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TERRITORIAL PATTERNS OF COVID-19 IN IRAN

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ABSTRACT

Motives: Spatial analysis has become an essential tool in understanding the underlying factors that contribute to the distribution of viral pandemics, diseases, injuries, and mortality patterns. By visualizing geographical data in spatial maps, researchers can identify local distribution patterns and potential drivers behind these patterns. In health and medical sciences, there has been a growing recognition that spatial analysis and mapping techniques are helpful in addressing various challenges related to the allocation of healthcare resource in both urban and rural areas.

Aim: The objective of this study was to analyze the spatial distribution pattern of the COVID-19 pandemic and the Index of Proximity Distribution (IPD) across 31 provinces of Iran between February 2019 and February 2023. A two-stage sampling method combining convenience and cluster sampling was used to examine COVID-19 distribution patterns in 31 provinces of Iran between 22 February 2020 and 22 February 2023. COVID-19 and IPD data were collected as part of this panel study. Data were analyzed using t-tests, chi-square tests, and analysis of variance (ANOVA) in SPSS version 28 ($\alpha = 0.05$). Subsequently, daily COVID-19 infection data for each province in the analyzed period were processed in ArcGIS software, and the spatial distribution pattern of the pandemic in Iran were visualized by point density analysis. Standard distance and standard deviation ellipse techniques were employed to assess the density or dispersion of infected individuals and to determine the spatial distribution pattern of COVID-19 in Iran. A spatial autocorrelation (Moran's I) analysis was conducted to identify the spatial distribution pattern of COVID-19 in Iran. Additionally, distance-based spatial autocorrelation was used to examine the prevalence of COVID-19 infection across Iranian provinces. In a grouping analysis, 31 Iranian provinces were classified into five groups based on the number of COVID-19 cases, and spatial statistics were used to examine the prevalence of COVID-19 within each group. A hot spot analysis and a standard distance (SD) analysis were conducted to explore spatial correlations in the number of individuals affected by COVID-19 in each province.

Results: Based on the Moran index, a random spatial pattern with a Z-Score of 1.485 was identified in March 2019, whereas a clustered distribution of COVID-19 with a Z-Score of 3.039 was determined in February 2023. The distance-based spatial autocorrelation analysis revealed a positive value of the Moran index (0.136627) at a distance of 383.3 kilometers from Tehran, which points to positive spatial autocorrelation and a higher number of COVID-19 cases in nearby regions. Conversely, the Moran index assumed a negative value of 0.040246 at a distance of 726.6 kilometers from Tehran, which suggests that the number of pandemic cases decreased over distance from Tehran. Moreover, based on the results of the hot spot analysis, Tehran province was identified as a hot cluster with a higher

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prevalence of COVID-19 cases in that region. In contrast, Bushehr province was classified as a cold cluster with a lower prevalence of COVID-19 cases in comparison with the surrounding regions. These findings provide valuable insights into the spatial distribution and clustering of COVID-19 cases in Iran. The shift from a random spatial pattern in 2019 to clustered distribution in 2023 indicates that the pandemic spread rate increased over time. The positive spatial autocorrelation near Tehran highlights the role of proximity and population movement in the transmission of the virus. Furthermore, the identification of hot spots and cold spots in a country can inform targeted interventions and resource allocation to effectively manage and control the pandemic. Overall, this study demonstrates the value of spatial analysis in identifying the spatial distribution patterns and the dynamics of the COVID-19 pandemic in Iran. The integration of spatial analysis techniques with epidemiological data contributes to a better understanding of spatial-temporal patterns, facilitates effective public health responses and resource allocation strategies. These findings contribute to the growing body of knowledge on the spatial epidemiology of COVID-19 and can aid in informing future preparedness and response efforts in Iran and other regions that face similar challenges.

Keywords: epidemiology, spatial analysis, Index of Proximity Distribution (IPD), COVID-19, Iran

INTRODUCTION

The last days of December 2019 witnessed the emergence of a global landmark event as the first confirmed case of an infection with a novel coronavirus was reported in Wuhan, a bustling metropolis nestled in Hubei Province at the heart of Central China. This pivotal moment sparked a series of consequential events that would soon engulf the globe in uncertainty (Cheshmehzangi et al., 2021). The Hubei health authorities sprang into action on 8 January 2020, launching an extensive survey to decipher the nature and extent of this mysterious viral outbreak. The clock ticked relentlessly, and by 20 January 2020, the dire situation could no longer be concealed, and an outbreak was officially declared. It was not just a run-of-the-mill disease; it was COVID-19, the harrowing pandemic that would reshape the course of history. In the blink of an eye, in the early days of March 2020, the viral contagion had transcended boundaries, traversing continents and oceans to lay its claim on a multitude of nations, including Iran (Nojomi et al., 2021). The spread of this pandemic was unlike anything we had ever witnessed; its ramifications were both staggering and unprecedented.

Traditionally, infectious diseases, such as the notorious COVID-19, are known to proliferate through close personal interactions and physical contacts. The transmission hinges on face-to-face communication, a characteristic that makes tracking and comprehending the spread of these diseases a formidable task. Interpersonal interactions that occur at various locations over time on a large scale should be captured to gain insights that can empower effective control measures. Yet in practice, the acquisition of micro-level data at a significant scale remains a challenge. In light of this scarcity, we are left with no choice but to rely on alternative indicators as proxies for interpersonal interactions and contacts. This method becomes all the more critical in our quest to understand and mitigate the spread of infectious diseases (Ma, Li, & Zhang, 2021; Ma, Li, Lan et al., 2021). In certain instances, spatial-based surveys have been undertaken to venture into the field and amass comprehensive data on the pandemic's dynamics. These efforts aim to provide invaluable information that can serve as a lifeline in our battle against infectious diseases, including the formidable adversary that is COVID-19 (Isaza et al., 2023). In this regard, and despite significant advancements in the field of disease management, infectious diseases remain a crucial concern in epidemiology and public health. Epidemiology plays a key role in identifying geographic areas and vulnerable populations that are at a higher risk of disease contraction and mortality due to associated risk factors (Kalbus et al., 2023; Miethke-Morais et al., 2021). Identifying these geographical areas and high-risk groups is instrumental in implementing appropriate healthcare and social interventions to mitigate the impact of these risk factors (Dhingra & Vandana, 2011).

Spatial epidemiology serves as a valuable tool in unraveling the causes behind diseases, injuries, and mortality (Boudou et al., 2023; Dawood, 2023; Kazi et al., 2023; Montoya et al., 2023). In the first step of analysis, geographical data are visualized, particularly in geographical maps, to provide insights into the spatial distribution patterns of diseases, injuries, and deaths, and facilitate causal identification (Wu, Shen et al., 2023; Wu, Williams et al., 2023). In recent years, spatial analyses and maps have been increasingly used in health and medical sciences due to their superior visualization capabilities compared to statistical tables (Afzali et al., 2020; Gomez Selvaraj et al., 2020; Huang & Kwan, 2023).

Given the expansion and active provision of health and medical services in various countries, spatial analyses should be incorporated in the healthcare sector to address the challenges related to the allocation of medical resources in urban and rural areas (Lu et al., 2023; Mungmunpuntipantip & Wiwanitkit, 2023; Zhu et al., 2022). Recent developments emphasize that spatial analysis, facilitated by the production of maps, is an essential and valid tool in processing, analyzing, and visualizing spatial information in domains such as health and environmental protection, disease ecology, and community health. Spatial analyses facilitate the determination of disease locations, assessment of healthcare facilities and services, and delineation of societal boundaries; therefore, they constitute fundamental elements of epidemiological and health studies (Arvin et al., 2023; Bratton & Wójcik, 2022; Krauss et al., 2023; Yao et al., 2023). The identification of these geographical areas and high-risk groups enables the selection of appropriate healthcare, medical, and social measures to mitigate the impact of these risk factors (Borges et al., 2022; Juneau et al., 2023).

The advancements in spatial technology have revolutionized data production and modeling, and opened new horizons in data analysis (Gamelas et al., 2023; Ortiz et al., 2022; Ramos et al., 2023; Takefuji, 2023). Consequently, topics such as spatial dependence, spatial links, spatial heterogeneity, spatial scale effect, and spatial clustering have been integrated into spatial process models (Coro, 2021; Shang Wui & Jahanbani Ghahfarokhi, 2022; Shen et al., 2020; Tu et al., 2023). Despite the fact that spatial phenomena may follow irregular distribution patterns, spatial analysis approaches have revealed that these phenomena follow discernible patterns that can be comprehended and recognized. These patterns enable the identification of general laws that transcend the boundaries of space and time (Banerjee et al., 2022; Boareto et al., 2022; Furati et al., 2021; Kolebaje et al., 2023; Ma et al., 2021; Ma et al., 2021; Sidwell & Smee, 2004).

The spatial distribution patterns of COVID-19 in Iran have been analyzed in several studies (including Isaza et al., 2023; Nojomi et al., 2021; Sharifi et al., 2022; Raoofi et al., 2020). Rahnama and Bazargan (2020) relied on ArcGIS software and spatial selfcorrelation to analyze the data of individuals diagnosed with COVID-19 between 22 February 2020 and 22 March 2020 (21,638 cases) and found that the provinces of Qom, Mazandaran, Gilan, Qazvin, Isfahan, Semnan, Markazi, and Yazd were situated within the HH cluster. This suggests that the number of COVID-19 cases in these provinces exceeded the national average and that 32.26% of Iranian provinces were grouped in the HH cluster. Additionally, an analysis of COVID-19 hot spots revealed that Qom, Golestan, Semnan, Isfahan, Mazandaran, and Alborz provinces were located in hot clusters, while Bushehr, Ilam, and Kermanshah provinces were located in cold clusters (Rahnama & Bazargan, 2020).

The present study aims to investigate spatial relationships in the distribution of COVID-19 cases from a medical perspective by modeling the spatial distribution of COVID-19 epidemiology in Iran.

MATERIALS AND METHODS

Survey Design and Data Collection

The survey was conducted in Iran between 22 February 2020 and 22 February 2023, to analyze the spatial distribution of COVID-19 cases and the Index of Proximity Distribution (IPD).

Sampling Method

- 1. A two-stage sampling method involving convenience and cluster sampling was used.
- 2. Data were collected from 31 provinces in Iran.

Data Recording

Daily data on COVID-19 cases and the IPD were recorded during the study period.

Data Analysis

- 1. Data were analyzed in SPSS version 28.
- 2. Data were processed statistically in t-tests, chisquare tests, and analysis of variance (ANOVA) at a significance level of α =0.05.

Spatial Data Visualization

The data on individuals infected with COVID-19 in each province was entered into ArcGIS software on a daily basis within the specified time interval.

Spatial Distribution Analysis

- 1. The daily spatial distribution of COVID-19 cases in Iran was visualized in a point density analysis.
- 2. Standard distance and standard deviation ellipse were used to assess the density or dispersion of the infected population and to identify the spatial distribution pattern of COVID-19 in Iran.

Spatial Autocorrelation Analysis

The spatial distribution pattern of COVID-19 in Iran was examined in a spatial autocorrelation (Moran's I) analysis.

Prevalence Classification

In a grouping analysis, 31 Iranian provinces were classified into five groups based on the number of COVID-19 cases.

Spatial Statistics

The spatial statistics of these homogeneous groups were examined to assess the prevalence of COVID-19 in different provinces of Iran.

Hot Spot Analysis

The spatial statistics in the hot spot analysis were used to examine spatial correlations in the number of COVID-19 cases across Iranian provinces.

Formulas for Calculating Standard Distance (SD) and Standard Deviational Ellipse (SDE)

1. Standard distance (SD) was calculated using the below formula (Coskun, 2023; Dolorfino et al., 2023):

$$SD = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{X})^2}{n} + \frac{\sum_{i=1}^{n} (y_i - \bar{Y})^2}{n}} \quad (1)$$

where: x_i and y_i are the coordinates of attribute i; \bar{X} and \bar{Y} are the central means of the attributes, and n is the total number of attributes.

2. The standard deviational ellipse (SDE) was calculated using the below formula (Gong, 2010; Moore & McGuire, 2019; Wang et al., 2015):

$$SDE_x = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{X})^2}{n}}$$
(2)

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where: x_i and y_i are the coordinates of attribute i; \bar{X} and \bar{Y} are the central means of the attributes, and n is the total number of attributes.

RESULTS AND DISCUSSION

On 22 February 2023, cases of COVID-19 infection were reported in Qom, Tehran, Gilan, and Markazi provinces. On that date, a total of 28 cases were confirmed in Iran, and 67.86% of all cases were reported in Qom province. The prevalence of COVID-19 in Iran began to increase on 2 March. Studies have shown that the spatial distribution of COVID-19 rapidly spread from Tehran, Qom, Gilan, Markazi, Mazandaran, and Isfahan provinces to their surrounding regions. The density of COVID-19 cases was highest in the northern, central, and northwestern parts of Iran, whereas eastern and southeastern regions were characterized by the lowest prevalence of the disease. On 22 February 2023, 23.6% of infected individuals in Iran were residents of Tehran province, 9.1% were from Isfahan province, and 7.9% were from Mazandaran province. Tehran and Qom provinces had the highest density of COVID-19 cases in Iran, while the lowest density was observed in the northwestern, southern, and southeastern regions. Research demonstrated that the density of cases decreased further away from the central areas of COVID-19 prevalence and distribution. The highest density of cases was noted in the northern and central regions of Iran.

The spatial distribution of COVID-19 cases in Iran measured with the standard distance method revealed the highest concentration of cases around Tehran province. A total of 602 cities (48.3% of all Iranian cities) were within the SD radius, which pointed to a high density of cases in the neighboring province of Tehran. The SDE analysis revealed that the prevalence of COVID-19 was more inclined towards northwest Iran. The direction of disease spread suggests that the spatial distribution was oriented predominantly towards northern and northwestern provinces. A total of 627 cities (50.3% of all Iranian cities) were within the SDE radius, which points to the spatial distribution of COVID-19 epidemiology.

Based on the research findings, on 22 February 2020, Moran's *I* was determined at 0.042422, with a z-score of 1.48557 and a p-value of 0.136868. This result indicates that the spatial distribution of COVID-19 cases in Iran followed a random pattern, with cases distributed across Qom, Tehran, Gilan, and Central provinces. However, by 21 February 2021, Moran's *I* increased to 0.200685, with a z-score of 3.039310 and a p-value of 0.002371, which points to a clustered spatial distribution pattern of COVID-19 in Iran. This result suggests that a high number of cases were reported in the provinces of Tehran, Isfahan, Mazandaran, Gilan, and Qom.

The z-score analysis revealed hot spots in Qom, Tehran, Golestan, Semnan, Isfahan, Mazandaran, and Alborz provinces, indicating a high concentration of COVID-19 cases in these areas. In these provinces, positive and statistically significant z-scores confirm the presence of a high number of infections. These hot spots accounted for 22.5% of all provinces, and most of these provinces are located in the northern and central regions of Iran. Conversely, Bushehr, Ilam, and Kermanshah provinces were identified as cold spots with negative z-scores and a low number of infections. These cold spots accounted for 9.67% of all provinces, and they are situated mainly in western and southwestern Iran. These results indicate that the provinces surrounding Tehran formed hot spots due to a high number of COVID-19 infections. Z-scores decreased and assumed negative values further away from Tehran, which led to the formation of cold spots with higher spatial autocorrelation between a smaller number of cases.

Iran's provinces were classified into five groups based on the number of COVID-19 cases. Tehran and Qom provinces were characterized by the highest number of infections, and they were assigned to groups 1 and 2, respectively. Group 3 consisted of Mazandaran, Gilan, Alborz, Markazi, and Isfahan provinces. The findings indicate that the spatial distribution of COVID-19 followed an adaptable pattern that was consistent with Torsten Hägerstrand's theory which considers the distance factor. The disease spread rapidly from Teheran, the center of COVID-19, to the neighboring provinces and cities, and it eventually reached distant provinces such as Sistan and Baluchestan, and Hormozgan. Cluster 4 was composed of Razavi Khorasan, Semnan, Yazd, Golestan, Fars, Khuzestan, Lorestan, Qazvin, and East Azerbaijan, which accounted for 29% of all Iranian provinces. Cluster 5 consisted of North and South Khorasan, Sistan and Baluchestan, Kerman, Hormozgan, Bushehr, Kohgiluyeh and Bover-Ahmad, Chaharmahal and Bakhtiari, Ilam, Kermanshah, Hamedan, Kurdistan, Zanjan, Ardabil, and West Azerbaijan, which represented 48.3% of all provinces. The spatial grouping and clustering of Iranian provinces based on the spread of COVID-19 highlighted the significance of spatial-temporal distance in disease distribution from the center (Tehran) to other provinces, following an adaptable spatial pattern.

Based on the research findings, Moran's I was determined at 0.136627, and the z-score reached 2.292634 at a distance of 383.8 km from Tehran province, which indicates a significant positive spatial autocorrelation at a 99% confidence level. The presence of a positive autocorrelation points to a high number of COVID-19 cases within a radius of 383 km. A negative spatial autocorrelation was identified at a distance of 762.6 km from Tehran province, where Moran's I and the z-score reached -0.040246 and -0.252883, respectively. In other words, beyond this point, the number of COVID-19 cases decreased. Hence, it can be concluded that distance played a crucial role in the spread of COVID-19 in Iran. The disease spread from the center to the periphery, and the spatial distance was reduced as COVID-19 reached successive provinces (Fig. 1).

Figure 2 provides an insightful visualization of the spatial distribution of COVID-19 in Iran, shedding light on the underlying dynamics of the epidemic.



Fig. 1. Spatial autonomy of COVID-19 in Iran



Fig. 2. Spatial pattern of COVID-19 distribution in Iran

Tehran province emerged as the primary focus of disease and the epicenter from which the spatial diffusion and propagation of COVID-19 originated and subsequently affected other provinces.

The concentration of COVID-19 cases was particularly high in the immediate vicinity of Tehran province, which can be attributed to higher population density in these areas. The interplay between spatial features, namely time and distance, exerted a profound influence on the spatial distribution patterns of COVID-19 in Iran.

Time was a factor that played a crucial role in the spatial dynamics of COVID-19. As the epidemic unfolded over the course of the study period, the spatial distribution of cases gradually spread beyond Tehran province, affecting neighboring regions and, eventually, more distant provinces. The temporal aspect of the epidemic's progression underscores the significance of monitoring and analyzing the spatial distribution of COVID-19 in real-time, as the disease navigated through various regions of Iran. Moreover, distance was also a factor that significantly affected the spatial distribution patterns of COVID-19 in Iran. The spatial distance between provinces influenced the rate and extent of transmission, and infection density was higher in areas situated in closer proximity to Tehran province. The interplay between distance and infection rates highlights the importance of spatial connectivity and inter-regional mobility in the spread of COVID-19.

In summary, Figure 2 provides valuable insights into the spatial distribution of COVID-19 in Iran. Tehran province was the epicenter, and the subsequent spatial diffusion of the disease was influenced by both temporal and distance-related factors. A better understanding of the intricate interplay between these factors is crucial for developing effective surveillance, prevention, and control strategies to mitigate the impact of the epidemic and protect public health across the country.

The spatial distribution of COVID-19 cases in Iran was analyzed in this study, with emphasis on factors

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such as time, distance, and spatial autocorrelation. The results have important implications for scientific discussions:

- 1. Temporal evolution of COVID-19: The study investigated the temporal evolution of COVID-19 in Iran, and it demonstrated that the number of infections increased after 22 February 2023. This observation highlights the dynamic nature of infectious diseases and the need for continuous monitoring and adaptive public health responses as the situation evolves.
- 2. Spatial distribution patterns: The analysis revealed that COVID-19 had distinct spatial distribution patterns across Iranian provinces. Infection cases were concentrated in the northern, central, and northwestern parts of Iran, where hot spots were identified. The identification of geographical patterns of disease distribution can facilitate resource allocation and targeted interventions.
- 3. Use of spatial analysis methods: In the present study, spatial autocorrelations were assessed, and hot and cold spots were identified with the use of statistical methods such as Moran's I, z-score, and the standard deviation ellipse. These methods are essential tools in epidemiology for understanding how disease clusters are formed in space and time.
- 4. Role of distance in the spread of disease: The analysis underscores the significance of distance in the spread of COVID-19. Infection rates were higher in proximity to Tehran province, and a noticeable decrease in the number of cases was observed beyond a certain distance from Tehran. This finding aligns with the concept that infectious diseases often spread more readily in densely populated areas and through human mobility.
- 5. Cluster analysis and grouping: Iranian provinces were categorized into clusters based on COVID-19 cases, highlighting the importance of spatialtemporal distance in disease distribution. This approach can inform public health strategies for containment and control, emphasizing the need for regional responses.
- 6. Epidemiological significance: The results underscore Tehran province as the epicenter of the

outbreak and the subsequent spatial diffusion of COVID-19 to other regions. This is a common characteristic of many infectious diseases, where urban centers often serve as focal points for disease spread due to high population density and connectivity.

- 7. Population density and disease transmission: The article briefly mentions that population density plays a role in the concentration of cases. The interaction between population density and disease transmission is a crucial aspect of epidemiology, as crowded areas can facilitate the rapid spread of infectious diseases.
- 8. Real-time monitoring: The discussion highlights the importance of real-time monitoring and analysis of the spatial distribution of disease. Timely data and spatial insights are critical for decision-making, especially when dealing with infectious disease outbreaks.

In summary, the research offers insights into the spatial distribution and dynamics of COVID-19 in Iran. It underscores the interplay of time, distance, and population density in disease transmission, and the importance of spatial analyses as methods that guide public health responses. This information is essential for epidemiologists and policymakers in managing and controlling disease outbreaks.

CONCLUSIONS

In conclusion, this study focused on modeling the spatial segregation and distribution of COVID-19 epidemiology in Iran between 22 February 2020 and 22 February 2023. The study revealed that the concentration of COVID-19 cases was highest in the northern and central regions of Iran, and lowest in northwest, south, and southeast regions. An analysis of the standard distance radius of COVID-19 spatial distribution demonstrated that 602 cities (48.3% of Iran's cities) were within this range.

Furthermore, an examination of the standard deviation ellipse representing COVID-19 prevalence in Iran revealed directional movement towards the northern and northwestern provinces. The spatial distribution pattern of COVID-19 appeared random on 22 February 2020, but a clustered pattern emerged by 22 February 2023, signifying the spread of COVID-19 across Iran. In a statistical-spatial analysis of hotspots, Tehran, Qom, Golestan, Semnan, Isfahan, Mazandaran, and Alborz provinces (comprising 22.5% of Iran's provinces) were identified as hotspots with a high prevalence of COVID-19 cases. Conversely, Bushehr, Ilam, and Kermanshah provinces (accounting for 9.67% of Iranian provinces) were classified as cold spots with a low number of infections.

Moreover, the spatial grouping analysis of Iran's provinces underscored the significance of the spatialtemporal distance factor in COVID-19 distribution from Tehran to other provinces. This factor plays a pivotal role in the spatial dynamics of the disease by influencing its spread from the epicenter to neighboring regions over time.

Furthermore, the study revealed various scenarios regarding the spatial distribution and dynamics of COVID-19 in Iran, indicating changes over time, the influence of proximity to Tehran, and variations in prevalence between different regions. The findings suggest that pandemics have complex dynamics and require nuanced strategies for control and response.

Different interpretations of the findings or alternative explanations for the observed spatial patterns of COVID-19 in Iran could could be offered:

- 1. Socioeconomic factors: It is possible that the shift from a random spatial pattern in 2019 to a clustered distribution in 2023 was influenced by socioeconomic factors, rather than an inherent change in the virus's behavior. It could be argued that regions with a higher population density, better healthcare facilities, or better access to testing may naturally cluster more cases.
- 2. Seasonal variability: The role of seasonal variability in COVID-19 transmission could also be considered. The clustered distribution observed in February 2023 could have been influenced by environmental factors, such as temperature and humidity, which are known to affect the transmission of respiratory viruses.

