bilo softver ili hardver) biti održiv.

5.2 Planiranje projekta

U sljedećoj fazi, planiranju projekta, već se mogu planirati konkretni načini na koje će projekt biti održiv. Ekonomska održivost najviše se očituje u planiranju budžeta, koji treba biti takav da omogući sve planirane aktivnosti, ali da ne stvara nepotrebne dodatne troškove za organizaciju. Ekološka održivost može se uključiti na način da se maksimalno iskoristi postojeća oprema (računala, mobilni uređaji itd.) umjesto nabavljanja nove (što doprinosi i ekonomskoj održivosti). Primjerice, ako se razvoja softver za virtualnu stvarnost (vengl. Virtual reality - VR) naočale, organizacija može kupiti naočale za potrebe testiranja, dok za pisanje koda može koristiti postojeća računala. Soares et al. (2024) navode da se prilikom nabave za potrebe projekta može napraviti evaluacija dobavljača i odabrati one dobavljače koji posluju održivo. Ugljični otisak projekta može se smanjiti tako da se sastanci projektnog tima održavaju online (ako se članovi tima nalaze na različitim lokacijama), da se izbjegnu putovanja. Projektna dokumentacija i ostale datoteke mogu se dijeliti online umjesto ispisivanja na papir.

Društvena održivost očituje se u uključivanju različitih skupina dionika u planiranje projekta, primjerice provedbom istraživanja s klijentima i budućim krajnjim korisnicima. Prije provedbe projekta dobro se zapitati koja će znanja biti potrebna krajnjim korisnicima za korištenje sustava i planirati edukacije. Clinning i Marnewick (2017) navode da je jednako važno osigurati da članovi projektnog tima imaju potrebna znanja te osigurati edukacije za njih. Komunikacija s članovima projektnog tima, osiguravanje potrebnih sredstava za rad, pružanje dodatnih edukacija i pravedna raspodjela posla ulaze u

economic dimension of sustainability (Soares et al., 2024). When examining the feasibility of a project, other dimensions of sustainability can be considered in the same way. For example, the impact of the project on the environment can be examined. This is especially important if the project develops hardware, or a physical product. If the organization wants the product to be environmentally sustainable, it can consider using environmentally friendly materials in production and environmentally friendly disposal of the product at the end of its life. The impact of the project on society should also be considered. The team initiating the project should ask itself what positive and negative effects the project will have, first on everyone directly involved, and then on the wider community. Technical sustainability is particularly important in IT projects, and it is a good idea to consider whether the final product (whether software or hardware) will be sustainable already at the initiation stage.

5.2 Project planning

In the next phase, project planning, specific ways in which the project will be sustainable can already be planned. Economic sustainability is most evident in budget planning, which should enable all planned activities without creating unnecessary additional costs for the organisation. Environmental sustainability can be included by maximising the use of existing equipment (computers, mobile devices, etc.) instead of purchasing new ones (which also contributes to economic sustainability). For example, if software for virtual reality (VR) glasses is being developed, the organization can purchase glasses for testing purposes, while existing computers can be used for writing code. Soares et al. (2024) state that when procuring resources for a project, an evaluation of suppliers can be conducted to select those that operate sustainably. The carbon footprint of the project can be reduced by holding project team meetings online (if team members are in different locations), to avoid travel. Project documentation and other files can be shared online instead of being printed on paper.

