University "Union – Nikola Tesla"
School of Engineering Management

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CONTENT/SADRŽAJ

A Message from the Editor-in-Chief

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Themes included in the journal are: Engineering management, Industrial engineering, Project management, Strategic management, Logistics, Operations management, Production systems management, Quality control, Quality management, Entrepreneurship, Risk management, Human resources management, Leadership, Organizational behaviour, Organizational culture, Financial management, Information systems, High technologies management, Environmental management, Waste management, Maintenance management, Creative industries management, Security management, and Marketing.

Editorial board is consisted of distinguished academics from various countries dedicated to establishing the highest academic standards and promoting engineering management principles in Serbia.

Information on the journal in English and Serbian can be found at the journal web page: https://sjem.fim.edu.rs/index.php/sjem.

Prof. Dr. Vladimir Tomašević, FRSA

Reč urednika

Serbian Journal of Engineering Management je naučno-stručni časopis, koji izdaje Fakultet za inženjerski menadžment i Društvo inženjerskog menadžmenta Srbije. Časopis je kategorisan od strane Ministarstva nauke, tehnološkog razvoja i inovacija. Časopis je takođe od 2020. indeksiran u EBSCO bazama. Časopis je indeksiran na ERIH plus listi od 2023. Ovaj međunarodni časopis je posvećen temama povezanim sa inženjerskim menadžmentom i industrijskim inženjerstvom i izlazi dva puta godišnje (u januaru i julu). Zastupljeni jezik za članke je engleski.

Teme zastupljene u časopisu su: inženjerski menadžment, industrijsko inženjerstvo, upravljanje projektima, strategijski menadžment, logistika, menadžment operacija, menadžment proizvodnih sistema, kontrola kvaliteta, upravljanje kvalitetom, preduzetništvo, upravljanje rizikom, upravljanje ljudskim resursima, liderstvo, organizaciono ponašanje, organizaciona kultura, finansijski menadžment, informacioni sistemi, menadžment u visokotehnološkim industrijama, menadžment životne sredine, upravljanje otpadom, menadžment održavanja, menadžment kreativnih industrija, bezbednosni menadžment i marketing.

Uredništvo časopisa čine istaknuti naučnici iz različitih zemalja sveta koji su posvećeni postavljanju visokog akademskog standarda i promocije principa inženjerskog menadžmenta u Srbiji.

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Uporedna analiza regionalnog upravljanja čvrstim komunalnim otpadom, tehnologije upravljanja i njihova primena

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Apstrakt: Kako se globalno stvaranje otpada nastavlja povećavati, neophodno je ispitati kako se sastav čvrstog komunalnog otpada razlikuje u različitim kulturnim i ekonomskim kontekstima. Ova varijacija utiče i na prakse upravljanja otpadom i na strategije ublažavanja klimatskih promena. Različiti kulturni konteksti dovode do prepoznatljivih obrazaca otpada, koji su oblikovani načinom života, obrascima potrošnje i lokalnim ekonomskim uslovima. Ova raznolikost naglašava potrebu za prilagođenim pristupima tretmanu otpada. Zemlje u razvoju mogu naići na prepreke u usvajanju naprednih tehnologija upravljanja otpadom zbog finansijskih ograničenja, dok razvijeni regioni mogu primeniti sofisticirane tehnologije kao što su hvatanje deponijskog gasa, anaerobna digestija i sistemi za pretvaranje otpada u energiju. Rad naglašava najsavremenije tehnologije koje nude obećavajuća rešenja za smanjenje emisija. Adaptacija i implementacija ovih tehnologija zavise od regionalnih i kulturnih varijacija, uključujući dostupnost lokalnih resursa i infrastrukture. Istaknuta je interakcija između praksi upravljanja otpadom i klimatskih promena, naglašavajući važnost kontekstualno specifičnih, isplativih rešenja u negovanju održivih sistema upravljanja otpadom koji doprinose globalnim ciljevima ublažavanja klimatskih promena. Razvoj i primena ovih tehnologija u velikim razmerama biće ključni u rešavanju rastućih izazova upravljanja otpadom i klimatskih promena.

Ključne reči: čvrsti komunalni otpad, gradski otpad, ublažavanje klimatskih promena, upravljanje otpadom, tehnologije, regionalno poređenje

A Regional Comparison of Municipal Solid Waste Management, Technologies and their Implementation

Abstract: As global waste generation continues to increase, it is imperative to examine how municipal solid waste composition varies across diverse cultural and economic contexts. This variation impacts both waste management practices and climate change mitigation strategies. Diverse cultural contexts give rise to distinctive waste patterns, which are shaped by lifestyle, consumption patterns, and local economic conditions. This diversity underscores the necessity for customized approaches to waste treatment. Developing countries may encounter obstacles in adopting advanced waste management technologies due to financial constraints, while developed regions may implement sophisticated technologies such as landfill gas capture, anaerobic digestion, and waste-to-energy systems. The paper emphasizes cutting-edge technologies which offer promising solutions for reducing emissions. The adaptation and implementation of these technologies are contingent on regional and cultural variations, including the availability of local resources and infrastructure. The interplay between waste management practices and climate change is highlighted, underscoring the importance of context-specific, cost-effective solutions in fostering sustainable waste management systems that contribute to global climate mitigation goals. The development and large-scale implementation of these technologies will be crucial in addressing the growing challenges of waste management and climate change.

Keywords: Municipal Solid Waste, Urban Waste, Climate Change Mitigation, Waste Management, Technologies, Regional Comparison

1.   Introduction

The rapid growth of urbanization, industrialization, and consumerism has led to an unprecedented increase in municipal solid waste (MSW) worldwide. MSW refers to waste generated by households, commercial establishments, institutions, and other non-industrial sources within a municipality. Its composition varies significantly depending on population density, socioeconomic status, cultural practices, and waste management infrastructure. Global MSW generation is predicted to grow from 2.1 billion tonnes in 2023 to 3.8 billion tonnes by 2050. Despite efforts to enhance waste management, only 13% of waste is converted into energy, 19% is recycled, and 68% still ends up in landfills or is openly dumped—leading to severe environmental, economic, and public health consequences (U.N.E.P., 2024). The environmental impact of MSW is significant, particularly due to greenhouse gas (GHG) emissions from landfills and incineration, which contribute directly to climate change (Wang et al., 2017). Landfilling, the most common waste disposal method, releases methane (CH_4) through organic waste decomposition, a greenhouse gas 25 times more potent than CO_2. Open dumping and incineration—widely practiced in low- and middle-income countries—contribute to carbon monoxide (CO), black carbon (soot), and particulate matter emissions, worsening air pollution and accelerating climate change (U.N.E.P. and C.C.A.C., 2021). To address these challenges, researchers and industries are exploring waste valorisation—the process of converting MSW into biofuels, chemicals, and raw materials—as a sustainable alternative to conventional disposal (Kaza et al., 2018). However, valorisation remains economically and technologically challenging due to high capital costs, operational inefficiencies, and the heterogeneous nature of MSW, which varies regionally and seasonally (Velvizhi et al., 2022; Velenturf et al., 2019). A crucial yet often overlooked factor in waste management is cultural influence. Waste composition and disposal methods differ across regions due to economic conditions, consumption habits, recycling infrastructure, and regulatory frameworks. Understanding these cultural and socioeconomic variations is essential to designing effective, climate- resilient waste management strategies. This review examines:

- The impacts of MSW across different cultural and economic contexts.
- Cutting-edge technologies aimed at optimizing MSW management.

2.   Impacts of Municipal Solid Waste Across Different Cultures

2.1.   Waste Composition and Cultural Variations

The composition of MSW is highly diverse, influenced by geography, economic development, seasonal variations, and cultural behaviors. Waste generation has a positive correlation to Gross Domestic Product (GDP), as high-income countries generate more waste per capita and in total (Kaza et al., 2018). The primary components of MSW include organic waste (food and yard waste), paper and cardboard, plastics, glass, metals, rubber and wood. Waste composition also fluctuates in relation to income. High-income countries generate large amounts of plastic packaging, electronics, and processed food waste due to higher consumption levels and food transport needs. Their waste management systems emphasize on recycling, incineration with energy recovery, and landfill gas capture. Middle- income countries face increasing waste challenges, with rising industrial and urban waste generation. They often lack advanced recycling or waste-to-energy (WtE) infrastructure, leading to higher rates of open dumping and informal waste collection. Low-income countries generate a relatively greater proportion of organic waste (food and agricultural residues), due to the limited amount of packaging used. but have limited access to waste treatment facilities. In many cases, open burning and uncontrolled landfilling are common, exacerbating GHG emissions and public health risks (U.N.E.P., 2024). In terms of management, MSW is composed of 40% biowaste, 40% recyclable content, 10% bulky waste and 10% other types. The organic fraction of MSW (agro and food waste) consists of approximately 30-69% carbohydrates (starch, cellulose and hemicelluloses), 5-10% proteins and 10- 40% lipids and has great potential to produce fuels and value-added products. Its exact composition varies depending on the geographical location and season (Zabaleta et al., 2017). On a global scale, waste generation per capita averages 0.74 kg per day, ranging from 0.11 kg in low-income regions to
4.54 kg in high-income nations (Karak et al., 2012). Though they make up only 16% of the world's population, high-income nations account for 34% (683 million tons) of total waste. By 2050, low- income countries are projected to generate three times their current waste levels, increasing their environmental burden (Kaza et al., 2018). The geographical distribution of waste generation also plays a role in emissions. The East Asia and Pacific region generate the largest amount of waste, while the Middle East and North Africa produce the least (Kaza et al., 2018).

Rapid waste growth in Sub-Saharan Africa, South Asia, and the Middle East is accelerating environmental risks due to poor infrastructure and limited policy enforcement. Understanding these cultural and regional differences in waste composition is crucial for designing targeted mitigation strategies that address both waste reduction and climate resilience.

2.2. Waste Management Practices

The management strategies employed by MSW adhere to the principles of the waste management hierarchy, a system that prioritizes upstream measures for the prevention of waste. The fundamental objective of this hierarchy is to minimize waste generation, with a focus on the repair and reuse of goods whenever feasible. Downstream measures to mitigate the impacts of waste on the environment include recycling, energy/resource recovery and disposal. Sustainable waste management practices aim to minimise waste generation, maximise resource recovery, and promote circular economy principles to reduce reliance on landfilling and incineration. According to the United Nations' Environment Programme Global Waste Management Outlook (2024), until 2020 38% of MSW generated globally was dumped or burned uncontrollably. In low-income regions where formal waste collection is lacking, open burning of waste is a widespread practice. This process releases black carbon, dioxins, and other air pollutants, contributing to climate change and respiratory illnesses. The remaining 62% of waste is managed controllably, with 30% of the MSW disposed of in landfills, while 13% was converted to energy and 19% was recycled. Landfills remain the dominant waste disposal method worldwide. In many developing regions, landfills lack methane capture systems, allowing large quantities of CH_4 to escape. Their significant contribution to GHG emissions, makes landfills a major driver of climate change (Kaza et al., 2018). Recycling rates vary significantly by region, influenced by government policies, economic incentives, and cultural attitudes toward waste. In high-income nations, formalized recycling programs process materials such as plastics, paper, and metals. In contrast, informal waste- picking economies play a crucial role in waste recovery in middle- and low-income countries, often without government support or regulation. Worldwide, researchers are conducting extensive studies to convert MSW into fuel and valuable chemicals using thermal and biochemical processes (Awasthi et al., 2022). To tackle the technological and economic challenges, the scientific and industrial communities have made significant efforts to develop novel, innovative, and cost-efficient waste valorisation processes that are more sustainable (Kumar et al., 2023).

2.3. Differences in Waste Management Between Countries

Africa

Municipal waste management in Africa faces significant challenges due to rapid urbanization, population growth, limited infrastructure, and financial constraints. Many African cities struggle with inadequate waste collection services, leading to widespread illegal dumping, open burning, and poorly managed landfills, practices that pose a significant environmental threat and loss of resources (Scarlat et al., 2015). More than 80% of MSW is deposited in a landfill or uncollected, while 5% is recycled and less than 1% is used for energy recovery (U.N.E.P., 2024). The uncollected waste ends up in waterways and informal dumpsites, contributing to severe environmental and public health issues. Formal recycling systems and legislation remain underdeveloped, and waste management largely relies on the informal sector, where waste pickers recover valuable materials such as plastics, metals, and paper for resale (Thabit et al., 2023). Despite these challenges, several African nations have made strides toward improving waste management practices. Countries like South Africa, Rwanda, and Ghana have introduced national policies promoting waste reduction, recycling, and sustainable disposal methods. Rwanda has implemented one of the world's strictest bans on plastic bags, significantly reducing plastic pollution (Behuria, 2021). South Africa has developed an extended producer responsibility (EPR) framework to encourage industries to take responsibility for the entire lifecycle of their products, including post-consumer waste recovery (Laubinger &Börkey, 2023). Innovative waste management solutions are emerging throughout the continent. These initiatives include community-led recycling programs, biodegradable packaging, and digital waste tracking systems.

North America

North America's MSW management is characterized by a diverse range of strategies, influenced by regional policies, economic factors, and technological advancements. The United States and Canada generate significant amounts of municipal solid waste (MSW), with 2 kilograms of waste production per capita per day, amongst the highest globally (U.N.E.P., 2024).

The majority of MSW consists of packaging material, and organic waste takes up 30% of the composition, one of the lowest percentages globally. While both countries have made progress in recycling and waste-to-energy (WTE) initiatives, landfilling remains the dominant waste disposal method, particularly in the United States, where over 50% of MSW is still sent to landfills. Out of 292 million tons of MSW generated in 2018, more than 146 million were landfilled, while 69 million were recycled, 25 million were composted and 34 million were combusted with energy recovery. In addition, about 18 million tons of food were processed through other food management pathways (U.S. E.P.A., 2020). In contrast, Canada has implemented more extensive waste diversion programs, with higher recycling and composting rates in certain provinces. Recycling infrastructure and policies vary significantly across states, provinces, and municipalities, leading to inconsistencies in waste management effectiveness. Cities such as San Francisco have implemented ambitious zero-waste strategies, emphasizing source separation, food recovery, extended producer responsibility (EPR), and bans on single-use plastics. (City and County of San Francisco, 2022). However, other regions continue to struggle with contamination in recycling streams and limited markets for recycled materials. Waste- to-energy technologies are gaining traction in North America, with 60 waste-to-energy plants operating in the United States in 2022, with a total generating capacity of 2,051 megawatts. These facilities reduce landfill dependency and generate electricity. In 2022, over 12.000 gigawatthours were generated from the combustion of municipal biogenic and non-biogenic solid waste (U.S. E.I.A., 2023). Organic waste diversion is also expanding, with composting and anaerobic digestion programs being promoted to reduce methane emissions from landfills. Emerging technologies, such as artificial intelligence for waste sorting, chemical recycling, and blockchain-based waste tracking, are gradually improving waste management efficiency.

South America

Municipal waste management in South America presents a diverse landscape, with significant variations in waste handling practices across countries and cities. A distinctive characteristic of MSW in South America is its high organic content, which is typical of many developing regions. This composition presents both a challenge and an opportunity: while organic waste contributes to environmental pollution when mismanaged, it also holds potential for composting and biogas production if properly treated. Rapid urbanization, economic disparities, and insufficient infrastructure pose major challenges, leading to high levels of landfill dependency and informal waste collection (Hettiarachchi et al., 2018). Many Latin American countries still rely on open dumps, which contribute to environmental degradation, air and water pollution, and greenhouse gas emissions. However, growing awareness of sustainability and climate change has prompted governments and municipalities to implement new policies aimed at improving waste management efficiency and promoting circular economy principles. Governance deficiencies remain a critical barrier, as the MSW system is complex and involves multiple stakeholders. Strong regulatory frameworks and institutional coordination are required to ensure effective waste collection and processing. Weak governance structures have led to environmental and health problems due to improperly managed waste (Hettiarachchi et al., 2018). Recycling rates in South America remain relatively low, while the informal sector plays a crucial role in waste recovery, with waste pickers collecting and sorting recyclable materials (Ferronato et al., 2018). Innovative waste management initiatives are emerging in cities like Bogotá, São Paulo, and Mexico City, where local governments are investing in waste-to-energy (WTE) facilities, composting programs, and digital platforms to optimize waste collection. Some countries have also introduced zero-waste policies to minimise landfill use and promote sustainable waste management.

Asia

Municipal waste management in Asia presents a complex and highly varied landscape, influenced by rapid urbanization, population growth, and economic disparities. East and South-East Asia is the highest producer of MSW in the world, with a production of over 550 million tonnes of MSW in 2020, the majority of which is uncontrolled (U.N.E.P., 2024). Many Asian countries face significant challenges in handling increasing volumes of MSW, with waste collection and disposal infrastructure struggling to keep pace. China is currently the largest emitter of CH4 in the world, accounting for 15.7% of global emissions in 2022 (I.E.A., 2024). However, between 2019 and 2021, China launched a zero-waste pilot program in 11 cities to promote sustainable urban development, circular economy practices, and emissions reductions, which was later expanded to 100 cities under the 14th Five-Year Plan due to its success. These ‚zero-waste cities' aim to minimise solid waste through green lifestyles, industry practices, and eco-park developments, with strong emphasis on public engagement and social media-driven participation (U.N.E.P., 2024).

Japan's advanced waste management system relies heavily on incineration with energy recovery, strict waste segregation, and strong public participation, all supported by comprehensive legal and educational frameworks promoting the 3Rs (Reduce, Reuse, Recycle) (Vuk et al., 2025). South Korea's waste management system is built on strict segregation, high recycling rates, volume-based fees, and strong public engagement, supported by policies like extended producer responsibility and digital monitoring tools (Vuk et al., 2025). Despite progress, many developing Asian nations continue to struggle with inadequate waste collection, illegal dumping, and plastic pollution.

India's MSW management faces major challenges due to a significant lack of data from rural areas, making it difficult to accurately assess waste generation and plan infrastructure. As a result, open waste burning remains a widespread disposal method, posing serious environmental and health risks (Chaudhary et al., 2021). The informal recycling sector plays a critical role in waste recovery across much of Asia, with waste pickers and small-scale recyclers handling a significant portion of material sorting and processing, often in hazardous conditions.

Australia

Australia's approach to municipal waste management is undergoing a transformative phase, driven by a confluence of factors including stringent national policies, advancements in waste treatment technologies, and a heightened public consciousness regarding environmental stewardship. Although as much as 50% of MSW is recycled in Australia, over 40% is still being directed to landfill sites, while less than 5% is being converted into energy (U.N.E.P., 2024). As a nation with one of the highest per capita waste generation rates on a global scale along with North America, Australia faces persistent challenges in its efforts to limit its reliance on landfill disposal. The National Waste Policy Action Plan, launched in 2019, epitomises the country's commitment to transitioning towards a circular economy model, characterised by ambitious objectives such as the phasing out of problematic plastics, enhancing resource recovery rates, and promoting the incorporation of recycled materials into manufacturing processes (D.C.C.E.E.W. 2024). Extended producer responsibility schemes have been implemented across diverse sectors, including electronics, packaging, and battery production, thereby ensuring that manufacturers assume responsibility for the post-consumer lifecycle management of their products. Waste-to-energy technologies, encompassing incineration and anaerobic digestion, are being actively explored as viable alternatives, with pilot studies being explored (Esfilar et al., 2021) and new waste-to-energy facilities are currently under development (Australian Renewable Energy Agency, 2024). Simultaneously, organic waste diversion initiatives are proliferating across the country, with local councils implementing green waste collection programs and composting facilities to mitigate methane emissions from landfills. These initiatives are crucial for reducing the environmental footprint of waste management and promoting the recovery of valuable resources from organic waste streams (Blanchard et al., 2023). A high percentage of MSW is recycled, as the Australian government has invested in local recycling infrastructure, including material recovery facilities and advanced sorting technologies, to improve the quality of recyclable materials and reduce reliance on overseas processing. Additionally, consumer-focused initiatives, such as plastic bags,deposit refund schemes for beverage containers, and public education campaigns, are helping to drive behavioral change (D.C.C.E.E.W. 2024).

Europe

Europe has established itself as a global leader in municipal waste management through stringent policies, innovative technologies, and a commitment to sustainability. The European Union (EU) has set ambitious waste reduction targets under the Circular Economy Action Plan, which mandates recycling, waste prevention, and sustainable product design (European Commission, 2020). In northern and western European countries 44% and 56% of MSW is recycled respectively, and another 42% and 34% respectively is transformed into energy. Southern and Eastern European countries still have a high percentage of landfilling at 40 and 45% as of 2020, but with potential to rapidly reduce it through the implementation of Directive 2018/851 (EU's Landfill Directive). This Directive introduces restrictions on landfilling of all waste that is suitable for recycling or other material or energy recovery from 2030 and sets a goal of 60% recycling of each EU country's MSW by weight, by 2030 (European Parliament & Council of the European Union, 2018). Germany, Austria, Slovenia, the Netherlands, Belgium, Luxembourg, Italy, and Denmark are the top eight EU countries in MSW recycling and composting, while Sweden, Finland, Denmark, Belgium, Estonia, the Netherlands, and Luxembourg are the top seven EU countries in terms of waste-to-energy and incineration rates of their own generated municipal waste. Malta, Greece, Romania, Cyprus, Bulgaria, Croatia, Hungary, Latvia, Spain, Portugal, and Slovakia are the top EU countries that use landfilling for the majority of their MSW (Eurostat, 2020).

Composting and anaerobic digestion have also gained prominence, while digital innovations, such as AI-driven waste sorting and blockchain-based tracking systems, are enhancing recycling efficiency and waste transparency across the region.

3. Cutting-Edge Technologies for MSW Management in Diverse Waste Contexts

3.1. Landfill Gas Capture and Utilisation

Landfill gas (LFG) consists mainly of methane (50-55%) and carbon dioxide (45-50%), along with water vapor, hydrogen sulphide and other compounds in smaller concentrations, and derives from the decomposition of the organic fraction of municipal waste (Lam &Lashaki, 2025). It is typically collected through a network of pipes and can be used as a gas after moisture removal (primary treatment) and hydrogen sulphide separation (secondary treatment). It can be further treated to remove impurities (advanced treatment) with a consistency of 96-98% biomethane, also known as renewable natural gas (RNG). RNG can be used by vehicles or through the gas pipeline system for heating. Cutting edge technologies focus on the simultaneous removal of several impurities, to simplify the treatment procedure. Table 1 presents the latest scientific advancements related to landfill gas purification and utilisation.

Table 1: Cutting-edge technologies for landfill gas utilisation.

Technology	Result	Reference
TRI-tethered G-10 silicas	Full performance throughout successive adsorption-desorption cycles, successful capture of H_2O, CO_2 and H_2S in one single step to produce RNG.	Lam &Lashaki, 2025
ECCS-CCU process based on CO_2 mineralization with NaCl	Generates biomethane and valuable chemicals (Na2CO3, Cl2, pure dense CO2 and Green-H2) while consuming water, NaCl,electricity and LFG.	Rodrigues et al., 2024
Steam Methane Reforming of LFG to Green H_2	Comparison of the economic and environmental aspects of Steam Methane Reforming, Dry Methane Reforming, Partial Oxidation Reforming, Autothermal Reforming.	Singh et al., 2025
chemical looping reforming of LFG with LaFe1-xNixO$_3$ perovskite oxygen carrier	Combined syngas and hydrogen production.	Yao et al., 2025
Ultra-rich combustion mode via porous reactor	Efficient H2-rich syngas production from low-calorific value LFG.	Mohammadpour et al., 2025

However, many developing countries have not incorporated landfill gas collection technologies yet, and the cost of the infrastructure needed can be substantial. Therefore, in order to mitigate the effects of landfill gas and especially methane, low - cost technologies that are easy to implement should also be examined. Verma et al. (2025a) propose a Biogeochemical Cover System (BGCC) for landfill gas mitigation—specifically targeting methane (CH_4), carbon dioxide (CO_2), and hydrogen sulfide (H_2S) emissions from municipal solid waste landfills. BGCC consists of layers of biochar-enhanced soil (for methane oxidation) with Basic Oxygen Furnace (BOF) steel slag for CO_2 and H_2S capture. The BGCC system has strong potential for application in developing countries, especially if biochar can be produced from local agricultural residues, such as rice husk, almond shell, walnut shell, corn stalk and hemp stalk (Verma et al., 2025b) and BOF slag or equivalent alkaline materials such as limeare locally available.

3.2. Anaerobic Digestion & Bioenergy Production

Anaerobic digestion technologies convert the organic fraction of MSW into methane and can be used in a wide spectrum of applications, from small scale individual systems to large, industrial scale plants. In the Sichuan Province of China, small-scale biogas plants are provided to low-income rural households, to support rural development and environmental protection. The biogas plants digest manure and recover the methane and digestate by-product through the process of anaerobic digestion, offering clean and affordable energy to homes and fertilizer for agriculture.

In addition to reducing greenhouse gas (GHG) emissions, the project improves indoor air quality and sanitation for rural communities (C.S.E.S., 2017). Rubber-balloon biogas plants or fixed-dome plants are also affordable and simple to construct and operate (I.S.A.T. & G.T.Z., 1999). Large scale plants are established in Europe and China, while associations such as the European Biogas Association (EBA) are committed to the deployment of sustainable biogas and biomethane production and use. China produces 8,500 Mm³/year of biogas through industrial scale plants, with an electricity capacity of 1,747 MW (Gustafsson et al., 2024). Germany has the highest number of biogas plants in Europe with over 10,000 industry scale plants, producing around 87 TWh/y, that is the highest global annual biogas production (Gustafsson et al., 2024). Recent advancements in anaerobic digestion technologies are analyzed by Uddin & Wright (2023). In principle, all biodegradable organic materials can undergo anaerobic digestion to generate biogas. However, the feedstock should be easily degradable and free from toxic substances that could harm the bacteria involved in the process. To enhance the hydrolysis or solubility of organic matter, various pretreatment methods—thermal, chemical, or mechanical—can be applied. Additionally, there is growing interest in recovering intermediate products like volatile fatty acids (VFA).

3.3. Carbon Capture in Waste Incineration

Waste thermal processing is a favorable alternative to landfilling, as it frees the area required for landfills, while limiting the methane emissions and producing energy as a byproduct of waste management, effectively lowering the treatment cost. Thermal processing methods include incineration, torrefaction, gasification, pyrolysis, conversion to refuse-derived fuel and plasma arc gasification. Waste incineration is used the most, as it is efficient and can be easily applied in relation to other thermal processing methods. However, the combustion process produces CO2 emissions that contribute to climate change. These emissions can be significantly reduced with the application of Carbon Capture and Storage (CCS) and Carbon Capture and Utilisation (CCU) technologies (CCUS). Integrating CCUS technologies to WtE incineration plants is complex, as it involves technical, regulatory, and economic considerations (Bertone et al., 2024). CCS is a technology aimed at storing CO2 permanently after capturing it. while CCU integrates it into the carbon cycle and reuses it to generate economic benefits (Tan et al., 2016; I.E.A., 2019). Most of the technologies associated with CCUS carry a significant investment cost that developing countries might not be able to cover. Solutions involve the pursuit of international funding and partnerships, as well as the retrofitting of existing coal powered power plants, and the construction of small-scale projects. Biochar production is also an alternative way of CCU that provides carbon sequestration and a method of improving soil health. In terms of cutting-edge technologies for more effective CCU pathways, El Helou et al. (2025) propose the incorporation of hydrogen injection into the CO2 removal separators. This process allows for a 48 %-77 % reduction in the net energy consumption for flue gas and syngas respectively. Biogenic CCU from flue gas of paper and steel industries can be utilised for the sustainable co- production of a high-value chemical component of liquid detergents (alcohol ethoxylate - AE7) and low-medium distillate range liquid fuel (Sadhukhan et al., 2025). Rodriguez et al. (2025) present a novel multienzymatic CCU platform that simultaneously converts industrial CO_2 emissions and crude glycerol waste into formate and dihydroxyacetone under mild, eco-friendly conditions, enabling efficient cofactor regeneration and green product recovery. An integrated carbon capture and utilisation (ICCU) approach combined with dry reforming of methane (DRM) is proposed by Li et al., (2025), demonstrating superior energy efficiency, economic viability, and CO_2 mitigation potential—especially when driven by solar energy—compared to conventional CCU systems. Regarding CCS, a high- resolution dynamic optimization model (PSOM) can be used to integrate three types of retrofitted CCS technologies (dedicated coal-fired coupled with CCS technology, dedicated gas-fired coupled with CCS technology, and coal-biomass co-firing coupled with CCS technology) into a national power system while accounting for hourly provincial-level variations in renewable energy availability and demand—enabling a detailed, scalable assessment of retrofitted CCS's role in cost-effective decarbonization (Zhou et al., 2025). Sun et al. (2025) offer that biomass and coal co-firing with carbon capture and storage (BCP-CCS) can help China reach its carbon neutrality goals by retrofitting existing coal-fired power plants rather than phasing them out entirely, by proposing a plant-level, high-resolution ‚ternary-matching' strategy that couples biomass residues, coal-fired power plants, and nearby carbon sequestration sites to realistically assess the retrofit potential, cost, and carbon reduction of BCP-CCS, addressing resource competition and geographic constraints. The CCS innovation dynamics in Norway were analyzed with the application of the Technological Innovation System (TIS) framework, focusing on the structural and functional aspects of the system and its weaknesses.

While there are positive developments, such as increasing R&D activity and demonstration projects, the Norwegian CCS innovation system faces systemic challenges, particularly in market formation and resource mobilization, with current political and financial frameworks insufficient to drive large-scale investment (Steen et al., 2024). Laljee&AlHajaj (2025) introduce an optimization-based model for designing cost-optimal CO2 pipelines that account for impurities, revealing that impurities significantly increase compression energy and transport costs, with a proposed penalty scheme to mitigate these costs, highlighting the need for impurity control in efficient CCS deployment.

4.   Conclusions

The growing challenge of managing municipal solid waste (MSW) is a multifaceted issue that requires a comprehensive understanding of regional differences, cultural practices, and technological limitations. As urbanization accelerates on a global scale, nations encounter a variety of waste management challenges, ranging from inadequate infrastructure and high landfilling rates in low- income regions to advanced recycling and waste-to-energy systems in high-income nations. The development of effective waste management strategies must address these disparities and promote sustainable practices through a circular economy model, resource recovery, and waste minimization efforts. The integration of innovative technologies, the enhancement of policy frameworks, and the promotion of public engagement present a substantial opportunity to mitigate the environmental, economic, and health ramifications of MSW. A concerted, worldwide effort to adopt more sustainable waste management practices will necessitate collaboration between governments, industries, and local communities to devise customized solutions that curtail waste generation, enhance recycling rates, and curtail reliance on landfills and incineration. Such efforts must be pursued in a manner that fosters climate resilience and environmental sustainability. The advancements in MSW management that are being developed and implemented at present demonstrate the potential for significant environmental, economic, and societal benefits. Technologies such as landfill gas capture and utilization, anaerobic digestion, and carbon capture in waste incineration represent critical components of sustainable waste management systems. The potential for converting landfill gas into renewable natural gas (RNG) represents a significant opportunity to curtail methane emissions while generating a valuable energy source. Similarly, anaerobic digestion technologies offer a dual benefit of generating bioenergy while reducing the environmental impact of organic waste. Furthermore, the integration of carbon capture, utilization, and storage (CCUS) in waste-to-energy (WtE) processes can significantly mitigate carbon dioxide (CO2) emissions, thereby contributing to climate change mitigation efforts. However, these technologies face significant challenges, including high infrastructure costs and limited technological accessibility in developing countries, which act as substantial barriers to their full implementation. However, the development of cost-effective, scalable solutions, such as the Biogeochemical Cover System for landfill gas mitigation, offers a potential solution for addressing these challenges in developing regions. As research progresses and new technologies continue to emerge, the evolution of MSW management towards more sustainable, circular economy models will be crucial in addressing global environmental concerns while fostering economic development, particularly in underserved communities.