- 3. Behavioral changes: Another perspective could focus on changes in human behavior, such as adherence to public health guidelines, maskwearing, and social distancing, as the primary driver of the observed spatial patterns. Thus, the clustering of cases in 2023 could be attributed to human behavior, rather than inherent changes in the virus.
- 4. Testing and reporting bias: Some critics may argue that clustering resulted from variations in testing and reporting, rather than the actual distribution of the virus. Regions with more robust testing and reporting mechanisms are more likely to identify and report cases, which could lead to apparent clustering.
- 5. Genomic variants: An alternative explanation could involve the role of viral genomic variants. The observed clustering could be related to the presence of more transmissible or vaccine-resistant variants in certain regions, rather than changes in population movement or spatial dynamics.
- 6. Demographic factors: Demographic factors such as the age and health of the population in different regions could be the key drivers of the spatial distribution of COVID-19. Regions with older or more vulnerable populations might naturally cluster more cases.
- 7. Interventions and travel restrictions: Government interventions, travel restrictions, or border controls in certain regions could lead to the observed clustered distribution. These policies could have artificially contained the virus in some areas, while allowing it to spread in others.
- 8. Data quality and methodological issues: Critics might question the reliability and accuracy of the data used in the spatial analysis. They could argue that the Moran index, distance-based spatial autocorrelation, and hot spot analysis techniques may have limitations and potential biases that influence the results.
- 9. Purely temporal factors: A different viewpoint could propose that the shift from random to clustered patterns could have resulted from temporal factors, such as the emergence of new waves of the

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pandemic, vaccination campaigns, or immunity development in the population, rather than spatial dynamics.

In addition, the study has several possible applications and implications:

- 1. Public health planning and response: The findings can inform public health authorities in Iran and other regions facing similar challenges about the spatial distribution and clustering of COVID-19 cases. This information can guide resource allocation, the deployment of medical facilities, and targeted interventions to manage and control the pandemic more effectively.
- 2. Epidemiological research: Researchers can use the results to further investigate the factors that contributed to the shift in the spatial distribution of COVID-19. This information can be valuable for epidemiological studies and for understanding the dynamics of the pandemic over time.
- 3. Monitoring and early warning systems: The shift from random to clustered distribution over time highlights the need for robust monitoring and early warning systems. This data can be used to develop models and forecasting tools to predict the spread of the virus and identify high-risk regions.
- 4. Travel and movement restrictions: The presence of a positive spatial autocorrelation near Tehran underscores the role of proximity and population movement in virus transmission. The authorities can use this information to implement travel restrictions and guidelines to limit the spread of the virus in highly connected areas.
- 5. Resource allocation: The identification of hot spots and cold spots contributes to more efficient allocation of resources. Hot spots may require additional medical personnel, testing facilities, and supplies, while cold spots may allow resources to be redirected to areas with greater need.
- 6. Health communication: Public health officials can use the presented data to develop targeted health communication strategies for different regions. Messaging and awareness campaigns can be tailored to address the specific challenges and trends in different areas.

- 7. Policy development: Policymakers can use the presented information to craft policies that are more region-specific. Different regions may require different strategies, and policies can be adapted accordingly.
- 8. Preparedness and response: The findings can inform future preparedness and response efforts not only in Iran, but also in other regions with similar patterns. As a result, regional authorities could predict changes in the pandemic's dynamics and adjust their strategies accordingly.
- 9. Research funding allocation: This study could influence decisions about where research funding is directed. Areas with hot spots may be prioritized for further research and resource allocation to better understand and combat the virus.
- 10. International collaboration: The study can facilitate collaboration and knowledge sharing among countries dealing with the pandemic. Similar spatial analysis can be conducted in other regions to compare findings and identify common trends.

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WHAT DRIVES CHINESE TECHNOLOGY IMPORTS INTO AFRICA? A REGIONAL PERSPECTIVE

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ABSTRACT

Motives: The factors that affect technology imports from China have never been examined in the literature, and this study was undertaken to fill in this knowledge gap. The factors that drive high-tech imports from China to Africa, including those that negatively impact imports, were identified. The results can be used to implement changes in the trade strategies of African countries, including industry 4.0 strategies or trade agreements with China, and to influence the behavior of companies importing high-tech from China.

Aim: The primary goal is to identify the factors that influence technology transfer, in particular the transfer of electronic and electrical technologies, in the areas of high-tech manufacturing. The second goal is to determine whether these factors have equal strength and direction of influence on different streams of technology transfer.

Results: The study demonstrated that both economic and geographical factors influence technology transfer, defined as two streams of high-tech manufactures: electronic and electrical, as well as other high-tech manufactures. However, the two import streams behaved differently, and different factors affected Chinese imports into Africa.

Keywords: Africa, China, technology transfer, technology imports

INTRODUCTION

In research on the relationship between China and Africa, technology imports as a form of technology transfer is a relatively unexplored topic (Oqubay & Lin, 2019). There are two conflicting views in the discourse. Some authors argue that Africa's openness to trade with China has not resulted in technology transfer to African countries (Elu & Price, 2010; Patroba, 2012; Youngman, 2013). Others point to the positive impact of importing capital goods from China to Africa, as technology transfer occurs simultaneously (Kaplinsky & Morris, 2009; He, 2013; Munemo, 2013). Various internal or external factors influencing the possibility of technology transfer have been identified by authors (Borojo & Jiang, 2016), but research has often failed to determine what factors influence the transfer of technology from China to Africa.

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It is reasonable to explore the area of Chinese-African cooperation in foreign trade, particularly the import of high technology from China, as it is a key channel for technology transfer. This is especially important since China introduced the Digital Silk Road as part of the Belt and Road Initiative in 2016, aimed at promoting and transferring Chinese technologies abroad. The study has two primary objectives: to investigate the economic and geographical determinants that impact technology transfer in the form of high technology manufactures, and to verify if these determinants affect different streams of technology transfer equally. The secondary objective is to check if technology transfer can be expressed using the aggregates used in the study. High-tech goods were divided into two categories: electronic and electrical high technology manufactures, and other high technology manufactures. This was done intentionally as they are different groups. China is the global leader in exporting electronic and electrical high technology manufactures, but has a small share in exporting other high technology manufactures.

The subject of the study is 53 African economies grouped into 5 regions according to the criterion of geographical location following "Geographic Regions" from United Nations Statistics Division (United Nations Statistics Division, 2022). To investigate the determinants of the Chinese imports with the use of the trade gravity in levels approach in a panel data set covering the period 2016–2021, we have applied the semi-mixed effect method using the Poisson pseudo-maximum likelihood (PPML) estimator as suggested by the recent empirical literature.

The article is divided into three parts: an introduction, a main section, and a conclusion. The first part reviews the literature and justifies the research issues. The second part describes the data and methods used. The third part presents the results and discusses them. The conclusion refers to the research questions, the purpose of the analysis, and its limitations.

LITERATURE REVIEW AND JUSTIFICATION OF THE TOPIC

There aren't many extensive studies that examine the trade connections between China and African countries and how it affects Africa's development, especially in terms of technology (Eisenman, 2012; Obobisa et al., 2021). Using the two-step GMM estimator system (Borojo & Jiang, 2016) analyzed the impact of trade relations between China and Africa on the total factor productivity (TFP). A study was carried out between 1995 and 2013, covering 38 countries. The results indicated that trade openness between Africa and other countries had a significant positive effect on the GDP growth of African nations. Furthermore, when trade openness between Africa and China was combined with improvements in institutional quality and human capital in Africa, the impact on TFP became positive and significant. The authors of the study concluded that for technological progress to result from trade with China, it is necessary for Africa to have a strong domestic absorptive capacity.

An extensive study on the links between China's trade with sub-Saharan Africa and technology transfer was conducted by Elu and Price (2010). An analysis of micro-level data from manufacturing firms in five sub-Saharan African countries was conducted, estimating firm-level production function parameters from 1992 to 2004. The results showed that increasing trade openness with China did not have an effect on the growth rate of TFP. This led to the conclusion that, in the long term, trade with China cannot be considered a source of prosperity for the countries analyzed. According to Munemo (2013), importing capital goods from China can significantly enhance technology transfer and stimulate economic growth in Africa. Therefore, it is essential to implement trade liberalization policies that attract Chinese capital investment.

He (2013) used regression analysis to evaluate the impact of imports from China on the exports of goods from Sub-Saharan Africa, in comparison to imports from the United States and France. The results showed that China's influence was

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significantly positive and stronger than that of the US and France. Furthermore, it was demonstrated that Chinese imports have a positive effect on the economic development of Sub-Saharan Africa, including technology spillovers, particularly those from moderately advanced technologies.

Hou et al. (2021) conducted a study focused solely on Ghana, using panel data at the company and industry level. They found that the effect of international trade on the productivity of Ghanaian manufacturing firms depends on the competitive advantage of the industry and trading partners. The empirical results showed that trade with China provides more opportunities for firms to increase productivity compared to trade with OECD countries. A higher intensity of imports from China was found to stimulate productivity growth.

Patroba (2012) and Youngman (2013) also studied specific African countries (Kenya and Botswana, respectively). Patroba (2012) found that Kenya imports both high-value-added and low-quality counterfeit products from China, while exporting unfinished goods. This trade pattern does not result in technology transfer. Youngman (2013) obtained similar results in his considerations.

To build the most precise representation of how trade with China affects technology transfer to Africa, several criteria were employed. The emphasis was on articles from the past ten years, and their citation on popular websites such as Mendeley or Semantic Scholar was a key factor in their selection. The literature review was divided into two parts. The first set of papers examined the use of gravity models in China-Africa trade relations, comparing the variables and approaches used by the authors. The second set of papers examined the impact of foreign trade on technological progress and technology transfer in Africa, with panel data analysis being an important selection criterion. These papers helped to identify additional variables that influence technological progress in the countries studied.

Numerous studies have demonstrated the influence of technology on international trade. A few examples are provided below.

Turkson et al. (2020) conducted a large-scale study that analyzed bilateral trade flows in Sub-Saharan Africa, with a focus on ICT. Their research, which covered 29 countries from 2004–2014, showed that prioritizing ICT development significantly increases trade. Additionally, Shinyekwa et al. (2019) examined the impact of COMESA on industrialization and productivity. Their analysis of the period from 2001–2015 confirmed the group's positive impact on industrialization, but the share of TFP was lower than expected, indicating a lack of convergence with international knowledge spillovers.

Some studies have focused on specific technologies, such as the one by Billon and Rodriguez-Crespo (2020) which examined the impact of the Internet, mobile phone, and broadband usage on bilateral trade flows in 33 sub-Saharan countries from 2004 to 2014. A gravity model was used to assess the combined effect of ICT usage and trade facilitation on intra-trade flows. The results showed positive and significant effects for mobile phone ownership in the exporting country, a positive impact of broadband on both exporters and importers, and a positive impact of internet usage on the importing country. However, trade facilitation had a negative effect on bilateral trade and there was an inverse relationship between ICT usage and trade facilitation, suggesting that a lack of trade facilitation may hinder the potential benefits of ICT usage in intra-sub-Saharan African trade.

Currently, there are a limited number of articles that discuss the impact of foreign trade on technological progress, including those mentioned in the introduction by Borojo and Jiang (2016), Elu and Price (2010), Munemo (2013), Patroba (2012) and Youngman (2013). However, the conclusions drawn from these studies are not clear-cut and only a select number of countries were included in the research.

The most direct connection between trade and technology transfer is through the direct import of advanced products, which is a method of technology transfer through trade that is often overlooked (Eaton & Kortum, 1999). In the article, the import of advanced machines and equipment, or high-tech goods, is considered as a main channel for transferring

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embodied technology. This is alongside acquiring intellectual property rights such as technical knowhow, patent and license agreements, and human capital migration as vehicles for transferring uncodified knowledge. Given the low level of innovation in the surveyed countries, the focus was on the most obvious channel for technology flow - embodied in high-tech goods - as other channels are less important to the continent. As a result, the article identifies technology transfer to Africa with this type of import, acknowledging the simplification used. High-tech goods imported by African countries are not homogeneous, so the study separately included electrical and electronic products and another category. The analysis may enhance scientific understanding of the role of various factors influencing imports of high technologies from China to African countries. There are only a few studies in the literature cited above that show the impact of trade with China on technological progress in Africa.

None of the studies have attempted to answer the question of what factors affect the import of technology from China. Additionally, no study has included all African countries, divided into 5 geographical groups, in relation to their trade relationship with China in high technology. Such a comprehensive analysis has not yet been conducted, and it could deepen our understanding of trade relations between Africa and China in high-tech goods. This analysis could also suggest changes in the foreign policy of African economies towards trade with China and the role of FDI related to the import of high technologies (Ankapo & Oyenubi, 2022; Młynarski, 2012; Wysiński, 2020).

The study has practical implications as it identifies factors that affect high-tech imports from China to Africa, including those that negatively impact imports. This information can be used to make changes in the trade strategies of African countries, such as modifying government industry 4.0 strategies or trade agreements with China, and changing the behavior of companies importing high-tech from China (Krukowska, 2022; Żukowski, 2020).

MATERIALS AND METHOD

This research utilizes multiple data sources to gather information on trade between African countries and certain macroeconomic indicators. The first source is UNCTAD, which provides data on foreign trade (including high technology products), GDP, FORCE, and OUTPUT. The second source is the World Bank, which provides data on RES. The final source is a website with a calculator used to calculate the distance between the capitals of countries (https:// www.distancecalculator.net/).

The study investigates almost all African countries that trade with China and for which data is available. The countries have been divided into 5 groups/regions (Northern Africa NA, Western Africa WA, Central Africa CA, Eastern Africa EA, and Southern Africa SA) according to "Geographic Regions". A total of 53 countries were included in the study (two countries, Saint Helena, and Sudan, were excluded from the analysis due to lack of data). The analysis period covers annual data from 2016–2021. Detailed descriptions of the economic potential of individual African regions and the business climate can be found in Cieślik (2022) and Szukalski (2013).

Intensity exchange in the field digital technology from China to countries Africa is measured by two alternative dependent variables: flow of high technology manufactures electronic and electronic (MTCE) as well as flow of other high technology manufactures (MTCO).

The variable MTCE stands for flow of high technology manufactures: electronic and electrical from China to African country. This category includes the most popular electrical and electronic office devices machines, automatic data processing machines or telecommunication equipment. These products are China's flagship exports to world markets, especially developing countries (Cieślik et al., 2020; UNCTAD, 2023). The variable MTCO stands for flow of high technology manufactures: other, which include more specialized technological products, such as aircraft, pharmaceuticals, or more complex specialized equipment. This type of products is much less frequently produced in China, which is also reflected in the incomparably lower export values of these products. Although China has specialized in high technology manufactures: electronic and electrical, it is no longer a major high technology manufacturer in the world manufactures: other. The exact division of the main categories into subcategories is presented in UNCTAD (2023). Moreover, African countries are not yet technologically advanced enough to import more hightech categories manufactures: other. At the moment, there is a much greater demand for typical high technology manufactures: electronic and electrical.

The basic explanatory variables include the size of partner as measured by the log of Gross Domestic Product (log GDP) and the log of the distance between trade partners (log DIST). The distance was measured as the distance between the capitals of trade partners from African countries and China. These are classic variables used in a gravity trade model. To control the effect of capital labour and capital productivity, we use the following variables: total employment in all activities in thousand (in USD millions) and output per capita (in USD). We also included the ratio of natural resources to GDP of African countries (RES) as an indicator: Total natural resources rents (% of GDP) (World Bank, 2022).

African countries differ in the level of wealth, and this may affect the level of trade with China. In connection with the above, it was assumed that the greater the differences in the level of development of countries measured by GDP, the lower the intensity of trade between these countries. As a measure of the development gap, the difference between GDP per capita for individual pairs of countries was determined according to the formula:

$$rfl_{ijt} = ln \left| GDPpc_{jt} - GDPpc_{it} \right| \tag{1}$$

We furthermore apply a number of dummy variables identifying the country belonging to a given geographical group, so we have 5 dummy variables (for i = 1, 2, 3, 4 or 5).

A gravity trade model can be treated as one of the most important tools in the trade analysis. It enables to determine and predict actual trade flows. The model has been known for 60 years – it was first presented in 1962 by Jan Tinbergen. Over time, the model has been developed quite intensively and currently has many empirical specifications/modifications.

With the increase in research, mainly empirical, using a gravity model, there have been many considerations regarding the correctness of the selection of its estimation method depending on the form of its specification, both due to its analytical form and variable inclusion in the model. The basic assumption adopted in the model is that trade flows from and to country are proportional to the GDP of both countries and inversely proportional to the distance between the countries (Tinbergen, 1962). Due to its natural limitations, this assumption seems to be insufficient, which is one of the reasons why additional variables representing the specific features of both partner countries have been included in the model (Westerlund & Wilhelmsson, 2009).

The stochastic version of the panel data gravity equation has the following form:

$$T_{ijt} = \alpha_0 Y_{it}^{\beta_1} Y_{jt}^{\beta_2} Z_{ij}^{\gamma} X_{ijt}^{\alpha} e^{\delta D_{ij} + \nu_t + \eta_{ij}} \varepsilon_{ijt}$$
(2)

where v_t are time effects which could account for business cycles, η_{ij} are unobserved heterogeneity effects, and ε_{it} is the stochastic error term. Further, α_0 , β_1 , β_2 , γ , α , δ are unknown coefficients. It is worth noting that within the panel data it is possible to include unobserved individual effects (*i*) and time effects (t) as well as effects for pairs of countries (*i*, *j*), and at the same time, all of them can be treated as constant or random.

In the classic approach, the model (2) is transformed into a log-linear form and then estimated using OLS. In the case of this estimation method, it is necessary to fulfill the assumption of independence of the explanatory variables of the model and the random component (homoscedasticity). Failure to meet this assumption results in the OLS estimation being inconsistent and biased (Santos Silva & Tenreyro, 2006). The proposed extension of the initial model to the form of additional explanatory variables may potentially generate a risk of heteroscedasticity.

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The second problem with logarithmic transformations is the occurrence of zero or very low trade flows and, consequently, impossibility to calculate the logarithm value and perform the transformations mentioned¹.

As a solution to both of the above estimation problems (OLS mismatch and null flows), Santos Silva and Tenreyro (2006) proposed the Poisson pseudomaximum-likelihood (PPML) estimator, which is often used for counting data. According to classical economic theory, if two variables are related by a constant elasticity model, as is the case with a gravity model, the function can be interpreted as a conditional expectation of the value of the explanatory variable for a given level of the explanatory variable. Obtaining an effective parameter estimate is possible in this case by using the PPML estimator. The authors argue that for this estimator, the data need not be Poisson distributed and the response variable need not be an integer for the Poisson likelihood-based estimator to be consistent. Moreover, the use of the estimator eliminates the problem of zero flows (Westerlund & Wilhelmsson, 2009).

The estimating regression of gravity model using PPML method has the following form:

$$T_{ijt} = exp \begin{bmatrix} ln\alpha_0 + \beta_1 lnY_{it} + \beta_1 lnY_{jt} + \gamma lnZ_{ij} \\ + \alpha lnX_{ijt} + \delta D_{ij} + \nu_t + \eta_{ij} \end{bmatrix} \varepsilon_{ijt}$$
(3)

where: Tijt is the trade flows from country i to country j, Yit, Yjt are GDPs of the two countries' i and j, Dij is the distance between the countries, Zij denotes

time-invariant information, *Xijt* denotes time-variant information, *vt* are time effects which could account for business cycles, ηij are unobserved heterogeneity effects, and ε it is the stochastic error term. Further, $\alpha 0$, $\beta 1$, $\beta 2$, γ , α , δ are unknown coefficients. It is worth noting that within the panel data it is possible to include unobserved individual effects (*i*) and time effects (*t*) as well as effects for pairs of countries (*i*, *j*), and at the same time, all of them can be treated as constant or random (Anderson & Van Wincoop, 2003).

It should be noted that in regression (3) the time effects, v_t and the country-pair-specific effects η_{ij} are estimated as fixed effects, which means that some time-invariant effects cannot be estimated. In accordance with the above discussion, the estimation of all gravity models presented in the article was carried out using the PPML procedure with robust standard errors in Stata 16.

RESULTS

The analysis is carried out for 53 trade partners of African countries and China in the period 2016–2021. The summary statistics of the variables used in the analysis are shown in Table 1.

The average MTCE was about 327513 (thousands USD) in the sample. The average MTCE level in the sample was 327513 (thousands of USD) with a very large deviation of 828549 (thousands of USD), respectively. The average MTCO was 38567 (thousands of USD) and the standard deviation of the sample was 85523 (thousands of USD). Both the deviation values and the difference between the minimum and maximum MTCE and MTCE values indicate a large diversification of high technology flows/imports from China to individual African countries. Such differentiation is also observed in the case of other variables describing the volume of exports and imports from both China (ALIC and ALEC)

70% of the countries surveyed have access to the sea (SEA), and distance from China (DIST) is the relatively least dispersed variable, as shortest distance to China is 7542 km from Egypt and the longest is 12640 km from Cabo Verde.

¹ There are several methods in the literature for addressing the issue of zero flows. One approach is to simply exclude country pairs with no turnover from the data, but this can result in the loss of information and unreliable estimation results. Another option is to use the original trade flow series between countries as the dependent variable, but this can lead to a wide range of values and attempts to rescale the series often result in inaccurate estimates. A further solution is to use nonlinear least squares (Frankel & Wei, 1993), which is an asymptotically correct estimator for a nonlinear flow model, but may be inefficient due to its failure to address heteroscedasticity (Santos Silva & Tenreyro 2006).

Variable name	Ν	Mean	SD	Min	Max
MTCE	318	327513	838549	292	7937232
MTCO	318	38567	85523	8	926044
ALIC	318	1795552	3372563	6653	25988152
ALEC	308	1223137	3417460	8	29830576
GDP	317	44584	85355	348	474517
FORCE	318	13168	19094	66	114017
PROD	317	4119	4374	212	23658
DIST	318	10640	1464	7542	12640
RES	318	9	8	0	47

Table 1. Summary statistics for variables for the sample of African countries in 2016–2021

The average GDP for the countries in the sample was 44584 units, with a deviation of 85355 units. In the case of the FORCE variable, it was on average 13168 units with a deviation of 19094 units, and for the PROD variable, the average was 4119 units with a deviation of 4374. We also observe a large variation in the RES variable, for which the mean is 9% and the deviation is 8%. The range of values for the natural resources of African countries ranges from 0% for Mauritius and South Sudan to 47% for Congo.

The estimation of the basic and extended specifications of the empirical model has been performed using a PPML with robust standard errors and with a dummy variable for group membership serving as a clustering variable. For the reasons indicated earlier, it was not possible to include the Sea variable in the model. The analysis was conducted for 53 of China's African trading partners in 2016–2021. Two explanatory variables were used in the study, i.e. the value of imports from China (y1), MTCE in (thousands of USD) and MTCO (thousands of USD).

Various model specifications were tested and shown in the table * 10 models. The overall matching of the models is high, explaining 85% to 95% of the variability of imports depending on the specification. The results are robust to potential modifications.

In most of the analyzed comparisons, the coefficients of traditional gravity model variables, such as the GDP of an African country and the distance between China and a given African country, are economically justified and their impact on the dependent variable is statistically significant. The intensity of Chinese imports decreases with the distance to the trading partner in the case of the MTCO variable for all groups, and increases in the case of the MTCE variable. As expected, it was shown that geographical proximity is an important determinant of trade flows (imports) in the case of the MTCO variable, and this fact, in the classical approach, may be associated with lower transport and information costs. In the case of the second variable, we have a situation contradicting our expectations, which may suggest focusing on determining the costs of transport and information related to the import of MTCE. According to the theory of Baldwin and Harrigan (2007), as the quality of products increases, so do their costs and profitability, making it more advantageous for China to enter more distant markets with its high-tech products due to higher profitability. In other words, the most efficient companies, such as Chinese high-tech firms, export high-quality products to the furthest markets. Melitz (2003) also examined markets in a similar manner, arguing that firms exporting to more distant markets should be more productive and therefore able to offer lower prices than those only exporting to nearby markets.

The impact of the wealth of an African country measured by GDP is as expected, and it is positively statistically significant only for countries of group 2 EA and 5 WA in the case of the variable MTCE of imports from China, while in the case of models of the MTCO variable, the relationship is opposite to the expected one: the higher the level of GDP, the lower the import of MTCO from China to the country,

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regardless of group affiliation. This phenomenon can be explained by the fact that other economies (the most developed), and not China, specialize in the MTCO category. Countries that reach a certain level of wealth (expressed, for example, by GDP) decide to purchase high tech manufactures: other products from other economies that specialize in their production. On the other hand, the low level of wealth of the average African country forces it to buy high tech products: other from China (they cannot afford a better manufacturer), although China does not specialize in them and probably offers goods of lower quality.

The impact of the development gap shown by rfl is negative (but not significant) for the MTCO variable, suggesting that the difference in development between an African country and China is irrelevant to the volume of MTCO imports. In the case of the MTCE variable, the value of the coefficient is statistically significant and positive, which suggests that the greater the difference in development between a given African country and China, the greater the tendency to import MTCE from China.

As in the case of GDP, the country's raw material wealth turned out to be significant only in the model of the MTCE variable for two groups of countries: 3 CA and 5 WA, and its negative value indicates that the greater the country's resource wealth in relation to GDP, the lower the import of MTCE from China to these countries. CA and WA are characterized by strong raw material ties with China, hence only for these regions the variable is significant. On the other hand, the negative relationship can be explained by the fact that these countries, strongly basing their economy on raw materials, are not interested in importing modern technologies. Chinese companies located in these regions are also focused on raw materials and do not import high-tech to their plants.