Social sustainability is reflected in the inclusion of different stakeholder groups in project planning, for example by conducting research with clients and future end users. Before implementing the project, the organization should ask itself what knowledge end users will need to use the system and plan training. Clinning and Marnewick (2017) emphasize that it is equally important to ensure that project team members have the necessary knowledge and to provide training for them as well. Communication with project team members, securing the necessary resources for work, providing additional training and fair distribution of

društvenu i individualnu dimenziju održivosti. Prilikom planiranja svakako treba razmisliti o karakteristikama proizvoda koji se razvija, što ulazi u sferu tehničke održivosti. Ako se razvija softver, treba razmisliti o odgovorima na sljedeća pitanja: Na kojim uređajima će on raditi? Hoće li raditi i na starijim uređajima? Hoće li raditi na različitim operacijskim sustavima? Hoće li sustav biti modularan i omogućiti da se zamijeni jedna njegova komponenta, bez da se mijenja cijeli sustav? Kako će se sustav ažurirati, i hoće li nakon provedbe ažuriranja raditi na istom hardveru? Kakva će biti interakcija krajnjih korisnika sa sustavom? Hoće li moći sami raditi prilagodbe i promjene? Kako će prijavljivati i rješavati probleme?

Već u fazi planiranja može se razmišljati o održivosti rezultata projekta nakon završetka projekta. Koji je očekivani životni vijek proizvoda? Kako će se pružati podrška klijentu i krajnjim korisnicima? Hoće li se proizvod dalje razvijati? Kako će se to financirati? Kako će sustav utjecati na ekonomsku održivost klijenta? Hoće li klijent imati visoke troškove održavanja? U većim projektima uz projektni plan može se napraviti i poseban plan održivosti, gdje su nabrojene konkretne mjere koje doprinose različitim dimenzijama održivosti (Amri i Bellamine Ben Saoud, 2014).

5.3 Provedba projekta

U fazi provedbe projekta aktivnosti se provode u skladu s projektnim planom. Tijekom provođenja aktivnosti društvena održivost očituje se u upravljanju projektnim timom, kao i u komunikaciji te suradnji sa svim zainteresiranim stranama. U svakom projektu može doći do nezadovoljstva i otpora od strane klijenta ili korisnika. Rješavanje problema učinkovito i na vrijeme također je dio društvene održivosti. Ekonomska održivost odnosi se na prilagođavanje budžeta po potrebi, kako bi projekt i dalje bio održiv ako se pojave neočekivani troškovi. Ekološki održive prakse provode se onako kako su planirane u prethodnoj fazi – primjerice, sve datoteke se dijele digitalno. Potrošni materijal koji se nabavlja i koristi za potrebe projekta trebao bi se ekološki zbrinuti nakon korištenja. Na isti način treba planirati zbrinjavanje opreme koja je nabavljena za potrebe projekta, a nakon završetka projekta neće se više koristiti. Planiranih karakteristika proizvoda, koje su vezane uz tehničku održivost, trebali bi biti svjesni svi koji rade na dizajnu i izradi proizvoda. Održivost se može uključiti u redovno projektno izvještavanje, gdje se stvarno uključivanje održivih praksi može usporediti s planiranim. Također, održive prakse mogu se uključiti i „u hodu“, tijekom provođenja projekta, ako voditelj ili članovi tima primijete da bi se neke aktivnosti mogle provoditi na održiviji način.

5.4 Zatvaranje projekta

U posljednjoj fazi, zatvaranju projekta, dobro je pogledati unatrag i razmotriti koliko je projekt bio održiv. Može se napraviti usporedba planiranih i