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Klimatske promene i njihov uticaj na vojni poligon Krivolak u 21. veku: izazovi, prilagođavanje i uloga pametnih vojnih tehnologija

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Apstrakt: Klimatske promene predstavljaju sve veći izazov za vojnu infrastrukturu, posebno u regionima podložnim ekstremnim vremenskim uslovima i ekološkim transformacijama. Ovaj rad analizira uticaj klimatskih promena na vojni poligon Krivolak u Severnoj Makedoniji. Integracijom podataka o životnoj sredini, vojne doktrine i novonastalih tehnologija, istraživanje sagledava kako se ova značajna obučna zona transformiše u pogledu upotrebljivosti terena, operativne spremnosti i logističkog planiranja. Rad predstavlja procenu zasnovanu na scenarijima, uz vizualizovane rezultate koji prikazuju operativne posledice klimatskih promena. Pored toga, predstavljeno je kako pametne tehnologije, poput geoprostornog monitoringa, prediktivnog modeliranja i adaptivnih sistema za obuku, mogu unaprediti otpornost. Ovi nalazi ukazuju na širu potrebu za integracijom svesti o klimatskim promenama i tehnološkog prilagođavanja u vojno planiranje i projektovanje infrastrukture.

Ključne reči: Poligon Krivolak, otpornost na klimatske promene, vojna spremnost, tehnološko prilagođavanje

Climate Change and Its Impact on the Krivolak Military Training Area in the 21st Century: Challenges, Adaptation, and the Role of Smart Military Technologies

Abstract in English: Climate change presents increasing challenges for military infrastructure, especially in regions prone to extreme weather and environmental transformation. This paper examines how climate change is affecting the Krivolak Military Training Area in North Macedonia. By integrating environmental data, military doctrine, and emerging technologies, the study explores how this vital training site is being reshaped in terms of terrain usability, training readiness, and logistical planning. The paper presents a scenario-based assessment and includes visualized results to demonstrate the operational consequences of climate change. Moreover, it introduces how smart technologies such as geospatial monitoring, predictive modelling, and adaptive training systems can improve resilience. These findings reflect a broader need to integrate climate awareness and technological adaptation into military planning and infrastructure design.

Keywords: Krivolak Training Area, Climate Resilience, Military Readiness, Technological Adaptation

1. Introduction

Across the globe, climate change is beginning to influence military decision-making, training logistics, and infrastructure planning. Armed forces are not only affected by rising temperatures, extreme precipitation, and environmental degradation, but also expected to operate effectively within these evolving conditions. In the Balkan region, the Krivolak Military Training Area represents one of the largest and most strategically significant defense zones. Located in a semi-arid landscape, Krivolak is increasingly exposed to temperature rise, unpredictable rainfall, soil erosion, and seasonal shifts, all of which have operational consequences on land usability, exercise schedules, and environmental safety (Tavares da Costa and Krausmann, 2021; European Commission, 2021; ICS Europe, 2022; Glavinov and Kamchev, 2023).

Numerous global defense strategies now identify climate change as a risk to readiness and mission continuity (Palazzo, 2022; NATO, 2022; CNA Corporation,2007). These effects include both direct consequences: such as heat-related training restrictions or erosion of maneuver terrain and indirect risks such as infrastructure degradation and energy supply instability. The European Defence Agency and other institutions stress the urgency of adopting site-specific climate resilience measures, including the use of renewable energy systems, integrated environmental monitoring, and digital scenario modeling (Naumann, et al., 2021; Bellasio et al., 2021).

This paper focuses on Krivolak as a critical case study. It reviews historical climate patterns and current environmental stressors, followed by a detailed table of site characteristics. It then presents a simulation-based scenario demonstrating how climate variables impact military use of the training area. Finally, the paper proposes adaptation strategies that incorporate geospatial tools, autonomous surveillance platforms, and data-driven energy management. The conclusions drawn offer guidance for policymakers, defense planners, and environmental engineers concerned with the future of military infrastructure under changing climate conditions (European Space Agency, 2020).

2. Overview of the Krivolak Military Training Area

The Krivolak Military Training Area is the largest and most strategically important training site in North Macedonia, covering approximately 22,500 hectares of primarily arid, rugged, and semi- mountainous terrain. Situated in the central-southern part of the country, Krivolak serves as a key facility for national military preparedness, NATO interoperability exercises, and international defense cooperation. The site includes live-fire zones, maneuver corridors, UAV testing fields, and simulated urban environments, making it a multi-domain training platform.

In recent years, Krivolak has experienced significant environmental pressure linked to climate variability. Increasing annual temperatures, changing precipitation patterns, and dry season expansion have led to more frequent soil erosion, vegetation loss, and the degradation of surface stability, which is essential for maneuver operations and infrastructure preservation. According to climate risk assessments across the Balkan region, the combination of heat extremes, sudden flooding, and water scarcity is expected to continue shaping Krivolak's usability and readiness conditions in the coming decades.

Several defense institutions have already begun integrating environmental and climate metrics into their training site assessments and modernization efforts. For Krivolak, the adoption of real-time climate monitoring tools, terrain-responsive infrastructure, and predictive modeling platforms is becoming increasingly relevant, especially as joint international exercises grow in frequency and complexity (Tavares da Costa and Krausmann, 2021).

Figure 1: Aerial View of the Krivolak Training Area

(Source: https://mod.gov.mk/at-krivolak-we-continue-to-develop-our-military-skills-a-joint-exercise-of-cadets-from-the-military-academy-with-members-of-the-army-of-montenegro/?__cf_chl_tk=usfFJAxx0vJpB6OuY4IGBT97QE3GtVAZSiMDgVTEvAE-1748788564-1.0.1.1-OrpljwT76FO_gbvSHyckXgzmKcE8O0fElkfpPx8lzCI)

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This aerial image captures a section of the Krivolak Training Area during a rotary-wing training exercise. The terrain visible here is indicative of the arid and semi-arid landscape that dominates the region and is increasingly affected by climate-induced soil erosion, vegetation stress, and seasonal surface instability.

Figure 2: Map View of Krivolak and Surrounding Infrastructure

(Source: https://www.google.com/maps/place/Krivolak/@41.5276923,22.1098246,15z/data=!3m1!4b1!4m6!3m 5!1s0x1356714a1bbffe8d:0x47ee944159df8069!8m2!3d41.5284194!4d22.1206661!16s%2Fm%2F04m xmrw?entry=ttu&g_ep=EgoyMDI1MDUyOC4wIKXMDSoASAFQAw%3D%3D)

This map highlights the geographic boundaries of the Krivolak Military Training Area in relation to nearby civilian settlements, road networks, and natural features such as the Vardar River. It provides context for the strategic location of the site and its logistical accessibility, both of which are increasingly influenced by seasonal climate variations and infrastructure exposure risks.

Table 1: Key Features of the Krivolak Military Training Area

Feature	Details
Location	Central-Southern North Macedonia
Total Area	Approx. 22,500 hectares
Elevation Range	230–950 meters
Climate Zone	Semi-arid to Mediterranean transition
Training Functions	Live fire, maneuver, UAV testing, NBC drills
Infrastructure Components	Shooting ranges, control towers, command zones
Vegetation Cover	Sparse grassland and shrubland
Average Summer Temperature	34°C (rising trend)
NATO Usage	Used in multinational joint exercises
Environmental Challenges	Soil erosion, heat stress, flood risk

Table 1 summarizes the essential physical, operational, and environmental characteristics of the Krivolak Military Training Area. These attributes define the site's strategic value and also indicate the environmental sensitivities that make it increasingly vulnerable to climate-related stress. The elevation range and semi-arid to Mediterranean transition climate shape the types of exercises that can be performed throughout the year. The site's sparse vegetation and open terrain provide ideal conditions for live-fire and maneuver operations, while also increasing susceptibility to erosion and dust propagation during dry seasons. The average summer temperature already reaches above 34°C and continues to rise annually, placing additional pressure on infrastructure and personnel endurance. Furthermore, Krivolak's frequent use in NATO-aligned training and multinational exercises underlines the importance of maintaining its operational readiness, which depends heavily on terrain stability, resource access, and adaptability to climate variability. These factors form the foundation for the scenario-based analysis and climate impact projections discussed in the next section.

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3. Scenario-Based Climate Impact Analysis

To better understand how climate change is affecting the operational value of the Krivolak Military Training Area, a comparative scenario was developed using baseline historical data and projected environmental conditions. This scenario models three critical indicators: average summer temperature, usable training days per year, and surface erosion risk. The aim is to quantify how ongoing climate trends may degrade the availability, safety, and sustainability of the training environment. These projections are informed by regionally observed climate patterns and defense-related environmental assessments (Palazzo, 2022). The figures below present a side-by-side comparison of historical conditions (baseline) and anticipated impacts by mid-century if no mitigation strategies are implemented.

3.1. Average Summer Temperature

The average summer temperature at Krivolak is expected to rise from approximately 31°C to 37°C. This increase will elevate the frequency of heat-related training cancellations and impose greater physiological strain on personnel, particularly during live-fire and extended field operations. Elevated temperatures also accelerate ground surface hardening, reducing maneuverability and increasing fire hazard risk.

Figure 3: Average Summer Temperature Comparison
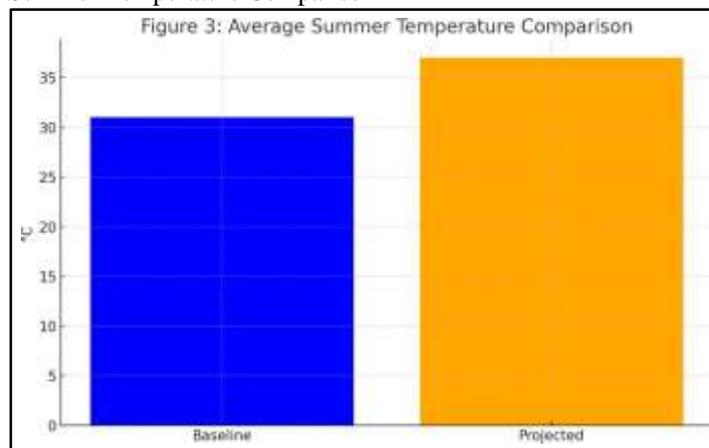
3.2. Usable Training Days per Year

Training availability is projected to drop from 260 usable days per year to around 195. This decline is attributed to heat stress thresholds, heavy rainfall episodes, and wind-induced dust storms, which can disrupt visibility and degrade sensor performance. Reduced scheduling flexibility could affect readiness cycles and coordination with allied exercises, especially during NATO seasonal rotations.

Figure 4: Usable Training Days per Year

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3.3. Surface Erosion Risk

Erosion risk is expected to more than double, from 25 percent to over 60 percent, due to intensified rainfall variability and vegetation decline. Surface instability poses direct threats to a range of infrastructure such as roads, bunkers, and observation points. It also impacts environmental compliance and could lead to training area closures for remediation and restoration efforts (European Space Agency, 2020).

Figure 5: Surface Erosion Risk Comparison

Figure 5: Surface Erosion Risk Comparison
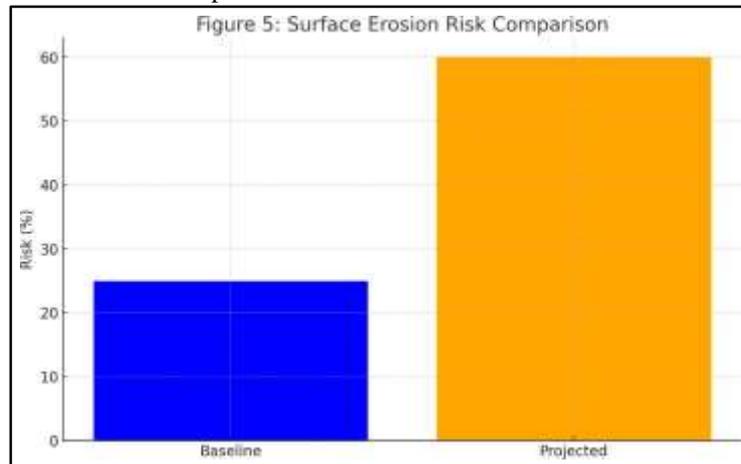
These scenario-based insights demonstrate that climate change is not only an environmental issue but a direct factor in training readiness, mission assurance, and long-term military planning. The results underscore the urgent need for climate adaptation policies at Krivolak, including infrastructure reinforcement, predictive monitoring systems, and seasonal training strategy revisions (Bellasio et al., 2021).

4. Adaptation Strategies and Technological Integration

The observed and projected climate impacts at the Krivolak Military Training Area demand a proactive approach grounded in both environmental resilience and technological modernization. As climate conditions increasingly influence training availability and infrastructure durability, it becomes critical to integrate adaptive strategies that preserve operational continuity and improve long-term sustainability.

One of the primary areas for adaptation lies in infrastructure design and material resilience. Roads, firing positions, and observation structures must be reinforced with erosion-resistant materials and drainage systems that respond to shifting rainfall patterns and seasonal runoff. Elevated summer temperatures also necessitate shade structures, heat-resistant pavements, and cooling shelters to protect personnel and sensitive equipment during prolonged exposure.

In parallel, technology can play a central role in climate adaptation. Installing real-time environmental monitoring stations throughout Krivolak would enable commanders to track temperature, soil moisture, and wind conditions, improving decision-making related to exercise planning and safety thresholds. Satellite-based terrain monitoring, combined with UAV surveillance, could identify areas undergoing rapid erosion or vegetation loss, allowing for timely remediation (ICS Europe, 2022). These data systems also support predictive modeling, helping planners forecast periods of reduced usability and adjust logistics accordingly.

Another essential element is the development of a seasonally adaptive training calendar. With a projected loss of up to 65 training days per year, military planners may need to redesign the training cycle to optimize exercises in early spring and late autumn, when temperatures and erosion risk are lower (Naumann, et al., 2021). This change would be supported by artificial lighting systems and modular training stations, enabling nighttime and low-visibility scenarios that take advantage of cooler conditions.

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Krivolak could also benefit from the integration of energy-efficient technologies, such as solar- powered observation posts and battery-backed command points, which reduce reliance on fuel logistics and improve environmental compatibility. This aligns with broader NATO and EU defense sustainability goals, which emphasize green defense infrastructure and climate-conscious military planning.

Finally, adaptation should extend to training doctrine and personnel awareness. Updating operational manuals to include climate risk protocols, first-aid procedures for heat injuries, and environmental restoration guidelines will enhance both preparedness and safety. Joint exercises can incorporate environmental risk management as a key training component, ensuring that climate resilience becomes a core skill for field commanders and logistics teams.

By integrating these measures, Krivolak can transition into a model for climate-resilient military training in the Balkans. The convergence of modern technology, adaptive logistics, and environmental science is no longer a theoretical consideration, it is a practical necessity for maintaining mission effectiveness under changing global conditions.

Figure 6: Climate Adaptation and Technological Integration at Krivolak Military Training Area
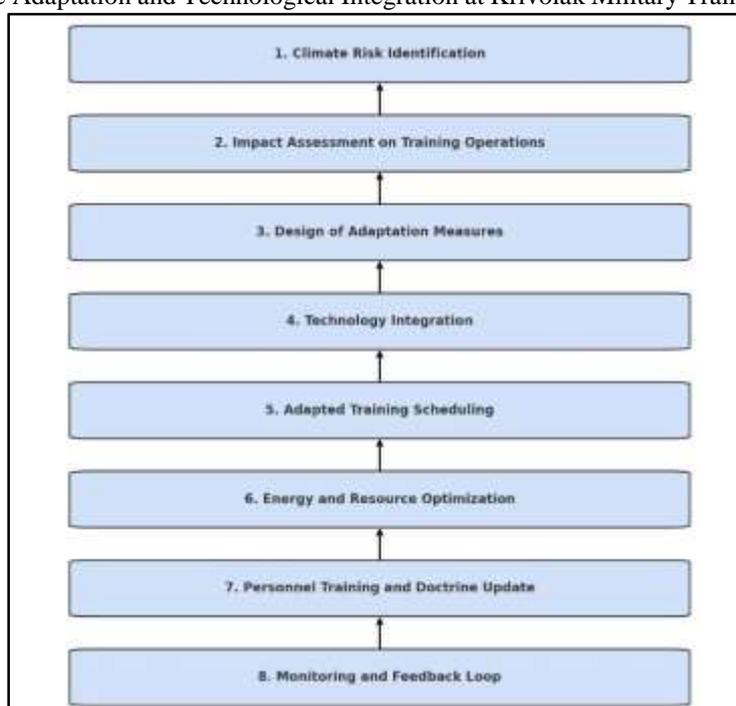
5. Conclusion and Strategic Implications

The findings presented in this paper confirm that climate change is not only an environmental or logistical concern, but a significant strategic factor for military training infrastructure. The Krivolak Military Training Area, as a core asset in the defense posture of North Macedonia and a key site for NATO-aligned exercises, faces increasing vulnerability from rising temperatures, variable precipitation, and terrain degradation. These changes directly affect the usability, safety, and operational readiness of the training zone.

The scenario-based analysis clearly illustrates the operational consequences of inaction. A projected reduction in usable training days, a steep rise in erosion risk, and intensified summer heat will all require immediate attention from military planners. Without structural and procedural adaptation, the long-term viability of Krivolak as a multi-domain training facility could be compromised.

However, this study also demonstrates that the integration of adaptive strategies ranging from real-time environmental monitoring to training schedule reform, can significantly mitigate the anticipated disruptions. Technological solutions, when matched with appropriate planning and infrastructure resilience, offer a path forward.

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More importantly, the eight-step workflow developed in this paper offers a transferable model that can guide climate adaptation in similar military zones throughout the Balkans and beyond.

Ultimately, military readiness in the 21st century will depend not only on tactical capability, but on strategic environmental foresight. Krivolak can serve as a pioneering example of how armed forces can operate smarter, sustainably, and more securely in an era shaped by climate transformation.

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Savladavanje bontona na radnom mestu: profesionalizam, produktivnost i institucionalni ciljevi

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Apstrakt: Bonton na radnom mestu, koji obuhvata neformalne kodekse profesionalnog ponašanja, utiče na komunikaciju, poštovanje, profesionalizam i inkluzivnost, što sve ključno doprinosi uspehu organizacije. Ova studija mešovite metode istraživala je vezu između bontona na radnom mestu i produktivnosti zaposlenih, kao i usklađenost sa institucionalnim ciljevima, uključujući veze sa ciljevima održivog razvoja (COD). Rezultati ankete sprovedene među 350 zaposlenih pokazali su jaku pozitivnu korelaciju (r = 0,68, p < 0,001) između pridržavanja bontona i produktivnosti. Regresione analize su otkrile značajne prediktivne veze između komponenti bontona, posebno efikasnosti komunikacije i poštovanja, i postizanja institucionalnih ciljeva (β = 0,54, p < 0,01). Kvalitativni intervjui su potvrdili ove nalaze, naglašavajući važnost obuke i liderstva u negovanju kulture bontona. Preporuke uključuju sveobuhvatnu obuku o bontonu, programe mentorstva i strukturirane mehanizme povratnih informacija kako bi se bonton ugradio u organizacionu kulturu, promovišući održivost i društvenu odgovornost. Praktično, bonton služi kao vitalna organizaciona prednost koja poboljšava učinak, reputaciju i inkluzivnost.

Ključne reči: bonton na radnom mestu, profesionalizam, produktivnost, organizaciona kultura, inkluzivnost.

Mastering Workplace Etiquette: Professionalism, Productivity, and Institutional Goals

Abstract in English: Workplace etiquette, comprising informal professional conduct codes, influences communication, respect, professionalism, and inclusivity, all of which contribute critically to organizational success. This mixed-method study investigated the relationship between workplace etiquette and employee productivity as well as institutional goal alignment, including connections to Sustainable Development Goals (SDGs). Results from a survey of 350 employees showed a strong positive correlation (r = 0.68, p < .001) between etiquette adherence and productivity. Regression analyses revealed significant predictive relationships between etiquette components especially communication effectiveness and respectfulness and institutional goal achievement (β = 0.54, p < .01). Qualitative interviews reinforced these findings, underscoring the importance of training and leadership in fostering etiquette cultures. Recommendations include comprehensive etiquette training, mentorship programs, and structured feedback mechanisms to embed etiquette into organizational culture, promoting sustainability and social responsibility. Practically, etiquette serves as a vital organizational asset that enhances performance, reputation, and inclusivity.

Keywords: Workplace Etiquette, Professionalism, Productivity, Organizational Culture, Inclusivity.

1. Introduction

In contemporary organizational contexts characterized by rapid globalization, technological transformation, and increasingly diverse workforces, workplace etiquette the unwritten norms guiding professional behavior and interpersonal interaction plays a crucial role in fostering environments conducive to productivity and institutional success (Ting-Toomey & Chung, 2012; Holistique Training, 2024).

Beyond traditional notions of politeness, etiquette encompasses behaviors such as respectful communication, punctuality, professional appearance, and inclusivity that contribute to positive workplace relationships and culture. As virtual and hybrid work arrangements become more prevalent, challenges arise in maintaining consistent etiquette standards, especially in digital communication contexts. These shifts, alongside increased cultural diversity, necessitate updated, empirically grounded frameworks to guide organizations in embedding etiquette as a strategic asset (Edstellar, 2025; Shore et al., 2011). Although workplace etiquette is recognized as vital in organizational theory and practice, there remains a lack of comprehensive, data-driven studies explicitly measuring its impact on quantifiable outcomes such as employee productivity, institutional goal alignment, and reputational capital. Additionally, the absence of robust frameworks that incorporate modern work environment complexities such as multicultural teams and digital communication limits organizations' capacity to cultivate and sustain etiquette-centered cultures.

Research Objectives:

- To identify and explicate core components of workplace etiquette that significantly influences professionalism, productivity, and organizational climate.
- To empirically examine the relationship between workplace etiquette adherence and institutional goal achievement.
- To explore how the integration of workplace etiquette with Sustainable Development Goals (SDGs) promotes organizational sustainability and social responsibility.

Research Questions:

- What are the essential behaviors and practices constituting effective workplace etiquette?
- How does workplace etiquette impact individual productivity and collective institutional outcomes?
- What practical strategies can organizations implement to embed workplace etiquette in alignment with SDGs?

2.   Literature Review

Workplace etiquette refers to the informal code of conduct governing interpersonal interactions, communication practices, and professional behavior within organizational settings. The study of workplace etiquette is grounded in several foundational theories that explain how respectful and cooperative behaviors influence organizational outcomes.Social Exchange Theory (Blau, 1964) posits that social interactions operate on a system of reciprocal exchanges; in the workplace context, respectful behaviors such as active listening and acknowledgment foster trust and cooperation among employees (Cropanzano & Mitchell, 2005). This mutual respect cultivates positive relational networks essential for organizational cohesion and effectiveness.Organizational Justice Theory (Greenberg, 1990) emphasizes the perception of fairness in workplace processes and outcomes. Fair treatment and accountability enhance employees' motivation and ethical behaviors, thus reinforcing a culture of etiquette that supports professionalism and productivity (Colquitt et al., 2001).Communication Theory, particularly the work of Burgoon, Guerrero, and Floyd (2016), explains that effective communication verbal and non-verbal is central to reducing ambiguity and workplace conflict. Non-verbal cues such as eye contact, posture, and facial expressions complement spoken words, conveying empathy and fostering trust critical for positive workplace relations.Emotional Intelligence (EI), conceptualized by Goleman (1995), plays a pivotal role in managing interpersonal dynamics by enabling individuals to recognize their own and others' emotions, regulate emotional responses, and navigate social complexities. High EI levels correlate with better teamwork, leadership effectiveness, and conflict resolution skills (Mayer, Salovey, & Caruso, 2004).

Building upon the theoretical underpinnings, workplace etiquette comprises multiple practical components that collectively shape professionalism and impact organizational success.

Punctuality is widely regarded as a visible indicator of respect for others' time and commitment to organizational goals. While Macan (1994) highlighted its role as a time management skill crucial for productivity, Hall's (1983) distinction between monochronic and polychronic cultures challenges standardized expectations. In multinational organizations, flexibility and cultural sensitivity in regards to time perceptions are necessary (Gudykunst & Kim, 2017).

Professional Appearance affects impressions of competence and credibility, especially in customer-facing roles. Impression Management Theory (Leary & Kowalski, 1990) explains how adherence to professional dress codes fosters trustworthiness and a positive organizational image (Churchgate, 2024). Dress norms also indirectly influence employee confidence and behavior.Respect for Colleagues is foundational to reducing workplace incivility and fostering psychological safety. Andersson and Pearson (1999) outlined how incivility spirals detrimentally affect job satisfaction and performance. Conversely, respectful behavior promotes positive social exchanges that increase collaboration and reduce turnover intentions, corroborated by Holistique Training (2024).

Effective Communication encapsulates both verbal clarity and non-verbal acuity. Active listening, defined as intentionally absorbing and responding to messages, is crucial for understanding and minimizing miscommunication. Giles (1973) further argued that communication styles influence interpersonal rapport and conflict outcomes. Digital Communication Etiquette has gained prominence with the rise of remote and hybrid work. Holistique Training (2024) stresses clarity, timeliness, and professionalism in emails and virtual interactions, noting that breaches in digital etiquette can damage professional relationships and institutional reputation.

There is increasing recognition of workplace etiquette's alignment with global sustainability and social responsibility agendas. The United Nations Sustainable Development Goals (SDGs) provide a framework linking organizational conduct to broader societal challenges. Notably, SDG 8 (Decent Work and Economic Growth) and SDG 10 (Reduced Inequalities) emphasize inclusive, respectful, and fair workplaces that uphold human dignity and promote equity (United Nations, 2024). Organizational cultures embedding etiquette contribute directly to these goals by fostering diversity, equity, and inclusion. Roberson (2006) and Shore et al. (2011) documented how inclusive cultures leverage etiquette norms to support innovation and employee engagement, which enhances organizational resilience and sustainability.

3.   Research Methodology

This research employed a mixed-methods design, combining quantitative and qualitative approaches to comprehensively examine the relationship between workplace etiquette and organizational outcomes.

- The quantitative component consisted of a structured survey administered electronically to 350 employees across various industries, including manufacturing, services, and education. The sample was stratified to ensure diversity in gender, age, and cultural backgrounds, facilitating generalizable results. The survey measured perceptions of etiquette adherence, productivity levels, and institutional goal alignment using validated Likert-scale items.
- The qualitative component involved semi-structured interviews with 15 HR professionals and organizational leaders who oversee employee development programs. These interviews provided deeper insights into etiquette training practices, challenges faced, and observed organizational impacts.
- Additionally, secondary data analysis entailed reviewing institutional performance reports, employee engagement indices, and turnover statistics from organizations that have implemented formal workplace etiquette policies.

The survey instrument was developed based on established measurement scales for workplace communication, respect, and professionalism (Robbins & Judge, 2019; Mayer et al., 2004). Items included statements such as ―Employees in my organization demonstrate respect during interactions‖ and ―Effective communication enhances my productivity,‖ rated on a 5-point scale from Strongly Disagree (1) to Strongly Agree (5). The questionnaire was pilot tested for clarity and reliability, with Cronbach's alpha coefficients exceeding 80 for all constructs.The interview protocol comprised open-ended questions exploring how etiquette is defined, taught, and reinforced, as well as perceived outcomes on productivity and institutional goals.

Based on theory and prior literature, the study proposed:
- Hypothesis 1 (H1): There is a positive correlation between workplace etiquette adherence and employee productivity.
- Hypothesis 2 (H2): The presence of robust workplace etiquette practices predicts higher alignment with institutional goals and enhanced organizational reputation.

Quantitative data were analyzed using SPSS Statistics (version 27). Descriptive statistics summarized demographic information and key variables. Pearson correlation coefficients tested relationships between workplace etiquette and productivity (H1). Hierarchical multiple regression assessed the predictive power of communication, respect, and professionalism on institutional goal alignment (H2), controlling for demographic covariates. Qualitative interview transcripts were coded thematically using NVivo 12, enabling the identification of recurrent themes related to training efficacy, leadership influence, and cultural sensitivity in etiquette application. Secondary data triangulated findings by assessing organizational metrics linked to workplace etiquette programs.

The study adhered to ethical research standards, including informed consent, confidentiality, and voluntary participation. Institutional Review approval was obtained prior to data collection, ensuring protection of participant rights and data security.

4.   Findings and Analysis

The quantitative data from 350 survey respondents demonstrated a strong positive correlation between workplace etiquette adherence and self-reported productivity (Pearson's $r = 0.68$, $p < .001$), supporting Hypothesis 1 (H1). Among the etiquette components measured, effective communication and respectfulness emerged as the strongest predictors of productivity, consistent with prior research emphasizing the role of clear and respectful interactions in performance enhancement (LinkedIn, 2022; Burgoon, Guerrero, & Floyd, 2016).

Hierarchical regression analysis revealed that these components collectively accounted for a significant proportion of the variance in institutional goal alignment ($\beta = 0.54$, $p < .01$), confirming Hypothesis 2 (H2). Control variables such as demographic factors did not substantially affect these relationships, indicating the robustness of etiquette's influence across diverse groups.

Interviews with 15 HR professionals and managers provided rich, contextualized support for the quantitative results. Key themes included:

- The critical role of continuous etiquette training in maintaining professional standards, particularly emphasizing digital etiquette in remote and hybrid environments.
- Leadership modeling of etiquette behaviors was identified as a crucial factor in embedding etiquette culture, fostering employee emulation and buy-in.
- The challenge of cultural diversity was reiterated, with calls for flexible and inclusive etiquette policies sensitive to different cultural norms and communication styles (Ting-Toomey & Chung, 2012).
- Participants stressed the need for feedback mechanisms that confidentially address breaches to promote accountability without fostering negativity.

Analysis of organizational performance reports and employee engagement scores from firms with formal etiquette policies showed positive trends. These organizations demonstrated:

- Up to 30% higher employee engagement scores compared to peers lacking such policies.
- More consistent achievement of balanced scorecard targets related to customer satisfaction and internal process efficiency.
- Enhanced institutional reputation, as evidenced by stakeholder surveys and client retention data.

These findings illustrate that formalizing workplace etiquette into organizational strategy and culture has tangible benefits beyond interpersonal relations, extending to measurable institutional success.

Table 1: Workplace Etiquette Integration Strategies and Expected Outcomes

Strategy	Description	Expected Outcome
Etiquette Training	Regular workshops on communication, respect, cultural sensitivity, and digital conduct.	Enhanced employee awareness and professional behavior.
Mentorship Programs	Experienced staff guide new employees on professionalism and etiquette norms.	Smooth onboarding and cultural integration.

Feedback Mechanisms	Systems for reporting and addressing etiquette breaches confidentially.	Timely resolution and culture maintenance.
Leadership Modeling	Managers demonstrate and reinforce etiquette standards consistently.	Increased adherence and motivation.
Performance Metrics	Inclusion of etiquette behaviors in employee evaluations and rewards.	Reinforcement of accountability and continuous improvement

Source:. Strategies are based on empirical findings combined with best practices in organizational development (Holistique Training, 2024).

5. Discussion

The evidence affirms workplace etiquette as a pivotal driver of professionalism, productivity, and institutional alignment. The strong correlation between etiquette adherence and productivity aligns with Social Exchange Theory (Blau, 1964), which explains that reciprocal respectful behavior builds trust and cooperation, essential for high-functioning workplace dynamics (Cropanzano & Mitchell, 2005). Further, communication's role as the highest predictor underscores foundational principles from Communication Theory (Burgoon et al., 2016), wherein clarity and empathy reduce misunderstandings and mitigate conflict. The impact of respect and accountability on institutional goal alignment reflects Organizational Justice Theory (Greenberg, 1990), where perceived fairness enhances employee motivation and ethical conduct, leading to improved organizational outcomes (Colquitt et al., 2001). The qualitative emphasis on leadership modeling supports theories of organizational culture development and transformational leadership, highlighting that etiquette norms are most effective when visibly supported by management (Kouzes & Posner, 2012). Importantly, the study's linkage of workplace etiquette to Sustainable Development Goals (SDGs) situates professional behavior within broader frameworks of social responsibility and equity (United Nations, 2024). SDG 8 (Decent Work and Economic Growth) and SDG 10 (Reduced Inequalities) are particularly pertinent, as fostering inclusive, respectful work environments embodies these global objectives (Roberson, 2006; Shore et al., 2011). This study with help from previous literature filled empirical gaps and illustrating how etiquette functions not only as a set of social norms but as a strategic organizational asset contributing to productivity, employee engagement, and reputation. Challenges identified, such as digital etiquette and multicultural sensitivity, echo contemporary scholarship advocating adaptive organizational practices (Holistique Training, 2024; Ting-Toomey & Chung, 2012).