The impact of the labor force of an African country measured by FORCE is negative and statistically significant only for the countries of the 2 EA and 5 WA groups² for the MTCE variable of imports from China, while for the models of the MTCO variable, the relationship is positive and significant for all groups, which shows that the higher the FORCE level, the higher the import of MTCO from China into the country. On the other hand, the positive relationship between FORCE and MTCO can be explained by the specificity of this product category.

The impact of the African country's productivity measured by PROD is negative and statistically significant for all African countries for the MTCE variable of imports from China, which means that the higher the PROD, the significantly lower the MTCE imports from China. However, in the case of models of the MTCO variable, the relationship is positive and significant for all groups, which means that the higher the PROD level, the higher the import of MTCO from China to the country. An increase in productivity may mean a decrease in demand for further Chinese hightech products of electrical and electronic equipment, which may indicate that the market has already been saturated with these products. On the other hand, in the case of MTCO, which is much lower compared to MTCE, there may still be potential in the market to increase imports and/or the process of increasing the level of efficiency/productivity may stimulate the demand for MTCO.

The influence of belonging to a given geographical region is clearly statistically significant in the case of the MTCE variable. African countries from groups 1 NA and 5 WA import significantly less than other countries, and of course, similarly, countries from groups 2 EA, 3 CA and 4 SA import significantly more MTCE from China than other countries. In the case of the MTCO variable, it should be noted that only the countries of group 4 SA import significantly more MTCO from China than other countries, while the countries of group 2 EA import significantly statement of group 2 EA import significantly more MTCO from China than other countries, while the countries of group 2 EA import significantly less MTCO from China than other ones.

² These two regions are characterized by the largest workforce in Africa, labor-intensive production, and at the same

time are heavily dependent on Chinese exports of high – tech electrical and electronic equipment (UNCTAD, 2023).

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Regressor -			MTCE					MTCO		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
lnDist	0.407*	1.113*	0.987*	0.145	1.283*	-0.782	-1.408*	-1.205*	-1.529*	-1.321*
lnGDP	3.043	10.483*	3.428	4.218	11.431**	-57.041*	-67.253*	-57.725*	-57.722*	-58.897*
InFORCE	-1.937	-9.354*	-2.322	-3.158	-10.313**	58.046*	68.228*	58.733*	58.716*	59.892*
lnPROD	-10.289*	-17.088*	-10.064**	-9.848*	-16.697*	58.910*	68.601*	59.165*	59.807*	60.113*
RES	-0.502	-0.548	-0.861*	-0.376	-0.922*	-1.208	-1.354	-1.039	-0.782	-0.886
rlf	7.818*	7.271*	7.220*	6.148*	5.911*	-1.081	-0.678	-0.632	-1.274	-0.424
Group 1	-0.275*	-	-	-	-	0.225	-	-	-	-
Group 2	-	0.295*	-	-	-	-	-0.401*	-	-	-
Group 3	-	-	0.034	-	-	-	-	0.049	-	-
Group 4	-	-	-	0.505*	-	-	-	-	0.269*	-
Group 5	-	-	-	-	-0.424*	-	-	-	-	0.103
Constant	59.255*	98.917*	51.958	58.094*	94.256*	-414.031*	-474.366*	-411.649*	-413.373*	-416.897*
R2	0.945	0.945	0.938	0.951	0.951	0.846	0.850	0.846	0.849	0.842

Table 2. Results of model estimation for MTCE (1-5) and MTCO (6-10)

*p<0.05; **p<0.10

CONCLUSIONS

The study found that both economic and geographical factors influenced technology transfer, understood as two streams of high technology manufactures: electronic and electrical, and other high technology manufactures. The determinant coefficients in most of the estimated models, such as the GDP of an African country and the distance between China and a given African country, were statistically significant, confirming the basic assumption of a gravity trade model and the importance of geographical distance in trade flows (imports). The impact of an African country's wealth, measured by both GDP and the level of the development gap (rlf), was somewhat in line with expectations. The model estimation results showed that the greater the difference in development between a given African country and China, the greater the tendency to import MTCE from China. Other determinants affecting the volume of imports from China included labor force and productivity per capita.

Then the article verified whether the determinants included in the study affected two different streams of technology transfer with equal strength and in the same direction. The study showed that determinants with different strengths and directions affected technology transfer streams. Different results were obtained for importing high technology manufactures: electronic and electrical and high technology manufactures: other. In the case of the first category, the streams were very high and reacted to changes in determinants differently than the stream of the second category with significantly lower values.

On the other hand, the objective of the study was to investigate whether technology transfer could be expressed using aggregates applied in the study. Both at the descriptive level and model estimation, we observed different shapes of distribution for both variables and different reactions to changes in determinant values, consistent with the second objective. These differences became even greater after analyses taking into account the geographical division of African regions.

At the end of considerations, several research limitations and areas for further research should be mentioned.

A major obstacle was limited availability of statistical data for African countries. Therefore, two economies were excluded from study, and for remaining ones, variables included in study had to be reduced to those that were reasonably complete. It is possible that access to more detailed data would identify additional factors influencing high-tech imports from China to Africa.

Moreover, the study relied on specific methods, and it cannot be excluded that other methods would have led to different conclusions. However, the method used seemed to the authors to be most appropriate for this type of study.

Furthermore, this study should be repeated in subsequent years to confirm results, especially due to the war in Ukraine. This event may likely have disrupted earlier trends.

Worth noticing, the study was conducted at a certain level of detail – high-tech goods were divided into two categories. However, within each category, there are more specific types of products. It is possible that a more detailed analysis would more accurately identify determinants affecting the import of specific technology from China.

Additionally, the study divided Africa into regions geographically, but it is possible that using a different division of economies could result in different study outcomes.

It's worth adding at the end, that the analysis could be expanded to include other economies, such as European or Asian countries, to compare their position in African technology imports with China. Such a comparison could lead to adjustments of ineffective strategies or the introduction of innovative tools in African countries.

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APPLICATION OF GIS IN LAND MANAGEMENT ON THE EXAMPLE OF UKRAINE

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ABSTRACT

Motives: Full-scale hostilities that occurred in Ukraine in 2022 have led to significant losses in agriculture and rural areas. These losses pose a serious threat to the country's food security and may lead to crises on international food markets. Also, to justify information needs and requirements in accordance with legal regulations relating to land use, food security in Ukraine should be considered through continuous monitoring and analysis of the available land resources, and the existing and projected structure of cultivated areas.

Aim: The aim of the study is to provide a theoretical and methodological basis for formulating practical recommendations regarding information and analytical support for the management of land resources through the use of GIS, in particular Earth remote sensing systems, in land management. **Results:** To improve the institutional environment for regulating land relations in Ukraine under new conditions of management, the following stakeholders should be considered in the process of managing land resources: 1) government, 2) local authorities, 3) agricultural enterprises, and 4) land owners. The study revealed problems with access to information and analytical support for managing land resources at the level of the central government, territorial self-governments, and agricultural enterprises. Digital transformation has a significant impact on agribusiness because it enables agricultural producers to interact with other stakeholders, compare their performance with competitors, and optimize production processes.

Keywords: digitalization, territorial communities, land resources, monitoring

INTRODUCTION

The domestic system of land use developed in recent years is characterized by a number of environmental and economic problems caused by the insufficient level of effectiveness of land resources management. At the same time in the process of management decision-making an important role is played by information support, in particular the updating of information about land resources, ensuring its availability and increasing the usefulness. That is formation of management system of land

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resources should be based on constantly updated information base about objects of land relations that causes necessity of increase of efficiency of use of information and resource potential and also creation of information system that will allow to provide the organization of the balanced land use. However, today land information systems function separately, based on analytical, statistical and technical systems, which leads to a significant number of errors in the process of planning, regulation, control and organization of land use. In this connection scientific substantiation of the main directions of information-analytical support of land management becomes especially urgent. Also, the regulation of land relations under martial law should be systematic, as it creates many simplifications to ensure the functioning of the agrarian sector of the economy and the rapid restoration of infrastructure of Ukraine (Kuryltsiv & Kryshenyk, 2022).

In connection with the significant deterioration of conditions for statistical and operational accounting of actual land use, remote sensing of the Earth based on artificial intelligence and geoinformation technologies is of great importance as a tool for data collection and analysis. Therefore, the relevance of the need to form information requirements for management decisions in land use increases, which includes in this study:

- definition and clarification of land management functions, which determine the requirements for information and analytical support of management decisions;
- substantiation of methodological foundations for the collection and processing of geospatial data in land management and land policy, including, in addition to statistical reporting and available data from the State Land Cadastre, other information flows and methods such as remote sensing, agroscouting, surveys, monitoring of open registers and information platforms, cross validation of data collected and their subsequent analysis in the Big Data and Data Mining;
- creation and continuous updating of an appropriate information model of data, including the structure, composition of geodata, new information flows, ways of their creation, processing, analysis, delivery,

visualization, interactive support for users in convenient forms;

 development of modern methodological approaches to modeling and forecasting of agricultural land use, which should provide support for management decision-making through modeling scenarios of long-term processes caused by internal and external social, economic, environmental, political internal and external factors.

Information and analytical support of land management for the purposes of their effective use should serve as the basis for further reforms, sustainable development of rural areas.

It's important to note that the full-scale hostilities that occurred in Ukraine in 2022 resulted in significant losses in agriculture and rural areas (Ibatullin et al., 2022). These losses pose a serious threat to the country's food security and may lead to crises in international food markets. More than 30% of the country's territory has been impacted by the effects of hostilities and at the end of 2022 is under occupation or remains dangerous for agricultural activities (KSE, 2023). Therefore, to manage land resources at different levels and make effective management decisions, it is necessary to have timely and reliable analytical information and GIS as well as remote sensing tools can be used for these purposes.

LITERATURE REVIEW

Now there is an increasing demand for timely and reliable information about the current state of land use. Solving the problem of inefficient informational support of land resources management is one of the main tasks on the way to rational use, protection of lands and taking decisive measures that would stop these negative processes. To keep the existing state of land resources is possible only through the development of information support of land management, namely the creation of a unified land-information system, which will contribute to the formation of a complete and reliable information database (Semenchuk & Yuzyk, 2018). Dorosh, Y., Dorosh, A., Derkulskyi, R., Bratinova, M. (2024). Application of GIS in land management on the example of Ukraine. Acta Sci. Pol. Administratio Locorum 23(1), 31–41.

Joireman and Tchatchoua-Djomo (2023) tackled the discrepancy between customary tenure rights and international policy regarding property restitution after conflicts. Additionally, they aimed to determine the paths taken by customary tenure systems in postconflict situations. These two concerns are inherently connected. There is an implicit and undefined assumption that individuals can always revert to rural agricultural livelihoods when they are forced to leave customary land. This assumption holds true only if customary land systems continue to operate as they did prior to the occurrence of violence.

Xu et al. (2022) categorized the tenure systems associated with rural homesteads in China, starting from 1949, using a systematic retrospective analysis. Three models were identified: the single entitlement system, the bipartite entitlement system, and the tripartite entitlement system. Under the single entitlement system (1949–1961), rural collective ownership solely served the economic utility function. In the bipartite entitlement system (1962–2018), collective ownership and the right to use were separated.

To an inexperienced observer or someone with an interest in history, the cadastral map may appear to be a mere relic of the past or an intriguing artifact. However, from a historical perspective, it served as a significant instrument of state policy, providing support for control and authority. The underlying motivation behind the creation of cadastral maps was rooted in economic, social, and political power. By providing crucial information, the map granted power to those in control, enabling them to effectively manage and tax land resources (Bacior, 2023).

Various indicators have been employed to assess and compare cadastral systems across different countries. The outcomes of these analyses play a crucial role in enhancing our comprehension of the intricate interplay between cadastral systems, land administration systems, and National Spatial Data Infrastructure (SDI) initiatives. Moreover, this enables a global assessment of cadastral systems, laying the groundwork for identifying best practices and offering a means to enhance national cadastral systems (Rajabifard et al., 2007).

Guzhva (2001) noticed in his work that there are problems of information systems and information resources of the organization. He proposed modern approaches to the development of automated information systems at enterprises. Believes that software products will help automate the processes of business planning of investment projects and strategic business evaluation in enterprises.

The adoption of the GeoPackage standard in mobile applications designed for land administration purposes enhances the practicality and effectiveness of field data collection. By utilizing various sensors such as fingerprint readers, cameras, and accurate GNSS sensors, along with seamless connectivity to cadastral databases through the KKP services, the mobile app significantly improves the efficiency of data capture. This app can be considered a facilitator for more streamlined and productive collaboration in the collection and validation of data for initial titling and forensic titling processes. Its performance has been tested in a village in Denpasar for boundary mapping and in two villages in the Bangli district of Bali Province for forensic titling purposes (Aditya et al., 2021).

According to Ponomarenko et al. (2011) information systems play a large role in the business management process. Information resource is one of the components of company economy. He proposed a process approach to the development of automated information systems and showed their classification for business management.

Pavlenko et al. (2013) highlighted the basics of modern information technologies and production systems in theory and practice. In their opinion, the functionality of information systems is of great importance in creating databases. They note the means of data processing: operational analytical and intellectual analysis.

According to Dyshlyk et al. (2018) the creation of national geospatial data infrastructure is aimed at developing the geospatial world in order to develop economy, provide vital services, maintain sustainable

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development, improving the lives of people around the world based on several things commonly accepted in the world. When forming the ideology of national geospatial data infrastructure and the relevant legal framework in Ukraine it is necessary to take into account the World development trends in this area. The system principles of creation of research institutes and the list of measures and actions to return the process of construction on an innovative way are offered.

The system approach is no less important in the management of land resources. Lyashenko (2019) believes that any system (object) is considered as a set of interrelated elements, has input, output, connection with the external environment and feedback. System approach to management assumes management of the organization as a single system, where any managerial influence on one part of the system affects its other parts, which means that it is necessary to manage the organization as a whole. As a way of management, the system approach is based on understanding the object of management as a whole, on revealing the diversity of its internal and external relations; a set of related, coordinated methods and means of managing the economy, industry, enterprise, subdivision, etc. At least any system management is based on two main system principles: providing a given purpose of functioning and creation of conditions for stability of existence in the changing world and protection against unauthorized external action.

MATERIALS AND METHODS

A number of general scientific and special research methods at the empirical and theoretical levels, in particular, system (structural and functional analysis), abstraction, analysis and synthesis, deduction and induction were used to achieve the objectives. The use of these methods made it possible to substantiate the information and analytical support land management, determine the content and tasks of institutional transformations in agriculture and agrarian policy.

Comparative and statistical analysis of the process of researching the quantitative composition of agricultural land of state institutions, the areas of land with or without title documents, the amount of land registered in the State Land Cadastre; abstract-logical method – when making theoretical generalizations and forming conclusions.

An important direction of information-analytical support of agricultural land use management at any level is the use of remote sensing. This method makes it possible to promptly assess the state of land over vast areas, timely identify and analyze threatening phenomena such as waterlogging, landslides, and land cover deterioration.

Spatial analysis use as the basic approach to identify the real state of land resources. Creating a system of integrated accumulation, processing, updating and storage of data, containing structured information about the current state of land, algorithms for analyzing the suitability of soils for the main types of land use, quantitative and qualitative indicators and normative monetary evaluation of land plots.

RESULTS

Land monitoring is one of the functions of land resource management. In accordance with the legislation, monitoring is a system of observing the state of land for the purpose of timely detection of changes, their assessment, prevention and elimination of the consequences of negative processes. At the local and regional level, land monitoring is carried out by territorial bodies of the State Geocadastre, at the national level by the State Geocadastre (Verkhovna Rada of Ukraine, 1993). In connection with the war, losses of crops, fires, as well as physical destruction of fields, there was a need to implement a new task, namely, monitoring of damage and loss of land caused by hostilities. Since the lack of proper land accounting creates gaps, we recommend filling this gap with methods such as remote sensing of the Earth and the use of geographic information systems. This choice of tools is justified by the fact that GIS allows for monitoring relatively quickly and without excessive costs, providing a broad overview of the state of the land. This, in turn, should become a universal

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tool for information support of organizational and management processes, effective management, use of information resources (Dorosh et al., 2020) and will allow competent state bodies at all levels to quickly and effectively make decisions that will contribute to ensuring food security of the country.

Because of the armed aggression the soil cover is destroyed, degradation processes develop, including on chernozems – mechanical destruction, pollution, clogging, etc. According to the data of the Ministry of Agrarian Policy of Ukraine (Minagro, 2023), in the structure of damages the greatest losses are fixed due to destruction or partial damage of agricultural lands and harvesting.

The total area of agricultural land in temporarily occupied, de-occupied and hazardous territories is more than 10 million hectares (Fig. 1) (Copernicus, Sentinel-2, 2022). In the structure of damage, the greatest losses are recorded due to destruction or partial damage of agricultural land and harvesting. Agricultural land suffered two significant types of damage – mine contamination and direct physical damage. In addition to minefields, areas affected by active combat operations are contaminated by unexploded ordnance, which poses a deadly threat to Ukrainian farmers during fieldwork. The second type of damage is physical damage to the fertile soil layer, such as craters from artillery shelling and rocket attacks, damage to the soil by the tracks of tanks or other military equipment (KSE, 2022).

About 19% of all irrigated agricultural land in Ukraine is located in the temporarily occupied Kherson region and another 10% in the partially occupied Zaporizhzhia region. The approximate cost of replacing and repairing the damaged irrigation infrastructure is \$225 million (KSE, 2022).

In addition to direct land damage, occupation, military actions and mine contamination limit farmers' access to fields and opportunities for harvesting.

The production of crops has been significantly impacted by Russia's invasion, with losses estimated at astonishing 1 billion UAH or nearly half a quarter of export potential. The most substantial production losses are for croplands, which accounts for 510 million UAH, followed by winter crops at 490 million UAH for spring 2022.

A significant part of the dangerous territories in order to return them to economic use requires measures to eliminate the consequences of military operations: demining, cleaning of fortification structures, restoration of the surface layer, etc., which requires the implementation of national programs and investment projects. After that,



Fig. 1. Croplands of Ukraine in Spring 2022 and Occupied Zones *Source*: own preparation based on Copernicus, Sentinel-2 (2022).

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significant areas of de-occupied land will most likely require land management, which includes the following: identification of disturbed lands and lands affected by negative processes and implementation of measures for their restoration or conservation, reclamation of disturbed lands, reclamation of lowproductive lands, protection of lands from erosion, flooding, waterlogging, secondary salinization, drying, compaction, pollution by industrial waste, radioactive and chemical substances and other types of degradation, conservation of degraded and low-productive lands.

Infrastructure facilities of the agricultural, warehousing, transport, energy and food industries experienced significant disruptions. Seaports were partially blocked, which reduced the export opportunities of the industry. Logistics, transport, storage and other economic chains are disrupted. Agricultural enterprises are experiencing an acute shortage of fuel and lubricants, seeds, fertilizers, plant protection products, and spare parts. Some agricultural equipment is damaged or involved in other humanitarian or military work. Employees of enterprises are enlisted in the armed forces of Ukraine, territorial defense and other non-agricultural activities.

Under these conditions, the implementation of anti-crisis agrarian policy in Ukraine should be based on current reliable information about the sown areas of crops available in the controlled areas, their spatial identification and condition. In this regard, GIS tools can also be used in the development of land management projects that provide environmental and economic justification for crop rotation and land management, developed at the request of landowners or land users in order to organize agricultural production and manage agricultural land within land ownership and land use for efficient agricultural production, rational use and protection of land, creation of a favorable environmental conditions and improvement of natural landscapes. It is necessary to assess the possibility of sowing, harvesting and organization of transport and storage processes. It is also important to determine the available areas of agricultural land for subsequent

sowing and harvesting potential in each region, taking into account the structure of crops and local resources and features, in particular military, production and climatic characteristics.

To improve the processes of data collection and processing in land management in terms of soil resources, the following issues in particular need to be addressed:

- conducting a repeat (or correction) of the solid ground survey, since the materials of the preliminary one, conducted more than 50 years ago, are outdated. The new survey should be carried out on new methodological principles, taking into account the consequences of the armed aggression of the Russian Federation against Ukraine;
- organization of land and soil cover monitoring taking into account European experience, improvement of the national system of agrochemical passportization of agricultural lands, operating in the country since the 60s of the last century, with the use of remote sensing tools. Combination of new cartographic-analytical materials obtained as a result of repeated soil survey with the data of agrochemical passportization and monitoring will be the same exemplary world level of information on soils (chernozems) of the country;
- improvement of information provision through formation of soil data bases with extended evaluation, cartographic and prognostic possibilities, activation of Ukrainian Soil Information Center, transfer of information to the State Land Cadastre;
- carrying out appraisal of soils according to improved methodology and determination of objective price of lands (normative value assessment).

In conditions of essential deterioration of conditions for realization of the statistical and operative account among tools of gathering and the analysis of the data of actual land use the remote sensing of the Earth with use of artificial intelligence and geoinformation technologies takes the major place. Yes, we are supposed to carry out with the help of these tools:

 determining the boundaries of arrays of agricultural land and crops;
- identification of infrastructure facilities and areas under land resources that were damaged during military operations and shelling;
- evaluating the availability of cropping areas to engage them in agricultural production;
- identification of the boundaries and areas of cultivation under specific crops, including a preliminary estimate of yields;
- analysis of the volume and structure of sown areas in the territorial section with forecasts of yields and gross yields of agricultural crops using vegetation indices;
- determination of the state and dynamics of land transformation by types of land.

One of the goals of monitoring as an element of land management is to collect information on damaged land as a result of armed aggression, which can also be done with GIS tools. Damage to land resources as a result of armed aggression was analyzed in particular using the spread of active fires according to NASA Firms and Copernicus Emergency Management Service (Fig. 2).

It has been established that the main land losses due to fires are concentrated in the 30-kilometer buffer zone along the line of contact and are obviously related to combat operations and shelling. The use of satellite imagery should make it possible to carry out preliminary work to identify, assess and zoning the areas of agricultural land affected by the armed



Fig. 2. Location of active agricultural fires region, taking into account the temporarily occupied and de-occupied territories of Ukraine as of September 2022

Source: own preparation based on NASA Firms and Copernicus Emergency Management Service data (2022).

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Fig. 3. Analysis of the nature and scale of agricultural land mass lesions using satellite images *Source*: own preparation based on satellite images Sentinel-2 (2023).

aggression. Automated detection of munitions explosion craters on satellite images with the installation of 30-meter buffer zones makes it possible to identify the main areas and concentration of such damaged lands (Fig. 3). The process of identifying craters after explosions was carried out using Python programming based on reference pixels selected by specialists.

Therefore, the following stakeholders should use Earth remote sensing information:

- 1. Public authorities (Ministry of Agrarian Policy and Food, the State Service of Ukraine for Geodesy, Cartography and Cadastre, etc.).
- 2. Local authorities (new united territorial communities).
- 3. Agricultural enterprises (agricultural holdings, agro-firms, farms, production cooperatives, etc.).
- 4. Owners of land lots.

The problems of information and analytical support for land management at the level of landowners can vary, and they often depend on the specific country, region or local conditions. However, some common problems that may arise include the following:

1. Lack of information: landowners may not have sufficient information about their rights and obligations, land law, procedures for registering property rights, etc. This can lead to illegal actions or conflicts.

- 2. Information registration systems: in some regions, there are outdated or inefficient systems for registering land rights, which can lead to delays in resolving land ownership issues or land transactions.
- 3. Corruption and unfair practices: owners may face corruption or unfair practices when trying to register land rights, submit documents, or receive information from the authorities.
- 4. Lack of access to technology: in some cases, owners may not have access to modern technology and the Internet, making it difficult to access information and interact with authorities.

The use of land resources at the level of an agricultural enterprise should combine the interests and goals of specific landowners (land users) and society as a whole, as well as all sides of land relations for their rational use and increase the efficiency of agricultural production.

Current problems of land management at the local level should include:

1. The need to determine the boundaries of actual economic use of land, often not coinciding with the legal boundaries and the legal regime of land.

- 2. Necessity of defining the cost of land use from the position of economic efficiency of production and economic activity.
- 3. Necessity of optimal planning of production use and protection of lands.

At all levels of management, a significant number of problems is expedient to solve by introduction of information technologies on the principles of geospatial data infrastructure. Technological solutions that are reasonable to use when creating informationanalytical systems of this level include: web platforms, GIS-technologies, artificial intelligence, machine learning, relational and non-relational databases, OLAP and OLTP, remote sensing of the Earth, etc. Combining modern technologies is an important tool to ensure the competitive advantage of any enterprise, society and state as a whole.