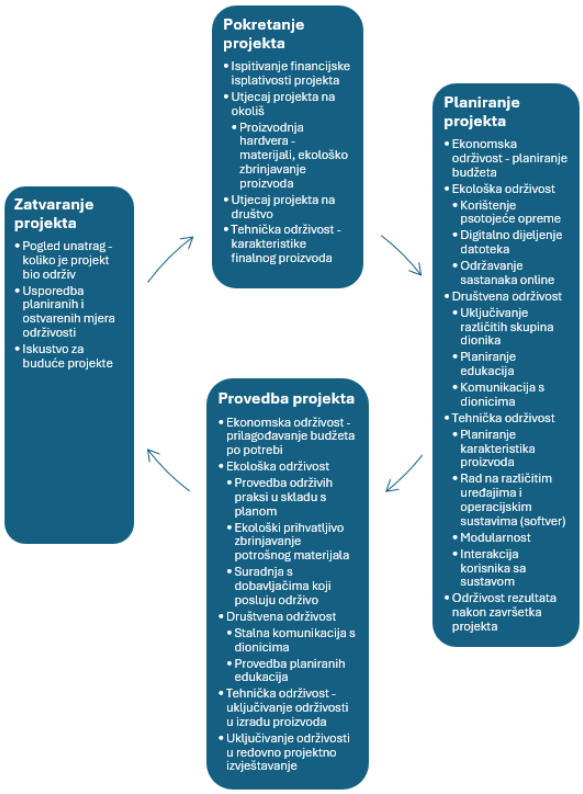
work are part of the social and individual dimensions of sustainability. When planning, the organization should definitely think about the characteristics of the product being developed, which falls into the sphere of technical sustainability. If software is being developed, the answers to the following questions should be rethought: On which devices will it work? Will it also work on older devices? Will it work on different information systems? Will the system be modular and allow for the replacement of one of its components without changing the entire system? How will the system be updated, and will it work on the same hardware after the update? What will be the interaction of end users with the system? Will they be able to make adjustments and changes themselves? How will they report and resolve problems?

Already in the planning phase, one can think about the sustainability of the project results after the project is completed. What is the expected lifespan of the product? How will the client and end users be supported? Will the product be further developed? How will it be financed? How will the system affect the client's economic sustainability? Will the client have high maintenance costs? In larger projects, a separate sustainability plan can be created in addition to the project plan, listing specific measures that contribute to different dimensions of sustainability (Amri and Bellamine Ben Saoud, 2014).

5.3 Project implementation

In the project implementation phase, activities are carried out in accordance with the project plan. During the implementation of activities, social sustainability is reflected in the project team's management, as well as in their communication and cooperation with all stakeholders. In every project, dissatisfaction and resistance from the client or user may occur. Solving problems effectively and promptly is also a key aspect of social sustainability. Economic sustainability refers to adjusting the budget as necessary, so that the project remains viable if unexpected costs arise. Environmentally sustainable practices are implemented as planned in the previous phase - for example, all files are shared digitally. Consumables purchased and used for the project should be environmentally disposed of after use. The disposal of equipment purchased for the project and no longer needed after it is completed should be planned in the same way. Everyone working on the design and construction of the product should be aware of planned product characteristics related to technical sustainability. Sustainability can be incorporated into regular project reporting, where the actual implementation of sustainable practices can be compared with the planned. Additionally, ostvarenih mjera održivosti, koliko su one zapravo koristile projektu te jesu li možda uzrokovale i neke probleme. Znanje i iskustvo stečeno na jednom projektu može se iskoristiti u budućim projektima (Soares et al., 2024).

Na Slici 2. prikazan je prijedlog održivih akcija prema fazama IT projekta.



Slika 2. Prijedlog održivih akcija po fazama IT projekta, izvor: autori

6 Primjer: održivost u projektu razvoja sustava za praćenje parametara u poljoprivredi

Nakon analize stručne literature vezane uz održivost u IT projektima, provedena je studija slučaja na konkretnom primjeru IT projekta. Radi se o projektu izrade uređaja za mjerenje parametara tla (temperature, vlage, pH vrijednosti) na polju te pripadnog softvera za upravljanje sustavom.

U ovom projektu održivost je uključena već od faze pokretanja projekta. Provedeno je istraživanje tržišta kako bi se ustanovilo postoji li interes za kupnju ovog sustava te ispitivanje financijske isplativosti projekta, što spada u ekonomsku održivost.

U fazi planiranja projekta uključena je ekološka održivost, primjerice prilikom nabave za potrebe projekta. Budući da tvrtka prije nije radila projekte u području poljoprivrede, bilo je potrebno nabaviti novu opremu. Provedena je analiza dobavljača te se nastojalo

sustainable practices can be incorporated "on the go" during the project implementation if the leader or team members notice that certain activities could be carried out in a more sustainable manner.