6. Conclusion

This paper underscores the critical role of workplace etiquette in fostering professionalism, productivity, and alignment with institutional goals. Integrating theoretical insights with practical strategies enables organizations to build respectful, inclusive, and high-performing cultures. Aligning etiquette with Sustainable Development Goals further enhances social responsibility and sustainability. Future research should longitudinally evaluate etiquette initiatives' effectiveness across sectors and cultures, considering how evolving technologies and work modalities affect norms and outcomes.

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Metode optimizacije proizvodnog procesa u pekarskoj industriji PGP Kolašin

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Apstrakt: Ovaj rad jeste primena inženjerskog menadžmenta u cilju optimizacije proizvodnog procesa u pekarskoj industriji, sa fokusom na konkretan primer – kompaniju PGP Kolašin iz Zubinog Potoka. Korišćenjem savremenih metoda menadžmenta kao što su analiza toka procesa, kontrola kvaliteta, upravljanje resursima i primena Lean principa, identifikovani su ključni faktori koji utiču na efikasnost i produktivnost. Posebna pažnja posvećena je tehnološkom aspektu proizvodnje, uključujući modernizaciju opreme i uvođenje automatizovanih sistema za praćenje proizvodnje. Istraživanje je obuhvatilo detaljnu analizu postojećeg stanja proizvodnog procesa, kao i predlog konkretnih mera za poboljšanje.

Ključne reči: inženjerski menadžment, optimizacija proizvodnje, Lean principi, tehnološka modernizacija, kontrola kvaliteta

Application of Engineering Management in the Optimization of the Production Processes in the Bakery PGP Kolašin

Abstract: This paper is an application of engineering management principles to optimize the production process in the baking industry, with a focus on a specific example - the company PGP Kolašin from ZubinPotok. Using modern management methods such as process flow analysis, quality control, resource management and the application of the Lean principle, key factors that affect efficiency and productivity were identified. Special attention was paid to the technological aspect of production, including the modernization of equipment and the introduction of automated production monitoring systems. The research included a detailed analysis of the current state of the production process, as well as a proposal for specific measures for improvement.

Keywords: Engineering Management, Production Optimization, Lean Principles, Testing Methods, Quality Control

1. Introduction

In the modern business environment, companies are increasingly faced with the need to improve their production processes, as well as with the challenges arising from the growing competition in the market. The bakery industry, as one of the most important sectors, is no exception to these challenges. On one hand, consumers demand greater product variety and faster delivery times, while on the other hand, companies must contend with rising costs and the need to improve efficiency. To meet these demands, businesses must apply advanced management methods and technologies that will enable faster, more efficient, and sustainable production processes.

Engineering management is a key discipline that combines technological and managerial principles with the goal of optimizing production processes and increasing productivity.

By applying techniques such as process flow analysis, quality control, Lean principles, and resource management, companies can significantly improve their business results. This paper explores the application of engineering management in the bakery industry, with a focus on a specific example – the company PGP Kolashin from ZubinPotok. Modern technologies play an important role in this process. The modernization of production equipment and the introduction of automated systems for monitoring production, as well as the application of new resource management methods, contribute to a significant increase in efficiency and cost reduction. As noted in (Heizer et al., 2020), process analysis and design are key to achieving a competitive advantage through efficiency, quality, and innovation.

This paper discusses how the application of engineering principles can be used to optimize workflows, reduce technological losses, and improve time management, thereby fostering long-term growth and development of the company. On the other hand, as stated in (Ilić, 2015) innovations in production and packaging technologies are crucial for survival and competitiveness in the food industry, and must be integrated into management strategies.

2. Literature review

The application of engineering management principles to the optimization of production processes has been extensively addressed by various authors. Heizer et al., (2020) emphasize that process design and analysis are crucial for achieving competitive advantage through efficiency, quality, and innovation. They argue that well-structured production processes directly impact the productivity and sustainability of manufacturing enterprises.

Ilić (2015) further stresses that continuous innovation in production and packaging technologies is vital for the survival and competitiveness of companies in the food sector. His findings suggest that companies must integrate innovation into their strategic management in order to adapt to changing market demands and consumer expectations.

In the context of the food industry, Nikolić and Petrović (2013) point out that bakery production is particularly sensitive to issues such as short shelf life, strict hygiene requirements, and the necessity of precision in recipes and processes. They emphasize that the implementation of modern management and technological solutions is crucial for maintaining product quality and reducing production losses

Grandov (2005) discusses the significance of organizational management in the growth of enterprises, especially in small and medium-sized businesses. He notes that with business expansion, it is necessary to hire specialized workers and define clear roles for management, leadership, and operational execution, thereby supporting sustainable business development.

Collectively, these studies underline the importance of combining technological innovation, organizational restructuring, and systematic quality control to improve production processes. In the case of PGP Kolašin, the application of engineering management principles follows these theoretical foundations, aiming to optimize production efficiency, enhance product quality, and ensure long-term business growth.

3. Theoretical framework of engineering menagment

3.1. General characteristics of engineering management

Engineering management involves the application of engineering principles to optimize processes, efficiently manage resources, and ensure continuous improvement of operations. (Schroeder et al., 2013) In other words, it is an interdisciplinary field that combines technical knowledge and management skills with the goal of improving processes, increasing efficiency, and achieving sustainable development in production. In the bakery industry, characterized by the daily production of large quantities of perishable products, the application of this concept holds particular importance. The bakery industry faces numerous challenges, including short product shelf lives, high quality demands, growing consumer awareness of healthy eating, and the need for efficient production organization. In this context, engineering management enables integrated management of the production process, encompassing technological, human, and material resources.

In the case of the company PGP Kolashin from ZubinPotok, the application of engineering management principles led to concrete improvements in the production process. Through process flow analysis, several critical points were identified in the production chain of bread and bakery products, including inefficient shift organization, excessive technological losses, and underutilization of equipment capacity. In response to these challenges, the company initiated a modernization process through:

- Installation of an automated system for monitoring baking time and temperature, leading to more consistent product quality;
- Reorganization of shift work based on the analysis of actual workload per work position;
- Introduction of Lean tools such as visual management and standardized operating procedures, which reduced the time needed to train new workers;
- Development of employee training programs in technological handling and equipment maintenance, resulting in a reduction of production downtimes by over 20% in the first year of implementation.

These results demonstrate how applicable and beneficial engineering management can be, even in smaller, regional production systems. It not only contributes to the improvement of technological and organizational efficiency but also establishes a foundation for long-term stability and development.

3.2. The role of engineering management in the baking industry

Engineering management plays a crucial role in the modernization and optimization of production processes within the bakery industry. This discipline, which integrates technical knowledge with management principles, enables the systematic improvement of efficiency, product quality, and overall productivity.

In the bakery industry, which faces specific challenges such as short product shelf lives, strict hygiene requirements, and precision in recipes, engineering management contributes to the creation of optimal work processes and sustainable resource utilization. By applying methods such as process flow analysis, Lean production, Six Sigma, and quality control systems, it is possible to identify and eliminate technological and organizational losses. The introduction of automation, the standardization of procedures, and the improvement of production planning allow for better control over all stages of the production process — from raw material procurement to final product distribution.

The application of engineering management at PGP Kolasin has demonstrated that even smaller, regional bakeries can significantly enhance their operations by adopting modern managerial and technological approaches. Through a systematic approach to production optimization, the company succeeded in increasing efficiency, improving product quality, and reducing operational costs, thus laying the foundations for sustainable growth and development.

4. Data and methodology

The research was conducted at the company PGP Kolašin from ZubinPotok, which is a representative example of a small to medium-sized bakery industry. Data were collected from the company's internal documentation (production plans, quality reports, internal procedures), interviews with management and production employees (production manager, technologists, quality controllers and operators) and direct observation of the process during production shifts.

The following methods were used to analyze the current state and formulate optimization proposals:

1. Process Flow Analysis: By mapping all steps in production, critical moments where time, raw materials or energy are lost were identified.
2. Application of Lean methodology: Tools such as 5S, standardized work and visual management were used to eliminate inefficiencies and improve the organization of the workspace.
3. Quality control methods: Data on key quality indicators were collected and analyzed, including the results of organoleptic tests, measurements of baking temperature, dough moisture and physical characteristics of the finished product.

The research was carried out in three phases: recording the current state of production processes, identifying critical points and developing and proposing specific improvement measures, with an assessment of their impact on productivity and quality.

4.1. Company characteristics

The geographical position of the municipality of ZubinPotok is undoubtedly very favorable. A place of centuries-old crossroads. A place of constant cultural changes, but also of great wealth in both archaeological sites and cultural and historical heritage. If we delve into the history of IbarskiKolašin in any way, we will undoubtedly find confirmation of centuries-old monuments, monasteries, churches and churchyards. On the other hand, the transit line of this place has been known since ancient times. The place of the main road in the past, but also now. As stated by Bojović (Bojović, 2012). The IbarskiKolašin region is in the valley of the upper reaches of the Ibar, between the mountains of Rogozna and Mokra Gora, Kosovo and the Ribarićka Gorge.

The municipality of Zubin Potok consists of 63 villages. The population of this municipality is of Serbian origin, except for the village of Čabra, which is inhabited by members of Albanian nationality. This village is at the very end of the west of this municipality. Living in this municipality is primarily in rural areas. When we talk about the aforementioned industry, ZubinPotok is a place where this industry has no competitive advantages. PGP Kolašin is the only wholesale bakery in this region, but also wider. This production and construction company was founded back in 1991. The company is owned by an individual and contains two sectors:

- construction sector;
- bakery industry sector.

If we look at the bakery industry sector from the management side, it is undoubtedly that the goal is to listen to consumers, follow trends wider than Ibarski Kolašin, respect for standards, but also higher quality production on the market. The simplest: goals to achievements.

4.1.1. Assets and expenses

In the case of any efficient operation of the enterprise or a specific task, each enterprise must have some property at its disposal. On the other hand, for any further function, it is inevitable that the means of work are in another place of use. Namely, the tasks of the business determine the type, volume and quality of the means. The achievement of the enterprise is reflected in the fulfillment of the tasks at the disposal of production.

4.1.2. Kolašin Bakery Resources

As for the company's assets, they have the basis for the material part of carrying out a certain activity. Through economic value, we achieve goals and tasks through assets. As for the economic terminology that defines assets, the most typical are two determinants: the company's assets or the capital that the company has. All the assets that this production has can be divided into three basic groups, namely things, rights and money. When we talk about the assets of the Kolašin bakery, we have two entities that it has. A more complex type of this asset state is in the means of work. As for the means of work, we have:

- tunnel oven;
- roto oven;
- machines for producing crusts;
- line for producing frozen puff pastry;
- line for preparing pies.

The tunnel oven has a large bread production plant. The scope of bread production per day is as much as 7,000 loaves per day. A rotary oven is a specialized machine that produces special types of bread. These breads are rye bread, buckwheat bread and wholemeal bread. The bakery program of the Kolašin bakery is based on the fact that production and sales are carried out in the same facility, i.e. the entire technological process is processed on site. The realization of production is based on several phases: production, procurement, marketing, sales, development, maintenance, storage and transport.

4.1.3.   Analysis of the current situation in the PGP Kolašin

When we talk about the analysis of the current state of the company PGP Kolašin, it covered all key aspects of the production process, work organization and resource use. The aim of the analysis was to identify weaknesses in the system, technological losses and organizational problems that affect efficiency and productivity. As for the production process side in PGP Kolašin, it is based on classical technologies for the production of bread and bakery products. The processes were mainly manual, with a limited degree of automation. Although traditional methods contribute to the preservation of the quality and authenticity of the product, the lack of modern equipment led to variations in quality and an increased percentage of technological losses.

The organization of work in PGP Kolašin has so far been based on traditional methods, adapted to long-standing practice, but insufficiently aligned with modern requirements for efficient production. Work shifts were not fully optimized in accordance with the real workload of work positions, which led to uneven distribution of tasks, excessive workload of individual workers and the occurrence of unplanned downtime in production. The lack of standardized work procedures resulted in productivity relying mainly on the experience of individuals, rather than on a systematically organized process. This practice increased the risk of errors, slowed down the integration of new workers and affected the stability of the quality of final products. All of the above indicates the need to introduce standardized operating procedures, precise distribution of tasks within shifts, as well as strengthening the internal communication and process monitoring system, with the aim of achieving a higher level of operational efficiency and consistency in product quality. The control system in the company PGP Kolašin has so far functioned on the basis of regular visual monitoring of the process by shift managers and more experienced workers. Although this approach provided a basic insight into product quality, it did not provide the level of precision and consistency required for modern bakery production. In addition, the control of incoming raw materials was limited to basic visual and organoleptic assessments, without the application of systematic analysis of raw material characteristics, which increased the risk of fluctuations in product quality.

Based on the analysis of the current situation, specific measures were proposed to optimize the production process and improve overall efficiency in the company PGP Kolašin. The optimization process includes the analysis and redesign of existing processes in order to increase efficiency and reduce costs, without compromising product quality. (Babić, 2012) Introduction of modern automated ovens with precise control of temperature and baking time, as well as installation of a system for automatic dosing of raw materials to reduce technological losses, as well as procurement of equipment for semi-automated mixing and shaping of dough. In addition to the above, reorganization of shift work based on analysis of the actual workload of work positions, through the application of visual management for better monitoring of process status in real time or the introduction of standardized operating procedures (SOP) for all critical production phases.

Improvement of quality control, i.e. establishment of a system of control points during all production phases, and not only at the end, as well as the application of the HACCP system for systematic food safety management or the introduction of regular internal quality audits. In addition to these measures, it is possible to organize regular training for workers in the field of technological operation, equipment maintenance and quality control, introduce mentoring programs for new employees, encourage a culture of continuous learning and skill improvement, replace outdated equipment with more energy- efficient models, introduce the concept of continuous improvement (Kaizen), apply the 5S methodology for arranging work spaces or identify and eliminate losses in the production process (waiting time, excess movement, excess inventory). However, as (Prof.dr. Grandov, 2005) states that with an increase in business volume, a manager should hire workers of various profiles and thus enable greater growth of the company. This is how the following basic roles are formed in the company: management, business management and execution.

4.2. Application of methods in optimization

According to the author (Jovanović, 2010) of the key aspects of production management in the baking industry, optimization of production processes requires the application of methodologies such as lean production, capacity management and continuous improvement, with the aim of reducing costs and increasing efficiency.

4.2.1. Process Flow Analysis

Process flow analysis is one of the basic steps in identifying opportunities for production optimization. At PGP Kolašin, this analysis was carried out through systematic mapping of all steps of the production process, from raw material receipt to final packaging and distribution of the product. The aim of the analysis was to identify in detail: places of technological losses, areas of increased waiting time, as well as inefficiencies in material handling. Each phase was assessed from the point of view of execution time, required resources, potential downtime and quality of output results. During the receipt of raw materials, the absence of a standardized quality control protocol was observed, which increased the risk of variations in the final product. In the production line, it was determined that the fermentation process was not optimally timed with the baking process, which led to periods of machine downtime. The manual packaging process was identified as a major bottleneck due to a lack of standardization and variations in work speed. The underutilization of existing equipment capacities, especially in the dough mixing and baking phases, indicated the need for better coordination of shift activities. The process flow analysis provided a clear view of where losses occur and what measures are necessary for improvement. The recommendations arising from this analysis include standardization of procedures, improvement of process synchronization, introduction of automated solutions in critical phases, and optimization of work assignment. By systematically approaching the process flow analysis, the company gained insight into the real causes of inefficiency, which laid the foundation for further activities to improve production efficiency.

4.2.2. Lean methodology

Lean methodology is a modern approach to managing production processes, the primary goal of which is the elimination of all forms of waste and the maximization of value for the end customer. Developed through the practice of Japanese industry, primarily at Toyota, Lean is now widely applied in various sectors, including the food industry. Within the company PGP Kolašin, the application of Lean principles was carried out with the aim of achieving greater operational efficiency, reducing costs and improving product quality. Through a detailed analysis of the process, seven basic types of losses were identified: overproduction, waiting, unnecessary transport, excess processing, inventory, unnecessary movement and production of defective products. Each identified loss was approached systematically with the aim of its elimination or minimization. In addition to the above, sorting, arranging, cleaning, standardization and self-discipline practices were introduced at all workplaces, which contributed to better organization and greater safety in production. Employees were encouraged to actively participate in proposals for process improvement, which created a culture of continuous improvement and greater workforce engagement, and visual tools such as charts, dashboards and markings at workplaces were also used, which increased the transparency of production processes and enabled faster identification of problems.

The basic idea of Lean thinking is to maximize value for customers while minimizing waste. Simply put, Lean thinking means creating more value for customers with fewer resources. (Womack & Jones, 2003, p. 14)

The application of Lean tools in PGP Kolašin resulted in reduced production cycle times, higher equipment utilization, reduced technological losses, and increased overall productivity. In addition, employee motivation was improved and the prerequisites for continuous process improvement in line with market demands were created.

4.2.3. Quality control

Quality control is one of the most important elements in optimizing the production process, especially in the bakery industry where a high and uniform standard of products is expected. As stated in one of the most famous books (Juran& Godfrey, 1999) on quality management, quality is defined as the ability to be used-a product or service that meets or exceeds customer expectations, providing customer value.

At PGP Kolašin, quality control is systematically set as an integral part of all production phases – from the receipt of raw materials to the final control of finished products. All raw materials (flour, water, yeast and other additives) are subject to strict incoming inspections. Physico-chemical and microbiological analyses are performed to ensure consistent quality of incoming materials.

In-Process Control (In-Process Control) is a process in which key parameters such as temperature, humidity and processing time are measured at each critical point of the production process (mixing, fermentation, baking). This allows for early detection of potential deviations and prevents the production of poor-quality batches.

After the production process is complete, the finished products are subjected to organoleptic (taste, smell, appearance), physical (weight, volume) and microbiological testing. Only products that meet predefined standards proceed to the packaging and distribution phase.

All quality control processes are documented in accordance with prescribed standards (for example, the HACCP system), which ensures consistency, monitoring of results and continuous improvement. Quality control is not entrusted only to specialized personnel, but all employees are obliged to follow and apply the basic principles of quality control in their work. On the other hand, according to the authors (Nikolić&Petrović, 2013), food quality and safety management is a critical aspect of the food industry, where companies must constantly align their production processes with strict regulatory requirements, while regular training enables awareness raising about the importance of quality and strengthens a culture of responsibility. The implementation of systematic quality control in PGP Kolašin contributed to an increase in the percentage of first-class products, a decrease in market complaints, as well as strengthening the brand's reputation as a reliable producer of bread and bakery products.

5. Results and discussion

Focusing on quality control at PGP Kolašin, the research showed that systematic monitoring of process parameters significantly affects the improvement of overall production efficiency. The introduction of automated systems for temperature and baking time control achieved:

1. Reduction of product quality variations by 30%.
2. Reduction of the number of internal complaints by 22% in the first six months.
3. Increase in the percentage of first-class products by 15%.

Regular control of raw materials and final products reduced overall technological losses. Standardization of inspection procedures and introduction of systematic training for employees contributed to faster identification and elimination of deviations in the process. The results indicate that quality control, as an integral part of engineering management, is key to ensuring process stability, improving productivity and building consumer trust. Further improvement requires continuous digitalization of control systems and the development of a quality culture among employees.

5.1. Suggestions for optimizing the production process

Based on the analysis of the current state of the production process of PGP Kolašin, specific proposals have been formulated aimed at improving efficiency, productivity and product quality. Efficiency and effectiveness are key to achieving a high level of productivity and competitiveness in operations management. (Stevenson, 2021) The proposed measures are based on the principles of engineering management and modern tendencies in production management:

1. Replacing outdated machines and introducing modern automated process control systems would contribute to improving product consistency, reducing technological losses and increasing energy efficiency.
2. Developing and implementing standard operating procedures for all stages of production will enable uniform quality, facilitate the training of new workers and reduce the risk of production errors.
3. Based on the analysis of the workload of the workplaces, it is necessary to redistribute shifts and tasks in order to ensure a more even utilization of human resources and reduce downtime in production.
4. The application of tools such as 5S (Lean principle), visual management and continuous improvement (Kaizen) will enable the identification and elimination of losses in the process, which will lead to a higher level of efficiency.
5. Defining critical control points and implementing a real-time quality monitoring system will ensure the timely detection and elimination of deviations in production.

6. Organizing regular training in the field of handling technological equipment, the application of quality standards and the principles of Lean production is the key to the long-term sustainability of the achieved improvements.

7. Implementing measures to optimize energy consumption and rationalize resource use will contribute not only to reducing operating costs, but also to preserving the environment.

6. Conclusion

The application of engineering management principles in the optimization of the production process in the baking industry, on the example of the company PGP Kolašin, has proven to be an extremely effective approach to improving overall efficiency and productivity. Through process flow analysis, the application of Lean methodology and the establishment of systematic quality control, better use of resources, reduction of technological losses and increased stability of the production process have been enabled. The integration of modern process management methods, such as the 5S system, visual management and standardization of work procedures, has contributed to greater transparency and timeliness in work. At the same time, the introduction of automated systems for controlling production parameters has enabled modern identification and elimination of deviations in product quality.

The research has confirmed that continuous process improvement, with active employee participation and systematic education, is a prerequisite for achieving long-term competitiveness in the baking industry. The application of engineering management not only increases operational efficiency, but also contributes to building an organizational culture geared towards innovation and sustainable development. Based on the results obtained, it can be concluded that the engineering management methods applied at PGP Kolašin have established a solid foundation for further improvement of production capacities, conquering new markets and satisfying consumers.

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Ekološki aspekti upravljanja medicinskim otpadom - primer Republike Srbije

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Apstrakt: Upravljanje medicinskim otpadom predstavlja ozbiljan izazov u mnogim zemljama, uključujući i Srbiju, gde postoje značajni problemi u pogledu efektivne primene postojećeg zakonskog okvira. U ovom radu je sistematski analizirana aktuelna situacija u Srbiji, identifikujući ključne nedostatke u zakonodavnom okviru, tehničkoj infrastrukturi, obrazovanju osoblja i nadzoru. Ovi nalazi su dobro potkrijepljeni relevantnim statističkim podacima, tabelarnim prikazima i poređenjima sa praksama u susednim zemljama Hrvatskoj, Sloveniji i Rumuniji. Analizom trenutne situacije u Srbiji identifikovani su ključni problemi, kao što su nedostatak adekvatnih tehnologija za tretman otpada, nizak nivo obrazovanja osoblja i neefikasan nadzor. Štaviše, komparativna analiza sa susednim zemljama ističe pozitivne primere, poput modernizovanih tehnologija u Hrvatskoj i Sloveniji koje smanjuju uticaj na životnu sredinu. Koristeći relevantne statističke podatke i analize, u radu se naglašava značaj ekološke dimenzije u upravljanju medicinskim otpadom, ukazujući na potrebu prelaska sa spaljivanja na ekološki prihvatljivije metode, kao što su autoklaviranje i tretman mikrotalasima. Na osnovu analize, rad predlaže nekoliko pravaca za dalja istraživanja, uključujući razvoj novih tehnologija, studije uticaja različitih metoda tretmana na životnu sredinu, potencijalnu saradnju sa EU i međunarodnim organizacijama. Cilj ovog istraživanja je da doprinese unapređenju sistema upravljanja medicinskim otpadom, smanjenju ekoloških rizika i unapređenju zdravstvenih standarda u Srbiji. Dalje, rad povezuje teorijsko znanje sa praktičnom primenom, naglašavajući potrebu za prelaskom na moderne tehnologije kao što su autoklaviranje i tretman u mikrotalasnoj pećnici, dok se kritički bavi zastarelim metodama kao što je nekontrolisano spaljivanje.

Ključne reči: medicinski otpad, ekološki aspekt, upravljanje otpadom, tehnologije tretmana, pravni okvir, obrazovanje, zaštita životne sredine

Ecological Aspects of Medical Waste Management – The Case of the Republic of Serbia

Abstract: Medical waste management presents a serious challenge in many countries, including Serbia, where significant problems exist regarding the effective implementation of the existing legal framework. This paper systematically analyzed the current situation in Serbia, identifying key shortcomings in the legislative framework, technical infrastructure, staff education, and oversight. These findings are well-supported by relevant statistical data, tabular presentations, and comparisons with practices in neighboring countries Croatia, Slovenia, and Romania. Through an analysis of the current situation in Serbia, key issues have been identified, such as the lack of adequate waste treatment technologies, low levels of staff education, and inefficient oversight. Moreover, a comparative analysis with neighboring countries highlights positive examples, such as modernized technologies in Croatia and Slovenia that reduce environmental impact. Using relevant statistical data and analyses, the paper emphasizes the importance of the ecological dimension in medical waste management, pointing out the need to shift from incineration to more environmentally friendly methods, such as autoclaving and microwave treatment. Based on the analysis, the paper suggests several directions for further research, including the development of new technologies, studies on the environmental impact of different treatment methods, and potential cooperation with the EU and international organizations.

The goal of this research is to contribute to the improvement of the medical waste management system, reduce ecological risks, and enhance health standards in Serbia. Further, the paper bridges theoretical knowledge with practical application, highlighting the need to shift towards modern technologies such as autoclaving and microwave treatment, while critically addressing outdated methods like uncontrolled incineration.

Keywords: medical waste, ecological aspect, waste management, treatment technologies, legal framework, education, environmental protection.

1. Introduction

Medical waste management represents one of the key issues in modern healthcare systems, as it directly concerns public health preservation and environmental protection. Medical waste includes all types of waste generated during healthcare delivery, research, and laboratory work, often comprising infectious, chemical, pharmaceutical, and pathological materials that require special treatment and disposal (Chartier et al., 2014). According to data from the World Health Organization, up to 15% of medical waste can be classified as hazardous, and in some contexts, this percentage can be significantly higher due to inadequate waste separation at the source (WHO, 2018). Despite the existence of numerous international standards and guidelines prescribing the collection, treatment, and disposal of medical waste, many countries still face serious implementation challenges, especially developing and transitioning countries, including Serbia (Windfeld & Brooks, 2015). Problems such as underdeveloped infrastructure, limited financial resources, weak institutional oversight, and low awareness of the risks of environmentally irresponsible waste management result in a large portion of medical waste still being stored, transported, and disposed of in ways that can have harmful environmental consequences. The ecological aspect of medical waste management is particularly important because this waste is often treated using methods that directly affect natural resources. For example, waste incineration without proper filters can lead to the emission of dioxins and furans – highly toxic compounds that accumulate in the food chain and may cause chronic diseases in humans and animals (Caniato, Tudor, & Vaccari, 2015). Improper disposal of pharmaceutical and chemical waste also endangers the quality of groundwater and soil, further complicating the situation in areas without developed sanitary landfill systems (Tudor, Noonan, & Jenkin, 2005).

In Serbia, medical waste management is regulated by a legal framework that includes the Law on Waste Management, the Law on Environmental Protection, and various by-laws. However, significant discrepancies in the application of these regulations are still observed in practice (Ministry of Environmental Protection, 2023). Beyond the normative aspect, it is also necessary to analyze the actual capacities of healthcare institutions for proper waste separation, storage, and treatment, as well as their cooperation with companies authorized for final disposal. In the context of climate change and global commitments to sustainable development, responsible medical waste management becomes not only a regulatory but also a moral and ecological obligation for all stakeholders in the healthcare and environmental sectors (UNEP, 2019). The paper aims to explicitly state ecological and public health dimension of the issue, which reminds us that medical waste management is not solely a technical or administrative matter, but also a question of ethics and responsibility towards society and nature. Furthermore, by comparing Serbia's situation with the practices in Croatia, Slovenia, and Romania, the paper provides valuable insights into improvement pathways that Serbia could follow. The paper goal is that trough analysis of the legal framework, available statistical data, scientific and expert sources, as well as comparisons provide good practice from the region and beyond.

2. Theoretical Framework

Medical waste refers to waste materials generated during diagnostic, therapeutic, and research activities in healthcare institutions. This type of waste is classified as hazardous due to the potential presence of infectious agents, chemicals, heavy metals, and radioactive materials (Chartier et al., 2014). The World Health Organization (WHO) categorizes medical waste into several groups, including infectious, pathological, sharps, pharmaceutical, chemical, cytotoxic, and radioactive waste (WHO, 2018). The environmental risks associated with medical waste are multifaceted. Infectious waste can lead to the spread of diseases such as hepatitis B and C, HIV, and other viral infections, while chemical and pharmaceutical waste can contaminate soil and groundwater, thus having long-term effects on biodiversity and human health (Windfeld & Brooks, 2015).

A particular problem lies in environmentally unfriendly disposal methods, such as open burning or untreated landfilling, which result in the release of toxins and heavy metals into the environment (Caniato et al., 2015). Further, infectious medical waste management must be carefully planned and implemented according to the rules in order to protect human health and the environment (Nikolić et al., 2022, Nikolić et al., 2023)

A sustainable approach to medical waste management involves implementing a waste hierarchy that includes prevention, source reduction, segregation, decontamination, recycling, and, as a last resort, safe disposal (UNEP, 2019). The implementation of modern technologies such as autoclaving, microwaving, and chemical disinfection significantly reduces environmental impact but requires adequate infrastructure and ongoing staff education (Tudor et al., 2005).

In the context of developing countries like Serbia, challenges include a lack of financial resources, insufficient regulation, and limited technical capacity (Kruk et al., 2018). Therefore, it is necessary to consider not only technical but also regulatory and societal factors that shape medical waste management practices, with a particular focus on environmental protection (Ugrinov & Stojanov, 2013).

3.   Methodology

This paper is designed as a qualitative-descriptive analysis, aiming to identify and examine environmental challenges and medical waste management practices in the Republic of Serbia. The approach used combines the analysis of secondary data, review of legal and institutional documents, and comparative analysis in relation to international standards and practices.

3.1. Data Sources

The data used in this study were collected from the following sources:

- Legislative and strategic documents of the Republic of Serbia, including the Law on Waste Management, the Law on Environmental Protection, as well as national strategies and regulations related to medical waste;
- Reports from national and international institutions, such as the Ministry of Environmental Protection, the Environmental Protection Agency, the World Health Organization (WHO), and the United Nations Environment Programme (UNEP);
- Scientific papers and relevant literature, including peer-reviewed articles dealing with waste management, public health, and environmental protection;
- Statistical data on the amounts of generated and treated medical waste, available through official databases and reports.

3.2. Analytical Methods

The following methods were applied in the analysis:

- Document analysis, used to examine the legal and institutional framework in Serbia;
- Comparative analysis, to compare national practices with the recommendations of international organizations and examples from regional and EU countries;
- Descriptive statistics, applied to publicly available data to present the quantities and types of medical waste in Serbia, as well as trends in their disposal;
- Content analysis, used to identify key environmental risks and issues arising from existing medical waste management practices.

3.3. Research Limitations

The main limitations of the research include:

- Limited availability of data, as there is no centralized database with detailed information on medical waste management at the level of all healthcare institutions;
- Lack of primary research, such as interviews or field observations, which could strengthen the analysis with practical insights from the field;

- Variability in the implementation of legal regulations among different healthcare institutions and regions in Serbia, which hinders the ability to draw universal conclusions.

Despite these limitations, the methods used provide a sufficiently reliable basis for drawing conclusions and proposing recommendations for improving environmentally responsible medical waste management in the Republic of Serbia.

4. Legal and Institutional Framework in Serbia

Medical waste management in the Republic of Serbia is regulated by a number of laws, by-laws, and strategic documents that define institutional responsibilities, rules for waste collection, transport, treatment, and disposal, as well as measures for environmental and human health protection. The legal framework largely relies on European Union standards, in line with the European integration process, but faces numerous challenges in implementation and enforcement in practice.