Improving the efficiency of public administration in the development of measures to create an information environment for the use of land resources becomes more relevant in the context of land reform, as well as the planning of its future actions. Therefore, there are some problems of information support that should be solved.

At the level of the state, among the problems of information and analytical support of land resources management we can single out:

- lack of quantitative and qualitative land records;
- imperfection of the methodology of statistical reporting on the state and changes in the land fund;
- imperfection of spatial analysis in information support;
- lack of complex system of monitoring of lands, their legal status and actual use, tracing of soil quality;
- presence of different types of errors in the records of the State Land Cadastre;
- insufficient efficiency and relevance of analytical data, in particular in terms of land protection, etc.

No less important aspect in the informationanalytical support is the spatial analysis, because it is the basic approach to identify the real state of land resources. It is necessary to create a system of integrated accumulation, processing, updating and storage of data containing structured information on the current state of land, algorithms for analyzing the suitability of soils for the main types of land use, quantitative and qualitative indicators and normative monetary evaluation of land plots in Ukraine. The following information should be included in this system:

- data from the State Land Cadastre;
- data from statistical reports (6-zem, 6a-zem, 6b-zem, etc.);
- cartographic materials;
- data from other cadastres;
- tax and lease payments;
- cartogram of agro-productive groups of soils;
- digital relief model;
- soil suitability scales;
- limits of administrative-territorial formations;
- indices of tillage and forest cover;
- anthropogenic overload factors;
- indicators of environmental sustainability of the territory;
- degree of soil erosion, etc.

At the level of territorial communities, the following problems arise:

- lack of officially approved community boundaries, which does not allow to establish the boundaries of the rights and powers of local government;
- lack of support for management decisions at the local level on the management of communally owned land;
- informational and analytical support of the local regulatory and legal framework regarding the regulation of land relations;
- problems of inventory of unregistered land, administration and collection of land tax, management of communal real estate, management of investment attractiveness of community land;
- introduction of community participation in community land use and protection planning.

CONCLUSIONS

Economic losses from military aggression pose a serious threat to the stability of the country's food security and may cause a crisis in international

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food markets. When formulating requirements and developing information resources for effective management of agriculture, it is necessary to take into account the importance of ensuring food security of Ukraine through constant monitoring at the local level and analysis of available land resources.

Data from various sources and satellite data were used to evaluate the damage to soil and farmland. Using data from the Ministry of Agrarian Policy and Food of Ukraine (MAPF), the decrease in crop production was estimated.

The application of GIS technology in land management is expected to improve data collection and processing processes for soil resources, which will help to Solving the following issues: updating the obsolete base of maps of agro-productive groups of soils; improvement of national agrochemical passportization system for agricultural lands bagricultural holdings with application of remote sensing tools; improvement of national agrochemical passportization system for agricultural holdings soil appraisal using improved methodology; and identification of objective land prices for appraisal of soils using improved methodology and definition of objective land price (normative monetary appraisal).

The mentioned statements will provide an opportunity for the application of GIS technologies in land management, particularly in the development of a working land management project for the reclamation of damaged lands, removal and relocation of topsoil, conservation of degraded and unproductive farmland, improvement of agricultural and forestry land, protection of land from erosion, flooding, waterlogging, secondary salinization, drying, landslides, compaction, acidification, pollution from industrial and other waste, as well as radioactive and chemical substances.

Land management at the level of agricultural enterprises requires the creation and proper functioning of an information system of data on land use in the context of each specific enterprise separately. Therefore, the use of relevant information is a guarantee of stability in the enterprises, which will lead to the attraction of investors and provide an opportunity to obtain a permanent income due to the rational use of land resources.

At all levels of management, it is advisable to solve a significant number of problems by introducing information technology on the principles of geospatial data infrastructure, which will allow the prompt use of relevant information in making effective management decisions.

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GOOD ARCHITECTURAL DESIGN AS A CATALYST FOR IMPROVING THE QUALITY OF LIFE IN CITIES

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ABSTRACT

The growth of cities has led to multiple transformations that have changed the urban fabric; for this reason, many locations in urban areas remain neglected. The present study was undertaken to search for solutions that would minimize adverse changes in the urban fabric, buildings, and urban spaces. The aim of the study was to present examples of good architectural design that can be considered catalysts that improve the quality of life in cities. Architectural design contributes to urban development not only at the level of individual buildings, but also at the level of the overall quality of urban life. The research methodology involved developing a theoretical framework for the research topic, and applying selected indicators to analyse several international examples and investigate the strategies deployed in various countries around the world. The study demonstrated that good architectural design must be inspired by a city's history, and that the urban context should be considered in order to integrate new urban development with the surrounding environment through catalytic mechanisms and their indicators. Sustainability, health, education, safety, psychology, material sourcing, and building materials are the most important quality of life (QoL) factors for developing a good architectural project.

Keywords: city, quality of life, local environments, catalytic mechanisms, urban catalyst, good design

INTRODUCTION

In recent years, the world has witnessed multiple transformations that have impacted our everyday lives. Such as urbanization, industrialization, and globalization. These changes have affected the ecosystem, human settlements, environment, public health, and economy. Which has led societies to act as governments or as individuals to provide any kind of solutions, to improve the quality of life (Muhammed & Abubakar, 2019). One of the solutions is the urban catalyst as a sort of improving quality of life.

The concept of improving the quality of life in cities is critical, as the growing population due to the rapid growth and urbanization processes, is changing the physical characteristics of cities to accommodate the new residents. That is, where the relationship between the built environment and the quality of life



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in cities can occur as a catalytic role in shaping current and future urban development). Improving the quality of life in cities is a very important issue in design and urban planning and the rise of population (rapid population growth) and urbanization processes, makes urban quality of life relevant to more and more people (Mouratidis, 2021). The concept of quality of life illustrates the interrelationships that enable us to describe, understand and measure, The complexity of the social and economic reality and the improvement of the quality of life is the driving force in human activity (Cloutier et al., 2018). In the modern era, the cultural and environmental contexts were neglected to accomplish an ideal way of living, with the use of modern technology, therefore contemporary architecture is returning to the real way of living to accommodate society's needs and comfort (Boschi & Pagliughi, 2002). In his book, Ballas, deals with the concept of quality of life at the ecological level, the concept's relationship with happiness, and its connection to public policy (Ballas, 2013). Though these needs are sometimes against sustainability principles (Yusoff, 2020).

Catalyst mechanisms are widely discussed in urban and architectural studies, due to their important role in the city, as the current study will show in the literature review. However, these mechanisms are neither studied comprehensively nor according to their relation to the concept of quality of life. This leads to the current study that aims to shed light on the integrative relationship between catalytic mechanisms and quality of life in the city and the role of architectural design in achieving that. By showing a number of previous studies, and summarize the definitions and indicators of catalyst and quality of life concepts. Followed by an analysis of a group of international catalytic projects and extracting their used mechanisms. Cities, in all their details, are an environment of possibilities, creativity and invention through the new designs that are implemented within their framework (the role of architects) is to learn from the capabilities and basic mechanisms of those cities and catalyst its potential and looks for opportunities in the current circumstances (Eisenschmidt, 2012)

the catalytic mechanisms in cities improve the quality of life and make it more creative, balanced and sustainable.

Research Methodology

- 1. Reviewing a number of studies on the concept of the quality of life and urban catalyst.
- 2. Clarifying the relationship between urban catalyst mechanisms and their role in improving the quality of life by Reviewing international examples of architectural catalysts projects in order to extract their approved mechanisms as good architectural designs.

Literature Review

The research aims to clarify some of the studies that are related to the concept of catalytic mechanisms, in the scale of the city in general (Attoe & Logan, 1988) have dealt with the importance of this concept in designing cities, as a part of urban rehabilitation of the existing and adding new elements to improve the context across the aesthetic, economic, and morphological aspects, by producing three strategies for transforming a building or group of buildings into a catalyst for urban development, which are (Attoe & Logan, 1989):

- 1. Reviving the inherent values of rehabilitation and employment.
- 2. Involvement within a unified urban structure.
- 3. Reorganization by adding new elements and links between buildings.

At the level of the ccenterntre, both (Sideroff, 2003) and (Bohannon, 2004) have focused on thealyst projects to revive the urban centcenterscities. Especially in the cities that possess distinctive and unique elements at the civilized and cultural level that distinguishes them from others, by producing three strategies (Bohannon, 2004; Sideroff, 2003):

- 1. Reviving a specific historical building;
- 2. Establishing a new building compatible with the context and local needs;
- 3. Rehabilitate the urban scene of the streets and the new buildings.

While Mai et al. (2014) have suggested reviving the economy of the city by transforming its activityintoo tourism, either in the cicenterre, or in its important district, despite the negative effect on its environmental and social life (Mai et al., 2014). However, Maria Cerreta mentioned the concept of green urban catalyst which can be achieved by applying the principles of sustainability at its various levels and creating relationships between its environmental, technical, economic, and financial parts, institutional, cultural and civic aspects, as well as taking into account the context to achieve a catalyst for positive urban values. The dissemination of the principles of sustainability in design is the dissemination and illustration of a set of experiences that can be defined as the "green urban catalyst", as it catalyst "green" urban development,

No.	Previous Literatures	Catalyst Mechanisms	Catalyst Levels	Catalyst Strategies	Indicators
1.	Attoe & Logan,	Catalysts in the	The aesthetic, economic, and	Reviving Inherent Values Unified urban structure Reorganization with	Rebuilding the elements of the new and existing urban environment
	1900	design of effect	morphvological	new elements and links between buildings	Creates urban formation and context
2.	Sideroff, 2003	Revitalization through catalyst projects	The reviving urban centres of cities	Creation of multiple forms of changes	Reviving a specific building. Establishing a new building with local context Rehabilitate the urban scene
3.	Bohannon, 2004	Civilization and culture catalyst	City's own cultural elements	Cultural elements improvement	Role in urban reviving Characteristic elements of cities Urban signs Distinctive urban areas
4.	Mai et al., 2014	Revitalization through catalyst projects	The reviving urban centres of cities	Tourism as a new function	Improve city's economy
					Improve the city's image
5.	Grodach, 2008				Act as a catalyst for economic development.
		Adding cultural project	Cultural node	Flagship Cultural Strategy	Symbiosis between the project and its surroundings
					Accessibility
					Revitalization of the city by tourism
6.	Kristo & Dhiamandi, 2016	Adding architectural projects	Public space	Pilot model Strategy	Location Architecture Program Aesthetic Effects Architectural Narratives
7.	Abdel-Ghani, 2017	Adding cultural project	Cultural node	Creative city strategy	Open cinema in public spaces Street Graffiti art
8.	Balvociene & Zaleckis, 2021	Place-making	Movement between multiple cultural nodes	Function Meaning Attraction	Using the surroundings Re-imagine and understand the identity of place Stimulate finding another such place in the city

Source: own preparation based on Authors (2022).

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influencing the integration strategy of project and context (Cerreta & Salzano, 2009).

Other studies have mentioned (adding activity to improve the city) as an architectural catalyst, where Grodach (2008), Kristo and Dhiamandi (2016), and Abdel-Ghani (2017) note a cultural project's ability to improve the city's image and act as a catalyst for economic development. As it could be an important node, a pilot model strategy, or a flagship cultural strategy (Abdel-Ghani, 2017; Kristo & Dhiamandi, 2016). One example is the Guggenheim Museum Bilbao, which promises to be an instant catalyst for the revitalization of the city. Besides considering the integration of the added project with the urban context, such as in the examples of the Museum of Contemporary Art in Los Angeles and the San Jose Museum of Art in San Jose, California (Grodach, 2008). The mentioned studies are summarized to extract the indicators of catalyst mechanisms in Table 1.

URBAN CATALYST. THE CONCEPT AND THE MECHANISMS

The term "catalyst" is derived from the field of chemistry, according to the Oxford English Dictionary, the concept refers to: a substance that may be present in small quantities but acts to increase the reactivity of a chemical process but has not changed chemically; If it slows down the reaction, it is called a negative catalyst. The concept of urban catalytic has appeared in the eighties of the last century, and it was linked to the positive effects caused by individual buildings on the urban level, and it has expanded later to be within the context of urban design and cities.

The process of achieving positive changes requires focusing on the catalytic project in itself, as it is an attractive element within its urban environment and the creation of secondary uses that enhance development and the identity of the project. In addition to focusing on the surrounding context from several sides, including: morphology, perceptual, social, visual, temporal and place authenticity factors to be part of the surrounding environment (Bohannon, 2004). And in urban renewal, architectural projects are considered as urban catalyst and alternative process for cities to provide solutions and better tools that adapt to their surroundings (Kristo & Dhiamandi, 2016; Oswalt et al., 2004).

The study of (Balvočienė & Zaleckis, 2021) has focused on adding multiple cultural nodes as catalysts to make the city more vital, vibrant, sustainable, and creative (Balvočienė & Zaleckis, 2021). While Attoe and Logan (1988) have dealt with the importance catalyst characterized as follows:

- 1. The surrounding environment and its elements are affected by a new element (the catalyst).
- 2. Strengthening the urban elements or transforming them in positive ways without erasing the old elements or reducing their value.
- 3. Understanding the context and integrating with it without harming it is a positive motivator.
- 4. Not all catalytic reactions are the same.
- 5. Motivational design strategy.
- A 6. product consisting of a group of components is the target of a catalytic reaction.
- 7. The catalyst is not consumed but remains renewable.

Whereas (Norton, 2009) has argued that Urban catalyst influence and change according to contexts, and catalyst projects. Whether in a single building or at the city level, these projects should be characterized by flexibility, attractiveness and ease of movement and transportation (Francin, 2015). Among the catalysts that support development: stadiums, museums, office buildings and other facilities. Urban designers and planners should design catalysts to create direct links between the catalyst and the commercial area it will serve to improve life in those areas and achieve a balance (Sternberg, 2002).

In addition to the mentioned above, community organizations, urban designers Planners and decision makers (government, developers). Attempts to implement urban interventions to achieve a broader vision, these interventions create new societal images and solve all their problems. This is done based on the values of those societies. As well as the participation of local people in shaping their city. Temporary urban interventions adopt and enhance community action to bring about broad and long-term changes (Hinthel et al., 2020).

So, the catalyst mechanisms Re-imagining and understanding the identity of the place, improving the quality of life and making those areas (building or city), and make it more creative and balanced.

QUALITY OF LIFE

Quality concept is defined as the excellence, while Quality of life (QOL) is defined by the World Health Organization (WHO) as the perception of individual's life, culture, and value, that determines his standards and goals. It is related to multiple aspects such as: health, safety, identity, and well-being, etc. (Wikipedia, 2022). Quality of life is defined as the ability to improve the standards of living and satisfaction with life (Muhammed & Abubakar, 2019). The quality-of-life concept is not a new concept as it returns to Aristotle's' writings where it is defined as the good life, or living well. And it is related to the satisfaction of life due to good health, comfort, and clean environment (Serag El Din et al., 2013). As the concept is multi-dimensional and related to multiple aspects such as health, psychology, urban planning, urban design, and architectural design.

Architects have been interested in achieving the best quality of life since the work of Vitruvius and Palladio, as they aimed to accomplish the famous three principles (Convenience, Durability, and Beauty), where convenience deals with location, building's relation to the surroundings, ventilation, thermal comfort, and social well-being (Boschi & Pagliughi, 2002). However other architects consider these characteristics as essentials for the good design, besides being able to make positive contribution to the neighborhood and the city as well (Moore et al., 2015).

Quality of life has been studied in the city's scale as a whole, as in the studies of (Friant, 2020; Khalil, 2012; Mouratidis, 2021; Nour, 2018; Romice et al., 2017; Serag El Din et al., 2013) that have produced multiple strategies to improve the quality of life in the level of metropolitan city, neighbourhood, and pedestrian level (Friant, 2020; Khalil, 2012; Mouratidis, 2021; Nour, 2018; Romice et al., 2017; Serag El Din et al., 2013).

While other studies have related quality of life concept with the principles of sustainable development or sustainability, either on neighbourhood level or individual building level (Ayoobi, 2021; Yusoff, 2020).

However, others have been specific in the level of the individual building's good design either in the scale of the whole building and its relation to the urban context (Moore et al., 2015), or in the specific design of architectural spaces and their environmental quality (Boschi & Pagliughi, 2002; Majerska-Palubicka & Cibis, 2019). As shown in Table 2.

The current study is concerned in the role of good architectural design as a catalyst mechanism that improves the quality of life in the levels of city in general. So it suggests four catalyst mechanisms as urbanely which are: City's Catalyst, City Center's Catalyst, Civilization and Culture Catalyst, and Place making Catalyst. Besides the mechanism of Adding Architectural Project, that will be studied specifically. As shown in Table 3.

The current study aims to show the capability of an individual good architectural design as a catalyst project in improving the quality of life of the city and this is going to be produced by applying the extracted indicators of (Table 3) on the selected case study.

Case Study: International Examples

The research will show a number of international examples as catalyst projects in order to extract their adopted mechanisms and strategies as follows:

Busan Cinema Centre in South Korea

This project is an open public space where architecture, entertainment, technology, culture, and public spaces come together to form an urban valley. The project houses several functions: theaters, cinema, conference center, offices, studios, restaurants, etc. The design connects open and closed spaces, It counts as an urban catalyst for cultural transformation and

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No.	Previous Literatures	Quality of life level	Quality of life strategy	Indicators							
1.	Serag El Din et al., 2013	Urban quality of life	Sustainability factors	Environmental dimension Physical dimension Mobility							
2. Friant, 2020				Social dimension							
3.	Khalil, 2012	Theories of urban design	New urbanism Smart growth Sustainable urbanism	Psychological dimension Economic dimension Political Dimension							
4.	Nour, 2018		Metropolitan scale	Material well-being							
5. 6.	Romice et al., 2017 Mouratidis, 2021	Urban design	Neighbourhood scale Pedestrian scale	Emotional and personal development Interpersonal relationships Physical well being							
7.	Yusoff, 2020	Sustainable development	Human needs Sustainable environment	Biological Needs Cultural Needs							
8.	Ayoobi, 2021	Sustainable urban design	Sustainability factors	Land use Transportation Resources Health Well-being Safety Culture Education Comfort Accessibility							
9.	Moore et al., 2015	Architectural design	Good design Design regulations Design review panels Design guidelines	Considering the character of context The interface between building and street Environmental performance Building's orientation flexibility and adaptability makes positive contribution to the context and to people health							
10.	Boschi & Pagliughi, 2002	Architectural spaces	Durability Convenience Beauty	Maintainable Indoor Air Quality (AI) Pleasant air quality Support of social needs and productivity Human needs Human comfort Distinguished aesthetic qualities Relationship to context (site)							
11.	Majerska-Palubicka & Cibis, 2019	Architectural spaces	Sustainable design Eco- tech design	Microclimate quality							

 Table 2. The Extracted Indicators of catalyst mechanisms from Literature Review

Source: own preparation based on Authors (2022).

Catalyst	Levels		Strategies					
mechanisms	Catalyst	Qol	Catalyst	Quality of life				
City's catalyst	Aesthetic, economic, and morphological		Reviving inherent values Unified urban structure Reorganization with new elements and links between buildings	Sustainability factors New urbanism				
City centre's catalyst	Reviving urban centres of cities	Urban + sustainable	Creation of multiple forms of changes Tourism as a new function	Smart growth Sustainable urbanism				
Civilization and culture catalyst	City's own cultural elements	development	Cultural elements improvement	Metropolitan scale Neighbourhood scale				
Place-making catalyst	Movement between multiple cultural nodes		Function Meaning Attraction	Pedestrian scale				
Adding architectural project catalyst	Cultural node Public space	Architectural design Architectural spaces	Flagship cultural strategy Pilot model strategy Creative city strategy	Good design Design regulations Design review panels Design guidelines Durability Convenience Beauty Sustainable design eco-tech design				

Table 3. Catalyst mechanisms integration with quality of life

Source: own preparation based on Authors (2022).

exchange "open architecture that becomes a catalyst for city culture" (Chousein, 2015). The project proposes a new intersection between public space, architecture, technology and cultural programs to achieve lively and vibrant landmarks that are considered a cultural icon within its urban surroundings. This intersection guarantees four overlapping areas: Urban Canal, Red Carpet District, Walk of Fame and BIFF Canal Park.

Project areas include Mountain Cinema, BIFF Hill, Concourse Double Cone and BOWL amphitheater. The roof and its elements are designed as a virtual sky that connects elements and areas in a continuous and multifunctional public urban space where media, technology, entertainment and leisure are integrated into an open architecture of mutable and customdesigned event experiences to result in a space that changes and responds to flows as a transforming cultural urban catalyst (Prix, 2012).

The basic concept of project was the overlapping of open and closed spaces and of public and private areas. While the movie theatres are located in a mountain-like building, the centre's public space is shared between an outdoor cinema and a huge public space (Jabakhanji et al., 2020).

Glasgow Riverside Museum of Transport in Scotland

The project is designed to create a dynamic relationship between the industrial district and the river (Glasgow River), the building is an urban catalyst being part of a broader development strategy in the city and a fine example of cultural development in a post-industrial city. This project also created an event in the urban context of the city (Chousein, 2015). The project included: 1) Building a project design that achieves access and more attention to interior design, presentation and organization; 2) Achieving a historical connection to the city; 3) That the project is a new iconic building.

The design of the project included several spaces around the building's curves that included green hills, symbolic sprinklers of children and silver birch trees embedded in a simple paving treatment. The project's gestures can be seen from the aesthetic of the project's exterior shell and the spontaneous landscaping common in the post-industrial Clyde Corridor. It establishes an important place on the river – even if it is separated from everything else.

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Adding Architectural Project Catalyst Strategies	Catalyst indicators	Case Study		dy	Urban Catalyst Mechanism	Catalyst indicators	(Case Study		у	QoL Indicators	С	ase	Stu	Study		
		1	2	3	4			1	2	~	;	4		1	2	3	4
	Improve city's image												Environmental dimension		√	✓	✓
			~	~	✓		Reviving Inherent Values	~					Physical dimension	√	✓	✓	✓
	Act as a catalyst for economic development	√	√	√	√	City's catalyst	Unified urban structure			•		~	Social dimension	✓			✓
Flagship	Symbiosis between the project and its surroundings	~	~	~	✓		Reorganization with new	~				√	Psychological dimension	√			√
Cultural Strategy		·		-	ŗ		elements						Economic dimension	✓	√	✓	√
	Accessibility	✓		✓	✓		Links between buildings.					√	Political Dimension	✓	√	✓	✓
	Revitalization of the city by tourism			✓	~	City centre's catalyst	Creation of multiple forms of changes					✓	Material well-being				
		✓	✓					~	~	~			Emotional and personal development	√			√
							Tourism as a new function	~	<i>_</i>			✓	Interpersonal relationships	✓			√
								·	•	·			Biological Needs			✓	✓
	Location		✓		\checkmark				т	-ե։			Cultural Needs	✓	\checkmark	✓	\checkmark
	Architecture Program	✓	✓	~	✓			n	mechanism does not contain adding new architectura project		n	Land use	✓	\checkmark	✓	√	
Pilot model						Civilization	Cultural				es not ontain ing new		Transportation	✓	✓		
Strategy	Aesthetic Effects	✓	✓	√		catalyst	improvement	a					Resources				
	Architectural			~				aı			aı	Health			✓	√	
	Narratives												Comfort			~	√
	Open cinema in public spaces				✓	Diace	Function	\checkmark	\checkmark	v	· .	√	Safety			√	√
Creative city					making	Meaning		\checkmark \checkmark			Education		\checkmark	√	✓		
strategy	Street Graffiti art.					catalyst	Attraction	\checkmark	~	v	· .	~	Accessibility	✓		√	✓

Table 4. Applying The Extracted Indicators on Case Study

Source: own preparation based on Authors (2022).

The building connects two streams, so it is a liquid and liquid design – a third mineral river (Murphy, 2011).

Euralille Youth Centre In France

The Euralille Center design goal is an "urban catalyst". It accommodates three stages (represented in the form of a triangle), as the design sets a special program at each point of the triangle that ensures privacy and continuity as well as revitalizing the neighboring places and achieving harmony with the urban context of the city. It's designed for all ages (stages of human development) and based on the history of Lille, as Lille is a European center for business, conference, study and living as well as tourism, as it is a medieval heritage city (Chousein, 2015).

Site selection and landscape design is the main goal of sustainable design, and effective land use is a prerequisite for good landscape design (2015, WBDG Sustainable Committee). In accordance with the principles of sustainability, the project included: Landscaping green spaces such as roofs, terraces and gardens. It takes into account the characteristics of the local ecosystem (Federal Ministry of Environment, Natural Resources, Buildings and Nuclear Safety, 2016).