5.4 Project closure

In the final phase, project closure, it is good to look back and consider how sustainable the project was. A comparison can be made of the planned and implemented sustainability measures, how much they actually benefited the project and whether they may have caused any problems. The knowledge and experience gained in one project can be used in future projects (Soares et al., 2024).
Fig. 2 shows a proposal of sustainable actions throughout the phases of an IT project.

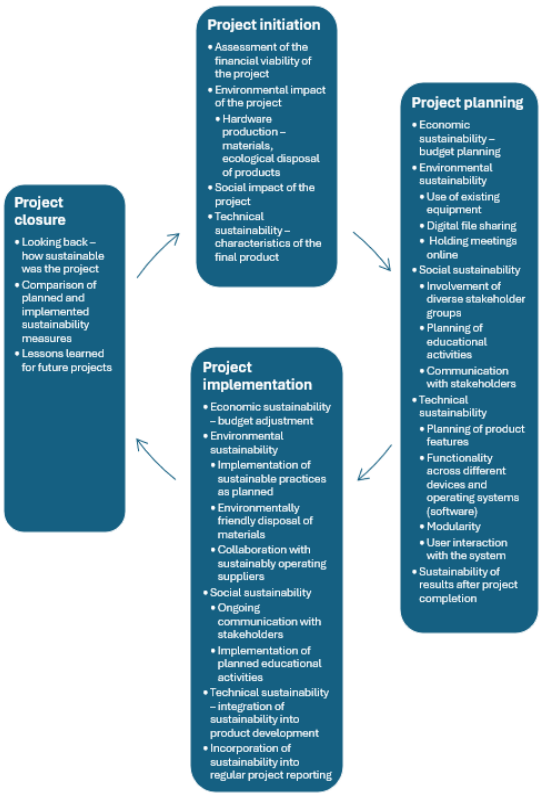


Figure 2. A proposal of sustainable actions throughout the phases of an IT project, source: authors

6 Case study: sustainability in an agricultural parameter monitoring system development project

After analyzing professional literature related to sustainability in IT projects, a case study was

poslovati s dobavljačima koji i sami posluju održivo. Također, kod projektiranja uređaja odabrani su materijali koji nisu štetni za tlo u kojem je uređaj postavljen. Planirano je i ekološki prihvatljivo zbrinjavanje opreme i materijala nakon završetka projekta.

U sve faze, od pokretanja do provedbe projekta uključeni su klijenti te je s njima održavana konstantna komunikacija, a u suradnji s drugim poduzećem – distributerom sustava organizirane su edukacije za korisnike sustava, što upućuje na društvenu održivost projekta. U fazi provedbe korištene su prakse koje se mogu smatrati ekološki održivima, kao što su digitalno dijeljenje datoteka i održavanje sastanaka online, iako primarni razlog tome nije bio težnja ekološkoj održivosti, već jednostavno praktičnost jer dio članova tima radi na daljinu. U fazi završetka projekta višak opreme i materijala ekološki je zbrinut, a sve što se može iskoristiti u budućem radu tvrtke je prenamijenjeno.

Ovo je primjer projekta koji nije samo održiv, već je i projekt „za održivost“. Sam sustav je tehnički održiv, a doprinosi trima dimenzijama održivosti – ekonomskoj, ekološkoj i društvenoj. Poljoprivrednicima omogućava efikasnije upravljanje proizvodnjom kroz praćenje parametara tla u realnom vremenu. Primjerice, praćenje količine minerala u tlu doprinosi racionalnijoj upotrebni gnojiva, što je dobro i za okoliš, i za smanjenje troškova poljoprivrednika. Također, pruža priliku manjim poljoprivrednim gospodarstvima da u svoje poslovanje uključe naprednu tehnologiju, koja nije preskupa i jednostavna je za korištenje.