4.1. Legal Regulations

The primary law governing waste management in Serbia is the Law on Waste Management (―Official Gazette of RS‖, Nos. 36/2009, 88/2010, 14/2016, 95/2018, 35/2021). This law defines key terms, principles, and obligations related to the generation, segregation, treatment, and tracking of waste, including medical waste as a specific category of hazardous waste. It stipulates that the waste producer is responsible for its proper disposal, including the obligation to maintain records and report the quantities and types of waste (Law on Waste Management, 2021).

The Law on Environmental Protection (―Official Gazette of RS‖, Nos. 135/2004, 36/2009, 72/2009, 43/2011, 14/2016, 95/2018, 144/2020) provides a general framework for the protection of natural resources and pollution prevention. This law further emphasizes the "polluter pays" principle and promotes preventive measures, including responsible waste management (Law on Environmental Protection, 2020).

In addition to these core laws, numerous by-laws regulate the handling of hazardous and medical waste in detail. Among them, the Rulebook on Waste Categories, Testing, and Classification (―Official Gazette of RS‖, No. 56/2010) is essential, as it defines types of waste and their characteristics.

4.2. Institutional Framework

The institutional foundation for implementing medical waste management policy in Serbia includes:

- The Ministry of Environmental Protection, responsible for developing strategies, legislative solutions, and monitoring the implementation of environmental policies;
- The Environmental Protection Agency, which collects data on types and quantities of waste, prepares annual reports on the state of the environment, and maintains the Polluter Register;
- The Ministry of Health, which oversees healthcare institutions and enforces sanitary and hygiene standards related to waste;
- Local governments, responsible for providing communal infrastructure, along with inspection services that conduct field oversight (Ministry of Environmental Protection, 2023).

However, in practice, there are frequent overlaps in jurisdiction and insufficient cooperation between the health and environmental sectors, resulting in inefficient oversight and inconsistencies in the collection and treatment of medical waste (Đukić & Petrović, 2020).

4.3. National Strategies and EU Alignment

Serbia adopted the National Waste Management Strategy for the period 2022–2031, which outlines plans for infrastructure modernization, improved monitoring, and the integration of the circular economy into the waste management system (Ministry of Environmental Protection, 2022). Additionally, through negotiations under Chapter 27 (Environment), Serbia has committed to aligning its legislation with Directive 2008/98/EC on waste and Directive 2000/76/EC on the incineration of waste, both of which clearly define the treatment of hazardous waste, including medical waste.

5. Results and Discussion

Table 1: Amount of Medical Waste in Serbia and Regional Countries (2019–2022)

Country	Medical Waste Quantity (kg per capita/year)	Notes	Source
Serbia	0.6 – 1.2 kg	Estimates vary depending on the type of facility	Ministry of Environmental Protection (2023)
Croatia	1.1 kg	Data for 2020	Eurostat, 2021
Slovenia	0.8 kg	Data for 2021	Statistical Office of the Republic of Slovenia, 2022
Romania	0.3 – 0.6 kg	Low rate of proper disposal in rural areas	Munteanu et al., 2018

Table 2: Medical Waste Disposal Methods in Serbia and the Region

Country	Incineration	Autoclaving	Recycling	Storage	Composting	Notes
Serbia	45%	25%	10%	20%	0%	Lack of recycling capacity and environmentally friendly methods
Croatia	20%	50%	25%	5%	0%	High implementation of eco-friendly methods like autoclaving
Slovenia	10%	60%	30%	0%	0%	Meets EU standards for medical waste treatment
Romania	60%	30%	5%	5%	0%	Incineration is dominant but lacks effective oversight

Table 3: Emission of Harmful Gases During Medical Waste Incineration (By Country)

Country	Portion of Gases Filtered	Dioxin and Furan Emission	Notes	Source
Serbia	10%	High	Insufficient technology for emission control in incinerators	Caniato et al., 2015
Croatia	80%	Low	Modern incinerators with filtration systems	Eurostat, 2021
Slovenia	90%	Very low	Incinerators comply with EU emission standards	Statistical Office of the Republic of Slovenia, 2022
Romania	30%	High	Outdated systems with ineffective oversight	Munteanu et al., 2018

Table 4: Inspection and Oversight Levels in the Region (2019–2022)

Country	Inspection Level (Inspectors per 100 facilities)	Frequency of Inspections	% of Facilities Certified for Waste Management	Source
Serbia	0.5	3 times per year	60%	Đukić & Petrović, 2020
Croatia	1.2	6 times per year	90%	Eurostat, 2021
Slovenia	1.5	4 times per year	95%	Statistical Office of the Republic of Slovenia, 2022
Romania	0.3	1–2 times per	50%	Munteanu et al., 2018

Country	Inspection Level (Inspectors per 100 facilities)	Frequency of Inspections	% of Facilities Certified for Waste Management	Source
		year		

Table 5: Education and Training of Healthcare Workers on Medical Waste

Country	% of Trained Workforce	Training Frequency	Coverage of Training Across All Institutions	Source
Serbia	50%	Once per year	60%	Chartier et al., 2014
Croatia	90%	Every 6 months	95%	Eurostat, 2021
Slovenia	95%	Every 6 months	100%	Statistical Office of the Republic of Slovenia, 2022
Romania	40%	Occasionally	40%	Munteanu et al., 2018

6.   Comparative Analysis

As a developing country, Serbia faces numerous challenges in medical waste management, similar to those encountered by other countries in the region. This section compares Serbia's medical waste management practices with those of Croatia, Slovenia, and Romania, in order to identify lessons learned and applicable practices that could improve Serbia's medical waste management system.

6.1. Medical Waste Management Practices in Croatia

In Croatia, medical waste management is highly regulated and aligned with European Union legislation. The country has clearly defined categories of medical waste and mandatory procedures for its treatment and disposal. Healthcare institutions are required to have separate systems for hazardous and non-hazardous waste segregation. Specialized incineration facilities are used for the disposal of medical waste, and transportation is carried out according to well-defined rules.

Additionally, Croatia has developed a robust control and inspection system that uses digital documentation to track waste flow, enabling greater transparency and reducing the likelihood of improper disposal. Mandatory training programs have also been introduced for healthcare personnel, enhancing the efficiency of waste handling and reducing errors in managing hazardous materials (EU Commission, 2019).

6.2. Medical Waste Management Practices in Slovenia

Slovenia is a regional pioneer in implementing sustainable medical waste management practices. The country boasts advanced medical waste treatment systems, including technologies such as autoclaving and microwave treatment, which are more environmentally friendly compared to incineration. Slovenia has also established waste recycling systems, particularly for plastic materials generated in the medical industry (Kovács & Bányai, 2020).

Beyond technological advancements, Slovenia's legal framework supports rigorous inspections and mandatory reporting from healthcare institutions on waste quantities and management status. The implementation of environmental standards across all levels of healthcare, along with continuous staff training, contributes significantly to reducing the environmental impact of medical waste.

6.3. Medical Waste Management Practices in Romania

Romania, on the other hand, still struggles with effective medical waste management. Although legal regulations exist, implementation faces serious challenges. Many healthcare institutions lack fully developed systems for waste segregation and proper storage, which leads to significant environmental and public health risks. Additionally, numerous incineration facilities do not meet EU environmental standards, resulting in high emissions of toxic gases into the atmosphere (Munteanu et al., 2018).

Despite the legislative framework, inspection and oversight in Romania are insufficient, making enforcement of regulations largely ineffective. There is also a substantial lack of training among healthcare workers, which directly impacts the quality of medical waste management.

6.4. Lessons Learned and Applicable Practices for Serbia

Based on the experiences of neighboring countries, several key lessons and practical solutions can be identified that could benefit Serbia:

- Technological modernization and infrastructure improvement: Introducing new technologies such as autoclaving and microwave treatment can significantly reduce environmental impact and increase efficiency. Investment in specialized facilities for medical waste treatment is crucial to decrease reliance on incineration.
- Digitization of waste tracking systems: Following Croatia's example, adopting digital platforms for tracking waste flow (from generation to final disposal) can increase transparency and allow for quicker detection of irregularities.
- Staff education and training: Implementing mandatory training for all healthcare workers to ensure proper handling of hazardous materials is a key step in reducing mistakes and accidents in medical waste management.
- Enhanced inspections and regulations: The government should strengthen inspection mechanisms and increase the frequency of controls to ensure full enforcement of the legal framework. Improved oversight can reduce illegal dumping and improper waste treatment.
- Cooperation with the EU: Collaborating with the European Union to align with legislation and best practices, and accessing funding for waste management system modernization, can support long-term sustainable solutions in Serbia.

7. Recommendations for Improving Medical Waste Management

Improving the medical waste management system in Serbia requires a comprehensive approach that includes legal alignment, strengthening institutional capacities, staff education, and technological innovation. Below are the key recommendations based on the analysis of current conditions and identified issues.

7.1. Alignment with European Standards

Further harmonization of national regulations with European Union directives is needed, particularly regarding hazardous waste treatment, emissions control, and the circular economy approach to waste. For example, Directive 2008/98/EC promotes the waste management hierarchy—from prevention, reuse, and recycling to final disposal—which should be clearly reflected in Serbia's national strategy (European Parliament, 2008).

7.2. Strengthening Control and Inspection Mechanisms

It is necessary to strengthen inspection services by increasing the number of inspectors, improving technical equipment, and establishing integrated databases that enable waste tracking ―from source to disposal.‖ Special emphasis should be placed on cross-sectoral cooperation between the Ministries of Health, Environment, and local governments (Đukić & Petrović, 2020).

7.3. Infrastructure and Technology Improvement

Healthcare institutions, especially in smaller towns, should have access to modern waste sterilization technologies (autoclaving, microwave treatment, chemical neutralization), which are safer for the environment than incineration (Windfeld & Brooks, 2015). Additionally, the development of regional waste treatment centers could reduce transport costs and increase efficiency.

7.4. Staff Training and Awareness Raising

Ongoing education of healthcare workers on proper waste segregation, storage, and treatment should become a mandatory part of professional development programs. Research shows that errors in waste management are often due to lack of knowledge rather than negligence (Chartier et al., 2014).

Awareness campaigns within the healthcare sector and the general public can contribute to behavioral change.

7.5. Developing a System for Pharmaceutical Waste

Pharmaceutical waste is a particular challenge, as expired medications often end up in sewage or municipal waste. A system for the organized collection of expired medications from households should be established, with clearly defined responsibilities for pharmacies and local authorities (UNEP, 2019).

7.6. Introducing Digital Waste Tracking

Digitizing the waste management system—through electronic databases, tracking software, and QR codes on containers—would enable more transparent and accurate reporting, better oversight, and identification of ―weak points‖ in the management chain (Ministry of Environmental Protection, 2023).

8.   Environmental Issues Associated with Medical Waste

Improper medical waste management affects not only human health but also has serious consequences for the environment. In Serbia, where the capacity for environmentally sound disposal is limited, a significant portion of medical waste is treated and disposed of in ways that increase the risk of air, soil, and water pollution. These environmental issues are particularly pronounced when medical waste is mixed with municipal waste, incinerated without proper emission controls, or improperly stored.

8.1. Air Pollution

One of the most serious issues is the incineration of medical waste under inadequate conditions, which results in the release of harmful gases and particulates. Burning plastics and other chemical materials found in medical waste releases dioxins and furans—highly toxic compounds with long-lasting effects on human health and ecosystems (Windfeld & Brooks, 2015). In Serbia, most incinerators lack modern filtration and emissions control systems, exacerbating the problem (Caniato et al., 2015).

8.2. Water and Soil Pollution

Improper disposal of liquid medical waste, pharmaceuticals, and chemicals leads to infiltration into soil and groundwater. Pharmaceutical substances that reach sewage systems or natural water bodies can have toxic effects on aquatic life and enter the human food chain (UNEP, 2019). Serbia still lacks an efficient system for treating pharmaceutical waste in all healthcare facilities, meaning a significant amount ends up in the environment without prior neutralization (Ministry of Environmental Protection, 2023).

8.3. Biological Contamination

Infectious waste, such as contaminated syringes, bandages, lab samples, and tissues, if not properly destroyed, can become a source of biological contamination and pathogen transmission. When in contact with animals or humans, such waste can cause and spread diseases like hepatitis B and C, HIV, and various bacterial infections (Chartier et al., 2014). In rural areas, where waste is sometimes disposed of in unsanitary landfills, there is a real risk of direct exposure to pathogens.

8.4. Microplastics and Long-term Effects

A large portion of medical waste consists of single-use plastic items—syringes, gloves, protective gear, and packaging. When not properly treated, this plastic degrades into microplastics that enter ecosystems and organisms, with still largely unknown long-term effects on human health (Kruk et al., 2018). Improper management of such waste can lead to microplastic accumulation in rivers, lakes, and agricultural soil.

8.5. Antibiotic Resistance Risk

A particular problem is the disposal of antibiotics and cytotoxic drugs into waterways, which contributes to the development of resistant microorganisms.

This phenomenon, known as antimicrobial resistance (AMR), is becoming a global public health concern and is directly linked to improper pharmaceutical waste disposal (WHO, 2018). Serbia has yet to establish an oversight system for this issue, posing additional environmental and health risks.

9.   Current Practices of Medical Waste Management in Serbia

Medical waste management in Serbia continues to face challenges in terms of implementing existing laws, applying waste treatment technologies, educating personnel, and ensuring effective oversight. The current practices are characterized by several key issues, including inadequate infrastructure, outdated technology, non-compliance with environmental standards, and inefficient supervision.

Statistical Data on the Amount of Medical Waste Generated

According to data from the Ministry of Environmental Protection of the Republic of Serbia, it is estimated that between 20,000 and 30,000 tons of medical waste are generated annually in Serbia. This includes all types of medical waste, such as infectious, chemical, pharmaceutical, and other hazardous waste. The exact quantity may vary depending on the type of healthcare institution and the degree of compliance with waste management regulations.

Hospitals and large healthcare institutions are estimated to generate approximately 75% of the total medical waste, while smaller contributions come from health centers and private clinics. Since many healthcare institutions lack proper systems for segregating and treating different types of medical waste, a portion of this waste is often disposed of with municipal waste, posing a serious environmental risk.

Practices in Hospitals, Health Centers, and Private Clinics

The approach to medical waste management in Serbia significantly differs depending on the type of healthcare facility:

- Hospitals: Larger hospitals in Serbia, which have specialized waste management departments, generally comply with legal regulations. However, there are shortcomings in the implementation of modern technologies. Incineration remains the dominant method of waste treatment, while recycling and other environmentally friendly methods are still rare. Additionally, there is no unified standard for staff training, leading to unintentional improper handling of waste.
- Health Centers: As smaller institutions, health centers often have limited resources for proper medical waste management. In many cases, staff are insufficiently trained to separate and properly dispose of medical waste, increasing the risk of contamination. Legal regulations are not fully enforced, and many facilities lack the necessary equipment and technology.
- Private Clinics: Private clinics, though producing less waste, often have better access to modern technologies and more resources to implement proper practices. However, smaller clinics may lack adequate infrastructure for medical waste treatment, leading to improper disposal in some cases.

Procedures for Collection, Transport, Treatment, and Final Disposal

In practice, the procedures for medical waste collection, transport, treatment, and final disposal in Serbia are often not aligned with international environmental standards, which poses a significant threat to human health and the environment.

- Collection: In most healthcare facilities, medical waste is collected in specialized containers for infectious and hazardous waste. However, it is not always properly separated from municipal waste, creating a contamination risk. There is also no consistent practice regarding container types and the frequency of waste removal.
- Transport: Medical waste is transported by specialized vehicles, but often without adequate training for drivers and workers handling hazardous materials, increasing the risk of accidents. Proper safety protocols are frequently not followed, raising the danger of spreading infectious diseases.

- Treatment: The most commonly used method of treatment in Serbia is incineration, which is not environmentally sustainable due to the release of harmful gases. Some hospitals use autoclaving, though on a limited scale. Microwave and other advanced technologies are still not widely available.
- Final Disposal: Disposal is primarily conducted by commercial companies licensed for waste treatment. However, many of these companies use technologies that are not fully compliant with EU environmental standards, such as outdated incinerators, which can have a negative environmental impact.

Infrastructure and Available Technologies

- Incinerators: Most medical waste incinerators in Serbia are outdated and environmentally unsound. Many lack modern filters, leading to emissions of dioxins and furans—compounds with serious health and environmental impacts. There is an urgent need to modernize these facilities to reduce harmful emissions and implement sustainable waste treatment solutions.
- Autoclaves: Although autoclaving is an effective and environmentally friendly technology for treating infectious medical waste, it is still not widely used in Serbia. Only large hospitals and some private facilities currently use this method. Expanding the use of autoclaves and other alternative technologies, such as microwave treatment, could significantly improve medical waste management.
- Recycling: There is no developed system for recycling medical waste in Serbia. Many materials that could be reused or recycled, such as plastic bottles and glass ampoules, are incinerated or end up in landfills.

Medical waste management in practice in Serbia reveals significant challenges related to legal enforcement, treatment technologies, and infrastructure. While there are regulations governing this sector, a major gap exists between legislation and its implementation. The lack of modern technology, insufficient staff training, poor supervision, and limited treatment capacities are key barriers to aligning with environmental standards and reducing the negative impact of medical waste on public health and the environment.

Table 6: Amount of Medical Waste Generated in Serbia

Year	Amount of Medical Waste Generated (tons)	Source
2020	22,000	Ministry of Environmental Protection, 2021
2021	24,500	Ministry of Environmental Protection, 2022
2022	26,000	Environmental Report, Ministry of Environmental Protection, 2023

Table 7: Use of Medical Waste Treatment Technologies in Serbia

Technology	Number of Facilities	Treatment Capacity (tons/year)	Share of Total Treatment (%)	Source
Incineration	4	10,000	50%	Ministry of Environmental Protection, 2021
Autoclaves	2	1,500	5%	Ministry of Environmental Protection, 2021
Microwave Treatment	1	500	3%	Ministry of Environmental Protection, 2021
Closed Recycling Systems	0	-	0%	Ministry of Environmental Protection, 2021
No Treatment Technology	-	-	42%	Ministry of Environmental Protection, 2021

Table 8: Use and Capacity for Medical Waste Collection in Serbia

Healthcare Institution	Containers for Infectious Waste	Containers for Hazardous Waste	Containers for Municipal Waste	Properly Segregated Waste (%)	Source
Hospitals	1,500	1,200	4,000	60%	Ministry of Health, 2020
Health Centers	300	150	800	40%	Ministry of Health, 2020
Private Clinics	200	50	150	70%	Ministry of Health, 2020

Table 9: Medical Waste Treatment Facilities in Serbia

Type of Facility	Number of Facilities	Treatment Capacity (tons/year)	Technology Used	Source
Incinerator	4	10,000	Incineration	Ministry of Environmental Protection, 2021
Autoclave	2	1,500	Autoclaving	Ministry of Environmental Protection, 2021
Microwave Treatment	1	500	Microwave Treatment	Ministry of Environmental Protection, 2021
Missing Technologies	-	-	-	Ministry of Environmental Protection, 2021

10. Conclusion

This paper presents an analysis of the current state of medical waste management in Serbia, compared with practices in neighboring countries, to highlight both the strengths and challenges faced. The key findings of this research can be summarized as follows:

1. Insufficient efficiency of the current system: Although Serbia has a legal framework for medical waste management, there are significant issues with its implementation, including inadequate infrastructure, low levels of staff training, and insufficient oversight. These factors contribute to improper waste disposal and negative environmental impacts.
2. Technological challenges: The use of outdated technologies, such as incineration, and the lack of modern treatment systems (such as autoclaving and microwave treatment) represent serious problems in the effective management of medical waste.
3. Comparative advantage of countries in the region: Practices in Croatia and Slovenia, which are aligned with EU regulations, serve as positive examples. These countries apply more efficient technologies, ensure greater transparency, and offer better training for workers, all of which result in a reduced environmental impact.

Emphasizing the Importance of the Environmental Aspect of Medical Waste Management

The environmental aspect of medical waste management is a critical issue in the context of environmental protection. Medical waste, especially infectious and chemical substances, can have long- term negative effects on ecosystems and human health. Inadequate control over the treatment and disposal of such waste can lead to contamination of soil, water, and air, and increase emissions of toxic gases such as dioxins and furans released during incineration. Proper medical waste management is not only a legal and economic obligation but also a moral responsibility that affects the health and well- being of the entire community. There is an urgent need to move away from unsustainable incineration practices towards more environmentally friendly technologies such as autoclaving and microwave treatment, which have already been successfully implemented in some European countries (e.g., Croatia, Slovenia). The analysis of technology usage, legal frameworks, education, and supervision clearly shows that Serbia has significant room for improvement in its medical waste management system.

When compared with countries like Croatia, Slovenia, and Romania, it is evident that nations with better regulations, modern technologies, and efficient oversight achieve better environmental performance, thereby reducing harmful effects on the environment. Serbia could improve its system by adopting modern technologies, implementing regular staff training, and strengthening institutional oversight-bringing it closer to international environmental standards and EU norms.

Potential Directions for Further Research

Given the complexity and importance of this topic, future research can focus on several key directions:

1. Development of new technologies for medical waste treatment: While autoclaving and microwave treatment are preferable alternatives to incineration, further exploration of other sustainable technologies, including recycling and reuse systems for medical waste materials, is necessary.
2. Environmental impact of different medical waste management methods: Detailed studies on how different treatment methods (incineration, autoclaving, recycling) affect local ecosystems can contribute to developing recommendations for optimal legal regulations and treatment conditions.
3. Education and training of healthcare workers: Increasing the level of education and training among healthcare professionals in medical waste management could be researched in the context of specific training methods, evaluation of their effectiveness, and strategies to improve responsibility in waste handling.
4. Integration with the EU and international organizations: Future research could analyze the benefits Serbia might gain from deeper integration with the EU in the field of medical waste management, including access to European environmental project funds and alignment with EU norms and practices.

Medical waste management is both an environmental and public health challenge. Based on identified shortcomings in Serbia and positive examples from other countries in the region, it is evident that there is a need for continued improvement of the waste management system, in order to reduce its negative impact on the environment and public health.

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Digitalno nasilje među mladima - slučaj Vrbas

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Apstrakt: Razvoj digitalne tehnologije i sve intenzivnije korišćenje interneta među mladima, doveli su do značajnog porasta onlajn nasilja, što predstavlja rastući društveni problem, sa ozbiljnim posledicama po mentalno zdravlje i bezbednost mladih. Ovo istraživanje kombinuje pregled relevantne literature sa kvantitativnom analizom podataka, prikupljenih anketiranjem učenika jedne gimnazije. Cilj rada je identifikacija ključnih faktora koji doprinose digitalnom nasilju, analiza njegovih posledica, kao i formulisanje preporuka za prevenciju i suzbijanje ovog fenomena. Rezultati pokazuju kritičan nedostatak digitalne pismenosti i svesti o bezbednosti na internetu među mladima, kao i potrebu za sistemskim unapređenjem zakonodavnog okvira i tehničkih mehanizama zaštite. Istraživanje zaključuje da je za efikasno rešavanje problema digitalnog nasilja neophodan integrisani pristup koji podrazumeva aktivnu saradnju između mladih, njihovih porodica, obrazovnih institucija, regulatornih tela i društvenih mreža. Predložene su konkretne mere za unapređenje digitalne bezbednosti mladih, sa fokusom na prevenciju, edukaciju i razvoj institucionalnih mehanizama podrške.

Ključne reči: onlajn nasilje, internet, mladi, bezbednost

Digital Violence Among Young People - the Vrbas Case

Apstract: Development of digital technology and everything more intense use of internet among to the young brought are to a significant extent increase online violence, which stands for growing social problems with serious mental consequences health and security young people. This research combines reviewing relevant literature with quantitative by analysis data collected by survey students in one grammar school. Goal work is identification key contributingfactors digitalviolence,analysis his/her consequence,as and formulation prevention recommendation and suppression this one phenomenon. Results show critical lack digital literacy and safety awareness on internet among young people, as and the need for systemic by improving legislative frame and technical mechanisms protection. Research concludes that it is for effective solving problems digital violence to be necessary an integrated approach that involves active cooperation between young people, their family, educational institutions, regulatory bodies and social network. The proposed are concrete measures for improvement of digital security young people, with focus on prevention, education and development institutional mechanisms support.

Keywords: Online Violence, Internet, Youth, Safety

1. Introduction

In the current digital time, the Internet is a key source of information and a main way of communication, but it also poses dangers, especially for young individuals, who are the biggest users of technology. The issue of young people's exposure to dangers online has become a global concern and needs a thorough approach. Research indicates that around one in three students faced some troubling experience on the Internet in the past year, while a range of students (from 13% to 51%, based on their behavior) put themselves or others at risk in different ways (Kuzmanović et al.,2019).The results of facing issues online can last a long time, impacting a person's mental, emotional and even physical health, particularly those affected by digital abuse: mental effects can include feelings of anxiety, discomfort, inadequacy, and anger; emotional effects can manifest as shame, diminished self esteem and loss of interest in activities they once enjoyed; physical effects can

be headaches, stomach pain, fatigueand insomnia (Žunić-Cicvarić& Kalajdžić, 2021). The goal of this paper is to explore the issue of cyber violence, which is characterized by using technology to cause, facilitate, or threaten harm to individuals, potentially leading to physical, sexual, psychological, or financial damage or distress.

This can also include taking advantage of someone's situation, traits, or weaknesses (Council of Europe, 2018). The most frequent kinds of cyberbullying are: posting or sharing disturbing, offensive, or threatening messages, images, or videos on others' profiles; recording and spreading sexual content; harassing phone calls; impersonating someone else; creating a social media profile in someone else's name; leaking someone's private information; making false claims or spreading rumors about others on social media, blogs; changing or stealing passwords; sending viruses; mocking in online chats and forums; leaving inappropriate comments on pictures and messages; and ignoring or excluding others, inciting hate. This paper intends to help understand the issue of online violence among youth by analyzing the views of high school students. The research includes a survey to showcase how often they face problems online, as well as an analysis of their views on safety in the digital world. Additionally, the paper is based on theoretical knowledge concerning issues in the online environment.

2. Research and Methods

The paper using a mixed research method to study the causes, effects, and possible solutions for stopping online violence among young people. The main part is a survey of high school students. The survey included important topics related to how young people face issues on the Internet: views on online violence, how often it happens, reasons behind it, effects, protective measures, and prevention steps. The research took place in November 2024, with 21studentsparticipating. The survey method used was paper and pencil (PAPI), which guarantees anonymity, confidentiality, and reliability of responses. The survey followed ethical guidelines, including informed consent from students, safeguarding privacyand ensuring anonymity and voluntary participation. This methodology allowed for a detailed assessment of online violence issues. The data gathered were analyzed using statistical techniques, with the results presented in tables and graphs later in the paper, alongside an interpretation focused on important findings and recommendations for future actions. The review of existing literature, national and international studies, and available statistics concerning young people's exposure to Internet issues is part of the secondary data analysis (Chlíbková et al.). The goal of this approach was to identify global trends and possible solutions for local implementation. Content analysis helped outline the framework for the primary research. The research aims to provide insights into the specific difficulties young people encounter online and to suggest ways to raise awareness, educate, and enhance current protection methods.

2.1. Awareness of Online Harassment

About knowing different types of online harassment and abuse: 90% of people said they were fully aware, while 10% said they were only partially aware. This shows that most respondents know a lot about online security problems but also points out the necessity for more education for the 10% who do not know all the dangers. Research indicates that even though online violence is increasingly acknowledged by students, there is still a part of the population that has not faced or grasped its full effects (Bogićević et al.).

Figure 1: Student's answer to question about awareness about online harassment.

Source: (Authors,2024)

2.2. Personal Experiences with Online Bullying

The survey found that: 43% (9 people) had either seen or faced online bullying, while 57% (12 people) had not. Earlier studies show that online bullying and violence among college students can badly impact their mental and physical health, making it crucial to grasp these experiences in academic settings (Ćeriman et al.). Additionally, research indicates that online bullying occurs more often in younger groups, implying that high school students might face these problems more than university students do (Bogićević et al.).

2.3. Types of Online Violence Encountered

The survey found different types of online bullying that respondents faced: Harassment or insults: 62%, Threats or intimidation: 33%, Spreading rumors or gossip: 29%, Fake profiles or false representation: 29%, Body shaming or bullying about looks: 19%, Exclusion or being left out: 14%, Sexual bullying: 0%, No experiences noted: 33%. These results match those of a study by the Children of Europe on the Internet (Kuzmanovic et al., 2019), which showed that verbal abuse, especially insults and mean messages, is the most frequent type of online violence faced by students. Additionally, the victimization types reported in our survey reflect larger trends in research about online violence, such as cyberbullying and sharing harmful material (Ćeriman et al.), and stress the important role of parental awareness and oversight in stopping these behaviors (Bukvić et al.).

Figure 2: Which of the following types of internet harassment have you encountered?

Types of Internet Harassment Encountered

- Harassment or insults (62%)
- False profiles (29%)
- Spreading rumors (29%)
- Threats (33%)
- Exclusion (14%)
- Body shaming (19%)

Note: Sexual harassment (0%) and None of the above (33%) not shown in pie chart
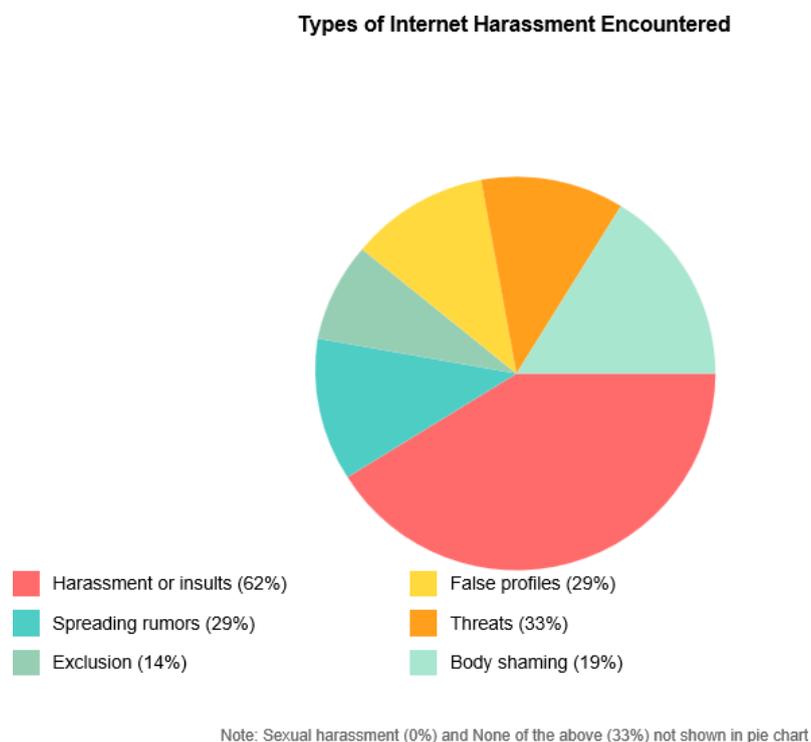
Source: (Authors, 2024)

2.4. Perceived Reasons for Online Bullying

Based on what respondents in different surveys said, the key reasons for online bullying included: Wanting power and control over others (67%) (Ćeriman et al.), Not having empathy or understanding the outcomes (57%) (Bogićević et al.), Seeking entertainment (57%), Having biases and discrimination (48%), Experiencing personal insecurity or frustration (43%), Facing personal conflicts and misunderstandings (38%), Following group pressure and peer influence (33%), and Other reasons (10%) (Bogićević et al.).

2.5. Impact on Mental Health

The different surveys revealed that many recognize the mental health effects of online bullying: 86% think online bullying greatly affects victims' mental health, 9% disagree, and 5% are unsure. These results match findings from the American Psychological Association (APA) and UNICEF, which show that online violence raises stress levels and can result in feelings of insecurity, embarrassment, depression, and anxiety, leading to lasting emotional effects (Ćeriman et al.).
Additionally, a study found that about 5% of university students face online violence, with certain types of victimization like illegal photography and online bullying increasing psychological distress (Chlíbková et al.).