The objective of this example is to create an atmosphere that enhances the lives of (children, and youth) positively influences their behavior through the design and purpose of the project within the city (Chinedu & Daminabo, 2022).

Mount Barker Centre in Australia

A catalyst project to achieve the goals sought within both the Council's 2012 Town Centre Strategy and the principles of their competitive Expression of Interest.

This project is expected to provide a true once in a generation opportunity to develop a placemaking and city-shaping project that elevates and transforms the Mount Barker City Centre, complementing and linking to the well-established activity bases in the center. Activity day or night, throughout all Four Seasons. A new destination for locals, and a regional tourism attraction. Safe and comfortable streetscapes, promoting community gathering through interactive art and integrating areas for activity and engagement.

This project present its innovative and thoughtful masterplan and vision for the whole site. This significant "catalyst project" aims to set a new benchmark for the activation and public enjoyment of the public realm and the planned development of prime retail and commercial, health and residential land uses driving citywide economic activity and employment (Burke, 2022; Mount Barker, 2022).

After describing the case study, the research will apply the extracted framework indicators on them, as shown in Table 4.

Results

After applying the extracted indicators in Table (4) on the selected case study, the results were as follows:

- 1. In the strategies of adding architectural project catalyst, all of the selected projects (case study) follow the flagship cultural strategy. And could be considered as pilot model strategies as well.
- 2. In the urban catalyst mechanisms, all of the selected projects (case study) follow the city center's catalyst and follows with fewer indicators both of city's and place-making catalysts.
- 3. In the quality of life (QoL) indicators, both the third (Euralille Youth Center) and the fourth (Mount Barker Center) case studies follow 16 of 19 indicators. The first case study (Busan Cinema Center) follows 11 of 19 indicators. While the second case study (Glasgow Riverside Museum) followed 8 of 19 indicators.

Discussion

- 1. Good Architectural Design Available in all catalyst projects related to improving the quality of life.
- 2. Improving the quality-of-life is available across all catalytic projects at the city level (eg. the Attoe & Logan study, 1988) or at the single building level (eg most of the literature review we describe).

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- 3. All catalyst projects achieved an improvement in the quality of life, both at the city level and the individual building.
- 4. Civilization and culture catalyst achieve: aesthetic and economic goals and achieve sustainable urban development at the level of the city, urban space and the level of the individual building. As well as achieving each of: Function, Meaning, Attraction.
- 5. The flagship cultural strategy contains a number of indicators that were found in all of the case study projects, such as improving the city's image because most of them are considered icons in the city. And acting as economic and tourism catalysts, besides the symbiosis of these projects with their surroundings. These indicators were also referred to in each of the studies: Bohannon (2004), Grodach (2008), and Abdel-Ghani (2017).
- 6. From the indicators of the pilot model strategy, the second and the fourth case studies were concerned mostly with selecting the location (eg. Kristo & Dhiamandi study, 2016). While all of them emphasized the architectural program to be multifunction projects. Besides the aesthetic effects that could be found in the LED roof of Busan Cinema Center, the fluid form of Glasgow Museum, and the colored façades of Euralille center, with no mention of this feature in Mount Barker Center. However, the Euralille center is the only project that has architectural narratives due to its city's history as a medieval city.
- 7. From the indicators of the creative city strategy, the only case study that follows the open cinema indicator was Mount Barker Center due to the existence of urban open space within the project, which gave it the capability to be used by the community creatively ,also we can see this indicators in (Abdel-Ghani study, 2020). Despite the existence of urban spaces in both of Busan Center and Euralille Center, they were not public.
- 8. City center's catalyst has two indicators that were followed by all of the case studies, the first indicator is about the creation of multiple forms of change, which is the act of most of the newly added architectural projects, while the other is

tourism as a new function, that could be noticed as a goal, especially in The catalytical projects, it was also covered in a study of (Mai et al., 2014).

- 9. The indicators of the city's catalyst mechanism were found in some of the projects. As the revival of inherent values, the indicator was found in the Busan center because of its structural concept to revive (cupola) from the structural values of Renaissance and Baroque from one side and reviving the modern roof from the works of Oscar Niemeyer and Le Corbusier on the other side. This indicator was found also in Eurolille Youth Center due to the concept of reviving the history of its medieval city. While the unified urban structure indicator was found in two of the case studies. As well as the indicator of reorganization with new elements. And barker center was the only project which links between buildings.
- 10. In the place-making catalyst mechanism, all of the projects follow the indicators of function and attraction. Because of their multi-functional architectural program and their attractive design either in the form or in the suggested uses respectively (this is also presented in the Balvočienė & Zaleckis study, 2021). However, meaning indicator was found in the concepts of Glasgow Museum and Euralille Center only.
- 11. The selected case studies followed most of the (QoL) indicators, all of them were found in the physical, economic, cultural, political, and land use indicators due to their importance in adding a new architectural project in the city. While the indicators of resources and material well-being indicators were the least important to the projects.
- 12. The best case study according to the availability of (QoL) indicators was Euralille Youth Center because of its design concept that is concerned with all of the sustainability aspects besides the city's history and integration with context. The other project was Mount Barker Center which follows the same indicators with an emphasis on community participation. Both of these projects contain an open space within the design of the architectural project.

- 13. The nearest case study was Busan Cinema Center, but its design did not pay attention to health, comfort, safety, and education indicators.
- 14. The last case study was Glasgow Museum, despite its creative design concept but it fails to connect with the city as it connects to the river, besides the lack of important (QoL) indicators such as the psychological, social, biological, health, and comfort indicators. However, this project emphasized new transportation methods more than other projects.

CONCLUSIONS

- 1. The mechanisms of catalytic intervention contribute to improving the quality of life and achieving good architectural design in interactive ways that serve the community, and achieving the level of sustainable development at the level of the city and architectural buildings.
- 2. Achievement of cultural projects and events (whether in the Place-making or the Reviving Inherent Values environments) improve the quality of life.
- 3. Catalyst mechanisms are related to the values of their local environments and include meaning, function and Attractiveness, aesthetic purposes, and economic growth in these environments.
- 4. Flagship Cultural and Pilot Model Strategies are more successful than Creative City Strategy in producing good catalytical architectural projects because they were either planned or suggested and won by compositions. While the projects of creative city strategy are spontaneous.
- 5. Tourism is an important aim to produce a good architectural project and to develop the city economically and culturally as well.
- 6. Good architectural design should inspire from city's history and respect the urban context, besides having an urban space within the design in order to achieve integration and reorganizing the new parts with the existing surroundings.
- 7. Place-making is achieved when the architectural project takes into consideration each city's

architectural narratives to give meaning and attraction to the functions.

8. Sustainability, health, education, safety, psychology, sources, building materials, and community participation are the most important (QoL) factors to design a good architectural project.

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PATHWAYS FOR IMPROVING WATER MANAGEMENT IN WESTERN ALGERIA: A MULTI-STAKEHOLDER ANALYSIS

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ABSTRACT

The aim of this study is to assess the relationships between the main stakeholders involved in water management in Sidi Bel Abbes city (western Algeria) to establish pathways for good governance, fair allocation and sustainability of water resources. A multi-stakeholder analysis was performed using the MACTOR method (method of actors and power relations) to analyze stakeholder strategies, alliances, and potential conflicts regarding water management. Data for the study were collected mainly during multi-stakeholder workshops with 6 main stakeholders who are directly involved in managing potable water. A field survey of 329 local households was conducted with the use of supplementary questionnaires. This study proposes that the power dynamics among actors should be considered during the decision-making process to improve collaborative interactions and the effectiveness of stakeholders engaged in water management. The research findings show that the stakeholder's roles and strategies should be coordinated and strengthened to ensure equitable allocation of water. Technical public agencies deploy management strategies that do not consider water quality as a priority, and they are more concerned with other strategic objectives. Additionally, the stakeholders disagree on many issues relating to water management due to overlapping and conflicting powers, which threatens the quality and availability of water resources. The study also demonstrated that the National Sanitation Office could play an important role as a relay stakeholder and that the Hydrographic Basins Agency should strengthen alliances and commitments with all stakeholders. Enhancing the participation of these stakeholders in water management procedures and empowering domestic water end users, particularly in densely populated residential areas, could help bridge divides and foster a unified approach to achieving sustainable water management objectives.

Keywords: MACTOR method, stakeholder analysis, water management, western Algeria

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INTRODUCTION

The management of water resources in developing countries is a major political, economic, and social priority that governments and international institutions have placed high on the 21st century political agenda (Sowers et al., 2011). This management primarily involves allocating these scarce and fragile water resources sustainably, in the context of socioeconomic and climatic changes.

Northwestern Algeria, situated within the semiarid regions of the Mediterranean area, comprises four major basins: the Tafna River, Sebkha salt lake of Oran, Macta Basin River, and Chellif Basin river. In this region, there is an abundance of water resources, including surface water, cold groundwater, and hydrothermal water, which have traditionally served as the primary sources of water consumption (Zemour et al., 2023). However, these resources are currently encountering challenges due to increasing demand and overuse, leading to the depletion of large groundwater reservoirs (Famiglietti, 2014). Despite the presence of these natural resources, water scarcity is a significant issue in Algeria. This scarcity is primarily attributed to recurrent droughts and the mismanagement of water resources, exacerbated by factors such as a substantial population growth, improved living conditions, urban and industrial development, and more (Kherbache, 2020). This phenomenon has adverse effects on meeting water requirements and allocating water for various purposes (Hamiche et al., 2015).

The Algerian government has made undeniable efforts to mobilize and distribute water, through implementing various projects like dam, network, and purification station construction, in order to provide domestic, industrial, and agricultural water. However, water problems persist, mainly due to issues with legislative procedures like laws and users' rights, problematic organization and collaboration between involved water management actors, and challenges with social acceptance (Hamiche et al., 2015; Hamlat et al., 2013). Sidi Bel Abbas city is considered one of the Algerian regions that are part of a natural area endowed with the rarest and most fragile water resources. The drinking water supply in this city suffers from a permanent deficit and an unfair allocation between the user sectors (Otmane et al., 2021). The lack of adequate institutional arrangements for water management results in challenges related to collaboration among stakeholders involved. This issue contributes to the overexploitation of the limited water resource (Kherbache & Molle, 2023) and disproportionately affects certain users, particularly privileged social groups.

To effectively implement sustainable water management, meet all user sector needs, and conserve these limited resources, it is crucial to gain a deeper understanding of allocation systems, interconnections among public institutions, non-governmental organizations, and users, as well as the distribution and exercise of governance powers. This understanding will enable informed decision-making and improve overall water resource governance. Governance here refers broadly to the rules, regulations, institutions, and processes that determine natural resource use through stakeholder interactions (Clement et al., 2020; OCDE, 2012). While numerous studies have examined organizations and regulations in relation to water management, with a focus on actor's behavior and institutional arrangements, less emphasis has been placed on understanding the influential power dynamics of these actors. However, it is crucial to recognize that actor's power forces play a pivotal role in facilitating the functioning and effectiveness of organizations involved in water management (Fetoui et al., 2021).

This study asserts that to achieve effective, collaborative action between water management stakeholders, it is vital to consider the power dynamics among actors during decision-making processes. Successful collaborative implementation relies on thoroughly understanding the relationships between institutions and organizations, as well as how governance powers are distributed within management processes (Fetoui et al., 2020).

The purpose of this study is to gain insights into the representation of stakeholders from various decision levels and sectors, identifying key actors, determining their level of influence, and examining power dynamics between dominant and subordinate entities. Furthermore, the study aims to explore the potential convergence or divergence of objectives concerning water resources (Godet, 1991; Lienert et al., 2013). The aim is to collect data on the positions, interests, influence, interrelationships, networks, and other attributes of these stakeholders, as this information is highly relevant for studying water management. A comprehensive understanding of stakeholder relationships is especially important for analyzing water governance, particularly in the early stages of decision-making processes (Hermans &Thissen, 2009).

This research paper aims to identify potential options and pathways for enhancing water governance in Sidi Bel Abbes city, with a specific focus on the roles of institutions and governance. It utilizes a stakeholder analysis approach to assess and understand the relationships between key water management stakeholders, along with their management strategies. The goal is to establish strategic recommendations for good governance and equitable water distribution between user sectors

Stakeholder analysis is applied in order to assess these relationships, using the MACTOR method (Godet, 1991). The selection of this methodology is rooted in the understanding that employing social research to evaluate the relationships and interactions among governance structures and actors can offer valuable insights into sustainable water management (Giordano et al., 2004; Ingold, 2011). This methodology can be characterized as a comprehensive strategy for comprehending the intricacies of a system and its transformations. It involves the identification of pivotal stakeholders, evaluating their specific interests within the system, examining conflicts and social perspectives, and proposing opportunities for collaboration and synergy (Fetoui et al., 2021). By adopting this holistic approach, a more profound comprehension of the system and its dynamics can

be attained, enabling effective decision-making and fostering harmonious interactions among stakeholders in the domain of water management.

METHODS

Case Study

The study was conducted in Sidi Bel Abbes city, located in northwest Algeria. The city is situated in the center of a vast undulating plain with an average altitude of 500 m. It is bordered by the mountains of Tessala to the north, and the mountains of Daya to the south. Sidi Bel Abbes is mainly located in the Macta watershed, which covers an area of 9,150 km2. The city has a population of 212,935 inhabitants (National Bureau of Statistics, 2008). It is located within the Oued Mekkera hydrographic basin, which belongs to the Macta Basin. It is contains 15 administrative districts (daira) and 52 communes (Fig. 1). Sidi Bel Abbes belongs to the semi-arid bioclimatic zone. The average annual rainfall in the region is 400 mm per year. Rainfall is low and has an uneven seasonal distribution, often resulting in a regional water deficit. The region suffers from water management and allocation challenges for drinking, services, industries, etc. This is due to climatic factors, urban expansion, and population increase (Benblidia & Thivet, 2010). The city depends on a water quota system to cover all districts. The water allocation system has two main groups. The first group has good quality distribution networks. It serves the city center and Sidi Al-Jilali districts, which are family housing areas. This group serves 109,031 people, which is 45% of Sidi Bel Abbes' total population. These people have 24 hour water supply. The second group represents the most populated single family housing areas. 133,261 people live in this group. They only get an average water supply of 14 hours per day (Benblidia & Thivet, 2010).

When it comes to agricultural potential, this city serves as a hub for wine cultivation. The industrial sector primarily concentrates on the production of agricultural machinery, electrical equipment, hoes, and dairy products. The irrigated agriculture in this area accounts for 30 Mm3 (33%) of the total water



Fig. 1. Localization of the city of Sidi Bel Abbas (Northwest of Algeria)

usage, as reported by the Directorate of Agricultural Services in Sidi Bel Abbes in 2017. Notably, one aquifer, namely the SBA aquifer, is currently overexploited due to the heavy demand from the agricultural sector.

Implementation of MACTOR analysis

In this study, the MACTOR method was employed as an integrated approach to thoroughly analyze and gain a profound understanding of stakeholders' networks, perceptions, and values. This method illuminates the nature of their relationships, identifies potential alliances, and conflicts while also examining their influence on local water governance and management. Through the utilization of the MACTOR method, a comprehensive evaluation of stakeholder dynamics is conducted, offering valuable insights into strategies aimed at improving water governance and effectively addressing potential challenges.

MACTOR is a stakeholder analysis method that employs a "matrix of alliances, conflicts, tactics, and objectives" to scrutinize interactions among various actors. This approach facilitates the analysis of actors' strategies and the assessment of power dynamics between them, while also delving into their agreements and disagreements concerning specific stakes and objectives (Elmsalmi & Hachicha, 2014; Godet, 1991). The utilization of MACTOR provides a comprehensive understanding of stakeholder dynamics, allowing for an in-depth examination of their relationships and objectives within the context of the study. MACTOR employs qualitative variables to assess the level of influence and dependency of each stakeholder in decision-making processes involving the other stakeholders. In this research, MACTOR is applied in the following two steps:

- The process begins with the mapping of key stakeholders involved in water management within Sidi Bel Abbes city, with an emphasis on presenting their individual missions, strategies, and objectives. Through surveys and interviews conducted with these stakeholders, two primary matrices are constructed;
 - a. The first matrix, referred to as the "MIDI matrix" (Matrix of direct and indirect influences) or the stakeholder/stakeholder matrix, categorizes stakeholders into five levels of relationships based on their degree of influence or dependency: The stakeholder has no impact on "stakeholder x" (assigned a score of 0);

- The stakeholder has the ability to negatively affect the management processes of stakeholder x to some degree in terms of time and space (assigned a score of 1);
- The stakeholder has the ability to significantly undermine the success of projects undertaken by stakeholder x (assigned a score of 2);
- The stakeholder has the ability to prevent stakeholder x from fulfilling their mission (a score of 3);
- The stakeholder has the ability to significantly jeopardize the existence of stakeholder x or is vital for their existence (assigned a score of 4);
- b. The second matrix is known as the "MAO Matrix" ("Matrix of Actors/Objectives") or the stakeholder/objective matrix. In this matrix, the attitudes of each actor towards a specific water management objective are represented, indicating their level of agreement (+1), disagreement (-1), or neutrality (0) towards that objective. Additionally, the matrix also indicates the importance of each objective.
- 2. The second step concerns the analysis of stakeholders relationships with MACTOR. The main outputs generated are:
 - a. The "influences and dependencies plan" depicts the positioning of stakeholders based on their direct influences and dependencies on each other. This plan is developed using the MIDI matrix, which identifies the levels of relationships among stakeholders. The stakeholders' positions are plotted in a two-dimensional graph with two axes representing influence (I) versus dependence (D). This visual representation helps to understand the relative influence and dependence among stakeholders in the context of water management. The plotted graph highlights the dominant stakeholder (s) and provides insights into four distinct position types: dominant stakeholders (having significant influence and low dependence), dominated stakeholders (having limited influence and high

dependence), intermediate or relay stakeholders (exhibiting both influence and dependence), and autonomous stakeholders (neither influential nor dependent) (Elmsalmi & Hachicha, 2014; Godet, 1991). This analysis helps identify the power dynamics and interdependencies among stakeholders involved in water management;

- b. Based on the MIDI matrix, the MACTOR method can also generate a "balance of power" indicator (R) that reflects the relative strength of each stakeholder. An aspect that could be the subject of a more comprehensive analysis of water policy in Algeria. This indicator takes into account direct influences and dependencies, as well as indirect influences that a stakeholder *i* has on a stakeholder *j* through a relay stakeholder called feedback. The value of R indicates the stakeholder's position in terms of decision-making power. A stakeholder with an R>1 has a strong influence on others. A high balance of power value suggests that a stakeholder holds a strong position, characterized by high influence and weak dependence and feedback (Godet & Durance, 2011). This indicator provides insights into the power dynamics among stakeholders involved in water management;
- c. The "correspondence map of stakeholders/objectives" portrays the strategic stakes, goals, and positions of each stakeholder in relation to water management objectives. This map is constructed using the "MAO Matrix" and enables the visualization of stakeholder groups with shared interests. It facilitates the assessment of their apparent independence, identification of stakeholders potentially threatened by others, and analysis of the overall social system's stability. This method offers valuable insights into stakeholder dynamics, interdependencies, and potential conflicts, contributing to a comprehensive understanding of the water management context.

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Collecting and analyzing field data

First, the data were collected from the literature (water resource potentials, resource users and allocation, and population density at the study site). Field data were gathered through.

Targeted surveys with 329 households selected based on two stratification levels. First, the selected samples belonged to the 15 administrative units. Second, samples were based on the potable water allocation system typology previously carried out in the region (Benblidia & Thivet, 2010), where two main beneficiaries are identified (family groups and single-family housing), in addition to the industrial sector. The process of identifying the surveyed beneficiaries was carried out in collaboration with community leaders and technical services. The research team conducted interviews with the beneficiaries between May and November 2017.

Multi-stakeholder workshops involve the participation of six primary stakeholders directly engaged in the management of potable water. These stakeholders include a representative from ADE (Algerian Water Company), DRE (Water Resources Department), ABH (Hydrographic Basin Agency), and ONA (The National Sanitation Office). Additionally, the workshops include the active involvement of 20 household representatives from both family groups and single-family housing.

The surveys and workshops had several objectives:

- 1. To engage in discussions regarding the challenges and issues faced by the city in terms of water resources.
- 2. To identify the objectives that stakeholders aim to achieve concerning water improvement.
- 3. To provide an explanation and gain approval for the methodological framework of stakeholder analysis.
- 4. To implement and analyze the extent of cooperation in joint water management initiatives.
- 5. To assess stakeholders' strategies and interactions, with scores recorded to indicate the level of influence and dependence between them.

A script (two empty matrixes) is used to record this scoring. This assessment allows us to identify two main entry data to MACTOR: the matrix of "stakeholder/ stakeholder" influences and dependencies, and the matrix of "stakeholders/objectives".

A scoring system is used to assess the relationships between stakeholders. This assessment identifies two main types of data that are needed to use the MACTOR tool, they are:

- 1. The matrix of "stakeholder/stakeholder" influences and dependencies, which shows how each stakeholder can influence or be influenced by other stakeholders.
- 2. The matrix of "stakeholders/objectives", which shows the objectives of each stakeholder.

RESULTS

Stakeholders' map, challenges, and objectives

The focused surveys with key stakeholders aimed to identify issues and challenges in Sidi Bel Abbes' water management. They also characterized the roles and strategies of each stakeholder regarding these issues. The main recorded challenges are drought, water scarcity, resource degradation, overuse, and allocation and management problems. Further challenges come from the significant costs to install and maintain water infrastructure. Other issues are inadequate monitoring, shortcomings executing development projects, and a lack of technical and managerial expertise among local staff.

The interviews also defined the roles and strategies of involved stakeholders in water management. These include urban water management (supply, transportation, distribution, marketing, network maintenance) by the Algerian Water (ADE). They also include infrastructure development to mobilize water resources (surface, groundwater, unconventional) by the Water Resources Directorate (DRE). Other roles are water resource management in natural hydrographic units by the Hydrographic Basins Agency (ABH). And managing the urban sewage network (operating, maintaining, renovating facilities) is done by the National Sanitation Office (ONA). The end users are represented by family housing groups (MHC) and single-family housing (MHI).

They are key actors that must be considered in water programs, based on their needs and consumption.

The analyses identified six main water management objectives regarding the specific challenges: Urban drinking water allocation (O1-GEPV) etc. These objectives represent the main missions and principles of national water policy, as outlined in Law 05-12 on water.

Relationships, influences, and dependencies among stakeholders (MACTOR results)

The analysis of relationships and mutual influences among the identified stakeholders (Fig. 2) shows that the ADE and ABH are the most influential stakeholder groups in the drinking water allocation system. They exert significant influence on other stakeholders for decision-making related to water management and access, while they are less susceptible to external influences. The analysis also shows DRE and MHC are dominated and especially influenced by and dependent on ADE and ABH. This is despite DRE's important role managing the Ministry's programs and implementing water projects and allocation. ONA is considered a relay between the dominant and dominated stakeholders. Finally, MHI (residents of collective housing) are neither influential nor dependent (autonomous) regarding water management at the study site.

According to the findings, in terms of influence in the water management decision process, and water governance, the ADE stakeholder has a higher R score ("balance of power" indicator that reflects the relative strength of each stakeholder) compared to other stakeholders, indicating that it is considered the most powerful (Fig. 3). This result confirms Algeria's and ABH's dominance in water management decision processes. The relay stakeholder (ONA) also has a strong influence on water management processes and governance because it has an R>1, so it could play an important role. The DRE, despite its high dependency, has a favourable balance of power. This analysis finally confirms that MHC and MHI have a weak influence, especially MHC, which is completely dominant and has a weak R score.



Fig. 2. Influences plan and dependencies between the main stakeholders involved in water management in Sidi Bel Abbes city *Source:* own elaboration based on MACTOR analysis (2021).



in Sidi Bel Abbes city Source: own elaboration based on MACTOR analysis (2021).

The following analyzes potential alliances and conflicts between these stakeholders toward the expected water management objectives in Sidi Bel Abbes city. Their relationships or power relations can support achieving these objectives.

Relationships and tensions among stakeholders concerning objectives and strategies in water management

The "correspondence map of stakeholders/objectives" (Fig. 4) reveals possible alliances and conflicts among stakeholders concerning water management objectives. The map shows a close proximity between most stakeholders and objectives, indicating they are aligned on the horizontal and vertical axes (Elmsalmi & Hachicha, 2014).