7 Diskusija i zaključak

U ovom radu analizirana je održivost u IT projektima. Iako je najčešća asocijacija uz pojam održivost ona ekološka, u literaturi su evidentni i drugi oblici održivosti koji uključuju ekonomsku, društvenu, tehničku, individualnu i kulturnu dimenziju održivosti. Analiza znanstvene literature u bazi WoS ukazuje na činjenicu da održivost u upravljanju IT projektima nije u većoj mjeri zastupljena kroz dosadašnji rad istraživača. Ovaj rad dio je šireg istraživanja koje se provodi u okviru izrade diplomskog rada prve autorice, a koje uključuje analizu nekoliko studija slučaja na konkretnim primjerima IT projekata u organizacijama privatnog i javnog sektora u Republici Hrvatskoj, s ciljem istraživanja u kojoj mjeri su razne dimenzije održivosti zastupljene u praksi. Jedan od primjera provedene studije slučaja opisan je i ovom radu.

Obzirom na važnost održivosti na globalnoj razini te ubrzani razvoj tehnologije, potrebni su dodatni napori kako bi se tema održivosti u IT projektima i IT sektoru dodatno istražila i počela aktivnije primjenjivati u praksi. Ovaj rad pruža početne smjernice za aktivnosti koje potiču održivo ponašanje kroz faze životnog ciklusa IT projekta.

conducted on a concrete IT project. The project involved the development of a device for measuring soil parameters (temperature, moisture, pH level) in the field, along with accompanying software for system management.

In this project, sustainability was integrated from the initiation phase. Market research was carried out to determine whether there was interest in purchasing such a system, along with an assessment of the project's financial viability, which falls under economic sustainability.

In the planning phase, ecological sustainability was taken into account, for example, during procurement for the project. Since the company had not previously worked on agricultural projects, it was necessary to acquire a new equipment. A supplier analysis was conducted, and efforts were made to work with suppliers that operate sustainably. Additionally, during the device design phase, materials that are not harmful to the soil were selected. Environmentally friendly disposal of equipment and materials after the project's completion was also planned. Throughout all phases—from initiation to implementation—clients were actively involved and maintained in continuous communication.

In cooperation with another company, which served as the system distributor, training sessions were organized for users, indicating the project's social sustainability. During the implementation phase, practices considered environmentally sustainable were used, such as digital file sharing and holding online meetings. However, these were primarily adopted for practicality, as some team members worked remotely, rather than out of a specific commitment to ecological sustainability. At the project's conclusion, surplus equipment and materials were disposed of in an environmentally responsible way, and everything that could be reused in the company's future work was repurposed.

This is an example of a project that is not only sustainable but also a project for sustainability. The system itself is technically sustainable and contributes to all three dimensions of sustainability: economic, ecological, and social. It enables farmers to manage production more efficiently by monitoring soil parameters in real time. For instance, monitoring mineral levels in the soil supports more rational use of fertilizers, which benefits both the environment and reduces costs for farmers. It also provides smaller agricultural holdings with the opportunity to integrate advanced technology into their operations—technology that is affordable and easy to use.

7 Discussion and conclusion

This paper analyses sustainability in IT projects. Although the most common association with the

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term sustainability is ecological, other forms of sustainability are evident in the literature, including economic, social, technical, individual, and cultural dimensions of sustainability. The analysis of the scientific literature in the WoS database suggests that sustainability in IT project management has not been extensively represented in the work of researchers to date. This work is part of a broader research project being conducted as part of the first author's master's thesis, which includes an analysis of several case studies conducted on specific examples of IT projects in private and public sector organizations in the Republic of Croatia to investigate the extent to which various dimensions of sustainability are represented in practice. One of the examples of the conducted case study is described in this paper.

Considering the importance of sustainability on a global level and the rapid development of technology, additional efforts are needed to investigate further the topic of sustainability in IT projects and the IT sector and to apply it more actively in practice. This paper provides initial guidelines for activities that promote sustainable behaviour throughout the phases of the IT project life cycle.

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