2.6. Contributing Factors to Online Violence

Students responded which reasons are dominant: personal conflicts and misunderstandings are 38%, personal insecurity and frustration 43%, desire for power and domination 67%, peer pressure and influence 33%, lack of empathy and awareness 57%, prejudice and discrimination 48%, entertainment 57% and other 10%. Main reasons found in other surveys is to cause online bullying: Not knowing the results (62%) (Ćeriman et al.), Being anonymous on the internet (48%) (Ćeriman et al.), Not enough education (43%), Pressure from friends or groups (38%), Unfair social situations or power differences (33%) (Ćeriman et al.), Weak enforcement of laws (24%), Poor support for victims (14%), Other reasons (14%). Authors have found their results are like other surveys.

Figure 3: Main reasons for internet harassment

Main Reasons for Internet Harassment
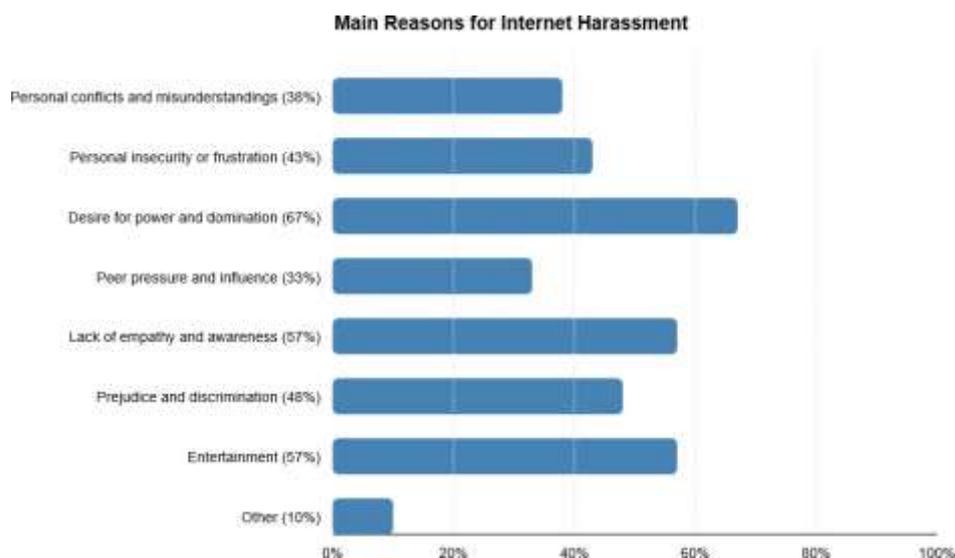
Source: (Authors, 2024)

2.7. Legal Awareness and Response Mechanisms

About legal awareness: 67% know all legal actions for online harassment, while 33% know some. No one said they were completely unaware. Yet, just 29% of people have used the reporting methods for online violence, even through 43% have faced or seen it. This shows a need for better and easier ways to report.

2.8. Platform Responsibility and Legal Measures

Social media platforms implement various technical and administrative measures to reduce the presence of digital violence. According to Gorwa, Binns, and Katzenbach (2020), platforms use algorithmic methods to detect and remove offensive content. On a national level, the report by the Regulatory Agency for Electronic Communications and Postal Services (RATEL, 2020) indicates that Serbia is continuously improving content moderation protocols, particularly in the context of protecting children and adolescents.

Despite this, eighty-one percent think that online platforms need to do more to stop online bullying. Additionally, eighty-one percent view the existing laws against online bullying as inadequate. Also, ninety percent feel that people who participate in online bullying should face legal punishment.

2.9. Educational Aspects

About formal education on online violence: 14.3% think current education is enough, 23.8% think it not enough, 61.9% think it somewhat enough.
As for adding it to school programs: 61.9% favor adding online bullying prevention to school programs, 9.5% against it, 28.6% unsure. Also, student participation in educational programs has a positive link with their behavior results, suggesting that better integration into the curriculum might improve positive behaviors in teenagers (Bogićević et al.). Education on the risks and protective measures on the internet is a key element in the prevention of digital violence. O'Keeffe and Clarke- Pearson (2011) emphasize the importance of educational programs that empower young people in   using the internet, while Kowalski and Limber (2009) show that school-based interventions can reduce the frequency of bullying behavior. On a local level, the Strategy for the Advancement of Digital Literacy in Education (Vlada RepublikeSrbije, 2020) defines specific measures and programs aimed at increasing awareness of internet safety, directly contributing to the prevention of online violence.

Figure 4: Educational aspects
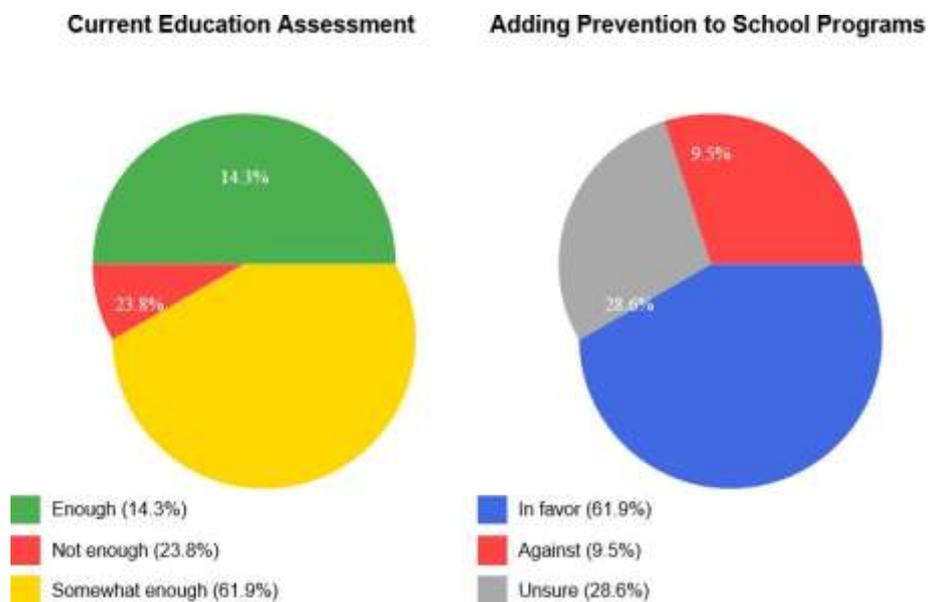
Source: (Authors, 2024)

2.10. Recommended Prevention Strategies

The prevention measures that receive the most support is: Increased parental supervision (23%), More strict laws and rules (22%), Educational initiatives and awareness efforts (13%), Better reporting systems on social media (13%), Community participation and aid (11%), Support for victims through counseling (9%). Preventive strategies, which include comprehensive school programs and legal interventions, have a significant impact on reducing the number of digital violence cases. A meta- analysis by Ttofi and Farrington (2011) confirms that school programs incorporating student and teacher education, social skills development, and strict rules on unacceptable behavior significantly reduce the prevalence of bullying. These programs are particularly effective when they are part of a broader strategy that involves parents, schools, and the local community.

Local data from the RATEL report (2021) further confirm that improving moderation systems and preventive mechanisms has a positive impact on reducing incidents in the digital environment, highlighting the importance of combining education with technological protection measures.

Figure 5: Recommended prevention strategies

Support for Prevention Measures
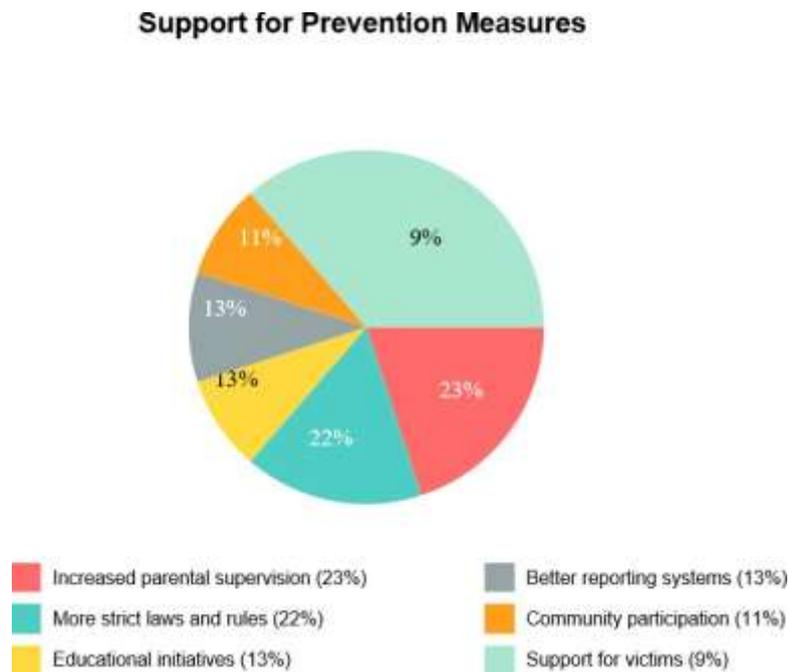
Source: (Authors, 2024)

2.11. Victim Support Strategies

Support for victims of online violence encompasses various aspects, ranging from emotional assistance to concrete interventions in crisis situations. Smith et al. (2008) and Waasdorp and Bradshaw (2015) highlight the significant positive impact of counseling programs on victims' recovery. Suggested approaches for aiding victims include: Providing emotional support (21%), Encouraging positive self esteem and self-care practices (21%), Promoting offline activities and social interactions (19%), Offering education on privacy and online safety (15%), Connecting with professional assistance (15%), and other methods (9%).

3. Conclusion

Online violence is a big and serious issue in society, especially for young people. Studies show that young individuals face many types of online bullying, including harassment, threats, and insults, as well as the spreading of rumors. A major factor in the growth of this problem is the lack of understanding of its consequences and the anonymity the internet provides. While young people know about the risks and harmful effects of online violence, they often do not have enough knowledge or tools to handle bullying and to protect themselves and others (Bogićević et al.). The issue of online violence is complex and solving it requires cooperation from all parts of society (students), families, schools, lawmakers, authorities, and social media platforms. Parents are crucial in preventing online violence by actively engaging in their children's online activities. They should guide their kids on how to use the internet safely and recognize potential dangers online (Bogićević et al.). Their involvement is also essential when children are victims of bullying, as they need to provide emotional support. Family education about digital violence and how to respond is vital for helping young members stay safe online (so they do not become victims or bullies). Schools should also introduce internet safety programs that prevent and respond to digital violence and inform students about their rights on digital platforms.It is important to enhance the educational role of the school, where changes in the structure and content of curricular and extracurricular activities could improve student relationships, encourage the development of their social skills and prosocial behavior, and contribute to creating a positive school climate. (Jevtić& Milošević, 2022). Education should not be just for students, but also for teachers and parents, so they can identify signs of bullying and provide the right support. A useful step for prevention is creating peer groups where young people can launch awareness campaigns on online safety, sharing knowledge with their classmates. These peer groups can also offer support for victims of online violence.

To establish a safe digital space, it is important to enhance the efforts of responsible institutions and existing laws in this field. Although there are some laws in place, they are not nearly enough to address the issue (Bogićević et al.). Actions should focus on protecting and supporting the victims of online violence while also working to identify and penalize the offenders. Social media platforms must also participate by implementing better safety measures and effective response strategies to online violence. For those targeted by online violence, it is crucial to provide clear information, resources, and contacts they can reach out to in cases of digital bullying, ensuring internet safety. Recommendations for young people experiencing this issue include seeking help from trusted adults, educational institutions, the National Security Contact Center for Children on the Internet, social work centers, various protection organizations, social media platforms, and law enforcement. Online violence is a worldwide issue that demands coordinated and thorough efforts at all levels. Only with joint prevention, educational initiatives, better legal frameworks, and support for young people can a safer digital environment be achieved for everyone.

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Procjena brenda gradaTrebinja kroz prizmu vještačke inteligencije

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Apstrakt: U savremenom digitalnom okruženju, brendiranje gradova prevazilazi tradicionalne pristupe i sve više uključuje savremene tehnologije, posebno vještačku inteligenciju (AI). Ovaj rad analizira brend grada Trebinja kroz prizmu place branding-a, uz korišćenje ChatGPT modela kao alata za obradu i interpretaciju sekundarnih podataka. Fokus je stavljen na šest ključnih dimenzija Brenda grada: percepciju, atraktivnost, razvoj, komunikaciju, identitet i zadovoljstvo građana. Korišćenjem dostupnih izvora i AI podrške, istraživanje nudi preliminarnu interpretaciju pozicije Trebinja unutar savremenih tokova razvoja Brenda grada. Metodologija se zasniva na opisnoj analizi i obradi podataka iz postojećih izvora, uz eksperimentalnu primjenu ChatGPT-a za analizu i tumačenje informacija. Ograničenja ovog pristupa proizlaze iz toga što model ne koristi aktuelne, stvarno vremenske podatke i ne može zamijeniti empirijska istraživanja, već služi kao njihova dopuna kroz simulacije i analitičku podršku. Shodno tome, neophodno je ove nalaze nadograditi primarnim istraživanjima, lokalnim anketama i statističkim izvještajima, kako bi se osigurala sveobuhvatnost i validnost donesenih zaključaka. Upotreba vještačke inteligencije se u tom smislu može posmatrati kao podrška istraživačkom procesu, ali ne i kao zamjena za klasične empirijske metode.

Ključne riječi: brendiranje grada, dimenzije Brenda grada, vještačka inteligencija, ChatGPT-a, analiza Brenda grada.

Assessing of the City Brand of Trebinje through the Lens of Artificial Intelligence

Abstract: In the contemporary digital environment, city bran goes beyond traditional approaches and increasingly incorporates modern technologies, especially artificial intelligence (AI). This paper analyzes the city brand of Trebinje through the lens of place branding, using the ChatGPT model as a tool for processing and interpreting secondary data. The focus is on six key dimensions of the city brand: perception, attractiveness, development, communication, identity, and citizen satisfaction. Using available sources and AI support, the research offers a preliminary interpretation of Trebinje's position within contemporary city branding development trends. The methodological approach relies on descriptive analysis and the synthesis of secondary data, along with the experimental use of ChatGPT for processing and interpreting information. The limitations of this approach lie in the fact that the model does not utilize real-time data and cannot replace empirical research, but rather complements it through simulation and analytical support. Consequently, it is necessary to complement these findings with primary research, local surveys, and statistical reports to ensure the comprehensiveness and validity of the conclusions. The use of artificial intelligence in this context can be seen as a support to the research process, but not as a replacement for traditional empirical methods.

Keywords: City Brand, Dimensions Of The City Brand, Artificial Intelligence, Chatgpt,City Brand Analysis

1. Introduction

In the digital age, a city's brand is no longer built solely through physical infrastructure, cultural offerings, or local policies, but increasingly through its digital presence and interaction with target audiences via modern communication channels (Joshi et al., 2025). In this context, technological innovations - particularly artificial intelligence (AI) - play an increasingly important role in shaping perceptions of a city and positioning it within the broader socio-economic environment.
City branding is becoming an increasingly significant element of local development in the context of globalization and digital transformation. As cities compete more intensely for the attention of investors, tourists, professionals, and the general public, it is essential for them to develop a recognizable, attractive,

and clearly positioned identity. In this process, modern technologies such as generative artificial intelligence (GAI) offer new possibilities within the scope of digital marketing (Abrokwah- Larbi, 2023).

As Benedek (2017) emphasizes, city branding represents a strategic approach that allows territorial units such as cities, regions, and countries to build a unique and recognizable image, similar to how products and services are branded. This approach not only contributes to international recognition but also stimulates innovation, investment, a shared civic identity, and overall development. A strong brand can motivate the creation of new businesses, the development of recreational content, and the general growth of the local community (Parkhomenko, 2023).

A city brand encompasses both mental and emotional associations. Mental associations are linked to the city's identity - its history, culture, and values - and tend to be stable and long-lasting (Mohammed et al., 2020). Emotional associations, on the other hand, relate to the perception and image of the city as formed by external target groups such as tourists, investors, or potential residents, and are more subject to change (Abdulla et al., 2023).

The strength of a city brand lies in the synergy between these types of associations, and research shows that a strong and consistent brand can enhance a destination's competitiveness, attract capital and human resources, and contribute to sustainable development (Ma et al., 2019).

The use of artificial intelligence (AI) and large language models (LLMs) in place branding research is still in its early stages, but their potential is evident. As Goemann (2022) notes, such tools require a comprehensive social approach that considers the benefits, challenges, and ethical issues that accompany their use - particularly when applied to the analysis of city and regional images.

In this study, ChatGPT - an open artificial intelligence tool developed by OpenAI - is used as an alternative analytical framework based on LLM technology for evaluating the city brand of Trebinje. The research is grounded in contemporary models and theories of place branding, with a focus on six key dimensions: perception and image, attractiveness, economy and development, communication and digital presence, identity and authenticity, and citizen satisfaction.

By using ChatGPT, this study aims to provide a preliminary interpretation of Trebinje's position within current trends in city brand development. Trebinje, as a city with rich cultural and historical heritage, natural beauty, and a distinct Mediterranean character, represents an excellent example of a locality where identity and brand development can be analyzed at the local level.

The subject of this research is the analysis of the city branding of Trebinje from the perspective of contemporary place branding, with support from AI as an auxiliary tool. The aim of the paper is to identify Trebinje's potentials, advantages, and challenges in the process of creating a sustainable and recognizable city brand, relying on existing data sources and interpretation through LLMs.

The methodological approach includes descriptive analysis and synthesis of secondary data, as well as experimental use of ChatGPT for data processing and interpretation. The limitations of this approach lie in the fact that the model does not use real-time data and cannot replace empirical research, but rather supplements it through simulation and analytical support.

2.   Literature Review

Cities play a key role in endogenous development due to their developed production systems that drive economic dynamics and create opportunities for networking. City branding can be described as a complex process involving the development of a city's marketing image through various communication strategies (Bonakdar and Audirac, 2020).

The aim of this process is to shape perceptions and associations that target groups have about a particular place, thereby enhancing its competitiveness and attracting investments, tourists, and talent.

The strategy of city branding is also applied as a response to population growth and the need to make tourism, investment, and trade increasingly competitive within the city. However, this strategy is not new. There is evidence of its application as early as the 19th century, and it has intensified with the rise of globalization (Zamudio et al., 2021).

City branding is a strategic tool that helps cities stand out amidst increasing global urbanization and competition (Ali and Khayat, 2024). At its core lies the creation of a unique and attractive identity that is recognizable and appealing to residents, visitors, and investors like.

The concept of city branding is gaining importance as cities increasingly recognize the need to position themselves as brands that transcend geographical boundaries. The goal is to establish a connection and create a recognizable identity among residents, visitors, companies, and individuals (Kavaratzisand Ashworth, 2006). As city management becomes more complex, the need arises for effective tools to identify opportunities and threats in the development of each city.

City branding is based on several key elements. Identity and image form the starting point, defining the city's unique character, including its cultural heritage, architecture, natural beauty, economic activities, and social structure (Ali and Khayat, 2024). Creating a strong brand image involves the strategic use of visual elements and narratives to highlight these attributes (Richards, 2020). Particular emphasis can be placed on the historical and cultural importance of landmarks, as well as on the visual characteristics of architectural heritage. Competitive positioning requires a detailed analysis of the city's strengths and weaknesses compared to others, to ensure competitiveness in the market (Anholt, 2007).

In recent years, the literature on the application of artificial intelligence (AI) in marketing has grown rapidly, reflecting increasing interest from entrepreneurs, consultants, and academia. While earlier research was mainly practice-driven, more recent studies show growing involvement of academic authors who examine the potential and challenges of AI technologies in branding, especially in creating brand image and communicating brand values (Pedroso, 2025).

In modern AI research, particular attention is given to Large Language Models (LLMs), which enable advanced language processing, understanding, and generation (Huang and Rust, 2021; Verma et. al, 2021). AI-based tools such as ChatGPT are increasingly used in marketing strategies and business routines, functioning as a digital alternative to traditional machine learning models, with the ability to recognize patterns and make decisions based on new datasets (Pedroso, 2025).

In this context, ChatGPT is defined as a system capable of learning from data, identifying patterns, and making autonomous decisions with minimal human intervention. Although earlier research in this area was dominated by consulting firms and practitioners, recent years have seen growing attention from academia (Chintalapati and Pandey, 2022; Verma et. al, 2021), particularly in future research on branding (Oh et al., 2020). AI significantly transforms marketing and consumer behavior by building knowledge from existing sources, as well as through interaction with practice (Davenport et al., 2020). Nevertheless, despite its advantages, this technology raises new concerns - particularly regarding data security, the balance between personalization and privacy, and ethical implications.

Following the recommendations ofMariutti& Florek (2022), there is a growing emphasis on the need for further interdisciplinary research in the field of place branding, as well as the development of more sophisticated methods for critical evaluation with clearly defined research objectives. In this context, artificial intelligence (AI) represents one of the modern tools that can significantly contribute to understanding city brands.

Future research perspectives in branding are moving toward changes resulting from the intersection of technology, brands, and social interaction (Oh et al., 2020) - a dimension still underrepresented in place branding studies. For this reason, the application of tools like ChatGPT, combined with theoretical foundations of this field, may be key to advancing academic insights. In this way, the present research contributes to the growing body of literature on the role of artificial intelligence in the social sciences. Although examples of AI use in academic studies remain limited, they can play a vital role in enhancing scientific inquiry, particularly in relatively well-developed fields such as city branding, which are of interest to researchers, practitioners, and policymakers around the world (Florek andPamment, 2024).

3.   Research Methodology

The methodological approach includes a descriptive analysis and synthesis of secondary data, as well as the experimental use of ChatGPT for processing and interpreting information. Primary data were obtained from a publicly available corpus that includes information on tourist visits, while secondary data are based on existing theoretical sources and academic literature in the field of city branding.

In this study, the open artificial intelligence tool OpenAI (ChatGPT) was used as an alternative large language model (LLM). Its application enabled interpretative data processing and categorization, with the identification of potential patterns, theoretical-practical insights, and inconsistencies within the city branding concept.

The criteria for measuring the city brand of Trebinje in this research are based on contemporary theories and models in the field of place branding, with a focus on: perception and image, attractiveness, economy and development, communication and digital presence, identity and authenticity, and citizen satisfaction. Simon Anholt (2007), one of the founders of the concept of nation and city branding, emphasizes the importance of image and perception as key factors of international recognition and competitiveness. His methodology, known as the Nation Brands Index - later extended to cities - includes aspects such as culture, people, governance, investment, and tourism.

Kavaratzisand Ashworth (2005) developed a layered model of city branding that includes the city's physical characteristics, symbolic representations, and stakeholder behavior. This approach highlights the importance of communication, identity, and local authenticity, directly related to the criteria used in this study.

Zenker and Braun (2010) introduced the concept of participatory city branding, where citizen satisfaction, sense of belonging, and their role as brand ambassadors play a crucial role. They also emphasize the need to measure economic indicators and digital presence in urban brand management strategies.

Hospers (2011) places special focus on smaller and transitional cities, stressing the importance of local culture, symbolism, and the actual quality of life in building a sustainable image and long-term attractiveness.

Based on these approaches, six criteria were formulated and used to analyze the brand of the city of Trebinje, combining both theoretical and practical components of measuring urban identity and attractiveness:

1. Perception and image of the city,
2. Attractiveness and appeal,
3. Economy and development,
4. Identity and authenticity of the city,
5. Citizen satisfaction,
6. Communication and digital presence.

4.   Research Results

The applied methodology was implemented using the case of the city of Trebinje, with results presented across six thematic areas developed with the help of ChatGPT (version up to 2024). The research was conducted in April 2025, and the focus of the interpretation was on analyzing theoretical relevance, potential grouping of indicators, as well as observed discrepancies in the results.
The aim of the analysis was to compare theoretical and AI-generated outputs, identify patterns, and highlight inconsistencies.

Artificial intelligence has undergone a paradigm shift - from a rule-based approach to one based on data and insights through deep learning (Kumar et al., 2019; Pedroso, 2025). This reflects back on the purpose and scientific contribution of this research.

Figure 1: ChatGPT (OpenAI, 2024) Response on the Comparative Analysis of City Brand Measurement Criteria: Six Detailed Items for the City of Trebinje

1. Perception and Image

General Criterion: How well-known the city of Trebinje is and what associations it evokes.
- **Associations**: A peaceful, safe, and sunny city, known for the Trebišnjica River, the old town, wine, and monasteries.
- **Recognition**: High within Bosnia and Herzegovina and the region (especially in Serbia and Montenegro), but low internationally.

2. Attractiveness and Appeal

General Criterion: Tourism, natural beauty, events, quality of life.
- **Tourism**: The number of visits is increasing, especially during the summer months. It is attractive for day trips from Dubrovnik and Herceg Novi.
- **Cultural and natural offerings**: Strong presence of wine, monasteries, the river, and traditional architecture. Cultural events are present but not internationally recognized.
- **Quality of life**: Considered one of the most pleasant cities to live in Bosnia and Herzegovina due to its climate, safety, and relaxed pace.

3. Economy and Development

General Criterion: Investments, employment, and innovation.
- **Investments**: Some presence of domestic and regional investors, particularly in tourism and energy sectors.
- **Start-ups and innovation**: Initial development through FabLab and collaboration with universities (Faculty of Production and Management), though still in the early stages.
- **Business opportunities**: A limited number of large employers, with a focus on small and medium-sized enterprises and the public sector.

4. Communication and digital presence

General Criterion: Media presence, social media, digital marketing.
- **Digital presence**: The city has active accounts and tourism-related websites, but its digital brand is still in development. There is potential, though promotion remains limited to a regional audience.
- **Online reviews**: Most comments on TripAdvisor, Google Reviews, and forums are positive, highlighting cleanliness, food, and accommodation.
- **Marketing**: There is a lack of an integrated brand strategy in digital campaigns.

5. Identity and Authenticity

General Criterion: Local culture, symbols, authenticity.
- **Identity**: Clear and authentic – connected with wine, history, faith, and a Mediterranean atmosphere.
- **Symbols**: Tvrdoš Monastery, old town, Trebišnjica River, local wines.
- **Residents as Ambassadors**: Local population is very proud of the city – a strong element of identity and potential in branding.

6. Citizen Satisfaction

General Criterion: Sense of Belonging, Engagement, Perception of Quality of Life
- **Quality of Life:** High level of life satisfaction, especially due to peace, safety, and the natural environment.
- **Engagement and Participation:** Citizen participation in city development decisions is limited, although local forums and councils exist.
- **Pride and Identity:** Strong local patriotism and positive emotional attachment to the city.
- **Institutional Support for Identity:** Lack of systemic and continuous campaigns to strengthen the sense of belonging through institutional initiatives.

Source: (Author)

The results generated using the artificial intelligence tool ChatGPT (version up to 2024) enabled the production of structured descriptions for each of the six criteria used to assess the city brand, with direct application to the city of Trebinje. For each question related to the individual criteria, the AI produced textual responses of approximately 300-400 words, featuring clearly categorized data and interpretation in relation to both the general framework and the specific local context. Figure 1 presents a comparative overview of the results.

Although it is clear that all six points intersect with the perceptual priorities that define the reputation of any successful urban city, there is a noticeable lack of verified data and complete information - particularly in areas such as technical depth, media framing, and scientific argumentation. This very lack represents a space for further validation and refinement of the conclusions derived through artificial intelligence tools, by combining them with primary research and local branding strategies.

The presentation of primary data on tourist visits is shown in Figure 2.

These data provide insight into tourism visit trends, enabling a deeper understanding of the current situation regarding the branding of Trebinje. The analyzed data will serve as a basis for further interpretation and identification of key factors that shape the city's image and development.

Figure2: Average Length of Stay in Trebinje
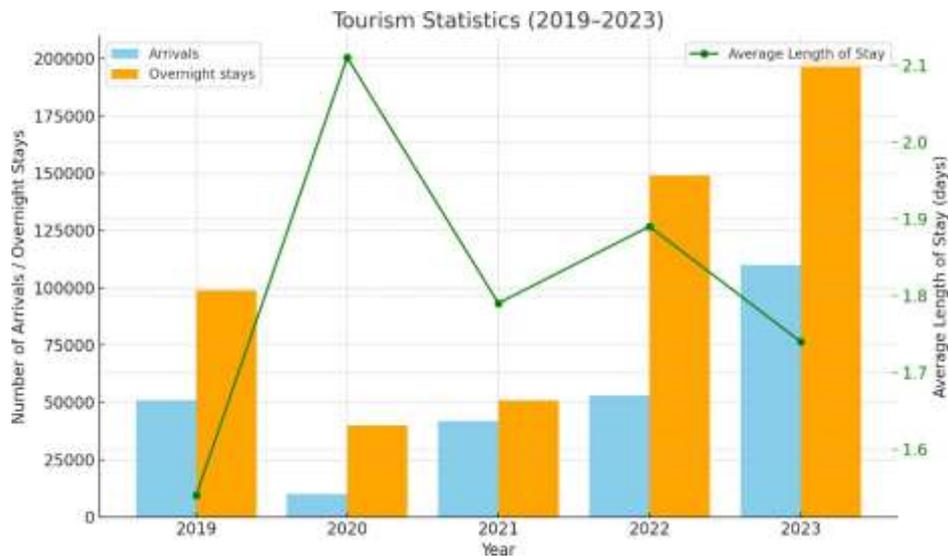
Source: (Statistical Office of the Republic of Srpska (Cities and Municipalities of RS) and the Tourist Organization of the City of Trebinje, 2023)

According to available data, tourism in Trebinje has shown a strong recovery after the pandemic, with a record 201,076 overnight stays registered in 2023. Of this number, 32% (64,308 overnight stays) were generated by domestic tourists, while foreign tourists accounted for 68% (136,768 overnight stays). Compared to the previous year, the number of arrivals in 2023 increased by 48% (index 148), while the number of overnight stays rose by 36% (index 136). The largest contribution to this growth came from foreign tourists.

The ALS (Average Length of Stay) was highest during the pandemic year (2.11 days), likely due to travel restrictions that led visitors to stay longer at safe and smaller destinations. In the following years, ALS values fluctuated between 1.74 and 1.89, indicating a stable but relatively short average visit. Although the number of visits is increasing, there is room for strategies aimed at extending tourists' stays through additional attractions, events, and cultural offerings.

5.   Discussion

The research findings suggest that there is significant room for improving the branding of Trebinje as a multi-day stay destination. Although Trebinje holds considerable potential - including natural resources, cultural heritage, and a favorable geographic location - there is no unified branding strategy that cohesively represents the city's identity. Promotional activities are most often carried out in a sectoral and isolated manner, which prevents the creation of a consistent and recognizable narrative.

Key recommendations include the development of an official Brand Strategy for the City of Trebinje, which would define the vision, goals, values, and key messages, while connecting the sectors of tourism, culture, economy, education, and sustainability.

In addition, this paper utilizes the ChatGPT model, an artificial intelligence-based tool, to support the analysis of secondary data on tourism traffic and the city brand. This approach enabled the rapid and efficient generation of an analytical framework based on available sources, previous research, and contextual patterns. Although the use of artificial intelligence represents a significant advancement in analysis, it is important to emphasize that the data generated by this model cannot replace primary research. ChatGPT does not use real-time information, and the data it produces represent interpretations of previously learned patterns, which may affect the accuracy and timeliness of the results.

Therefore, while artificial intelligence is an efficient tool for analysis, the research process should also rely on classical empirical methods, such as primary research, local surveys, and statistical reports. These data sources allow for the validation of findings and offer deeper insight into the specific characteristics of the local market and visitor behavior. The use of artificial intelligence can be extremely valuable as a support tool in the research process, but it should not be used as a substitute for traditional methods that enable the collection of verified and concrete data.

6.   Conclusion

In this analysis, artificial intelligence tools - specifically the ChatGPT model - were used to support the synthesis and structuring of data related to the development of tourism and the brand of the city of Trebinje. This approach enabled the rapid creation of an analytical framework based on available secondary sources, previous research, and contextual patterns.