Additionally, the map provides an alternative perspective on relationships regarding specific objectives. It reveals potential alliances and conflicts regarding water management processes and procedures related to these objectives. Assessing the levels of convergence or divergence among stakeholders on the same objectives allows identifying where there is high consensus. It also reveals which stakeholders play a significant role in achieving or not achieving the objectives (Fetoui et al., 2020). Figure 4 shows that the most involved stakeholders in water management are DRE and MHC, which are concerned with three objectives. The DRE is involved in the achievement of the urban allocation of drinking water (O1-GEPV), the development of storage infrastructure and water mobilization (O2-DIMSE), and the availability of drinking water (O5-DISEP). Family group housing (MHC) is concerned with the development of storage infrastructure and water mobilization (O2-DIMSE), and the availability and quality of drinking water (respectivelyO5-DISEP and O6-QUAEP). Despite being involved, MHC faces complete domination and possesses an unfavorable balance of power in achieving these three objectives.

Besides, the ADE is more concerned by the achievement of the urban allocation of drinking water (O1-GEPV) and is not effectively involved in achieving the other objectives, although it's a favorable balance of power. The ONA and ABH also have strong influences on water management processes (taking on account the direct and indirect influences and dependencies and the power forces), but they are not effectively involved to achieve the objectives of sanitation network management (O4-GREAS) and water management in natural hydrographic units (O3-GEUHN), respectively. The drinking water quality (O6-QUAEP) is required only by singlefamily housing (MHI), and this confirms its actual



Fig. 4. Correspondence map of stakeholders/objectives for the case of water management in Sidi Bel Abbes city

Source: own elaboration based on MACTOR analysis (2021).

bad quality. The problem of water availability for MHI will persist if there is no cooperation with other stakeholders.

Urban drinking water allocation (O1-GEPV) has the highest consensus, agreed on by three stakeholders (ADE, DRE, and ABH). The most contentious objectives are sanitation network management (O4-GREAS), water management in natural hydrographic units (O3-GEUHN), and drinking water quality (O6-QUAEP).

DISCUSSION

Water resource sustainability in the Sidi Bel Abbes region requires a rational water policy relying on coordination between stakeholders. This work clarifies relationships between these stakeholders, suggesting potential alliances and cooperation. This is critical for successful water allocation projects and sustainable management strategies.

Most water resource management and allocation projects in Sidi Bel Abbes city are coordinated by ADE, ONA, and DRE – the most dominant stakeholders. Achieving objectives and project success depends on better involvement from these stakeholders. For example, DRE's strong power could enhance its influence and role in water management decisions. Given its favorable power balance, ONA has potential to strengthen its role as a regulating entity. This could facilitate communication and bridge gaps between other stakeholders. However, the challenge lies in achieving independence and fostering effective dialogue between ONA and other dominant stakeholders. To improve water allocation management, we propose enhancing the involvement of ONA in advocating for the interests and needs of all users and mediating conflicts. In fact, existing conflicts mainly concern the complication of the financial situation. This is related to network shutdowns when defects occur. It also relates to when the volume of wastewater exceeds the plant's capacity. The wastewater then flows directly into the Mekerra valley. This contributes to direct water pollution. It also creates conflicts and various pressures between stakeholders. Additionally, there are other contributing factors.

The realization of project objectives and the overall success of these initiatives hinge significantly on the extent of collaboration and the improvement of relationships with other influential stakeholders. For instance, the effectiveness of these projects requires strengthening the influence of MHC and MHI (consumers). Although these stakeholders benefit from well-functioning distribution networks, they remain heavily reliant on ABH, which oversees water resource management within natural hydrographic units and assumes a pivotal role in water governance by considering both direct and indirect influences and dependencies with other stakeholders. Additionally, they depend on ADE for water supply, transportation, and distribution. This implies that these consumers, despite their vested interest, have limited control over both the quantity (availability) and quality of water. They possess minimal influence in the formulation of water management strategies and lack the ability to partake in decisions regarding water allocation. Additionally, their dependency is influenced by socioeconomic, political, and environmental factors.

To achieve stability and effectiveness in water management within the study area, it is imperative for the limitations associated with the influence of these stakeholders to either diminish or become more prominent. Therefore, measures should be taken to bolster their role, inclusiveness, and contribution to water management processes. This is essential for addressing the issue of imbalanced water distribution.

Fetoui et al. (2021), in their study on enhancing rangeland governance in Tunisian arid zones, confirm that the achievement of the objectives and success of rangeland management depend on the level of cooperation and improvement of relations between dominant stakeholders. A strategy development process was also recently undertaken, respectively, in South Khorasan (Iran) and Vojvodina Province (Serbia), based on the inclusion of all stakeholders in the water allocation strategy (Nasrabadi & Shamsai, 2014; Srdjevic & Srdjevic, 2013).

Flexibility in administrative processes is paramount to facilitate the meaningful engagement of both influential and less influential stakeholders. Successful water governance demands accountability and transparency from all parties involved. As highlighted by Fetoui et al. (2021), effective coordinated management in public policy is contingent not only on organizational aspects but also on the establishment of legitimacy. Reliable transparency and coordination among stakeholders play a pivotal role in empowering various coalitions to attain their goals.

The findings of the study also also contribute to the categorization of objectives that can be subject to collective negotiation during the formation of alliances or close monitoring in cases of conflict. This categorization allows stakeholders to prioritize and collaboratively address crucial objectives or take necessary actions to manage conflicts effectively. It paves the way for the development of strategic recommendations and the identification of key challenges in achieving effective and equitable water management. Given that effective water sector management is the ultimate goal shared by all stakeholders, this study has enabled an analysis of each stakeholder's role in attaining this objective. The results highlight the quality of interconnections between all stakeholders, particularly ADE, DRE, and ABH, in ensuring the fulfillment of water supply objectives for end users.

The analysis also reveals that MHI faces no issues regarding water availability because some residents own licensed or unlicensed wells, which can serve as an ideal solution in case of interruptions and fluctuations in water distribution. Therefore, MHI's primary focus is on ensuring water quality. However, the identification of a stakeholder with limited influence can present challenges that may impact the sustainability of the water management process.

It is concerning to note that technical public agencies like ABH and ONA may prioritize specific aspects, such as water quantity, while potentially neglecting the critical element of water quality. This imbalance in priorities could have repercussions on overall water management and the attainment of sustainable outcomes. In fact, there is a disagreement in the goals for the water management process due to overlapping and conflicting powers between ONA

and ABH, leading to differing concerns and weak alliances in achieving certain objectives. This situation poses a threat to the quality and availability of water resources.

As a result, the availability and quality of drinking water emerge as the primary concerns for end users, and any management approach that fails to address these objectives is unlikely to be successful. Therefore, it is imperative for all stakeholders to contribute to the achievement of these objectives, and the significant influence of ADE can play a pivotal role in facilitating this accomplishment. It could collaborate with ONA to consider and prioritize quality and availability in local water management projects. Furthermore, the convergence between ADE and DRE could be very beneficial for sustainable water management. This is explained by their strong cooperation in the process of preparing and improving water distribution programs. The efficacy of this collaboration could be further strengthened through the active engagement of ABH, ensuring the alignment of its objectives, which encompass identifying, assessing, sourcing, and distributing water, with those of ADE and DRE.

Other investigations have yielded comparable outcomes in strengthening multi-stakeholder collaborations in water management, for example the study of Pluchinotta et al. (2018). This study highlights the growing emphasis on promoting effective stakeholder cooperation to facilitate the decision-making process in water management. Du et al. (2019) conducted a study to examine the environmental awareness and preferences of multiple stakeholders regarding the adoption of best management practices (BMPs) in water conservation zones in northern China, aiming to address nonpoint source pollution challenges. In another study by Mirzaei et al. (2019), the authors aimed to identify and evaluate policy instruments that could enhance water reservoir governance. These policy instruments were classified into three interconnected dimensions of water governance: effectiveness, efficiency, and trust and engagement.

Several states in Algeria have implemented various management systems by incorporating new companies responsible for water allocation and sanitation, such as the Water and Sanitation Companies (SEOR, SEAAL, and SEACO) located in Oran, Algiers, and Constantine, respectively. In these urban areas, recent years have witnessed a notable improvement in water management, even in the face of occasional fluctuations and interruptions in water supply. This progress can be attributed to the effective coordination among all stakeholders, leading to positive outcomes and the delivery of high-quality water to many areas on a 24-hour basis.

A public-private partnership for water management in Sidi Bel Abbes city could present a viable solution. In such a partnership, either the public or private sector could undertake activities like drilling boreholes for agricultural and industrial purposes, establishing seawater desalination units, developing infrastructure for utilizing purified wastewater in irrigation, and connecting to water supply systems to guarantee self-sufficiency in communal and industrial areas. Margerum and Robinson (2015) conducted a study on the diverse requirements of public-private partnerships that rely on cooperation and coordination. They also examined the various levels at which these partnerships operate, including actions, organizations, and policies.

In addition to this alternative, providing the necessary financial capabilities to provide equipment for water exploitation and diversion from neighboring areas is also an important point that must be considered in the rehabilitation of the distribution network for Sidi Bel Abbes city. The increased daily consumption in the city also requires finding solutions that guarantee the creation of new water resources. These programs for mobilizing available water resources (groundwater and surface water) or diverting water from other governorates (Tlemcen, Camp, and Al-Bayadh) require great efforts and collective action at each stage of the process to fill the gap and ensure good water management.

CONCLUSION

Sidi Bel Abbas city faces the challenge of water resource scarcity resulting from irregular inter-annual and seasonal rainfall distribution, rapid demographic growth, urban development, and notably, a deficiency in coordination among the stakeholders engaged in water management. As a consequence, addressing the issues of water scarcity and management calls for collaboration and harmonization among all relevant stakeholders. This cooperation is essential to judiciously harness and equitably distribute the existing water resources, mitigating the risk of conflicts, particularly in densely populated residential areas.

The primary goal of this research was to enhance water management in Sidi Bel Abbes city by identifying key questions and strategic recommendations derived from an in-depth analysis of stakeholder relationships. The insights generated from this analysis encompassed a range of aspects, including stakeholder networks, behaviors, mutual influences, dependencies, the distribution of power, as well as shared goals and areas of conflict. This analysis opens up possibilities for stakeholders to work together and discover common ground to achieve a variety of objectives related to water availability, quality, allocation, sanitation network management, water management within natural hydrographic units, the enhancement of storage infrastructure, and water mobilization. It's important to acknowledge that these objectives may sometimes be in conflict with one another. The insights derived from this analysis shed light on how these relationships can be cultivated and reinforced to ensure participatory and sustainable management of water resources. Consequently, some actors stakeholders have the capacity to enhance their dominance or, conversely, redress the balance of power to wield greater influence in the water management process.

The results indicate the presence of conflictual relations between the Hydrographic Basins Agency and the National Sanitation Office, impacting not only water availability and quality but also the equitable distribution of water. Furthermore, the results demonstrate that the Algerian Water Administration and the Water Resources Directorate are more effective in the water management process, owing to their dominance and their ability to form alliances and reach consensus in the preparation and improvement of water distribution programs. This collaboration could be further strengthened through the active involvement of ABH in tasks related to identifying, evaluating, sourcing, and distributing water.

This underscores the pivotal role played by ONA as an intermediary stakeholder, contributing to the reinforcement of alliances and commitments with all stakeholders to achieve the established objectives of sustainable water management. Through the active engagement of these stakeholders in water management processes and by empowering end users in decision-making, it becomes feasible to bridge the gap among stakeholders and establish a collective approach towards realizing the designated objectives.

Furthermore, flexibility within the administration is crucial to ensure the active participation of both dominant and less influential stakeholders. Effective water governance necessitates accountability and transparency among all stakeholders. Trustworthy transparency and coordination among stakeholders also play a significant role in enabling various coalitions to achieve their objectives. The findings of this study ultimately aid in categorizing objectives that can be collectively negotiated during alliance building or closely monitored in cases of conflict. This categorization enables stakeholders to prioritize and collaboratively address key objectives or take necessary measures to effectively manage conflicts.

While this research primarily focuses on the local scale, it offers valuable insights into the institutional design of water management approaches specific to this locality. These insights can also be extrapolated and applied to other regions with similar or diverse contexts. Consequently, the findings have the potential to contribute to the development of effective water management strategies across various geographical areas. To enhance the study, the integration of additional

variables related to natural aspects, demographics, and human behaviors and practices would be beneficial.

Despite the significance of stakeholder analysis using the MACTOR method in the context of water management and governance, it's essential to acknowledge that this study, and the MACTOR method itself, has some limitations, particularly concerning the collection of required input. Stakeholders are naturally hesitant to disclose their strategic objectives and the methods of their external actions.

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AUGMENTED REALITY AS A TECHNOLOGY THAT SUPPORTS THE SPATIAL DEVELOPMENT PROCESS

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ABSTRACT

Motives: The solutions for designing spatial development methods in planning documents are presented as 2D graphics with supplementary descriptions. Due to the lack of specialist knowledge and insufficient spatial imagination, some readers may be unable to understand the graphic and descriptive content of such documents. The above can lead to the construction of objects that disrupt spatial order without violating the law. This problem can be solved by applying augmented reality (AR) in spatial planning. This paper presents the capabilities of a method for visualizing different spatial development variants on the example of buildings. A model of a building plot and the surrounding area, covered by a local spatial development plan, was developed.

Aim: The aim of this study was to determine the applicability of the AR technology for identifying low-precision areas in the plan and its potential impact on the method of land development, with a resulting deterioration in spatial order.

Results: The use of the AR technology enables analyses and assessments of planned development in the context of spatial order and its integration with the existing elements. Visualizations presented with the AR technology show that different interpretations of the local zoning plan generate spatial chaos. The utility of 3D visualization for an average reader was also presented. The AR technology can be used at the stage of preparing planning documents (community participation, adopting the plan), adopting by-laws (councilors), and enforcing these regulations (investors' decisions).

Keywords: spatial planning, spatial imagination, augmented reality, visualization

INTRODUCTION

The clarity of future solutions for spatial development methods is one of the main issues in the spatial planning process. Clear and comprehensible presentations of the planned functions, design solutions and limitations are of great importance. This mainly concerns spatial elements such as buildings, transport systems, and greenery. Standard design solutions in planning documentation are presented as 2D graphics with supplementary descriptions. The main aim of 2D drawings is to visualize future functions with the use of colored contours and sectoral symbols. The descriptive part contains detailed guidelines on the method

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of spatial development with predefined functions. This method of presentation may be difficult to understand for the average reader.

Planning documents are intended for officials, planners, architects, investors, and local communities. This applies at the stage of drafting, adopting, and enforcing by-laws. According to the Act on planning and spatial development, the local community may participate in the process of drafting planning documents. These documents are shared with the public, the adopted solutions are discussed, and stakeholders can make comments and motions. Therefore, by actively participating in the process of preparing planning documents at the local level, residents can have a real influence on changes in their environment. However, the participants are often unable to comprehend the developed documents, both graphics and descriptions, due to a lack of specialist knowledge about urban development and architecture, and poor spatial imagination. Local lawmakers who are responsible for spatial planning and development often experience similar limitations. In order to vote for or against the proposed bills, one has to understand the solutions adopted in planning documents. Similar obstacles are faced by non-professionals who read planning documents, for example those seeking real estate for purchase and planning an investment. Therefore, planning documents should be clear, understandable, and easy to interpret. This problem can be solved by using augmented reality (AR) to present the planned function and method of land development. The authors assume that the visualization of spatial development in 3D AR can lead to a better understanding of the spatial relations between the elements of spatial development and their surroundings.

This article describes the use of the AR technology for presenting the provisions of a draft local land development plan which is the most important document in the Polish planning system and which constitutes a by-law. The aim of this study was to determine the applicability of the AR technology for identifying low-precision areas in the plan and its potential impact on the method of land development, with a resulting deterioration in spatial order. In addition to disturbances in spatial order, imprecise local planning provisions bring about significant legal consequences. The ambiguity of such provisions makes them difficult to interpret, both by investors and by public authorities dealing with architectural and construction matters. This can considerably impact investment decisions because a zoning plan imposes limits on real estate use and - together with other regulations - affects its execution. Therefore, a local land development plan should contain unambiguous provisions which do not raise doubts as to their interpretation. Otherwise, disputes may be brought before an administrative court. Moreover, the utility of 3D visualization of a plan has been demonstrated, and this technology can be used in the planning stage, both during public consultations and when the document is approved and passed, as well as before a potential investment is planned.

This study analyzes a model of an undeveloped building plot covered by the local land development plan whose provisions are imprecise. It can be safely assumed that the use of 3D visualization at the stage of public consultations and later, if the plan is passed, would require changes in its provisions.

LITERATURE REVIEW

Augmented reality

Humans gather information about the world through their senses. However, due to the development of information technologies, the sense of sight became dominant. As a result of technical progress, we are surrounded by images which impose a certain vision of the world (Kuczamer-Kłopotowska, 2014; Milgram et al., 1995). We pay great attention to the appearance and the esthetics of the presented materials and information. This is noticeable in practically every area of life, including more realistic special effects generated digitally in films, realistic fairy tales combining fairy tale characters with the real world, interactive museums, and others. Therefore, AR is a rapidly developing field of technology.
Augmented reality has been an area of interest for many professionals since the 1950s. Research began about 10 years later, and it was initiated by a pioneer of computer graphics, Ivan Sutherlan, and a group of students from the Harvard University and the University of Utah (Pardel, 2009; Caudell & Mizell, 1992). In simple terms, AR is a technology that combines the real world with the virtual world. It is created by overlaying digital objects on a real-world image. Image processing devices such as cameras, glasses, smartphones, tablets, and cameras are used for this purpose. Ronald Azuma (1997; 2017) has had a great impact on technology development. He defines AR as a system that merges two types of worlds, the real and the virtual.

Another feature of the AR system is that every object in three-dimensional space is located in the real world. This means that the objects present in the real world have a precise location. A third parameter, namely the interactivity of objects, can be introduced when an object's location is known and when the digital and real worlds can be combined (Kołodziejczyk, 2013). Nowadays, the main goal and the greatest challenge for the development of AR technologies are to obliterate the difference between virtual and real objects. This can be achieved by improving the accuracy with which shapes, colors, and mutual relations between virtual objects and the real world are represented. The operating principle of the AR technology is presented in Figure 1.

Due to the development of computer technology, the possibility of creating AR has increased significantly. The exponential growth of information technology (Moore, 1965) has significantly contributed to the above. Recent years have witnessed considerable progress in mobile devices such as smartphones and tablets which are conducive to the propagation of AR. Due to a significant increase in their computing power and popularity, the number of AR-based applications is growing rapidly (Buchwald, 2018). This is because the application of AR on mobile devices increases the user's experience of the virtual world. Technological progress has also affected the way information is presented by linking the use of geographic information to areas commonly associated with a strong visual perception of space (Marques et al., 2019). Therefore, AR is applied in many areas, including education, sales, marketing, sports, tourism, commerce, medicine, entertainment, automotive industry, and cultural heritage. Augmented reality is also used in architecture, construction and land development planning, which will be discussed in greater detail in chapter "The use of AR in spatial and architectural planning".

The ability to see and feel depth is a very complex process. To be able to distinguish between distances,



Fig. 1. Operating principle of augmented reality

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Fig. 2. Stereoscopic vision

several conditions must be met. Our brain uses several guidelines to correctly interpret the object it sees. These are listed in Figure 2. They include pictorial, visual, dynamic, stereoscopic and some cognitive functions.

The image may not be correctly identified when one of the clues is misinterpreted by the brain. Such an effect may be used intentionally, for example by magicians. However, in the case of land development planning, correct interpretation of records and images is desirable. As indicated above, the spatial vision of an object can be problematic. Most land development plans involve maps (2D), and each recipient visualizes the presented content individually. Therefore, this approach leaves wide room for interpretation. The availability of free three-dimensional AR applications and the potential of tablets and smartphones support the design and implementation of spatial skill development strategies (Carbonell & Bernejo, 2016) to standardize the users' visualization abilities.

The use of AR in spatial and architectural planning

Until now, the process of land use planning, architectural and structural design was limited to the creation of 2D graphics, descriptive information, or mockups of the proposed solutions (this solution is rarely used because it is laborious and time-consuming). The applied 2D model may lead to discrepancies due to varied interpretations of planning documents, spatial development projects and architectural and structural projects because many people have poor spatial imagination. Individuals differ in their ability to imagine and visualize 2D content. Naturally, the view in the X and Y plane alone does not reflect all spatial relations. The information about the vertical component (height), presented in a descriptive way or with the use of sectoral symbols, is also difficult to understand or imagine. The spatial interpretation of planning solutions is therefore significantly hampered.

Augmented reality creates new digital forms in space, and attempts are made to create an environment that is identical to the real world, which

Source: own elaboration based on Howard and Rogers (2012) and Juszka and Papir (2016).

is why the AR technology is increasingly often used in planning and architecture. Digital three-dimensional (3D) environments provide new ways of landscape visualization and topographic interpretation. The advent of AR offers a new way of developing 2D image reading skills. For example, AR can be applied to present terrain features (hills, dunes, depths, valleys, mountains, shapes and slopes), which provides a new way of interacting with the landscape (Carbonell & Bermejo, 2017).

Augmented reality has enabled architects to transfer their designs from 2D format and present them to the public in three dimensions (Siwak, 2016; Tomkins & Lange, 2020). This brings many benefits. A 3D model enables the public to view a designed building in real-world terrain, and it demonstrates whether the building is well-integrated into the surrounding space (Asanowicz, 2012). In addition, AR facilitates digital reconstructions of destroyed buildings, for example in museums (Han et al., 2013). The most important decisions are made at the planning or pre-planning stage. The changes introduced at this stage are less costly and time-consuming compared with later stages of architectural design, not to mention the construction process itself (Peckienė & Ustinovičius, 2017).

Augmented reality can also be used in spatial planning. Spatial design has changed dynamically in the last decade, mainly due to the involvement of local communities in the planning process during public consultations (Konopacki, 2014; Zamojski, 2020). Effective integration of new projects into the existing elements of development is important both for the designers and the community living in the area. However, 2D drawings of the planned investments do not always show how the designed building or public facility will fit in with the existing buildings and the landscape. The popularity and increasing computing power of mobile devices make enable all participants to use AR to visualize the proposed solutions. Augmented reality is used in public debate as a tool for making changes and corrections in graphic models of future investments. The language of communication must be accessible to both specialists and laymen (Khan & Dong, 2011;

Marques et al., 2017). Gamification, fuzzy control and AR can solve many of the problems encountered by local and central authorities in managing the spatial planning process. In addition, according to specialists, AR and other ICT systems, such as the Internet, significantly improve communication between urban planners and the future users of space (Milovanovic et al., 2017). Effective communication with citizens is a factor that contributes to the success of public participation in solving spatial planning problems (Olszewski et al., 2017). Social geoparticipation in spatial planning promotes civic engagement through the use of tools adapted to the cultural, historical, economic and social reality of a given city, as well as precise 3D modelling techniques and VR/AR tools (Küspert & Zink, 2017). These tools not only improve the spatial planning process, but also contribute to the evolution of an open geoinformation society which will create "smart cities" in the future (Allen et al., 2011).

In addition to enhancing communication, AR can also improve decision-making in the process of approving an investment project. A visualization of a building or another project can be easily accepted or rejected by remote voting using a mobile device (Allen et al., 2011). Thanks to AR, participants can see how the object will look like from every possible angle. Augmented reality also enables the participants to experience the sensory attributes of a given location, including light, wind and smell (Goudarznia et al., 2017).

Research on the use of AR for enhancing public participation in the spatial planning process was conducted in the Finnish cities of Raseborg and Helsinki. According to the residents of Raseborg, AR was a very helpful tool during land-use planning and public consultations. Another study was conducted on planning officials who saw AR as a very useful tool for analyzing the form of newly designed buildings, their integration into the existing development, influence on the surrounding landscape, and potentially adverse impact on the local community (Konopacki, 2014).

Applications enabling users to create their own vision of the surrounding space play an important role

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in the process of social participation. "Wysadzulice" was a Polish application that had been developed with the use of AR (it is no longer active). The application enabled users to design urban squares or streets by adding various types of objects, including trees, flowerbeds or benches, to the existing reality. The users could visualize their needs concerning land planning in the surrounding area. As a result, community members could influence the shape of the local space. The program also greatly facilitated communication between the residents and the local authorities. At the same time, the application enabled the authorities and planners to collect information about local needs concerning spatial development. The program was an attractive tool for effective public participation (Maksymiuk et al., 2017). 3D visualization techniques have emerged as a new global trend in spatial and urban-architectural planning (Broll et al., 2004; Dickmann et al., 2021; Phan & Choo, 2010).

Polish spatial planning system at the local level

Poland has a three-tier spatial planning system which covers the national, regional (spatial development plans developed by voivodeships) and municipal (study of conditions and directions of spatial development, local spatial development plan) levels. Local zoning plans play the most important role in the Polish spatial planning system. This basic tool spatial policy tool is implemented by the commune (the smallest unit of territorial division). This document has legal force and it is universally binding on municipal authorities, public institutions, businesses and citizens. The local plan determines land use, the location of public investments, and the development methods and conditions of land development necessary to achieve spatial order, and it constitutes the basis for all planning activities. The process of drafting local plans involves an element of public participation, which means that every interested citizen can actively participate in the creation of the plan during public consultations. Local spatial development plans are optional; they are adopted at the discretion of the municipal council, and they

may cover the entire municipality or selected areas (Nowak, 2019). According to the Spatial Planning and Development Act of 27 March 2003, the local spatial development plans specify:

- land-use types and boundaries separating different land-use types or different types of development;
- the principles of developing building layouts and land development indices, the maximum and minimum development intensity as the ratio of the developed part of a plot to its total area, the minimum biologically active area relative to built-up area, the maximum building height, the minimum number of parking places, building contours and dimensions.

The position of buildings relative to roads, public areas and the borders of adjacent plots, facade and roof color are determined as needed.

Pursuant to the decision implementing the Act on Spatial Planning and Development (Regulation, 2021), a plan concerning the requirements to create public space should lay down the rules for temporary service facilities, technical equipment and greenery, including determining orders, prohibitions, abandonments and restrictions on land development. The decisions on building layout and land development parameters and indices should specify the building contours, built-up area relative to plot area, including the percentage of the biologically active area, as well as the dimensions and height of the planned buildings and roof geometry.

The draft local plan is prepared as a 2D drawing (Fig. 3). The textual description is an integral part of a plan, and it contains detailed regulations on the method of land development.

A local revitalization plan is a special form of a local spatial development plan (Szlachetko, 2017). The descriptive part includes regulations on the principles of spatial composition and harmonizing the planned buildings with the existing ones.

The visualization of the revitalization plan provisions consists of an urban planning concept for the area covered by the plan (2D model) and a spatial structure model of the area covered by the plan, which takes into account terrain features



Fig. 3. An excerpt from the local spatial development plan of Olsztyn city *Source*: https://msipmo.olsztyn.eu/imap/.

prepared in a 3D realistic form, enabling a change of the point of observation in space, considering the existing and planned spatial development elements (3D model). The third element of visualization are the views of selected characteristic elevations or developed views of public spaces, taking into account the nearest surroundings.

The provisions of a local plan (including the revitalization plan) can regulate many issues in detail. Local plans have a direct impact on future spatial development, and their provisions must be comprehensible for the recipients, including local communities interested in changes in the immediate surroundings, investors who make financial decisions, and local lawmakers. The method of presentation, including 2D drawings and a textual description, is not clear for most recipients. In general, 3D visualization techniques are not required by law, except in revitalization plans. However, these plans and the relevant preparatory procedures have been introduced only recently. Despite the fact that visualization is not obligatory, it is used increasingly often at the stage of a draft plan preparation as an element which enhances the study's clarity for an average reader.

Local spatial development plans are prepared by licensed spatial or urban planners or individuals who have a degree in architecture, urban planning or spatial development. Therefore, they have well-developed spatial perception and imagination, and they can mentally convert drawings and textual descriptions into a 3D format. Most (or all) members of municipal councils are not experienced in this area and have no knowledge of these issues (Korbel, 2018), which is why the visualization of drawings and the text of a local plan can be difficult. The above can lead to erroneous decisions regarding plan approval. The same applies to the citizens who participate in public consultations, for whom the draft plan presented for public viewing may not be fully clear. This is a very important consideration because by actively participating in the process of creating the document, local communities can influence the appearance of the surrounding space (Korbel, 2018). Therefore, visualization techniques should be included in the process of preparing planning documents, which is enabled by the development of tools for the acquisition and processing of spatial information (Sieminski, 2011). It can make the

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provisions of the plan more understandable for the recipients and enhance their clarity. A realistic 3D presentation is more appealing to amateurs (Kolecka, 2008). The precision of local planning provisions is a separate issue. A lack of precise provisions leads to the free choice of spatial development methods concerning design solutions, building dimensions and color. It has a considerable impact on spatial order, despite theoretical compliance with the plan provisions.

These concerns justify the use of 3D visualization techniques in spatial planning, especially in the visualization of planned urban and architectural solutions proposed by municipal officers responsible for spatial planning (Korbel, 2018). Additionally, AR facilitates communication between the local community and individuals in charge of spatial development (Grassi & Klein 2016). Therefore, the legal regulations applicable to planning documents should include provisions governing the use of modern techniques for visualizing the proposed spatial solutions. The first attempts to develop a preliminary concept of a universal modelling language (UML) of a database scheme for integrating the 3D cadaster with 3D spatial planning have been made in Poland (Bydłosz et al., 2018).

METHODOLOGY

The literature review clearly confirmed the utility of AR in the spatial planning process. The main aim of the study was to visualize spatial development with the use of AR, and it was achieved through the following intermediate objectives:

- to interpret the provisions of a local spatial development plan;
- to analyze the spatial development concept;
- to assess the applicability of novel technologies for visualizing spatial development;
- to support communication with the investor.

These tasks were carried out based on technological solutions that are available to all users of mobile devices, namely smartphones.

Considering the specific nature of the AR technology, the design and presentation of future spatial development methods were analyzed indoors and outdoors. To visualize the existing spatial development with the AR technology, the study relied on design guidelines that comply with the local spatial development plan and specify the parameters of future feasible development. Design solutions arising from the plan were adapted to a single building plot and a residential building, and its elevation was considered. The stages of the study are presented in Figure 4.



Fig. 4. Conceptual framework

Table 1. Modules applied in the process

Number	Name	Characteristics			
Module 1	A background map can be prepared based on data acquired during independent fiel Module 1 Background map a vector map developed in the GIS or CAD environment or with the use of the existin (databases or geoportals)				
Module 2	Markers	A marker is usually an image in JPG or PNG format with the following characteristics: Rich in detail; Good contrast; No repetitive patterns; Format (8- or 24-bit PNG and JPG formats; JPGs must be RGB or greyscale). The Vuforia library (https://library.vuforia.com/) was used in the study			
Module 3	3D Object Models	Models can be prepared with a tool for designing three-dimensional spatial objects. Architectural designs are usually developed with the use of dedicated software (e.g. CAD). The models can also be applied to changes in land relief. An intuitive SketchUp tool was used in the study			
Module 4	Coordinate-based geolocation	The coordinates assigned to 3D objects should be expressed in the WGS84 system (a system of coordinates commonly used in GPS-based navigation devices). Other systems can be used (PZ-90, GTRF, CGCS2000) if 3D objects are modeled with different navigation devices (e.g. GLONASS, Galileo or Beidou). The script was prepared in the UNITY3D environment			

The main objective of the study relating to spatial planning and development, namely the maintenance of spatial order and the achievement of investment goals, is presented on the right side of Figure 4. This procedure starts with an analysis of plan provisions and ends with a 2D spatial development design, which is often not completely clear to the average reader. Hence, an AR-supported 3D spatial development design can considerably enhance the clarity of the proposed solutions and support the identification of alternative methods of spatial development. Therefore, an iterative approach to spatial development planning should be used. The comments made by readers after the visualization stage are taken into consideration in consecutive drafts of the spatial development design. This stage is represented by dotted arrows in the diagram.

An analysis of the technological aspect of the proposed solution associated with the visualization of spatial development produced four technical models. Two applications were prepared for the identified models. In Figure 4, the first application is represented by modules 1 to 3, and the second application is represented by module 4. The modules and the tools used in their creation are shown in Table 1.

RESULTS

Imprecise fragments of a local plan can generate various ideas and expectations regarding the future development of space. In many cases, buildings erected in compliance with by-laws raise negative emotions or even lead to legal disputes. These problems were analyzed on the example of Bartąg, a village in the suburbs of Olsztyn, in the municipality of Stawiguda in north-eastern Poland. The area is covered by a local spatial development plan that had been adopted as a by-law. A general map of the area and the corresponding excerpt from the local plan are presented in Figure 5.

The local plan for the study area was prepared in 2008. Single-family housing is indicated as the dominant type of development. In the plan, the study area (Fig. 5 and 6) is marked as zone 2MN designated for the construction of single-family houses with gardens. The plan contains the following provisions: 1. regarding land development:

- all new buildings must have a double-sloped or multi-hip roof, inclined at an angle of 33–45°, covered with ceramic roof tiles or with rooftile-like material – red or brown;
- the height of a single-family home or a terraced house cannot exceed one story, counting from the lowest corner of the building to the eaves, plus a habitable attic;

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- 2. regarding environmental protection:
 - only the absolutely necessary changes in terrain are allowed;
- 3. specific provisions:
 - only one residential building may be erected per one building plot;
 - two or more plots can be joined, and one building can be constructed on joined plots;
 - the principal mass of the building is situated in such a way that the roof ridge is parallel to the road axis;
- 4. 60% of the plot must remain biologically active (non-developed).



Fig. 5. Location of the study area - Bartąg

Numerous construction investment projects were initiated in the study area only in the past two years. Only several isolated buildings, not neighboring on one another, had been constructed in the area earlier due to the lack of the road infrastructure.

The intensity of construction investments revealed the imprecision of local plan provisions, especially where individual investments bordered on developers' investments. These investors have different priorities regarding the forms of spatial development. Developers aim at maximizing profits by increasing development density and building terraced or semi-detached houses. In turn, private investors have a preference for detached buildings with a larger recreational area. The landscape in the study area before and after recent investments is shown in Figure 6.

The development status of the study area in 2016 is presented in Figure 6A. In Figure 6B (photograph taken by a drone), the same area is shown in 2020 after four new detached houses had been built. Current development is presented in Figures 6a-c (Fig. 6a and 6c - detached houses; Fig. 6b - semidetached houses). The buildings in Figure 6a were constructed first (which is why one of them can be seen in both Fig. 6A and Fig. 6B). In the group of newly constructed buildings, the objects in Figure 6b were designed in compliance with the same local plan as the buildings in Figures 6a and 6c. Figure 6d presents changes in terrain associated with one of the investment projects. A comparison of the study area before (Fig. 6A) and after investment completion (Fig. 6B) reveals considerable changes in terrain features.

Figure 6b shows that the objects presented in Figure 6b do not fit in with the surroundings, whereas the buildings in Figures 6a and Figure 6c are similar in terms of the architectural features. According to the plan, the height of residential buildings may not exceed one story above ground. At first glance, the buildings in Figure 6b resemble two-story buildings with a habitable attic, whereas the remaining buildings have one story and a habitable attic. This is because the first above-ground story in "b"-type buildings is theoretically an underground story, i.e. a cellar, which can be attributed to the imprecision of plan fragments. Building height was not linked with the height of the roof ridge, as shown in the building in Figure 6b.

Augmented reality can be useful for avoiding the situations shown in Figure 6 at the stage of plan creation, public consultations, issuing building permits,



Fig. 6. The study area before 2016 (A) and after the most recent investments in 2020 (B) (a, b, c – present form of development, d – terrain features associated with one of the investment projects)

or before purchasing land plots for construction. Augmented reality enables visualization of the possible methods of spatial development in an urban planner's or architect's office, or in the field. It enables multiple interpretations of the provisions of the plan, as discussed below.

In the first variant, AR was used to visualize plot development based on a background map (indoors). A general orientation map was the starting point for visualizing plot development in AR (MODULE 1 in Fig. 4). In the analyzed case, the general orientation map was a map of the building plot and its immediate surroundings (Fig. 7).

Subsequently, 3D models were developed for the existing buildings neighboring the plot covered by the design. Markers showing visualizations of the existing residential buildings were prepared (Fig. 8).

In the next step, the prepared markers were used as the basis for generating projections of the analyzed methods of spatial development (MODULE 2 in Fig. 4). The examples of newly designed buildings are shown in Figure 9, and the proposed changes in terrain features are shown in Figure 10.

3D models were prepared in the SketchUp program in accordance with the planning guidelines (MODULE 3 in Fig. 4). This program is intended for creating 3D objects, and it is used by planners and architects. Moreover, the files created in AutoCAD can be imported to the program. Models of new buildings were created based on the planning guidelines laid down in the local spatial development plan.

The process was completed by developing a MOBILE APPLICATION 1 (MODULE 1, 2 and 3, Fig. 4) which employs AR. The application can be used to visualize plot development and to determine whether the newly designed buildings meet the conditions laid down in the local spatial development plan. Additionally, the application can be used as a tool for public consultations. Augmented reality can be used to visualize both the existing and newly

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Fig. 7. Background map for plot development



Fig. 8. Examples of 3D models of the existing buildings



Fig. 9. Examples of 3D models of newly designed buildings *Source*: own elaboration – adaptation of models from https://assetstore.unity.com/.



Fig. 10. Example of changes in terrain features

Source: own elaboration - adaptation of models from https://3dwarehouse.sketchup.com.

designed spatial development, and it can be helpful in assessing the integration of the new objects with real-world conditions. The user can generate many models of newly designed building to select the best design solutions.

The application can generate different models of new buildings. Augmented reality can be used

to assess their impact on the existing spatial order (Fig. 11 and 12) and to explain the provisions of the local spatial development plan to potential investors/ officials/residents.

The second variant shows the effect of using AR in the field. In the analyzed case, the Unity3D MOBILE APPLICATION 2 (MODULE 4 in Fig. 4)

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was used to present possible forms of plot development based on Global Navigation Satellite System (GNSS) coordinates (Fig. 13).

In the presented approach, users can assess the spatial relations in reality and make corrections to spatial development designs. Augmented reality is also a valuable tool for persons who find it difficult to interpret ordinary 2D maps and designs.

DISCUSSION AND CONCLUSIONS

Augmented reality tools deliver practical benefits, and they can be widely applied in spatial, architectural and construction-related planning. The use of the AR technology enables analyses and assessments of the planned development in the context of spatial order and integration with the existing elements (Soria



Fig. 11. Alternative methods of plot development: semi-detached house (left), detached house (right)



Fig. 12. Visualization of buildings with different roof color

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Fig. 13. Visualization of buildings that comply with the provisions of the local plan (screen capture from a smartphone)

& Roth, 2018). The visualizations presented with the AR technology show that different interpretations of local plan provisions can result in spatial chaos. Detailed parameters for determining the method of spatial development are not available, and the imprecision of local plan provisions contributes to the degradation of spatial order.

In the first version, the visualization of the development design was performed based on background maps and markers (these solutions are applied by, among others, Vuforia and Wikitude Augmented Reality). In this approach, real-world objects were visualized with the use of virtual reality based on a marker analysis conducted with a mobile device (smartphone) and the generated computer graphics (3D objects).

The provisions of the spatial development plan provisions can also be visualized based on a scanned flat plane (this solution has been implemented by Google – ARCore).¹ In this case, the device scans the background map and uses it as the basis for generating a 3D model which, when the application is run again, can be displayed in a different location (centimeter differences in the map scale). In this solution, the model's location must be corrected each time against the background map. This solution primarily involves an understanding of the natural environment. This process involves scanning the surroundings and recognizing characteristic points and planes. An algorithm in the mobile devices interprets groups

¹ https://www.wikitude.com/; https://developer.vuforia. com/; https://developers.google.com/ar.

of points which create common planes (horizontal or vertical). ARCore determines the boundaries of these areas and localizes a predefined digital object on these boundaries.² An advantage of this solution is that there is no need to generate a separate marker. Unlike in the approach that involves markers, the displayed object is generated in a different location each time. For a 3D object to be placed correctly relative to the obligatory building line, an interactive element must be added, namely the option of changing the object's position and editing its shape (width, length and height). This requires a more extensive knowledge of informatics.

Since an interactive element can also be used in the marker approach, this solution was applied in this study. In the solution based on the prepared markers, 3D objects generated in the process will be always displayed in the same location. Therefore, the marker-based technology is the recommended solution whenever a map is used as the background element.

Augmented reality can also be used to visualize the designed spatial development directly in the investment area based on GNSS coordinates. In comparison with the previous solution, this approach facilitates the presentation of 3D models on a scale of 1:1, which can be as large as up to several dozen meters. The accuracy of coordinate determination is a significant limitation in this case. The altitude coordinate is smallest in the installed GNSS receivers, for example in smartphones. The difference between the actual and the measured height can reach up to several meters. The option of adjusting the height of a 3D object determined in the field was implemented to eliminate this technological limitation. The instability of the determined co-ordinates is a certain problem. GNSS receivers in smartphones determine position at 1-second intervals. This position is determined in realtime, and the consecutive observation intervals can differ by several meters. Therefore, the displayed object was stabilized by averaging the positions from several measurement intervals (the determined positions should not be refreshed every 1-second interval)

² https://developers.google.com/ar.

(Kaźmierczak, 2020). A local system of coordinates was defined for each 3D object.

The presented methods seem to be optimal for visualizing spatial relations. The marker-based approach for presenting 3D objects seems to be particularly useful. A map with a land development plan can be used as such a marker. This solution preserves the carto metricity of a visualization, particularly its scale. However, it is more laborious because it requires a background map. The frame of the reference parameters for the map, the marker and the 3D object is easier to define in the programming environment. The beginning of the frame of reference, the directions of the coordinate axes, and the units of measurement are defined when an object is created. The location where a 3D object is displayed on the marker is also defined.

The AR application enabled the visualization of a newly developed building and a comparison with the existing buildings. Augmented reality can be used to assess the impact of newly designed buildings and their foundations on spatial order. Therefore, applications that rely on AR can be used as tools in the process of developing local plans by designers as well as decision-makers who approve the adopted solutions. Augmented reality is also a tool which can be widely used in consultations - the generated development models can help users to select the most suitable form of buildings (Fegert et al., 2020; Saßmannshausen et al., 2021). Augmented reality is also a useful tool for investors. The AR technology can play an important role in the investment process at the stage of adapting the architectural design to the surroundings. This technology can also be used to track moving objects, and it involves a sound component.

These functions corroborate the hypothesis put forward at the beginning of this paper, namely that visualization of spatial development of a building plot in 3D AR helps to understand the spatial relations between a building and its surroundings (Goudarznia et al., 2017). The study also demonstrated that the AR technology can be used to identify imprecise fragments of the local plan and its impact on the method of space development.

The use of AR facilitates an understanding of spatial development planning which takes into account the principles of spatial order. Technological progress and the popularity of mobile devices have increased the availability of 3D visualizations involving the AR technology.

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THE EFFECT OF VAT REDUCTIONS ON NEWLY BUILT PROPERTIES AND CONSTRUCTIONS IN HUNGARY

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ABSTRACT

Motives: This study was undertaken to determine the feasibility and macroeconomic impact of reduced VAT. As an EU Member State, Hungary may apply reduced tax rates in accordance with the Council Directive 112/2006/EC. In Hungary, due to the high general tax rate, the range of products and services with reduced tax rates plays a special role.

Aim: In Hungary, a preferential VAT regime was introduced to reduce the increase in the price of newbuild properties. The aim of this study was to examine whether reduced VAT had the desired effect. Therefore, the effect of 5% VAT on the Hungarian real estate price index was analysed based on the data provided by the Hungarian National Bank with the use of various statistical methods.

Results: The study demonstrated that a reduced VAT rate on newly built properties that meet certain conditions in Hungary had an impact on the real estate market. The date of the building permit, which is a prerequisite for applying a reduced tax rate, increased real estate prices as an immediate effect, which was reduced somewhat by the final consumer price due to the reduced tax rate. This double effect stabilised the real estate market price index.

Keywords: fiscal policy, real estate market, reduced tax rate

INTRODUCTION

The Value Added Tax (VAT) is widely used type of a sales tax. It is levied on the prices of products and services in all stages of production, distribution, and sale to the final consumer. The VAT has common characteristics, but considerable differences can be observed in VAT systems around the world. The main difference is the tax rate applied in every country. Standard tax rates are generally applied, and most countries also use reduced rates and exemptions. There are no common rules concerning tax rates, and the European Union (EU) is the only exception in this regard. Tax rates are set individually by the Member States, and the EU has only limited competences. The EU has common rules on VAT, but these provisions are part of a well-regulated framework. The above implies that the EU countries may apply different tax rates and reliefs. At present, tax rates are regulated by the Council Directive 2006/112/EC of 28 November 2006 on the common system of value added tax, which has been amended several times.

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According to this directive, Member States can apply a standard VAT rate and one or two reduced rates.

One of the goals of Hungarian economic policy is to provide greater support for families. Therefore, upon the EU's consent, a reduced tax rate of 5% was applied to the construction and sale of newly built properties on 1 January 2016. The reduced VAT rate is expected to decrease market prices and an increase macroeconomic demand. The present study was undertaken to analyse the real effects of the reduced VAT rate in Hungary and to examine whether this measure had the desired effect. The research hypothesis postulates that the reduced VAT rate has a delayed impact on the Hungarian property market.

LITERATURE REVIEW

Taxes constitute the competence of the Member States, and the EU has only limited competence in this regard. The main goal of the Treaty on the Functioning the European Union was to harmonise national legislation to ensure the establishment and the functioning of the internal market and to avoid distortion of competition (Treaty on the Functioning of the European Union (TFEU), 1958). There cannot be any obstacles to free competition in a harmonised internal market. Domestic markets cannot be protected against imports from EU markets that apply different tax rates. Double taxation should also be avoided within the EU. Therefore, the EU has common rules on VAT, but these regulations are only a part of legislative framework. Therefore, the VAT system is harmonised in the EU and does not differ in general, but Member States may apply the rules differently, which implies that tax rates and reliefs

can differ across countries. The EU laws apply to VAT and tax harmonisation in all Member States.

At the EU level, VAT is regulated by the Council Directive 2006/112/EC of 28 November 2006 on the common system of value added tax, which has been amended several times. This study focuses on the impact of reduced VAT rates, and VAT rates in different EU countries will be examined. According to Directive 2006/112/EC, the Member States can apply a standard VAT rate and one or two reduced rates. However, special rates can also be applied, which further complicates the situation. The VAT rates in the EU countries are presented in Table 1.

The EU has a standard VAT rate of 15%, and reduced rates can be applied to specific goods. Special rates can be levied on products outside this list and only in certain countries. The goods and services that are subject to reduced rates include basic life necessities such as food, water, pharmaceutical products, medical equipment, books, newspapers, tickets to theatres, concerts, museums, and sporting events, radio and television broadcasting services, housing, funeral services, healthcare and dental care, municipal cleaning, refuse collection, and waste treatment. The present study focuses on the provision, construction, renovation, and alteration of housing as part of social policy (2006/112/EC regulation, 2006).

It should be noted that Hungary has the highest standard VAT rate not only in the EU, but also in the world. Standard VAT rates in the EU countries are presented in Figure 1.

What are the implications of the VAT burden from the consumers' point of view? As demonstrated in the below map (Fig. 2), the VAT burden of European households ranges from 14.7% (Hungary) to 6% (Luxemburg).

Table 1. VAT rates in	the	EU
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Catagorias	Standard rata	Reduced rate	Special rates				
Categories	Standard Tate		Super-reduced rates	Zero rate	Parking rate		
Measure	min. 15%	min. 5%	less than 5%	0%	min. 12%		
Products	the supply of most goods and services	specific goods and services	limited products in certain countries	there is no product with zero rate	goods and services that aren't included into the reduced rate		

Source: own preparation based on (Official Journal of the European Union, 2006).

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The current study focuses on reduced VAT rates in social housing. This product category has been included in Annex III to the VAT Directive, which means that all EU countries can apply VAT rates of minimum 5% in the social housing sector. Reduced VAT rates are not applied in Bulgaria, Denmark, Germany, Estonia, Greece, Croatia, Latvia, Lithuania, Austria, Slovakia, Finland, and Sweden. In these countries, the standard VAT rate is between 19% and 25%. The remaining countries apply one or two reduced rates in the social housing sector. Reduced VAT rates in the EU are presented in Figure 3 (European Commission, 2021).

In Hungary, VAT is regulated by the Hungarian Value Added Tax Act (Hungarian Value Added Tax Act, 2007) (hereinafter referred to as the VAT Act) which is consistent with the EU Council Directive 112/2006. The directive allows the Member States to apply reverse taxation and reduced tax rates, and in Hungary, these measures have been applied several times in recent years. The purpose of reverse taxation is to decrease the risk of budgetary tax fraud, and in Hungary, a reverse charge mechanism applies to construction services, agricultural products, and metal sales. The construction industry requires special attention because real estate construction typically involves more subcontractors; therefore, reverse taxation can decrease costs for private buyers (who use construction services / buy property). Before reverse charge was applied to the construction sector, the range of semi-finished property was typical, and subcontracting services were risky. Reverse taxation has thus led to greater transparency on the construction market and reduced tax evasion.