However, this methodological approach has certain limitations. Primarily, the data generated through ChatGPT do not originate from directly verified sources but represent interpretations of previously learned patterns. Furthermore, the model does not use real-time information unless explicitly provided, which may affect the timeliness of the data. Additionally, a clear methodology for data collection and processing is lacking, so it is advisable to view this information as a supplement to primary research rather than a substitute for it.

The analysis of Trebinje's tourism potential and city brand indicates a positive development trend, especially in the post-pandemic period, marked by growing international visibility and high tourist satisfaction. Nevertheless, results partially derived with the support of the ChatGPT model carry certain methodological limitations, as they are based on secondary data without direct empirical validation.

Accordingly, these findings should be complemented with primary research, local surveys, and statistical reports to ensure the comprehensiveness and validity of the conclusions drawn. The use of artificial intelligence, in this context, can be seen as a support tool in the research process, but not as a replacement for traditional empirical methods.

Therefore, the future development of the Trebinje city brand should be based on clearly defined indicators, a comprehensive strategy, and openness to innovations that include the active participation of citizens, institutions, and technology. Such an approach can ensure a long-term sustainable and recognizable identity for the city - both for its residents and the broader public.

Ultimately, successful brand management of the city of Trebinje requires strategic planning, institutional support, integration of the local community, and modern communication approaches. Through the implementation of the proposed measures, it is possible to strengthen Trebinje's position as a dynamic and authentic city that balances tradition with modern development.

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Unapređenje SecuDroneComm platforme: Uporedna analiza savremenog stanja sa modernim IKT platformama za bezbednu komunikaciju

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Apstrakt: Brzi razvoj IKT rešenja značajno je transformisao bezbednu komunikaciju bespilotnih letelica (UAV). Ovaj rad predstavlja SecuDroneComm - hibridnu platformu osmišljenu za sigurnu i niskolatentnu komunikaciju između drona i komandnog centra. Platforma se upoređuje sa IKT okvirima poput ITU-T X.805, SmartNet arhitekture i sistema sa federativnim identitetom, s fokusom na enkripciju, arhitekturu servera i strategije implementacije. SecuDroneComm koristi hibridne servere, SDN-slične koordinatore i napredne bezbednosne protokole (TLS 1.3, OAuth, AES-256), što je čini pogodnom za primenu u ratnim uslovima, vanrednim situacijama i zdravstvu. Buduća unapređenja uključuju 5G mreže, validaciju zasnovanu na blokčejnu i naprednu kontrolu pristupa. Usklađena sa savremenim IKT trendovima, platform SecuDroneComm pokazuje visok potencijal da postane referentno rešenje za sigurnu i skalabilnu komunikaciju UAV sistema u dinamičnim okruženjima.

Ključne reči: SecuDroneComm, sigurne IKT platforme, hibridna serverska arhitektura, komunikacija bespilotnih letelica (UAV), razmena podataka u realnom vremenu

Advancing SecuDroneComm: A Comparative State-of-the-Art Analysis with Modern ICT Platforms for Secure Communication

Abstract: The rapid growth of ICT has transformed secure UAV communication. This paper presents SecuDroneComm, a hybrid platform designed for secure, low-latency drone-to-command communication. It is compared with ICT frameworks like ITU-T X.805, SmartNet, and federated identity systems, focusing on encryption, architecture, and deployment. SecuDroneComm uses hybrid servers, SDN-like coordinators, and robust security (TLS 1.3, OAuth, AES-256), making it suitable for battlefield, disaster, and health missions. Future enhancements include 5G, blockchain, and advanced access control. Aligned with modern ICT trends, SecuDroneComm shows strong potential as a benchmark for secure, scalable UAV communications in dynamic environments.

Keywords: SecuDroneComm, Secure ICT Platforms, Hybrid Server Architecture, UAV Communication, Real-Time Data Exchange

1.　　Introduction

In today's fast-paced technological landscape, secure communication systems are essential for modern infrastructure, facilitating everything from personal devices to extensive industrial and military operations. The rise of drones and their incorporation into critical systems has introduced additional complexity and significance to these platforms. These unmanned aerial vehicles (UAVs) have evolved from specialized tools to vital assets in areas such as surveillance, disaster response, logistics, and defense. However, their growing deployment also presents challenges in ensuring secure, real-time communication between drones, their control centers, and the wider network. SecuDroneComm, a hybrid platform aimed at providing secure communication between drones and their command centers, stands out as a timely and innovative solution. It is built on the foundations of advanced ICT systems, utilizing technologies like AES-256 encryption, TLS 1.3, and hybrid server architectures to guarantee data integrity, confidentiality, and availability.

Although current systems have made progress in tackling these issues, there are still gaps in scalability, adaptability, and the capacity to integrate smoothly within dynamic environments (Agarwal & Wang, 2005), (Ahmad et al., 2012).

1.1. The Role of Secure ICT Platforms in Modern Communication

Secure ICT platforms play a vital role in various critical operations. These systems are designed to ensure that sensitive data is transmitted and processed securely, protecting it from interception or unauthorized access. This need becomes even more crucial in areas like drone communication, where operations are distributed and wireless transmission is inherently vulnerable. While platforms such as ITU-T X.805 and SmartNet have made significant contributions to secure ICT infrastructure, they often struggle to meet the modern demands for mobility, real-time responsiveness, and global scalability (Alkussayer & Allen, 2010), (Amir et al., 2004a). SecuDroneComm seeks to tackle these issues by merging the strengths of traditional systems with contemporary innovations (Amir et al., 2004b). It employs hybrid servers that combine the scalability of cloud-based solutions with the low-latency advantages of local servers. Furthermore, the implementation of logical coordinators, similar to SDN controllers, optimizes data flow and resource allocation throughout the system (Amir et al., 2020).

1.2. The Importance of Real-Time Communication for Drones

Drones depend on a constant flow of information to carry out their functions successfully. Whether it's gathering surveillance data or performing autonomous actions, each task relies on secure and reliable communication channels. In critical situations such as battlefield reconnaissance or disaster response, even a slight delay or disruption in communication can have dire consequences (Amin et al., 2003). Conventional ICT systems frequently fall short of the high-speed, low-latency demands of these applications, which is why solutions like SecuDroneComm are essential (Barrows & Powers, 2009), (Benzel et al., 2006).

1.3. Bridging the Gap: Comparing SecuDroneComm with Existing Platforms

Current ICT platforms have significantly advanced secure communication. For instance:

1. ITU-T X.805 offers a comprehensive security framework for ICT systems, but it is primarily designed for stationary environments, making it less effective for mobile and dynamic operations (Braga & Nascimento, 2012).
2. The SmartNet architecture, aimed at energy systems, demonstrates the capabilities of distributed ICT frameworks, yet it lacks the real-time responsiveness essential for UAV operations (Braga, 2013).
3. Federated identity systems in mobile and wireless communications improve user authentication and access control, but they often struggle with scalability and interoperability issues, especially in hybrid server environments (Chatisa et al., 2023), (Chockler et al., 2001).

By drawing insights from these systems, SecuDroneComm integrates advanced features like OAuth-based access control and TLS-encrypted connections, while also catering to the specific needs of drone communication.

Its hybrid design facilitates smooth operation across both local and cloud servers, ensuring uninterrupted data flow even in areas with limited connectivity (Diesburg & Wang, 2010), (Edgar et al., 2011).

1.4. Key Features of SecuDroneComm Platform

1. Hybrid Server Architecture: SecuDroneComm combines local and cloud servers, enabling it to meet various operational needs. Local servers ensure low-latency performance for real-time applications, while cloud servers provide scalability and redundancy for long-term data management (ELECTRA, 2013).
2. Advanced Security Protocols: At the core of SecuDroneComm is a strong focus on security. It utilizes AES-256 encryption to protect data, TLS 1.3 for secure transmission, and OAuth for reliable user authentication. These protocols work together to secure data throughout its entire lifecycle (Enck et al., 2011), (Fragkiadakis et al., 2013).

3. Logical Coordinator (SDN Controller): Drawing from software-defined networking (SDN) principles, the logical coordinator facilitates efficient data routing and server resource management. This feature is especially useful in hybrid environments, where data may need to be dynamically allocated between local and cloud servers (Hiltunen et al., 2001).
4. Real-Time Responsiveness: The platform is built to meet the high-speed demands of drone communication. Its optimized architecture reduces latency, ensuring that data is transmitted and processed promptly (Horsmanheimo et al., 2017).
5. Scalability: SecuDroneComm is capable of scaling from small tactical deployments to extensive, distributed networks. Its modular design allows for the addition of new nodes, servers, or drones without interrupting ongoing operations (Hussain et al., 2014), (Huawei Technologies Co., Ltd., 2023).

1.5. Applications and Use Cases

1. Military Operations: In defense situations, drones frequently operate in challenging environments where secure communication is essential. SecuDroneComm allows for real-time data sharing between UAVs and command centers, ensuring that reconnaissance and tactical decisions rely on accurate, up-to-date information (International Telecommunication Union, 2003), (ITU-R, 2015).
2. Disaster Management: In the event of natural disasters, drones are crucial for assessing damage and finding survivors. SecuDroneComm supports the secure transmission of this information to response teams, enabling timely and coordinated efforts (Keidar et al., 2000).
3. Public Health Monitoring: The platform can also be utilized for health surveillance, such as tracking air quality or identifying pathogens in urban settings. By connecting with cloud servers, it enables health agencies to analyze data on a large scale while ensuring local responsiveness (Pereira et al., 2013).
4. Industrial Applications: Whether inspecting pipelines or monitoring factory emissions, drones equipped with SecuDroneComm guarantee that sensitive industrial data remains secure from breaches or tampering (Reardon et al., 2012).

1.6. Challenges and Opportunities

Implementing SecuDroneComm brings its own challenges, especially when it comes to integrating its components in various environments. The need for advanced technology infrastructure, including hybrid servers and logical coordinators, demands careful planning and investment. Moreover, the platform must be adaptable to keep pace with changing security threats and technological progress. On the flip side, these challenges also open doors for growth. By leveraging emerging technologies like blockchain for data validation and AI for threat detection, SecuDroneComm can significantly boost its capabilities. Collaborating with existing ICT platforms and manufacturers could also speed up its adoption and improvement (Saxena & Chaudhari, 2012), (Schrittwieser et al., 2012).

2. Literature Review

This section examines the latest advancements in ICT platforms designed for secure communication, contrasting them with the proposed SecuDroneComm platform. It incorporates insights from the provided materials to create a thorough understanding of current systems and identifies areas for improvement (Siddiqi et al., 2006).

2.1. Overview of SecuDroneComm Platform

SecuDroneComm is a sophisticated hybrid ICT platform crafted for secure, real-time communication between drones and command centers. Its design combines local and cloud servers, enabling low-latency operations in restricted environments while also allowing for scalability in large-scale deployments. Notable features include AES-256 encryption for data protection, TLS 1.3 for secure data transport, and OAuth-based user authentication. The system includes a logical coordinator, akin to an SDN controller, which dynamically routes data and optimizes server resources (Wang et al., 2012), (Wischounig-Strucl & Rinner, 2015).

This platform is especially well-suited for high-stakes applications such as military operations, disaster response, and public health surveillance, where data security and real-time responsiveness are essential.

By utilizing a modular architecture and state-of-the-art technologies, SecuDroneComm provides flexibility and adaptability across a variety of operational scenarios (Yanmaz et al., 2017).

2.2. Overview of Other ICT Platforms

The following ICT platforms showcase different strategies for ensuring secure communication, each tailored to specific use cases and challenges:

1. ITU-T X.805 Framework: This comprehensive security framework, ITU-T X.805, emphasizes end-to-end protection for networked systems. It features a three-layer architecture (Infrastructure, Services, Applications) and eight security dimensions, offering a solid approach to securing data in distributed environments. However, its emphasis on traditional IP-based networks restricts its use in modern dynamic scenarios like UAV communication (Agarwal & Wang, 2005).
2. SmartNet Architecture: SmartNet is crafted for secure communication within energy systems, utilizing distributed ICT frameworks such as IoT and 5G. Its SGAM (Smart Grid Architecture Model) facilitates efficient data alignment and flow in smart grids. While it shines in flexibility and system integration, its focus on energy systems limits its relevance to UAV operations and real-time needs (Ahmad et al., 2012).
3. Trust-ME Federated Framework: This platform focuses on federated identity management, making user authentication easier across various systems. By utilizing Single Sign-On (SSO) and Intrusion Detection Systems (IDS), Trust-ME improves both security and user experience. However, its main focus is on identity and access management, rather than on real-time data transmission or hybrid architectures (Alkussayer & Allen, 2010).
4. Spread Secure Communication: Spread is a system created for secure group communication, using dynamic group key management protocols. It guarantees data confidentiality and integrity while ensuring scalability for collaborative settings. However, its effectiveness in UAV-based applications is limited due to the complexity of group configurations and the dependence on pre-established networks (Amir et al., 2004a).

Table 1: Overview of the SecuDroneComm and other proposed platforms

Platform	Core Focus	Key Features	Applications
SecuDroneComm	Real-time UAV communication	Hybrid server architecture, AES-256 encryption, TLS 1.3, SDN-like logical coordinator	Military, disaster response, public health monitoring
ITU-T X.805	End-to-end security	Layered architecture (Infrastructure, Services, Applications), Eight security dimensions	Traditional IP-based systems, networked environments
SmartNet	Energy system communication	Distributed ICT frameworks, SGAM model, integration with IoT and 5G	Smart grids, energy management
Trust-ME	Federated identity management	Single Sign-On (SSO), Intrusion Detection Systems (IDS), centralized policy control	Identity management, secure authentication
Spread	Group communication security	Dynamic group key management, scalable data integrity solutions	Collaborative environments, enterprise communication

Source: Authors' research

3.   Comparison of SecuDroneComm with Proposed Platforms

The SecuDroneComm platform offers a distinctive method for ensuring secure communication among drones by utilizing advanced encryption protocols, a hybrid server architecture, and dynamic routing.

Although existing platforms like ITU-T X.805, SmartNet, Trust-ME, and Spread have made important strides in secure ICT communication, they each fall short in meeting the unique needs of real-time UAV operations. This section presents a comparative analysis, highlighting how SecuDroneComm differentiates itself and draws lessons from these other platforms (Agarwal & Wang, 2005), (Ahmad et al., 2012), (Alkussayer & Allen, 2010), (Amir et al., 2004a).

Table 2: Comparison of SecuDroneComm with Proposed Platforms

Platform	Primary Focus	Strengths	Limitations
SecuDroneComm	Secure real-time UAV communication	Hybrid server architecture, AES-256 encryption, TLS 1.3, SDN-like logical coordinator	Requires advanced infrastructure; initial setup complexity
ITU-T X.805	End-to-end network security	Comprehensive layered framework; adaptable to multiple network scales	Focused on traditional IP-based systems; limited support for mobile and hybrid environments
SmartNet	Distributed energy communication	IoT and 5G integration; highly flexible distributed architecture	Tailored for energy systems; lacks emphasis on UAV and real-time responsiveness
Trust-ME	Federated identity management	Single Sign-On (SSO); intrusion detection; seamless user access	Geared toward authentication and access management; less focus on data routing or scalability
Spread	Secure group communication	Dynamic group key management; scalability for collaborative networks	Complexity in managing group configurations; not optimized for hybrid server architectures

Source: Authors' research

4.   Effectiveness Comparison of SecuDroneComm with Proposed Platforms

To assess the effectiveness of the SecuDroneComm platform, it's crucial to examine key performance indicators like latency, security, scalability, adaptability, and user accessibility (Agarwal & Wang, 2005), (Ahmad et al., 2012). This section will compare SecuDroneComm with other leading ICT platforms, such as ITU-T X.805, SmartNet, Trust-ME, and Spread, based on these metrics.

The goal of this comparison is to showcase SecuDroneComm's strengths, pinpoint areas where it outperforms existing systems, and explore potential opportunities for improvement (Alkussayer & Allen, 2010), (Amir et al., 2004a).

Table 3: Effectiveness Comparison of SecuDroneComm with Proposed Platforms

Metric	SecuDroneComm	ITU-T X.805	SmartNet	Trust-ME	Spread
Latency	Real-time with hybrid servers	Moderate	High in static environments	Moderate	Depends on group size
Security	AES-256, TLS 1.3, OAuth	Multi-layered framework	Blockchain-based encryption	Federated authentication	Group key management
Scalability	Highly scalable (hybrid model)	Limited to network scope	Flexible in distributed grids	Limited to authentication	Scalable in group settings
Adaptability	Dynamic routing with SDN-like logic	Rigid for IP-based systems	Focused on energy systems	Limited to access control	Limited to preconfigured groups
User Accessibility	Modular design for easy integration	Structured but static	Advanced IoT integration	SSO for seamless access	Complex group configurations

Source: Authors' research

SecuDroneComm stands out from other platforms in several important areas related to UAV communication:

- Its hybrid architecture allows for real-time data processing with minimal latency (Agarwal & Wang, 2005).
- Cutting-edge security protocols offer strong data protection while maintaining scalability (Ahmad et al., 2012).
- The dynamic routing system enhances its adaptability to various and changing environments (Alkussayer & Allen, 2010), (Amir et al., 2004a).

By evaluating the strengths and weaknesses of competing platforms, SecuDroneComm integrates their best practices and addresses significant gaps, positioning itself as a leader in secure UAV communication.

The figures below present a comparative schematic that illustrates the workflows of these platforms (Agarwal & Wang, 2005), (Ahmad et al., 2012), (Alkussayer & Allen, 2010), (Amir et al., 2004a), (Amir et al., 2004b), (Amir et al., 2020), (Amin et al., 2003).

Figure 1: SecuDroneComm Platform Workflow
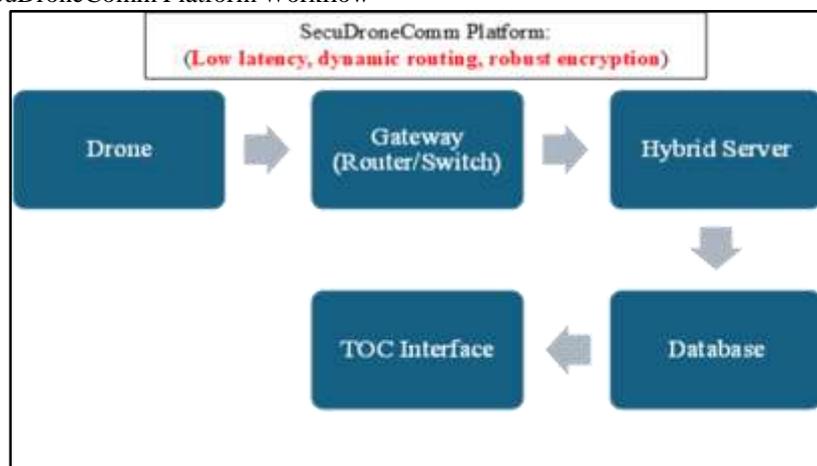
Source: Authors' research

Figure 1 provides an overview of the SecuDroneComm workflow, emphasizing its real-time data handling, robust security layers, and flexible integration capabilities. This schematic highlights how the platform coordinates between UAVs, edge servers, and end-users to ensure seamless and secure communication.

Figure 2: ITU-TX.805 Platform Workflow
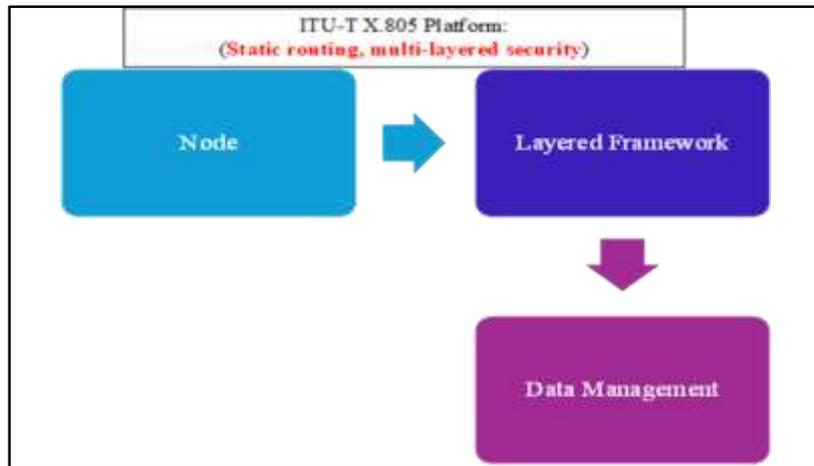
Source: Authors' research

Figure 2 depicts the workflow of the ITU-T X.805 platform, which is characterized by its structured but relatively rigid architecture. The figure illustrates how the platform's multi-layered security framework is integrated within traditional IP-based systems, providing a reference point for legacy ICT solutions.

Figure 3: SmartNet Platform Workflow
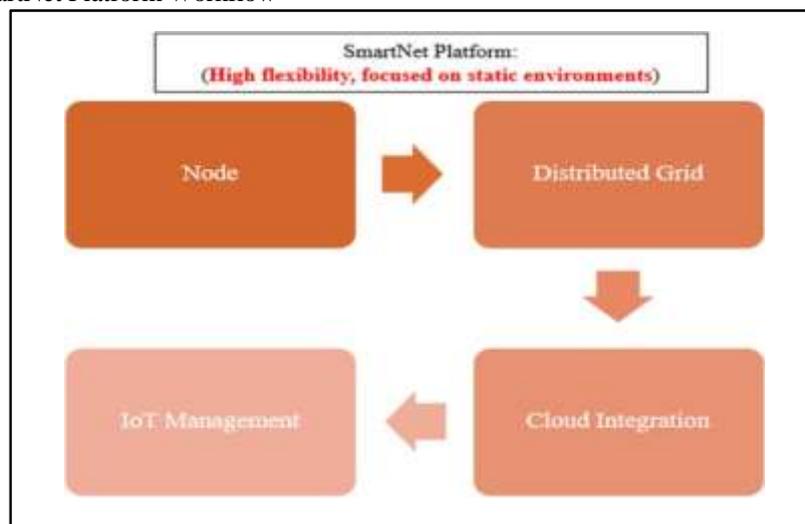
Source: Authors' research

Figure 3 demonstrates the operational flow of the SmartNet platform. This solution focuses primarily on energy efficiency and secure communications within distributed grids. The figure underscores SmartNet's reliance on blockchain-based encryption and its advanced integration with IoT environments.

Figure 4: Trust-ME Platform Workflow
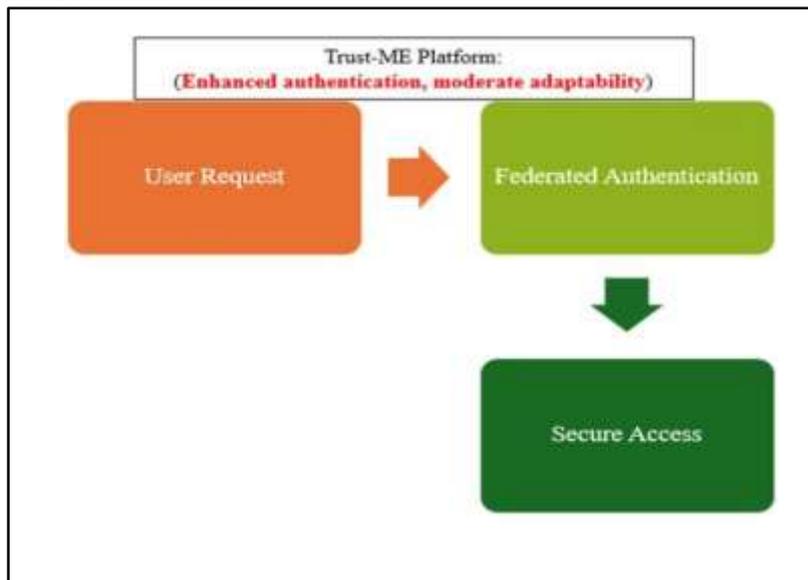
Source: Authors' research

Figure 4 illustrates the Trust-ME platform's workflow, which leverages federated authentication and single sign-on mechanisms for streamlined access control. The schematic details how Trust-ME manages user identities and access privileges, though its adaptability remains limited compared to newer solutions.

Figure 5: Spread Platform Workflow
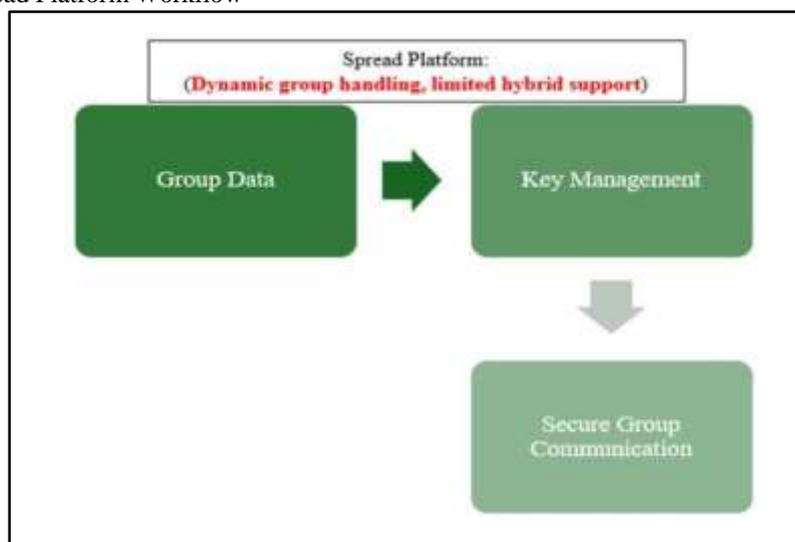
Source: Authors' research

Figure 5 shows the Spread platform's workflow, with an emphasis on group communication and key management. The platform is particularly suitable for preconfigured group settings, though its adaptability is constrained by static group definitions.

4.   Conclusion

The SecuDroneComm platform marks a major step forward in secure communication systems designed specifically for real-time UAV operations. It integrates a hybrid server architecture with strong encryption protocols such as AES-256 and TLS 1.3, along with a dynamic routing mechanism influenced by SDN principles. This combination effectively tackles key issues like latency, scalability, and adaptability.

Its modular design and ability to integrate with other systems make it a flexible solution for a range of applications, including military operations, disaster management, and public health surveillance. When compared to existing platforms like ITU-T X.805, SmartNet, Trust-ME, and Spread, SecuDroneComm offers better real-time responsiveness, improved security, and increased flexibility in changing environments. However, to implement it successfully, challenges such as infrastructure requirements, cybersecurity threats, and the necessity for user training must be addressed. By using phased deployment strategies, incorporating emerging technologies like AI and blockchain, and ensuring compatibility with legacy systems, SecuDroneComm can further boost its effectiveness.

As UAV operations and secure communication advance, SecuDroneComm is poised to establish a new benchmark in ICT platforms. Its cutting-edge approach addresses the shortcomings of traditional systems while also laying the groundwork for future innovations, guaranteeing safe and efficient communication in a world that is becoming more interconnected and complex.

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Da li pametne hotelske sobe utiču na kvalitet hotelske ponude? Stavovi gostiju različitih hotela

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Apstrakt: Turizam je postao sinonim za uživanje, odmor i upoznavanje novih kultura, što je dovelo do porasta potražnje za kvalitetnim sadržajima tokom slobodnog vremena. Kako bi odgovorila na sve složenije zahteve savremenih turista, hotelska industrija se neprestano prilagođava i unapređuje i tako nastoji da poveća njihovo zadovoljstvo. Najnovija tehnološka rešenja, posebno uključivanje pametnih tehnologija u hotelske sobe, ima za cilj da kroz automatizaciju i personalizaciju transformiše iskustvo gostiju. Metodologija: Ova studija ispituje uticaj pametnih hotelskih soba na percepciju kvaliteta usluge kod gostiju poreklom iz različitih evropskih zemalja. Istraživanje je sprovedeno anketiranjem i intervjuisanjem ispitanika iz osam evropskih zemalja. Rezultati pokazuju različite nivoe prihvatanja i zabrinutosti u vezi sa tehnološkim inovacijama. Analiza hi-kvadrat testa korišćena je za ispitivanje odnosa između identifikovanih faktora (inovativnost, optimizam, nelagodnost, nesigurnost) i percepcije kvaliteta usluge, pri čemu su uočene statistički značajne razlike. Rezultati: Istraživanje pokazuje visok nivo entuzijazma kod nemačkih i holandskih gostiju, različite stavove kod gostiju iz Austrije, dok gosti sa Balkana ispoljavaju viši stepen zabrinutosti. Implikacije: Dobijeni rezultati mogu pomoći hotelijerima da unapede tehnološku ponudu i povećaju zadovoljstvo gostiju, uzimajući u obzir kulturološke i geografske razlike.

Ključne reči: pametne hotelske sobe, kvalitet hotelske usluge, percepcije gosta

Do Smart Hotel Rooms Affect the Quality of The Hotel Supply? Multi-Hotel Guest Perspectives

Abstract: Tourism has become a way for people to enjoy, relax, and experience new cultures, increasing the demand for satisfying leisure activities. To meet these evolving demands, the hospitality industry is constantly adapting and improving guest satisfaction. Recent advancements in technology, particularly the integration of smart technologies in hotel rooms, aim to revolutionise guest experiences through automation and personalisation. Methodology: This study explores the impact of smart hotel rooms on service quality perceptions across diverse European guests. Surveys and interviews conducted in eight European countries reveal varying levels of acceptance and concerns regarding technological innovations. The chi-square analysis was utilised to examine the relationships between identified factors (innovativeness, optimism, discomfort, insecurity) and service quality, revealing statistically significant differences. Findings: The results show high enthusiasm among German and Dutch guests, mixed feelings among Austrians, and more concerns among guests from Balkan countries. Implications: These findings could help hoteliers improve their technological solutions and increase guest satisfaction by considering cultural and geographical differences.

Keywords: Smart Hotel Rooms, Hotel Service Quality, Guest Perceptions

1. Introduction

According to Chen et al. (2024), tourism has evolved significantly, becoming a symbol of enjoyment, relaxation, cultural enrichment, and unique experiences. The urge to travel has intensified among tourists, driving a strong desire to spend their leisure time in ways that meet or exceed their expectations (He et al., 2024). Certain scientists believe that the contemporary lifestyle has influenced changes in both the demand side (Yang & Smith, 2024) and the supply side (Ren, 2024).

Conversely, the need for continuous adaptation to the ever-changing demands of tourists and careful planning of business strategies has become crucial for the survival of tourism enterprises (Lim et al., 2024). For instance, in recent years, free Wi-Fi has become an essential feature in hotel services (Tajeddini et al., 2024). However, while necessary, it alone is insufficient to create a memorable experience (Reyes-Menendez et al., 2018). Tourists are likely to express significant dissatisfaction if this amenity is absent.

As the hospitality industry undergoes rapid technological advancements, the integration of smart technologies in hotel rooms has become a key aspect for enhancing guest experience (Han et al., 2024). According to Wu and Cheng (2018) the hospitality industry has continuously evolved, incorporating technological advancements to enhance guest experiences and operational efficiency. In recent years, the concept of ―smart hotel rooms‖ has emerged, integrating advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and automation (Yang et al., 2021). These innovations promise to revolutionize the way guests interact with their accommodations, potentially elevating the overall quality of hotel services (Buhalis & Leung, 2018).

Smart hotel rooms are equipped with interconnected devices that allow guests to control various aspects of their environment, such as lighting, temperature, and entertainment systems, through voice commands or mobile applications. This level of customization and convenience is designed to meet the growing expectations of modern travelers who seek seamless and personalized experiences (Neuhofer et al., 2015). By providing such tailored experiences, hotels can significantly enhance guest satisfaction and loyalty, which are critical factors in the highly competitive hospitality market (Bilgihan, 2016). According to Xu et al. (2021) the increasing implementation of facial recognition technology further indicates the shift towards a more secure and personalized guest experience. By using facial recognition for check-ins and access control, hotels can streamline the check-in process, enhance security, and provide a touchless experience, which has become particularly important in the context of the COVID-19 pandemic (Han et al., 2021). This technology not only enhances guest convenience but also addresses contemporary health and safety concerns. Moreover, smart hotel rooms can contribute to operational efficiencies by enabling predictive maintenance, energy management, and real-time data analytics. These technologies not only improve the guest experience but also support sustainable practices and cost savings for hotel operators (Ivanov et al., 2017). As hotels seek to distinguish themselves in a competitive market and appeal to technologically inclined guests, the implementation of smart room technologies is becoming increasingly relevant.

The initial hypothesis of the work was the assumption that the quality of hotel services in modern business conditions directly depends on the ability to adopt innovations as a business concept. This paper investigates the impact of smart hotel rooms on the perceived quality of hotel offerings from the perspective of guests across multiple hotels. The study employs a multi-hotel approach to gather diverse perspectives, considering different hotels, hotel locations, and guest country of origin. The findings provide insights into the complex connections between features in smart hotel rooms and guests' views on the hotel's overall quality, offering practical implications for hoteliers seeking to optimize their technology-driven offerings. Furthermore, the multi-hotel perspective provides a comprehensive understanding of how diverse guest demographics and hotel contexts influence the reception and effectiveness of smart technologies in different settings.

2. Literature review

The concept of hotels that strive to create a unique experience for tourists through various technological solutions can be called ―smart hotels.‖ A smart hotel is defined by its incorporation of advanced technologies to provide customers with distinctive and technology-centric experiences (Kim & Han, 2020). Devices within these hotels that can send and receive data among themselves make them ―smart.‖ By managing these devices through their phones, tablets, or laptops, guests customize their hotel stay according to their wishes and needs. The essential difference that distinguishes smart systems from others is that smart systems react to the environment and learn during operation, leading to process improvement (Minić et al., 2014). These modern technologies aim for optimal efficiency by automating services, and the primary advantage of a smart hotel for hotel operators lies in financial benefits through improved productivity and reduced labor costs. Some advantages of smart hotels include improvements in the sustainability of hotel rooms through the automatic adjustment of lighting levels and room temperature, resulting in significant energy savings (Casais & Ferreira, 2023).

Additionally, smart hotels offer greater personalization of services, such as welcoming messages on the TV screen addressing the guest by name, and access to personal Spotify and Netflix accounts, as well as audio books and music (Ristova & Dimitrov, 2019). They also provide faster access to information, allowing guests to ask questions and receive answers from smart devices regarding hotel content, local tourist attractions, or even displays with suggestions for available restaurants, including ratings left by guests of those restaurants (Leung, 2019). Moreover, decision-making can be enhanced through the use of information, enabling hotels to discover a guest's most popular TV channels (Yang et al., 2021). Finally, smart hotels facilitate preventive maintenance and repairs, as hotel staff can monitor the performance of devices within the hotel (Minić et al., 2014).

According to Lukanova and Ilieva (2019), among the technological solutions that contribute to the intelligence of a hotel are automated room controls, which include the maintenance of temperature, lighting, and air conditioning from a single control point with the ability for automatic adjustments in response to changes in room conditions. Voice recognition technology plays a significant role by answering questions about the hotel, local attractions, traffic, weather forecasts, playing music, selecting TV channels, adjusting room lighting, and more (Buhalis, Moldavska, 2022). Furthermore, face recognition capabilities allow smart hotels to identify guests through passport photos submitted during mobile check-in, with some establishments offering a mobile app for swift self-check-in and activating a mobile key for room access (Han et al., 2021).

Additionally, connecting smart hub devices enables guests to select various services during their hotel stay, such as booking appointments for massages, pedicures, manicures, reserving a table in a restaurant, buying airline tickets, and ordering room service, all from their room using smartphones or hotel tablets (Minić et al., 2014). This increased connectivity leads to a higher level of personalization, allowing guests to fully customize their stay according to their wishes and needs (Gupta et al., 2022). Lastly, the remote monitoring of the operation of smart devices aids in detecting malfunctions before they lead to major issues, identifying problems, and enabling quick reactions to ensure smooth operation (Minić et al., 2014).

Smart rooms, as a constitutive element of smart hotels, provide an unforgettable experience for guests. Managing basic information about the usage of specific devices can be a viable solution for employees to learn about the guest's most listened-to radio stations or favorite TV channels. Furthermore, complimentary Wi-Fi services significantly impact guest satisfaction, with hotels offering this amenity receiving higher social media ratings compared to those without it (Bulchand- Gidumal et al., 2011). Moreover, the integration of self-service and robotic technologies in service automation not only reduces labor costs but also enhances operational efficiency, captivating guests with the novelty of innovation and fostering customer delight (Bilgihan et al., 2011). In addition to the functions mentioned above, smart hotel rooms may also feature smart hangers that provide feedback if laundry services are needed (Backendorff et al., 2019). Another popular technological solution that is growing in popularity in hotel business is hotel keyless entry system. Mobile key entry systems, integrated into hotel booking applications, not only streamline check-in processes for both guests and staff but also contribute to an improved guest experience by facilitating easy rebooking, seamless interaction with cloud-based hotel management, and ensuring enhanced security measures, as the downloaded room key is encrypted and tied to the registered mobile device for the specified booking period (Torres, 2018).

3. The research methodology

In their research, Zhong et al. (2022) concluded that innovation in hotels is the key to survival and a measure of quality. Our survey involved a varied group of 441 participants from eight European countries, six of which are in the EU (Germany, Austria, Italy, Croatia, Slovenia, Netherlands, BiH, and Serbia) and aimed to explore four main elements: innovativeness, optimism, discomfort, and insecurity, specifically in relation to their experiences with smart hotel rooms. The ratings, using a Likert scale, ranged from 1 to 5, where 1 indicated strongly agree and 5 indicated strongly disagree.

The research utilised surveys and interviews to gather data from various hotels: Arion Cityhotel Vienna und Apartments, a&t Holiday Vienna, Eventhotel Pyramide - Vösendorf Austria, Ananas - Vienna, Scope Hotel City Stay Frankfurt, Via Suites Netherlands, Garden Hotel Novi Sad, and Hotel Veliki Novi Sad. The data were collected throughout 2024, from January to December.

The aim was to understand the impact of these factors on guests' overall perception of service quality.

To analyze the relationships between the identified factors and service quality, we utilized the chi-square analysis. The work started from the assumption that there would be no difference in the answers about the gender of the respondents, and statistically significant differences are those with $p < 0.05$. The survey instrument included carefully crafted statements for each factor, aiming to capture sophisticated insights into participants' perceptions and attitudes. This methodology allowed us to gain a comprehensive understanding of how guests' characteristics and emotions in smart hotel environments contribute to the evaluation of service quality, revealing potential areas for improvement.

Factor: Innovativeness

- I can usually figure out new high-tech product and services in smart rooms without help from others.
- In general, I am among the first in my circle of friends to acquire new tehnology when it appears.

Factor: Optimism

- I like the idea doing business via computers and smart rooms because you are not limited to regular business hours.
- Technology and smart rooms gives people more control over their daily lives.

Factor: Discomfort

- New high-tech product and services in smart rooms are often too complicated to be useful
- When I get technical support from a provider of a hightech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do.

Factor: Insecurity

- I do not consider it safe giving out credit card information over a computer
- I do not feel confident doing business with a place that can only be reached on lin
- If you provide information to a machine or over the Internet, you can never be sure if it really gets to the right place.

4. Result and Discussion

Out of the total number of participants, 54.9% (242) were male, while 45.1% (199) were female. The research was carried out in 8 European countries, with respondents predominantly from the Netherlands (23.1%), Austria (22.4%), and Germany (18.4%). A more detailed overview is provided in the following Table (1).

Table 1: Country of origin

		Frequency	Percent
Valid	Germany	81	18,4
	Austria	99	22,4
	Italy	29	6,6
	Croatia	47	10,7
	Slovenia	28	6,3
	Serbia	21	4,8
	Netherlands	102	23,1
	BiH	34	7,7
	Total	441	100,0

Source: Authors' research

In Table 2 below, there is a summary of the frequency of visits to 8 different hotels located in 4 countries and 5 different cities. The highest number of guests stayed at Arion Cityhotel Vienna and Apartments (19.3%), Via Suites Netherlands (15.9%), and Eventhotel Pyramide (14.5%). A more detailed insight is available below.

Table 2: Hotels

		Frequency	Percent
Valid	Arion Cityhotel Vienna und Appartments	85	19,3
	a&t Holiday Vienna	61	13,8
	Eventhotel Pyramide - Vosendorf Austria	64	14,5
	Ananas - Viena	57	12,9
	Scope Hotel City Stay Frankfurt	49	11,1
	Via Suites Netherlands	70	15,9
	Garden hotel Novi Sad	29	6,6
	Hotel Veliki Novi Sad	26	5,9
	Total	441	100,0

Source: Authors' research

Netherlands, Austria and Germany are the most common countries of origin, contributing 102, 99 and 81 guests (Table 3). These three countries make up a significant portion of the total number of guests. The guest's native country vary between hotels. For example, Arion Cityhotel Vienna und Apartments gets a mix of people mainly from Austria, Germany, and the Netherlands. On the other hand, from the observed sample, two hotels in Novi Sad are primarily attracting the attention of domestic tourists and tourists from neighboring countries.

Table 3: Country of hotel guests' origin

		Germany	Austria	Italy	Croatia	Slovenia	Serbia	Netherlands	BiH	Total
Hotel	Arion Cityhotel Vienna und Appartments	12	6	13	10	11	2	22	9	85
	a&t Holiday Vienna	6	19	3	3	0	3	16	11	61
	Eventhotel Pyramide	8	22	2	2	0	0	27	3	64
	Ananas	8	24	0	5	1	1	15	3	57
	Scope Hotel City Stay Frankfurt	12	16	5	3	0	0	12	1	49
	Via Suites Netherlands	35	12	6	7	0	0	10	0	70
	Garden hotel Novi Sad	0	0	0	9	9	7	0	4	29
	Hotel Veliki Novi Sad	0	0	0	8	7	8	0	3	26
Total		81	99	29	47	28	21	102	34	441

Source: Authors' research

Tables 4, 5, 6, 7, 8, and 9 show the respondents' attitudes regarding innovativeness factor.

The Table 4 assesses guests' confidence in understanding new high-tech products and services in smart rooms without assistance, categorized into three levels (The columns under ―Strongly agree,‖―Partly agree,‖ and ―No change‖). Overall, while there are variations in the levels of agreement across countries, the majority of guests generally express confidence in their ability to figure out new high- tech products and services in smart rooms independently.

Table 4: Comprehension of emerging technologies

| | | I can usually figure out new high-tech product and services in smart rooms without help from others. | | | |
		Strongly agree	Partly agree	No change	Total
Country of hotel guests' origin?	Germany	28	43	10	81
	Austria	35	58	6	99
	Italy	14	12	3	29
	Croatia	22	24	1	47
	Slovenia	8	16	4	28
	Serbia	3	13	5	21
	Netherlands	36	61	5	102
	BiH	24	6	4	34
Total		170	233	38	441

Source: Authors' research

Table 5 presents the results of the Pearson Chi-Square test, which was used to examine the statistical significance of the relationship between the analyzed variables.

Table 5: Pearson Chi-Square test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	39,252[a]	14	,000

Source: Authors' research

The results (Table 6) suggest significant differences in guests' tendencies to acquire new technology early based on their country of origin. The case is similar like with the previous results.The highest number of guests, regardless of their country of origin, agree that they are among the first to test new technological solutions when they appear. We can see that generally, with the increase in the level of development of the country, the number of guests who strongly agree with the statement also increases (Germany, Austria, Netherlands)likely due to higher technological advancement. On the other hand, tourists from Slovenia, Serbia, and Croatia have shown a slightly lower level of confidence possibly due to limited access to the latest technologies (Shin et al., 2022).

Table 6: Early adoption of new technologies

| | | In general, I am among the first in my circle of friends to acquire new tehnology when it appears. | | | |
		Strongly agree	Partly agree	No change	Total
Country of hotel guests' origin?	Germany	41	34	6	81
	Austria	42	55	2	99
	Italy	10	16	3	29
	Croatia	13	30	4	47
	Slovenia	6	16	6	28
	Serbia	8	8	5	21
	Netherlands	58	38	6	102
	BiH	18	15	1	34
Total		196	212	33	441

Source: Authors' research

Table 7 shows the results of the Pearson Chi-Square test conducted to determine the statistical association between the variables under investigation.

Table 7: Pearson Chi-Square

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	40,427[a]	14	,000

Source: Authors' research

Since p=0.000, this indicates a statistically significant difference in respondents' answers based on their country of origin (Table 5 and Table 7). This can be explained by research conducted by Chung and Song (2024), according to some nationalities may exhibit lower levels of confidence or variability in their perceptions, which could be influenced by factors such as technological familiarity, cultural attitudes towards technology, and prior experiences (e.g. Serbian or Slovenian people). On the contrary, countries with higher levels of technological development and penetration (e.g., Germany, Austria, Netherlands) tend to have guests who are more confident with new technologies (Ali et al., 2024).

Table 8 presents the distribution of responses regarding hotel guests' opinions on finding smart rooms very useful and supporting their further development and progress across different countries. According to Aggarwal and Mittal (2024), Generally, people are quite open to adopting innovations. Smart rooms have demonstrated significant utility, especially in saving time, a feature highly valued by hotel guests. (Sun & Nasrullah, 2024).

Table 8: Perceived utility of smart rooms according to respondents

		I find smart rooms very useful and I support their further development and progress			
		Strongly agree	Partly agree	No change	Total
Country of hotel guests' origin?	Germany	36	42	3	81
	Austria	56	39	4	99
	Italy	14	15	0	29
	Croatia	21	23	3	47
	Slovenia	7	17	4	28
	Serbia	12	9	0	21
	Netherlands	44	43	15	102
	BiH	11	20	3	34
Total		201	208	32	441

Source: Authors' research

The chi-square test results, p-value of 0.013, suggest that there is no statistically significant association between these opinions and the country of hotel guests' origin (Table 9). This statement has proven very useful as it indicates that the concept of smart rooms is already becoming a standard in the hotel industry (de Lurdes Calisto & Sarkar, 2024).

Tables 10, 11, 12, 13, 14, and 15 display respondents' attitudes regarding optimismfactor.The Table 10 presents a comprehensive overview of guests' preferences regarding the idea of conducting business via computers and smart rooms, with a particular focus on the flexibility offered outside regular business hours. Some scientists, such as Avgoustaki & Cañibano (2024), agree that flexible working hours are crucial for improving efficiency in business. Looking at the research results, it can be concluded that the majority of respodents strongly support the notion of flexible business hours through smart rooms. The Table 12 provides insights into guests' perceptions regarding the impact of technology and smart rooms on their daily lives. The findings from the study support specific conclusions reached by Escandon-Barbosa et al. (2024). They suggest that smart rooms and technology offer increased flexibility in work hours, leading to reduced stress and a heightened sense of control over daily responsibilities (Haber & Carmeli, 2023).

The Table 14 presents the distribution of responses with the statement regarding the impact of technology and smart rooms on their efficiency in their occupation. The results are connected with increased incorporation of technology in workplaces and enhanced digital skills in observed countries.

The majority of guests across all countries acknowledge the positive influence of technology and smart rooms on their work efficiency.

Tables 11, 13, and 15 show a statistically significant variation in respondents' responses based on their country of origin, evidenced by p=0.000. This aligns with the conclusions drawn by Escandon-Barbosa et al. (2024), who argue that the accessibility of new technologies directly influences their adoption and utilization in business. This suggests that developed countries are more advantaged in this regard compared to less developed ones. Tables 16 through 21 present respondents' opinions on discomfort factor.The Table 16. suggests variations in guests' perceptions of the complexity of new high-tech products and services in smart rooms based on their country of origin. The results could indicate that an individual's perception of the complexity of technologies in smart rooms depends on their experience with these technologies, as well as the type of technology applied and how it is implemented in hotel rooms, rather than their country of origin (Orbaiz & Arce-Urriza, 2024). The results seen in Table 17 confirm the statement, given that p=0.300.

The Table 18 reveals varying perceptions among guests from different countries regarding feeling taken advantage of during technical support. As with the previous analysis, these results suggest that guests' responses regarding the support they received and their feelings about it are primarily influenced by their prior experiences with these situations rather than solely by their country of origin. The statistically significant association, indicated by the p=0.008, suggests that country of origin does not play a role in shaping these perceptions.

The Table 20 delves into guests' sentiments regarding their interactions with smart room technology, specifically exploring whether they sometimes feel that the smart room works —against them‖ as users. Countries with higher technological adoption and familiarity might experience frustration due to higher expectations from smart technology. Guests might expect seamless functionality, and any deviation can be perceived as the technology working against them. According to Downen et al. (2024), there is a substantial number of guests that feel that smart rooms work against them sometimes. When it comes to the results of Table 21, it can be concluded that there is statistical significance in the responses (p=0.000). There is a significant difference in how guests from different countries perceive the functionality of smart rooms, with some countries showing higher agreement with the statement than others.

Tables 22, 23, 24, 25, 26, and 27 display respondents' attitudes regarding the **Factor Insecurity.** Table 22 examines guests' attitudes toward the safety of providing credit card information over a computer. According to Ortiz et al. (2024) there's a significant difference in perception regarding the safety of giving out credit card information over a computer among guests from different countries. This variation can stem from cultural differences, varying levels of exposure to online transactions, or different experiences with cybersecurity (Chaudhary, 2024). For businesses, especially in the hospitality industry, this insight emphasizes the importance of providing multiple payment options and ensuring that all customers feel secure in the transaction methods offered. Recognizing and adapting to these perceptions can improve customer satisfaction and trust, particularly among international guests with diverse viewpoints on online payment security.

The Table 24 examines guests' confidence levels in conducting business with a place that can only be reached online. The result shows that perceptions towards online-only businesses are significantly influenced by the respondents' cultural or national background. This finding is crucial for businesses that operate online, as it highlights the importance of cultural sensitivity and the need for strategies tailored to different international markets.

The Table 26 examines guests' attitudes toward providing information to a machine or over the Internet. According to Oghazi et al. (2020) cultural attitudes towards data security and privacy can significantly influence trust levels. In countries like Italy, where privacy concerns are high, guests could be more sceptical about online information provision. Also, Guests from Bosnia and Herzegovina (BiH) and Netherlands intensely express lower level of trust, due to cultural attitudes towards privacy and higher concerns about data security. Guests from Croatia, Slovenia, and Serbia present mixed opinions indicating that various factors are influencing like in previous table analysis.

Tables 23, 25, and 27 reveal a statistically significant variation in respondents' answers based on their country of origin, with p=0.000.

This highlights a personalized approach to sharing personal information online, indicating that education and personal experience are more influential than general attitudes.

These findings support the initial hypothesis H, suggesting that the quality of hotel services in contemporary business environments directly depends on the ability to adopt innovations as a business strategy, impacting both supply and demand sides.

5.   Conclusion

This study focuses on how smart hotel room technologies are perceived by guests from different countries, and examines how they affect the quality of hotel offerings. The findings suggest that while there is a high level of engagement with these technologies among guests from Germany, Austria, the Netherlands, and Italy, there are significant differences in terms of confidence, skepticism, and overall acceptance.

Guests from Germany and the Netherlands are guests are generally very receptive to intelligent technologies and show strong preference for enhanced comfort and personalized experiences. Their high level of trust in online transactions indicates a comfort with digital interactions that hotel owners can take advantage of to improve guest experiences. Furthermore, they are clearly ready to adopt new technologies, and demonstrate considerable confidence in the use of features such as automated room controls and personalized service options in intelligent hotel environments.

Austrian guests have a mixed view, seeing the advantages of smart technologies but also being careful, especially when it comes to doing business online. This suggests they prefer a mix of traditional and tech-based services. Italian guests express concerns about the complexity and security of these technologies, particularly regarding online credit card transactions and privacy.

In contrast, guests from the Balkan countries, including Serbia, Croatia, Slovenia, and Bosnia and Herzegovina, exhibit more varied and generally lower levels of confidence in smart technologies. Their careful attitude shows how cultural and geographical factors affect the acceptance of new technologies, emphasizing the importance for hoteliers to use more customized strategies that respond to the specific concerns and expectations of these guests.

The study underscores the critical role of cultural sensitivity and the need for adaptive strategies in the hospitality industry. It highlights that the successful integration of smart technologies in hotels not only depends on the technological solutions themselves but also on how these technologies align with the diverse expectations and cultural backgrounds of hotel guests.

This analysis offers valuable insights for hoteliers aiming to enhance service quality through technology, and it helps deepen our understanding of the complex relationship between guest traits and their views on smart hotel rooms.By offering empirical data on how smart technologies affect hotel service quality when considered through the prisms of cultural diversity and technological acceptability, it also adds to the body of academic literature. This research will contribute to the development of more responsive, inclusive, and technologically advanced hotel experiences that appeal to a modern tourists as the hospitality sector develops.

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Dela Atanasija Nikolića – primer inženjerskog menadžmenta u praksi i liderstva za dobrobit društva

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Apstrakt: Imajući u vidu njegovu odlučnost da pokrene promene i ostvari zajedničke ciljeve, primenu inženjerskih principa i znanja, liderskih i administrativnih veština radi efikasnog upravljanja projektima i resursima može se reći da je Atanasije Nikolić pionir inženjerskog rukovođenja u Srbiji, u praksi. Atanasije Nikolić pripada generaciji srpskih intelektualaca koji su postavili temelje društvenog i ekonomskog sistema u Srbiji, u 19. veku. Na osnovu svog inženjerskog obrazovanja, liderskih veština i brojnih interesovanja Atanasije Nikolić je pokrenuo neke od ključnih projekata za razvoj infrastrukture, ekonomije, poljoprivrede, obrazovnog sistema i kulturnih institucija. Rad ima za cilj da pokaže kako posedovanje znanja, inženjerskog obrazovanja, volje i vizije može da pokrene promene u društvenom i ekonomskom razvoju. Prema njegovoj knjizi „Biografija verno svojom rukom napisana", tekstovima koji se odnose na njegov život i aktivnosti, kao primer primenjenog inženjerskog menadžmenta i liderskih veština prikazuju se postignuća Atanasija Nikolića i osvetljava njegov doprinos društvenom i ekonomskom uređenju. Na ovaj način, prikazuju se aktivnosti sprovedene kako bi se Kneževina Srbija brže organizovala i približila evropskim državama, ali i ističe značaj inženjerskog menadžmenta u praksi i liderstva za dobrobit društva.

Ključnereči: Atanasije Nikolić, Kneževina Srbija, inženjerski menadžment, liderstvo

Achievements of Atanasije Nikolić – an Example of Engineering Management in Practice and Leadership for the Benefit of Society

Abstract: Having in mind his determination to initiate change and achieve common goals, application of engineering principles and knowledge, leadership and administrative skills for effective project and resource management, Atanasije Nikolić can be considered a pioneer of engineering management in Serbia, in practice. He belongs to the generation of Serbian intellectuals that have laid the foundation of the social and economic system in the 19th century in Serbia, and with his engineering education, leadership skills and numerous interests, Atanasije Nikolić initiated some of the key projects for the development of infrastructure, economy, agriculture, educational system and cultural institutions. The paper aims to show how a person with engineering education, will and vision can initiate changes in social and economic development. According to his book "Biography faithfully written by his own hand", the texts related to his life and activities, this work shows the achievements of Atanasije Nikolić as an example of applied engineering management and leadership skills, and illuminates his contribution to the social and economic organization. In this way, the work shows the activities initiated so that the Principality of Serbia could be organized more quickly and get closer to European countries, but it also highlights the importance of engineering management in practice and leadership for the benefit of society.

Keywords: Atanasije Nikolić, Principality of Serbia, Engineering Management, Leadership

1. Introduction

The idea of engineering management education appeared at the beginning of the 20th century, when technology and management knowledge was needed in order to manage large industrial and government projects. Engineering management is a discipline that studies and applies engineering principles in operational and strategic management and nowdays could be applied in numerous fields such as production, industrial design, construction, information and telecommunication technologies. Simply put, it brings together the technological problem-solving, organizational and planning abilities in order

to oversee the performance of complex enterprises. Engineering management education covers topics that enhance the value of new graduates by teaching immediately applicable management skills (Pence & Rowe, 2012: 48).

However, if we remember the words of Henry G. Stott[1], that "Engineering is the art of organizing and directing people and controlling the forces and materials of nature for the benefit of the human race" (1907), then Atanasije Nikolić, who belongs to the generation of Serbian intellectuals that have laid the foundation of the social and economic system in the 19th century, is a pioneer of engineering management in Serbia, and moreover, with whom the significant study and application of science began, in the Principality of Serbia.

Many people nowdayshaven't heard much about AtanasijeNikolić (1803-1882), and his work dedicated to the development of the economy, education and infrastructure systems, state organization and cultural identity. A well educated man, comming from Bački Brestovac (Austro-Hungarian Monarchy at that time), with a strong sense of national identity, moral responsibility and inexhaustible energy, Atanasije Nikolić was the initiator of national key institutions, a professor and the first Rector of the Lyceum. He is one of the Society of Serbian Letters[2] founders, its regular member and an honorary member of the Serbian Learned Society. He also advocated the establishment of the National Library.

All of his work is driven by the idea of education in order to create a modern and cohesive society, with belief that the improvement of society depends on the spread of knowledge.

Picture 1: Atanasije Nikolić. (Source: Life and work of Serbian scientists, book 7. Serbian Academy of Sciences and Arts)

2.   A leader dedicated to the welfare of society

Leadership is "a process whereby an individual influences a group of individuals to achieve a common goal" (Northouse, 2008: 2), and can be seen as a process and a set of skills. As a process, it refers to the interaction with the group, initiating actions that bring the change. From the personality aspect, these are the qualities that allow him to convince the group. According to Katz's model, leadership skills include technical foundation, social orientation and conceptual ability. The first type of skills refers to the possession of knowledge, the second is focused on people and the ability to see their perspectives, and the third is on ideas, the ability to create visions and strategies (Northouse, 2008: 29).

Atanasije Nikolić was a man of technical skills, social orientation and conceptual ability, above his time, he initiated various projects that created new development directions. In many fields, Atanasije Nikolić was the first in Serbia, one of the first educated Serbian engineers, the initiator of engineering education, builder of modern roads. He has great merits for technological development, he made several melioration canals, according to his projects the first hard-surfaced roads in Serbia were built and the route of the main "Constantinople Road" was diverted through the Morava valley. Three decades before the appearance of the first railway in Serbia, he explored the terrain and made plans for the future railway.

Academic teaching and education in the fields of civil engineering and geodesy in Serbia began in 1846, when the Engineering School was established, as a part of the Belgrade Lyceum. Atanasije Nikolić was the founder of the Engineering School, and among the courses there were Practical Surveying,

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1 American engineer, American Institute of Electrical Engineers (AIEE) president from 1907 to 1908.

2 From which Serbian Academy of Sciences and Arts was later formed.

Mechanics, Architecture, Drawing and German Language.[3]

He founded the first art schools - the Drawing School in Novi Sad and the Music School in Kragujevac, the first Agricultural School in Topčider, he also founded the first textile workshop for the production of blankets and cloth in Topčider, the first schools for assistant engineers, schools for apprentices which worked on Sundays and were the forerunners of national and workers' universities (Sarić, 2001: 3). Systematically, he approached the creation of a Serbian technical dictionary, so that natural sciences could be taught in Serbian language. He started the first urban planning works in Serbia, drew up plots of land in Vračar, drained Topčider, planted a forest and a park, and founded a nursery garden. The formation of the park began in 1842 and it was the first Serbian park system based on European models of the palace complex - the Residence of Prince Miloš (Milošev konak) was designed to look natural, but still cultivated (Ćorović and Blagojević, 2012: 53). He worked on hydrotechnical projects, land reclamation projects, dams and embankments.

Also, he is reformer of Serbian agriculture. His merits are the first scientific and applied works on soils in Serbia. He is the founder of the first Agricultural School, in Topčider in 1853. He organized courses for peasants, wrote textbooks and started magazines in this field, in the Serbian language. He wrote the first books on agriculture (Agriculture, Farming, Viticulture, Fruit and Forestry, Cattle Breeding), and he even started publishing the first agricultural magazine (Uncle Srećko) with the articles and advices for farmers how to maintain their households, but this literature often did not even reach the audience it was intended for. The Agricultural School was abolished, but the agricultural and chemical experimental station was founded there in 1898. The first fertilization experiments in Serbia, meteorological measurements, production of seedlings, animal husbandry breeding, innovations in fruit growing, viticulture and afforestation began there (Životić, 2023: 63).

He was engaged in military and state affairs. While working in the civil service, he introduced worker's books, made the postal service independent, and wrote the rulebook for police officers. He is responsible for casting the first cannon in Serbia, founded the first workshop for the production of ammunition in Belgrade, and participated in several confidential diplomatic missions. He advocated for the establishment of the Topolivnica in Kragujevac. On the proposal of Ilija Garašanin, the State Council agreed and in 1848, the Topolivnica (cannon foundry) was opened in Belgrade. Atanasije Nikolić, as the first highly educated expert in Serbia, was engaged in the production of weapons.[4]

When he was appointed as the first Rector of the Lyceum, in addition to teaching and school administration, his task was actually to create the first higher education institution, from the procurement of accessories, the furnishing of the classrooms, to the making of the seal. He created the first graphic designs for the seals of the Society of Serbian Literature and the Lyceum (Đurić, 2020: 58).

Picture 2: Proposal for the seal designed by AtanasijeNikolić. (Source: Serbian Academy of Sciences and Arts)

As a trained artilleryman-engineer, he participated in the design of the defense belt along the rivers Danube (1849) and Sava (1854). He spoke German, Russian, and Hungarian, procured weapons and carried out diplomatic missions for the Principality of Serbia (Sarić, 2001: 3).

That he was a man of inexhaustible ideas and a wide range of interests could be seen in his commitment

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3 The studies lasted three years, and the Decree on establishment of the school stated: "In this school, the theory in the above sciences will be taught during winters, and during summers the students will be used together with engineers in measurements and construction of buildings and roads for the purpose of practical training, thereby supervising and implementing construction plans of various structures". (University of Belgrade, Faculty of Civil Engineering (2015) Available at: https://www.grf.bg.ac.rs/p/docs/informatori/brochure_about_the_faculty_1442307536595.pdf).

4 The first casts were not of good quality, and help was sought from abroad. First from Belgium, when also the first steam engine arrived in Serbia. Then, according to the decision of Prince Aleksandar Karađorđević from 1851, the foundry moved to Kragujevac. Through the efforts of Ilija Garašanin, Charles Loubrieu, the supervisor of a private foundry in Paris, came from France, and the first successfully cast cannons were from 1853. The first foundry building was built between 1851 and 1853 and was destroyed due to groundwater. The new building was built on the foundations of the old one, reminiscent of the original. In 1953 the building was placed under the protection of the state as a cultural asset of great importance. The foundry ceased operations in 1968, and since 1973 there has been a factory museum, called the Old Foundry.

to theater, literature and publication work. At his suggestion, St Sava became a school patron[5]. Along with Joakim Vujić and Jovan Sterija Popović, he laid the foundations of Serbian theatre. He organized the first performances in Novi Sad in the twenties of the 19th century. He founded the first theater in Belgrade, the "Đumruk" Theater in 1841, and the Theater "Kod Jelena" in 1847. He wrote several plays, with themes from Serbian history and motives from national literature. In some plays, he even acted. He published calendars and two books of Serbian folk tales (Đurić, 2020: 60). With his works, he revives the tradition and contributes to the maintenance and renewal of Serbian culture in the rebellious XIX century (Ivanović, 2020: 101).

Through creativity and persistence, decisions made, plans realized and actions implemented, the above achievements of Atanasije Nikolić show what kind of infrastructural, economic, organizational, security, educational and cultural changes could be initiated by management based on engineering education and principles, motivated by a vision and focused on a development strategy.

3. Life path according to his own words and deeds

Atanasije Nikolić was born in Bački Brestovac in 1803, in a merchant family. The period of his education was marked by poverty and perseverance, he started school in Sombor, studied high school in Sremski Karlovci, Novi Sad and Gyor. He attended the Artillery School in Vienna, and passed his engineering exams in Budapest. In addition to his excellent success, he knew that in Vienna "without protection" he would not advance, that the highest he could reach on the military ladder, despite all his efforts, was the rank of sergeant. For a time he worked as professor at a private drawing school in Novi Sad. The first drawing school in Novi Sad he founded in 1824. When he was confirmed as an "Engineer" by the University of Budapest (1829), he worked voluntarily on engineering jobs. Despite all the troubles, he worked dedicatedly, but didn't get a job as a regular engineer. Seeing that he could not progress significantly there either, he left and briefly served on the estate of Count Petar Čarnojević near Arad. When he finally got a well-paid job as an engineer in Munkač (Mukačevo, Ukraine) on the estate of Count Schönborn, he received an invitation from the Ministry of Education of the Principality of Serbia to become a professor at the newly opened Lyceum in Kragujevac. At the crossroads, he immediately chose the road to Serbia, but didn't dare to leave until he could organize the trip and relocation. He moved to Serbia with his family in 1839. He was appointed professor of Mathematics and Surveying at the Lyceum. He wrote the first high school textbooks for his subjects Algebra and Elementary Geometry, in Serbian.

Picture 3: Title pages of the textbooks Algebra and Elementary Geometry, by Atanasije Nikolić (Source: Life and work of Serbian scientists, book 7. Serbian Academy of Sciences and Arts)

Soon, he was appointed Rector of the Lyceum. The progress of the institution he led was visible. With this, he won the favor of the authorities, especially Ilija Garašanin, which will soon separate him from his professorship. After the Lyceum moved from Kragujevac to Belgrade, Nikolić became the Head of the Ministry of Internal Affairs (which included the state administration, the army, health and the economy).

His contribution to the state administration was great, but it also meant less time for teaching and scientific activities. Nevertheless, Nikolić remains consistent with his engineering and educational vocation. Together with Jovan Steria Popović, he participates in the founding of the Society of Serbian

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5 He organized the first school celebration of St. Sava in Serbia, which was coordinated with the beginning of the celebration of St. Sava in Matica srpska in 1839 (Đurić, 2020: 58).

Letters in 1841. The first Engineering school in Serbia, founded by him, operated from 1846 to 1849. He invested numerous ideas and activities in the development of agriculture in Serbia. During 1852, he traveled around European countries, studied their agriculture and agricultural schools. Upon his return, he founded the Agricultural School and carried out the first crossbreeding of foreign cattle breeds with domestic ones. He advocated the planting of mulberry trees, one of his ideas was to raise silkworms and produce silk. However, there are no more mulberries, some of his efforts did not last long, because they were not recognized as an interest of the community.

3.1. Service in the state administration

Service in the state administration and dealing with politics is the fate of numerous Serbian scientists. As a confidant of Ilija Garašanin, he engaged in the welfare of the Serbian state and society. As a connoisseur of opportunities from both the banks of the Sava and the Danube, and with the national interest always on his mind, he played a major role in organizing the crossing of volunteers from Serbia to Vojvodina (1848), as well as in the procurement of weapons on the orders of Ilija Garašanin (1862), for the needs of the Principality of Serbia.

During his time, the Obrenović and Karađorđević dynasties alternated, he had many obsticles on his way, but political changes did not hinder him from working on the development of the country.

"Friends have always told me that I should not do so much for the common good, that no one would thank me for it; but I am passionately busy with the improvement of Serbia, so I could not do otherwise, and I always have a habit of answering them: I know that the world rewards hard work with ingratitude, I know that ingratitude awaits me, but I will do my duty, no matter what happens to me" (Nikolić, 2002: 138).

Some of his efforts were not long-lasting, due to the resistance in accepting the initiatives, they did not even reach the broad masses of the people. Although he was aware of this, he did not hesitate for a single moment in his attitudes and actions. Consequently, his achievments laid the foundations for the development of Serbian statehood, they remain to nowdays and are part of the cultural heritage.

3.2. Persistence, intellectual courage and soft skills of a leader

"The paths of reconciliation, collective and individual investment in the shaping of a new cultural era, were impassable. Thanks to persistence and extraordinary intellectual courage, as well as restraint, to put obstacles, ridicule and patriarchal reluctance to accept changes into the background, Atanasije Nikolić managed to rise above his environment and his time" (Stefanović, 2004: 109). His journey to and through Serbia can be an example, what people who care about social interest have to put up with. However, numerous activities of Atanasije Nikolić also show that for a leader there is no other choice than persistence in the effort to implement changes and work on development.

Leadership also matters for economic outcomes. By promoting their economic values, leaders play an active part in shaping their environment (Arvate & Story, 2024: 17). Leaders who believe in their own strength, know how to recognize the potential in the environment and work on it, consequently achieve success in their endeavours.

Leadership involves decision making and requires competencies known as soft skills, such as visioning, communication, honesty, integrity, continuous learning, courage, tolerance, and creativity (Riley et al., 2008: 143) "Engineering is the professional art of applying science to the optimum conversion of natural resources to the benefit of man" (Smith, 1962). Atanasije Nikolić with all his diverse interests is an example of a leader with a vision, as well as integrity, continuous learning, courage, tolerance, and creativity, who initiated change in his environment. Not paying much attention to attacks and obstacles, Atanasije Nikolić did not waste energy and time on irrelevant things. Aware of the importance of the moment and the role entrusted to him, he worked on a broad plan with the aim of general progress. His dedication to scientific and educational work in Serbia in 19th century, cultural identity, economic and social progress, may be temporarily silenced, but is still there as a guide for harmonizing collective and personal development.

4. Conclusion

Many people nowdays haven't heard much about Atanasije Nikolić, and his work dedicated to the development of state organization and cultural identity. Liberation heroes are often in the foreground. However, example of Atanasije Nikolić and his projects implemented with the aim of economic, infrastructural, educational system development show that leadership skills and engineering management can initiate progress and changes in society, for the common benefit and development in future. Therefore, his example is a kind of heroism that should be pointed out to the generations to come.This paper draws attention to the achievements of Atanasije Nikolić and importance of leadership and engineering management in practice.

Following examples like Atanasije Nikolić, who did not hesitate, in education, in personal development for the purpose of general well-being, can be useful for today's man, in overcoming the problems that arise every day. In a society where authorities and boundaries are collapsing, examples like Atanasije Nikolić are more than instructive and necessary. It shows how knowledge in technology and management could be useful, initiate changes and bring development in education, infrastructure, economy and agriculture, state administration and even lay the foundations of cultural and scientific institutions.

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[6] Institution and E-mail address [in this stage leave it empty for the peer review purpose]

Summary in Serbian: This document is a template for formatting the papers in order to prepare them for printing. This summary provides briefly the information related to the content of the article so that the reader can rapidly and accurately assess its relevance. Authors should explain the goals of research or state the reason (reasons) why they have written the article. Then, it is necessary to describe the methods used in the study and briefly describe the results they have obtained in the research. The abstract should be between 100 and 250 words long.

Keywords: 3-5 keywords for indexing and search purposes

Title of Paper in English

Abstract in English: This document presents a template for preparing the print-ready papers thatwill be included in the Serbian Journal of Engineering Management. The abstract briefly summarizes the article and gives the reader the opportunity to assess its relevance. The authors should elaborate the goals of the research or state their reason (reasons) for writing the paper. It is additionally required for them to describe the methods used during the research and give a brief description of the results and conclusions of the research. The abstract should be between 100 and 250 words long.

Keywords: 3-5 keywords for indexing and search purposes

2. Introduction

The paper should be written using MS Word for Windows (on Serbian Cyrillic, Latin or English – UK keyboard). The length of work should not be more than 10 pages including text, diagrams, tables, references, and appendices.

The format is **A4**. Use **2 cm** for the lower and upper margin and **2.5 cm** for the left and right margin. The spacing within one paragraph should be one (single), while the spacing between paragraphs is double. To format the text, it is recommended to use font Times New Roman.

3. Structure of the paper

In the first line of the first page the title should be written in Serbian language (16 pt). Under the title of the paper the spaces for name(s) of the author and the names of the author's institutions should be indicated as specified and aforementioned in this Guideline. After the space for the institution of the last author, leave one blank line and write the short summary (10 pt) in Serbian. After the summary, provide an overview of key words. After the paper title you indicated, include the summary and key words in the Serbian language, whereas they should be indicated in English like above.

Numbered subtitles of the first level must be formatted using the font 12 pt bold, a second-level sub-titles should be 10 pt bold. The text, and a list of references should be formatted using the font 10 pt.

4. Graphs, tables and formulae

All illustrations, regardless of whether they are diagrams, photographs or charts are referred to as images. The name and number of images should be displayed as centred.

Figure 1: Accommodation units according to the structure of hotel capacities in 2011 and 2012, written in the form of percentage
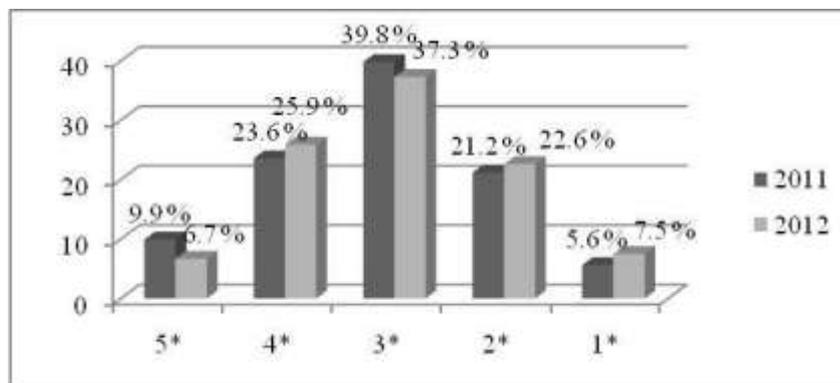
Source: (The Ministry of Finance and Economy, 2013)

The title and number of the table should be presented above the table as centred

Table 1: Accommodation units according to the structure of hotel capacities in 2011 and 2012, written in the form of percentage

Category	2011	2012	Number of accommodation units (2011)	Number of accommodation units (2012)
5*	9,9	6,7	1452	990
4*	23,6	25,9	3486	3911
3*	39,8	37,3	5895	5636
2*	21,2	22,6	3102	3420
1*	5,6	7,5	1133	1132
total	100	100	15068	15089

Source: (The Ministry of Finance and Economy, 2013)

Submit your article, including tables, images, etc., as a single file. In addition, you should submit all figures and tables (which are entered in black and white) as separate files in TIFF or JPF format with a minimum resolution of 300dpi.

Formulae should be centered on the page and properly numbered, as in the following example. It is recommended that you format the rows with formulae in Microsoft Word (using MathType).

$$PVo = \frac{FVn}{(1+i)^n}$$

(1)

5. Conclusion

In conclusion, the authors should summarize the results they have obtained in the research.

6. Literature

When quoting the literature, the APA referencing system should be used. For more information, see the Publication Manual of the American Psychological Association (6th ed.).

When quoting within the text, as in the sentence where you mention the author and specify his words, then after the author's name you should indicate the year of publication of the quoted text in parentheses, at the end of the sentence there should be the number of page in which the text should be indicated: according to Čerović (2012) ,,quoted text''(p.10). When the author is not mentioned in the sentence, then his last name, the year of publication and the number of page should be indicated in parentheses at the end of a sentence, and if the quote was created by paraphrasing or summarizing, then data about the page number is not required: (Čerović, 2012). If there are two or more references by the same author, but they were published at the same time in the same year, the referencing should look like this (Harish, 2008a; Harish, 2008b). When two authors wrote the paper together, the surnames of both authors are written as follows (Petković and Pindžo, 2012), or (Tew & Barbieri, 2012). The call for references in the text requires working with more than two authors and should be stated as follows (Luque-Martinez et al., 2007). When citing a source that does not show the number of pages (such as electronic sources) use the author's name and year of publication if the author is known, and if the author is a corporation or an organization, write down the organization name and year of publication (Ministry of Finance and Economy, 2013).

References should be given at the end of the main text in alphabetical order, following the last name of the author. Below are shown examples of using APA style for citations appearing in various forms (books, journal articles, proceedings, electronic resources, etc.).

A book with one author:
Example: Hrabovski, Tomić, E. (2009). *Health tourism destinations.* Novi Sad: Prometheus.

A book with several authors:
When you have multiple authors, all of them are supposed to be mentioned, but as soon as the last surnames are added and if there are more than seven authors, mention the first six and then write … at the end of the last author.

Example: Barrows, C. & W. Powers, T. (2009). *Introduction to the Hospitality Industry.* 7th edition. Hoboken, New Jersey: John Wiley & Sons, Inc.

A book which was translated from a foreign language:
Example: Spic, E. H. (2011). *Art and psyche: a study of psychoanalysis and aesthetics.* (A. Niksic, prev.). Belgrade: Clio.

A book with an editor for a collection of papers; proceedings:
If the book is a collection of papers on the appropriate topic, the authors should mention the editor of their work with the surname and first initial in parentheses as they add "edit" if the person is editor, or "Ed." as editor if the book is written in a foreign language.

Example: Đurković, M. (ed.) (2007). *Serbia 2000-2006: state, society, economy, Belgrade:* Institute for European Studies.

Papers in the proceedings:
Example: Cerovic, S. (2012). *Modern concepts of strategic tourism destination management.* Scientific conference with international participation "Tourism: Challenges and Opportunities", Trebinje.

Papers published in the journal by one author:
Example: Harish, R. (2008). Brand Architecture and its Application in Strategic Marketing. *The Icfai University Journal of Brand Management,* 7 (2), 39-51.

Papers in a journal with two authors:
If the article to which you refer has a DOI number, references need to be added.

Example: Tew, C. Barbieri, C. (2012). The perceived benefits of agritourism: The provider's perspective. *Tourism Management*, 33 (6), 215-224. doi: 10.1016 / j.tourman.2011.02.005

Papers in a journal with more than two authors:
Example: Luque-Martinez, T. Castaneda-Garcia, A. J., Frias-Jamilena, D. M., Munoz-Leiva, F. & Rodriguez-Molina, M. A. (2007). Determinants of the Use of the Internet as a Tourist Information Source. *The Service Industries Journal*, 27 (7), 881 to 891. doi: 10.1080 / 02642060701570586

Newspaper article with the aforementioned author:
Example: Muscle, M. (days 1 February 2012). US Steel has reduced its losses. *Politika,* p. 11

Newspaper article with no author specified:
Example: Straževica ready in two months. (Days 1 February 2012). *Politika,* p. 10

Thesis in the printed version:
Example: Dewstow, R. A. (2006). *Using the Internet to enhance teaching at the University of Waikato* (Unpublished master's thesis). University of Waikato, Hamilton, New Zealand.

Document or database from the Internet, the private or official web page for which we know the database author:
Example: Kraizer, S. (2012). Safe child. Retrieved on 29 October 2012, from http://www.safechild.org/

Document or databases from the Internet, the official web page for which we do not know the author:
Example: Penn State Myths. (2006). Retrieved December 6, 2011, from http://www.psu.edu/ur/about/myths.html

Document or databases from the Internet, private or official web page where the author is a corporation or organization:
For example, the Ministry of Finance and Economy. (2013). Information on tourist traffic in Serbia. Retrieved on 06 February 2013 from http://www.turizam.mfp.gov.rs/index.php/sr/2010- 02-11-17-24-30

The sources which were not used in the paper should not be included in the list of references. References should be cited in the language in which they are published without translating them into the language of paper.

Obrazac za pripremu radova za objavljivanje u časopisu
Serbian Journal of Engineering Management

Naslov rada na srpskom jeziku

Ime Prezime[1]*, Ime Prezime[2], Ime Prezime[3] [ostavite u ovoj verziji prazno za potrebe recenzije]

[1] Institucija i i-mejl adresa [ostavite u ovoj verziji prazno za potrebe recenzije]
[2] Institucija i i-mejl adresa [ostavite u ovoj verziji prazno za potrebe recenzije]
[3] Institucija i i-mejl adresa [ostavite u ovoj verziji prazno za potrebe recenzije]

Apstrakt: Ovaj dokument predstavlja obrazac za formatiranje radova tako da izgledaju kao da su već spremni za štampu. Sažetak predstavlja kratak informativni prikaz sadržaja članka koju čitaocu treba da omogući brzu i tačnu ocenu njegove relevantnosti. Autori treba da obrazlože ciljeve istraživanja ili navedu razlog (razloge) zbog koga pišu članak. Zatim, potrebno je da opišu metode korišćene u istraživanju i ukratko opišu rezultate do kojih su došli u istraživanju. Sažetak treba da sadrži od 100 do 250 reči.

Ključne reči: 3-5 ključnih reči za indeksiranje i pretraživanje

Title of Paper in English

Abstract: This document presents a template for preparing the print-ready papers that will be included in the Serbian Journal of Engineering Managment. The abstract briefly summarizes the article and gives the reader the opportunity to assess it's relevancy. The authors should elaborate the goals of the research or state their reason (reasons) for writing the paper. It is additionally required for them to describe the methods used during the research and give a brief description of the results and conclusions of the research. The abstract should be between 100 and 250 words in lenght.

Keywords: 3-5 keywords

1. Uvod

Rad pisati koristeći MS Word za Windows (tastatura za srpsku ćirilicu, latinicu ili engleski jezik - UK). Dužina rada treba da bude najviše 10 strana uključujući tekst, slike, tabele, literaturu i ostale priloge. Format stranice je **A4.** Koristite **2 cm** za donju i gornju marginu, a **2,5 cm** za levu i desnu marginu. Razmak izmeĆu redova u okviru jednog pasusa je jedan, dok je razmak izmeĆu paragrafa dvostruki. Za formatiranje teksta preporučuje se korišćenje fonta **Times New Roman.**

2. Struktura rada

U prvom redu na prvoj strani treba napisati naslov rada na srpskom jeziku (16 pt). Ispod naslova rada treba ostaviti mesto za navoĆenje ime(na) autora, nazive institucija autora onako kako je naznačeno u ovom Obrascu. Nakon institucije poslednjeg autora, ostaviti jedan prazan red i u sledećem napisati kratak sažetak (10 pt). Nakon sažetka sledi pregled ključnih reči. Nakon prikazanog naslova rada, sažetka i ključnih reči na srpskom jeziku, potrebno je i na engleskom jeziku naznačiti prethodno navedeno.

Numerisane podnaslove prvog nivoa treba formatirati korišćenjem fonta 12 pt boldovano, a podnaslove drugog nivoa 10 pt boldovano. Tekst, kao i spisak literature treba formatirati korišćenjem fonta 10 pt.

3. Grafički i tabelarni prikazi i formule

Sve ilustracije, bez obzira da li su dijagrami, fotografije, grafikoni nazivaju se slike. Naziv i broj slike treba prikazati na sredini reda iznad slike.

Slika 1: Procentualno učešće smeštajnih jedinica u strukturi hotelskih kapaciteta u 2011. i 2012. godini
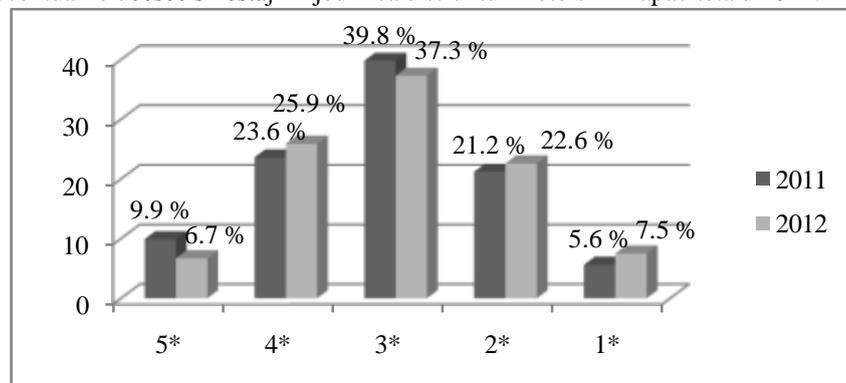
Izvor: (Ministarstvo finansija i privrede, 2013)

Naziv i broj tabele treba prikazati iznad tabele na sredini reda.

Tabela 1: Procentualno učešće smeštajnih jedinica u strukturi hotelskih kapaciteta u 2011. i 2012. godini

Kategorija	2011.	2012.	Broj smeštajnih jedinica (2011)	Broj smeštajnih jedinica (2012)
5*	9,9	6,7	1452	990
4*	23,6	25,9	3486	3911
3*	39,8	37,3	5895	5636
2*	21,2	22,6	3102	3420
1*	5,6	7,5	1133	1132
ukupno	100	100	15068	15089

Izvor:(Ministarstvo finansija i privrede, 2013)

Pošaljite svoj rad, uključujući tabele, slike itd, kao jednu datoteku. Pored toga, treba dostaviti sve slike i tabele (koje se unose u crno-beloj tehnici) kao posebne fajlove u JPF ili TIFF formatu sa najmanje 300dpi rezolucije.

Formule treba centrirati na stranici sa numeracijom, kao u narednom primeru. Preporučuje se formatiranje redova sa formulama u Microsoft Word-u (MathType).

$$PVo = \frac{FVn}{(1+i)^n} \qquad (1)$$

4. Zaključak

U zaključku autori treba da sumiraju rezultate do kojih su došli u istraživanju.

Literatura

Prilikom navoĆenja literature, treba se pridržavati uputstva APA sistema navoĆenja literature. Za više informacija pogledajte *Publication Manual of the American Psychological Association* (6th ed.).

Prilikom citiranja unutar teksta, kada u rečenici spominjete autora i navodite njegove reči, onda posle imena autora treba navesti godinu izdanja citiranog teksta u zagradi, a na kraju rečenice potrebno

je navesti broj strane na kojoj se nalazi rečenica u tekstu iz koga navodite: prema Čeroviću (2012), „citirani tekst― (str.10). Kada se autor ne spominje u rečenici onda njegovo prezime, godinu izdanja rada i broj strane u radu navesti u zagradi i na kraj rečenice, a ako je citat nastao parafraziranjem ili rezimiranjem, onda podatak o broju strane nije neophodan: (Čerović, 2012). Ukoliko se navodi dve ili više referenci istog autora, a pri tom su objavljene u istoj godini, poziv na reference treba navesti na sledeći način (Harish, 2008a; Harish, 2008b). Kada su dva autora rada, navode se prezimena oba autora na sledeći način (Petković i Pindžo, 2012), odnosno (Tew &Barbieri, 2012). Poziv na reference u tekstu za radove sa više od dva autora treba navesti na sledeći način (Luque-Martinez i sar., 2007). Kada citirate izvor koji ne prikazuje broj strana (kao što su elektronski izvori) koristite prezime autora i godinu objavljivanja, ukoliko je autor poznat, a ukoliko je autor korporacija ili organizacija, naziv organizacije i godinu objavljivanja (Ministarstvo finansija i privrede, 2013).

Reference treba navesti zajedno na kraju glavnog teksta azbučnim redom po prezimenu autora. U nastavku su prikazani primeri korišćenja APA stila za citiranje u raznim oblicima pojavljivanja (knjiga, rad u časopisu, zbornik, elektronski izvori itd.).

Knjiga sa jednim autorom:
Primer: Hrabovski, Tomić, E. (2009). *Destinacije zdravstvenog turizma.* Novi Sad: Prometej.

Knjiga sa više autora:
Kada imamo više autora navodimo ih sve, s tim što pre poslednjeg prezimena dodajemo i, odnosno &, ako imamo više od sedam autora, navodimo prvih šest, zatim pišemo pišemo tri tačke, i na kraju poslednjeg autora.

Primer: Barrows, C. W. & Powers, T. (2009). *Introduction to the Hospitality Industry.* 7th edition. Hoboken, New Jersey: John Wiley&Sons, Inc.

Knjiga, prevod dela:
Primer: Spic, E. H. (2011). *Umetnost i psiha: studija o psihoanalizi i estetici.* (A. Nikšić, prev.). Beograd: Clio.

Knjiga sa urednikom ili prireĐivačem, zbornik radova:
Ako je knjiga zbornik radova na neku odgovarajuću temu, kao autora navodimo priređivača tog dela i uz njegovo prezime i inicijal imena u zagradi dodajemo "ured." ako je urednik, ili "prir." ako je priređivač, ili pak "Ed." kao editor ako je knjiga pisana na stranom jeziku.

Primer: Đurković, M. (ured.) (2007). *Srbija 2000-2006: država, društvo, privreda, Beograd:* Institut za evropske studije.

Rad u zborniku radova:
Primer: Čerović, S. (2012). *Savremeni koncepti strategijskog upravljanja turističkom destinacijom.* Naučni skup sa međunarodnim učešćem "Turizam: izazovi i mogućnosti",Trebinje.

Rad u časopisu sa jednim autorom:
Primer: Harish, R. (2008). Brand Architecture and its Application in Strategic Marketing. *The Icfai University Journal of Brand Management,* 7(2), 39-51.

Rad u časopisu sa dva autora:
Ako članak na koji se pozivate ima DOI broj, treba ga dodati referenci.

Primer: Tew, C. &Barbieri, C. (2012). The perceived benefits of agritourism: The provider's perspective. *Tourism Management,* 33(6), 215-224. doi:10.1016/j.tourman.2011.02.005

Rad u časopisu sa više od dva autora:
Primer: Luque-Martinez, T., Castaneda-Garcia, J. A., Frias-Jamilena, D. M., Munoz-Leiva, F. & Rodriguez-Molina, M. A. (2007). Determinants of the Use of the Internet as a Tourist Information Source. *The Service Industries Journal,* 27(7), 881-891. doi: 10.1080/02642060701570586

Članak iz novina sa navedenim autorom:
Primer: Mišić, M. (1. feb. 2012). Ju-es stil smanjio gubitke. *Politika,* str. 11.

Članak iz novina bez navedenog autora:
Primer: Straževica gotova za dva meseca. (1. feb. 2012). *Politika,* str. 10.

Teza-štampana verzija:
Primer: Dewstow, R. A. (2006). *Using the Internet to enhance teaching at the University of Waikato* (Unpublished master's thesis). University of Waikato,Hamilton, New Zealand.

Dokumenta ili baze podataka sa interneta, privatne ili zvanične internet stranice kojima se zna autor:

Primer: Kraizer, S. (2012). *Safe child*. preuzeto 29. oktobra 2012, sa http://www.safechild.org/

Dokumenta ili baze podataka sa interneta, zvanične internet stranice kojima se ne zna autor:
Primer: *Penn State Myths*. (2006). Preuzeto 6. decembra 2011, sa http://www.psu.edu/ur/about/myths.html

Dokumenta ili baze podataka sa interneta, privatne ili zvanične internet stranice kojima je autor korporacija ili organizacija:
Primer: Ministarstvo finansija i privrede. (2013). *Informacije o turističkom prometu u Srbiji.* preuzeto 06. februara 2013. sa http://www.turizam.mfp.gov.rs/index.php/sr/2010-02-11-17-24-30

Izvori koji nisu korišćeni u radu ne treba da se nalaze u popisu literature. Reference treba navoditi na jeziku na kome su objavljene bez prevođenja na jezik rada.

Instructions for Authors

The Journal Committee strives to maintain the highest academic standards. The submitted papers should be original and unpublished until now. Also, it is forbidden that papers are in the process of reviewing in some other publication.

The papers would be subjected to check. The paper should fit the outlined academic and technical requirements.

Paper Types

Original unpublished scientific paper:
- Original scientific paper;
- Plenary lecture and paper presented at the conference;
- Review paper;
- Scientific review; discussion.

Original unpublished professional paper:
- Original professional paper;
- Contribution
- Book review.

Papers may be written in Serbian and English for authors from Serbia and the region or English for authors from other countries.

Submitted papers must be in alignment with guidelines for authors. In case they have not followed these guidelines, they would be reviewed for correction.

All manuscripts are subject to *double blind review*, i.e. the process of double ―blind‖ anonymous reviewing. The papers must not contain any references which may indicate the author(s).

Paper Submission

Authors should send their papers via email casopis@fim.rs in .doc or .docx format.

The application consists of two separate attachments:
- Attachment 1, which contains the following data: the title of paper, author's name (without professional title), institution and address (email, postal address, phone number), as well as the asterisk next to the author in charge of correspondence;
- Attachment 2, which contains the paper with the following elements: paper title, abstracts, key words, the middle part of the paper, tables, graphs, references and attachments.

Authors, who pass the *double blind* anonymous review, will receive the document called the Author's Statement of Originality, which will be filled in, underlined, scanned and sent to the email: casopis@fim.rs.

Paper content

All papers should contain: introduction, which elaborates on the aim and subject of the research, main hypothesis, work methods and paper structure; middle part of the paper where research is outlined (it is further divided into sub-headings) and conclusion, which represents summed up results and implications for further research.

Author's rights

After accepting the paper and signing up the Author's Statement of Originality, the author signs the statement according to the Author's Rights of the Journal.

Author's editions

Authors of published papers will receive one print version of the paper for their personal usage.

Paper submissions:

Papers should be submitted via email: casopis@fim.rs.

Uputstvo za autore

Uredništvo časopisa nastoji da održi visok akademski standard. Radovi, koji se podnose, treba da budu originalni i do sada neobjavljeni. TakoĊe, radovi ne smeju da se nalaze u postupku recenzije u nekom drugom časopisu. Radovi će biti podvrgnuti proveri. **Tekst rada mora da odgovara akademskim i tehničkim zahtevima.**

Tip rada

Originalni naučni rad, koji nije objavljen:
* Originalni naučni rad;
* Plenarno predavanje i rad prezentovan na konferenciji;
* Pregledni rad;
* Naučna kritika, odnosno polemika.

Originalni stručni rad, koji nije objavljen:
* Stručni rad;
* Informativni prilog;
* Prikaz knjige.

Jezici radova mogu biti srpski i engleski za autore iz Srbije i engleski za autore sa drugih govornih područja.

Podneti radovi moraju biti usaglašeni sa uputstvom za autore. U slučaju da nisu usaglašeni, biće vraćeni na ispravljanje.

Svi rukopisi podležu tzv. *double blind* recenziji, odnosno procesu dvostruko „slepe―, anonimne recenzije. Tekst rada ne sme da sadrži bilo kakve reference koje mogu da ukažu na autora/e rada.

Prijava radova

Autori treba da pošalju svoje radove elektronski, putem i-mejla casopis@fim.rs u vidu priloga u .doc ili .docx formatu.

Prijava se sastoji iz dva odvojena priloga:
* Prilog 1, koji sadrži sledeće podatke: naslov rada, imena autora (bez titula i zvanja), institucija/e i adresa/e (i-mejl, poštanska adresa, broj telefona), kao i zvezdicu kod imena autora koji je zadužen za korespondenciju;
* Prilog 2, koji sadrži rad sa sledećim elementima: naslov rada, apstrakt/i, ključne reči, središnji deo rada, slike, tabele, grafikoni, reference, prilozi;

Autorima, koji proĊu dvostruko anonimnu recenziju, biće poslat dokument Izjave autora o originalnosti rada, koji će popuniti, potpisati, skenirati i poslati na i-mejl casopis@fim.rs.

Sadržaj rada

Svi rukopisi treba da sadrže: uvod, koji čine cilj i predmet istraživanja, osnovna hipoteza, metode rada i struktura rada; središnji deo rada u kome se prikazuje istraživanje (dalje podeljen na potpoglavlja) i zaključak, koji predstavlja sumiranje rezultata istraživanja kao i implikacije za dalja istraživanja.

Autorska prava

Po prihvatanju rada i potpisivanje izjave o originalnosti, autor potpisuje izjavu kojom prenosi autorska prava na Časopis.

Autorski primerci

Autori publikovanih radova će dobiti primerak štampane verzije časopisa za lično korišćenje.

Dostavljanje radova:

Radovi se dostavljaju putem i-mejla casopis@fim.rs.

List of Reviewers/Spisak recenzenata

Editorial Board concluded this issue on July 1, 2025.
Uređivački odbor je zaključio ovaj broj 1. jula 2025.