Thus, the B2B market has been stabilised, but to encourage new investments and generate economic growth, the demand for investments should also increase in the private sector. In addition, one of the goals of Hungarian economic policy is to provide greater support for families, including family housing allowance (FHA). The main goal of the housing allowance system is to enable families with young children to obtain loans on preferential terms. However, new tax policy instruments have been

Fig. 1. Standard VAT rates in the EU countries (%) *Source:* own elaboration based on European Commission data (European Commission, 2021).

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Fig. 2. Distribution of VAT paid by households as a percentage of their gross income by household type (2015) *Source:* own elaboration based on Eurostat data (Eurostat, 2021).

introduced, and upon the EU's consent, a reduced tax rate of 5% was applied to the construction and sale of newly built properties on 1 January 2016. Prior to 2015, the increase in real estate prices was kept in check by lower taxes on newly built real estate, as shown in Figure 4.

The value of the property usually differs from its market price. Kobylińska and Źróbek analysed market data for 2010–2013 and found that property can be overpriced by 21.5% on average (Kobylińska & Źróbek, 2016). It should be noted that a reduced tax rate can be only applied under certain conditions. In many cases, similar restrictions have been introduced to VAT laws applicable to real estate in other EU countries. The tax rates for newly built properties in the EU countries are presented in Figure 5.

As previously mentioned, reduced tax rates are applied at the discretion of each Member State; therefore, only several examples will be discussed for the needs of this study. In France, in addition to residential real estate, construction sites are also



Fig. 3. Differences between standard and reduced VAT rates for social housing in the EU countries (% points) *Source*: own elaboration based on European Commission data (European Commission, 2021).



Fig. 4. Nominal real estate price index quoted by the Hungarian National Bank *Source*: own elaboration based on Hungarian National Bank data (Central Bank of Hungary, 2020).

subject to a reduced tax rate. In Belgium, a reduced tax rate is applied to the conversion and rental of real estate. In Portugal and Italy, a reduced tax rate ("nonluxury housing"; "social housing with controlled costs") is linked with the household budget, whereas in Eastern European countries, a reduced rate may be applied only to property whose area does not exceed the prescribed limit. In Hungary and Poland, the reduced tax rate can be applied to apartments with a maximum floor area of 150 m² and residential buildings with a maximum floor area of 300 m².

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Fig. 5. VAT rates (%) for newly built properties in the EU Member States

Source: own elaboration based on European Commission data (European Commission, 2021).

According to the government, reduced VAT should decrease market prices and increase macroeconomic demand. However, in addition to the price effect, substitution and income effects also appear on the consumer side; therefore, the price effect is very difficult to measure. Barrel & Weale (2009) found that a 2.5 percentage point (pp) reduction in VAT increased consumption by 1% and GDP by 0.5%, but no long-term effect of the VAT reduction was observed (Barrell & Weale, 2009). In turn, Bernal observed that a 2 pp decrease in the VAT rate did not lead to a significant decrease in food prices in Poland (Bernal, 2018).

In 2006, Gabriel and Reiff relied on Hungarian data to determine the extent to which VAT effects are reflected in product prices, and they concluded that a VAT reduction did not decrease prices, but a VAT increase led to an increase in prices (Gábriel & Reiff, 2006). Manente & Zanette examined the impact of a reduced VAT rate in the Italian tourism sector and found that a VAT reduction from 10% to 5% led to a 4.4% increase in demand (Manente & Zanette, 2010). In 2010, the VAT rate on restaurant meals was reduced from 22% to 13% in Finland and from 25% to 12% in Sweden. However, these changes did not lead to a decrease in prices or an increase in demand (Harju & Kosonen, 2013). Thus, in the light of international experiences, the aim of this study was to determine whether housing investment trends developed differently in the period before and after the application of a reduced VAT rate and to determine the impact of a reduced VAT rate on the number of issued building permits and new-build properties. The analysis was based on real estate market data covering the period between 2Q2003 and 2020 (Central Bank of Hungary, 2020). Data were analysed by comparing two independent samples and by examining time series.

MATERIALS AND METHODS

In the first stage of the study, the demand for new-build housing was analysed before and after the introduction of a reduced VAT rate. The reduced VAT rate on real estate was adopted as a dummy variable; therefore, the data in the period between 4Q2013 and 2015 were labelled as 0, and the data in the period 1Q2016 and 2Q2020 were labelled as 1. These values denote the absence or presence of a reduced tax rate on real estate in 2013-2015. The two periods contain independent variables and can therefore be considered as two independent groups for statistical analysis. The two groups of data (before and after the application of a reduced VAT rate) were processed in the Mann-Whitney test to determine the number of issued building permits and then new properties. Outliers were handled by logarithmization (Ramanathan, 2003) by log transforming the number of issued permits and the number of new properties.

The time horizon for issuing a building permit was examined in the following step of the analysis. The length of delays that affected the number of building permits on the real estate market was examined with the use of a vector autoregression (VAR) model. Based on the literature, a 4-quarter delay was adopted in the model. The administration and

implementation of real estate development projects is a lengthy process. In Poland, the real estate division process lasts more than 6 months (Bieda et al., 2016).

RESULTS

The effect of a reduced VAT rate on demand for new-build housing

The analysis of building permits revealed that data did not follow a normal distribution (Shapiro--Wilk test 0.013%); therefore, the medians of two



Fig. 6. Boxplot of the number of permits *Source*: STATA output.



Fig. 7. Boxplot of the number of new buildings *Source:* STATA output.

independent samples were compared in the Mann-Whitney test. The median values of the number of building permits differed significantly between two periods, as demonstrated by the boxplots in Figure 6.

Based on the assumption that the number of newly built properties was normally distributed (Shapiro--Wilk 15.472%), data were analysed in the t-test for independent samples which revealed a significant difference between the average values, as illustrated by boxplots in Figure 7.

The effect of a reduced tax rate in different time periods

The STATA output in Figure 8 indicates that the number of issued building permits influenced the number of new construction properties with a delay of 3 and 4 quarters. This is not surprising because this period corresponds to the length of a typical construction project.

Based on the above, it can be concluded that a clear relationship exists between the number of issued building permits and the number of newbuild properties after 3 and 4 quarters. Therefore, the influence of the number of newly built properties on property prices was examined in the last step of the analysis.

The effect of a reduced tax rate on the property price index

During the VAR analysis, no time series effect was observed between the number of newly built properties and the property price index; therefore, a regression model was used to examine the relationship between the two variables, and the statistical output is shown in Figure 9.

The results of the regression model indicate that the number of issued building permits increased (p = 0.000) and that a 5% real estate tax decreased the real estate price index.

. var d_ln_new_build d_ln_per	mit, lags(1/4)	exog(t)
Vector autoregression		

vector autoregre	ssion						
Sample: 1961q3	- 1964q4			Number	of obs	=	14
Log likelihood =	41.76842			AIC		=	-3.109775
FPE =	.0003162			HQIC		=	-3.194284
<pre>Det(Sigma_ml) =</pre>	8.78e-06			SBIC		=	-2.196836
Equation	Parms	RMSE	R-sq	chi2	P>chi2		
d_ln_new_build	10	.184583	0.9666	404.6647	0.0000		
d_ln_permit	10	.108646	0.7821	50.25895	0.0000		
	Coef.	Std. E	err.	z P> z	[95%	Conf	. Interval]
d ln new build							
d ln new build							
L1.	551261	.24090	26 -2.	29 0.022	-1.02	3421	0791006
L2.	5866308	.22288	41 -2.	63 0.008	-1.02	3476	149786
L3.	6145765	.24390	79 -2.	52 0.012	-1.09	2627	1365257
L4.	.2488178	.25090	036 0.	99 0.321	242	9441	.7405798
d ln permit							
L1.	0706884	.33845	io1 -0.	21 0.835	734	0385	.5926617
L2.	4466089	.35358	37 -1.	26 0.207	-1.1	3962	.2464024
L3.	.8556893	.39436	14 2 .	17 0.030	. 082	7553	1.628623
L4.	.7342376	.26310	85 2.	79 0.005	.218	5544	1.249921
t	003561	.01530	008 -0.	23 0.816	033	5499	.0264279
_cons	.1577954	.22874	69 0.	69 0.490	290	5402	. 606131

Fig. 8. Results of the VAR model *Source*: STATA output.

. regress hp_index tax5 ln_permit ln_new_build

Source	55	df	MS	Number of ob	s = 30
Model	.145602753	3	.048534251	 F(3, 26) Prob > F 	= 33.74 = 0.0000
Residual	.037402461	26	.001438556	R-squared	= 0.7956 d = 0.7720
Total	.183005213	29	.006310525	Root MSE	= .03793
	L.				
hp_index	Coef.	Std. Err.	t	P> t [95%	Conf. Interval]
tax5	1468783	.0461628	-3.18	0.0042417	6730519893
ln_permit	.21172	.0360765	5.87	0.000 .1375	636 .2858763
ln_new_build	0057995	.016366	-0.35	0.7260394	403 .0278412
	-1.570162	.2797365	-5.61	0.000 -2.145	1689951549

Fig. 9. Results of the regression model *Source*: STATA output.

CONCLUSIONS

The main aim of this study was to analyse the applicability of a reduced VAT and its macroeconomic impact. As an EU Member State, Hungary may apply reduced tax rates in accordance with the EU Council Directive 112/2006. Due to a high general tax rate, the range of products and services that fall subject to reduced tax rates in Hungary plays a key role. Therefore, the effect of 5% VAT on the Hungarian real estate price index was analysed based on the data provided by the Hungarian National Bank with the use of various statistical methods. In the first step, the number of building permits and the number of newly built properties was compared before and after the introduction of a reduced VAT rate, and the analysis revealed that both indicators were significantly higher after a reduced VAT rate had been introduced. Before 2021, the application of a reduced tax rate for new construction properties was tied to the date of the issued building permit. Therefore, the study examined the time period after which the number of issued building permits (as a precondition for applying the reduced tax rate) affected the number of new construction properties. The VAR model demonstrated that supply on the real estate market increased with a delay of 3 and 4 quarters, which corresponds to the length of a typical construction project.

Real estate prices can ultimately be measured with the real estate price index; however, a delay was not observed between the number of newly built properties, the number of issued building permits, the introduction of a 5% tax rate, and the price index, which implies that a simultaneous effect exists between the indicators. The regression model supported this assumption, and it revealed that the number of issued building permits increased and that 5% VAT decreased the property price index. These results are consistent with the economic revitalization effect observed by Barrel & Weale and Manente & Zanette in the Italian tourism sector.

Overall, the study demonstrated that a reduced VAT rate that can be applied to newly built properties in Hungary under certain conditions had an impact on the real estate market. The date of the building permit, which is a prerequisite for applying the reduced tax rate, increased real estate prices as an immediate effect, but it was somewhat reduced by the final consumer price due to the reduced tax rate. In view of the substitution effect in microeconomics, prices were not expected to decrease by 22 percent. This double effect stabilised the real estate market price index.

The results of this study can be used by other EU Member States which have considerable free-

dom in applying reduced VAT rates on products and services. The delay effect in other areas could be investigated using the presented method. For example, a reduced VAT rate on accommodation services would not lead to an immediate increase in the number of bookings because users make reservations months in advance. The applicability of a reduced VAT rate can be considered in a specific economic context, and the delay effect can be incorporated into the model by analysing the impact of reduced VAT.

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Note: The results of this study have not been presented in a different form, such as a poster/abstract at a conference.

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SPATIAL ANALYSIS OF CULTURAL ECOSYSTEM SERVICES IN LUBLIN: PERCEPTIONS OF LOCAL RESIDENTS AND TOURISTS

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ABSTRACT

Motives: Cultural ecosystem services (CES) are perceived differently by local residents and tourists. Therefore, an understanding of spatial patterns in CES is important for urban planning. Aim: To determine whether residents and tourists differ in their perceptions of CES groups in Lublin, and whether these perceptions are influenced by gender, age, occupation, and frequency of visits. Results: The relative value of CES groups was ranked in the following descending order of importance: physical, social, cultural, inspirational, and spiritual activities by local residents (n = 138), and inspirational, cultural, spiritual, physical, and social activities by tourists (n = 134). The Wilcoxon test showed that the total and average number of the identified locations was higher among residents than tourists. The chi-square test revealed a difference between the CES categories identified by the local residents ($x^2 = 265.602$, df = 5, p < 0.01) and tourists ($x^2 = 25.660$, df = 5, p < 0.01).

Keywords: Public Participatory Geographical Information System, non-material values, cultural ecosystem services, urban green spaces

INTRODUCTION

Cultural ecosystem services (CES) are part of ecosystem services (Haines-Young & Potschin, 2018) and provide intangible benefits (MEA, 2003) and human well-being (Cheng et al., 2019) in gradually developing urban areas (UN, 2020; Willis, 2015). In large cities, where urban green areas are often lacking (Iraegui et al., 2020), CES is the most relevant for city dwellers (Chen et al., 2020) and such urban green areas are the only places available to city residents and tourists and

provide a fundamental interaction between people and nature (Andersson et al., 2014). While CES is important for improving the quality of life, it is not always considered in planning decisions (Dasgupta et al., 2021). At the same time, a fuller consideration of CES along with an analysis of the perceptions of different people can help avoid future conflicts (Darvill & Lindo, 2016) in cities. There is now a need not only to quantify CES, but also to incorporate them into decision-making activities (Hirons et al., 2016). Therefore, the Public Participation Geographic

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Information System (PPGIS) is used to characterize the CES spatially. This approach generates spatial information to assess CES by involving different categories of people (Brown & Fagerholm, 2015). For example, in our study we compared local residents, who live permanently in the city and tourists. People's perception of CES is greatly influenced by a variety of sociocultural factors such as gender, age, location, and education (Dade et al., 2020). In addition, the frequency of visits (Petrosillo et al., 2007) influences how visitors perceive CES. Often, the city's beautiful attractions are important tourism resources (Bachi et al., 2020). But also often, despite tourism's contribution to the local economy, tourism can have an antagonistic impact on local communities (Petrosillo et al., 2013). It is therefore important to strike a balance between the interests of the community and tourism businesses (Brown, 2006). Analyzing the perception of CES by local residents and tourists can help inform urban planning and management decisions. Spatial analysis methods have been used in the literature to assess CES. In the past, a difference in the perception of CES by seasonal and permanent residents has been demonstrated (Petrosillo et al., 2013). However, understanding of CES is still insufficient (Milcu et al., 2013). Among the numerous studies analyzed in the literature (Kosanic & Petzold, 2020; O'Brien et al., 2017) on urban CES, there is insufficient basis in the definition of CES and their nomenclature (Blicharska et al., 2017). There are also differences in CES, social and tourism policies in Poland, UK and Finland (Dłużewska et al., 2020). There are also too few CES assumptions in applications to the theoretical foundations and research practices of CES (Dłużewska, 2016). There is no sufficient research on the possibilities of city parks, such as, for example, research conducted for the city of Poznań on the provision and regulation of CES in the city and their social reception (Stępniewska, 2021). There is also a lack of research on the CES of the city parks of Lublin, which motivated us to conduct this research. This is particularly relevant in the overall context of the growth of the world's urban population (UN, 2020).

The use of participatory mapping methods known as participatory GIS (PPGIS) is promising. These methods involve people in creating spatial information for different urban layouts (Brown et al., 2018) and have been widely used for CES estimation since the 1990s (Jones et al., 2018). The aim of our study was to examine the perception of CES on the example of the city parks of Lublin, to show the differences in perception by tourists and residents and to determine whether perceptions of CES in Lublin is higher for local residents in comparison to tourists, whether they are influenced by gender, age, occupation and frequency of visits. PPGIS approach was also applied to map areas with high levels of perception of the top five groups of CES activities (Physical, Social, Inspirational, Cultural and Spiritual) of CES values by local residents and tourists and identify differences in their perception. The city of Lublin was chosen as one of the largest cities in eastern Poland (the regional center of the Lubelskie Voivodeship).

MATERIALS AND METHODS

The perception of 22 objects located in Lublin by residents and tourists was analyzed (Fig. 1). Among them, 14 parks as contemporary parks, created along with the development of new districts of Lublin, historical parks, with good historical and cultural values (Adamiec & Trzaskowska, 2012) and objects with domination of the area of green and water elements. Each time Lublin authorities intend to introduce any changes or improvements within landscape spatial management, a proper resolution of Lublin City Council has to be adopted, as it happened on 8 September 2022 (Uchwała, 2022). The city of Lublin covers an area of approximately 147.5 km² and has a population of 336,339 (Lublin, 2023). In 2022, more than twice as many tourists and domestic visitors (752,823) came to Lublin compared to data from 2021, and more than 20 percent more than in 2019 (Barometr turystyczny, 2022). Forests cover over 11% of the city's area and are an important element of Lublin's green structure.



Fig. 1. Location of the Lublin study area and distribution of CES selected by local residents and tourists: 1 – Saski, 2 – Akademicki, 3 – Saint John Paul II, 4 – Ludovy, 5 – Bronovice, 6 – Rusalka, 7 – Tatary, 8 – Zavilcova, 9 – Gorki Czechovskie, 10 – Veglin, 11 – Poczekajka, 12 – Rury, 13 – Abramovice, 14 – Kalina parks, 15 – Botanical Garden, 16 – Stasin Reserve, 17 – Lublin Open Air Village, 18 – Majdanek museums, 19 – Dabrova, 20 – Stary Gaj, 21 – Rudki forests, 22 – Zemborzycki Reservoir

The main method of data collection was a structured questionnaire. This traditional questionnaire evaluation methods of CESs are mostly carried out (Yang & Cao, 2022). The survey was used to obtain subjective CES assessments of the city and was addressed to residents and tourists. The respondents were asked to choose up to 4 places on the map of Lublin that they consider important for each of the 5 CES categories, namely Physical, Social, Inspirational, Cultural, Spiritual (Table 1).

Table 2 presents the questions asked to the respondents in the questionnaire. These were questions related to the category of respondents, their gender, age, level of education. Then there was the question "where do you go most often, when you want" and ready-made answers, the first three of which can be

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 Table 1. Categories of cultural ecosystem services (CES) used for Public Participation Geographic Information System (PPGIS) survey in the Lublin (Poland)

Activity group	Associated to CES which promote	CICES v5.1 code*
Physical	recreational (passive and active), walking, cycling, sailing	3.1.1.1 3.1.1.2
Social	social interactions, e.g., doing picnics, seating in a bench with friends, walking with other senior	3.1.1.2
Inspirational	knowledge, and inspiration, e.g., scientific, educational, aesthetic appreciation.	3.1.2.1 3.1.2.2 3.1.2.4
Cultural	cultural benefits for the users, e.g., educational, cultural, heritage.	3.1.2.2 3.1.2.3 3.2.1.3
Spiritual	spiritual experiences associated to nature, e.g., symbolic, sacred or religious.	3.2.1.1 3.2.1.2

* Some CICES codes linked to more than one activity group and corresponds to dominant group.

Table 2. Survey questionnaire for residents and tourists

Questions	Answers			
Are you a local resident of Lublin city or tourist?	local resident/tourist			
Gender	female/male			
Age group	up to 18/18-30/31-40/41-50/51-60/more than 60			
Level of education	secondary/higher/other			
Where do you go most often when do you want to:				
to be close to nature	Please pointe 4 objects and relevance of activity (as 1/2/3/4/5-points Likert-scale) for them and frequency of your visit (daily/weekly/monthly/yearely)			
to be where is quiet and in piece	-//-			
to relax (walking, running, sweeming)	-//-			
to be with friends	-//-			
to be with family	-//-			
to meet new people	-//-			
take part in a social events	-//-			
inspiration of unique of place	-//-			
inspiration with creatione (paint, poem, song, photo)	-//-			
to develop knowledge	-//-			
to learn about things	-//-			
to learn history and traditions	-//-			
to understand things and cultural heritage	-//-			
to attend cultural events	-//-			
to meditate	-//-			
to develop spiritual values	-//-			
to reflect on personal religious values	-//-			
Do you partake in any environmental activities	yes/no			

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attributed to Physical activity, the next four to Social activity, the next four to Inspirational activity, the next three to Cultural activity, and the last three to Spiritual activity (Table 2). In the questionnaire, following these answers, the respondents assessed the relative importance of the places they visited, using a rank from 1 to 5 (from 1 very unimportant to 5 very important - Likert scale) and frequency of visits (daily/ weekly/monthly/yearly). The last question (Table 2) reflected the respondents' activity for environmental protection. The city map showed respondents landmarks and major roads to help them identify places that were important to them in creating CES. We used translations of the questionnaire into English and Polish. The study was conducted from 01.05 to 31.05. 2023, taking into account the distribution of population in all districts of Lublin. This period also included weekends. 272 respondents were interviewed (138 for residents and 134 for tourists) in various parts of the city (also at the bus station, railway station and airport). Each of respondents were asked pointed 4 objects and selected 1/2/3/4/5-points Likert-scale for them and thus represented 552 repetitions for residents and 536 for tourists of selected objects on the analyzed map of the city of Lublin. The high representativeness of the sample of respondents can be seen in the example of women (53.8% in the population of Lublin in 2023 and 51.3% in sample of respondents) among the surveyed residents of Lublin.

CES locations (number of locations for each group indicated by local residents and tourists), impact of the frequency of visits to the city on the respondents' perception of CES were processed in QGIS software. The total number of places mentioned by tourists and local residents for each category of CES was calculated. According to the frequency daily, weekly, monthly and yearly visits were identified. The significance level of 0.05 was used in all statistical analyses. Wilcoxon test was also used to analyse differences in the number of places for each CES. Statistical analysis was conducted using the Statistics software. To spatially characterise the location of CES sites and the differences in their perception by local residents and tourists density maps of sites (using the Kernel density function) were created. The data obtained

(provided by each respondent) on the importance of CES was extrapolated as the weight of each point, with a search radius of 1500 m and a grid resolution of 100 m. The statistical significance of the difference between local residents and tourists was investigated using the chi-square test.

RESULTS

When analyzing the descriptive statistics, it should be noted that among the surveyed residents of Lublin (n = 138), women amounted to 51.3% and men to 48.7%. Gender showed the greatest influence in the social group. The social group was mentioned slightly more often by women than by men. In age groups, the majority of residents (51.2%) have less than 30 years, and 9.1% were over 60 years old. Age also has the greatest impact on social activity. Young people (aged 19-30) consider social and physical activity very important. In terms of education, people with higher education prevailed (39.2%). The level of education had no effect on the analyzed activity groups. Most of the respondents visited selected places once a week (40.5%), and only 3.4% visited them every day. Less than 10% of local residents participated in conservation activities. Among tourists (n = 134), women accounted for 65.6% and men for 34.4%. The majority (57.2%) were no more than 30 years old and 14.8% were over 60 years old. People with higher education prevailed (42.4%). In the case of tourists, the Inspirational group had a slight advantage. Only age had the greatest impact on Spiritual activity (people over 60 more often chose places from the Spiritual activity group). The Wilcoxon test showed that for all CES categories, the average number of places identified by local residents was higher than for tourists (Table 3). Table 3 shows not only the total but also the average number of CES facilities belonging to each of the five CES groups identified by local residents and tourists. The relative importance of the CES groups for tourists and local residents varied and can be ranked in 1descending order of importance for local residents: Physical, Social, Cultural, Inspirational and Spiritual activity, and for tourists: Inspirational, Cutural, Spiritual Physical and Social activity.

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Category	Respondence Category	Physical	Social	Inspirational	Cultural	Spiritual
Total	Local Residents	365	354	345	347	261
	Tourists	190	187	235	225	203
Average	Local Residents	2.6	2.5	2.1	2.2	1.6
	Tourists	1.6	1.5	2.1	2.0	1.7

Table 3. Total and average number of CES locations identified by local residents and tourists by CES groups

Local residents of the city who permanently resided in the city visited CES facilities in various parts of the city. We have identified clear spatial patterns for local residents and tourists. In particular, the locations with the highest concentration of CES (intense red color) differed between local residents and tourists. For local residents, the maps highlighted the rather varied distribution of areas identified by those interviewed. The Physical activity group is characterized by a dispersed arrangement of facilities selected by residents in the northern and southern parts of the city. At the same time, respondents indicated more objects in the northern part, and less in the southern part (Fig. 2a). However, the importance of these objects for the respondents was quite high both in the northern and southern



Fig. 2. Kernel density map of distribution of CES for local residents for activity groups: a – Physical, b – Social, c – Inspirational, d – Cultural, e – Spiritual

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parts (red circle in the figures). This is facilitated by the presence of picturesque parks, such as the Saski Park, the cemetery-park on Lipowa Street, the Academic Park in the northern part, and the forests of Dabrowa, Stary Gaj and Rudki in the southern part, which attract the attention of Lublin residents. In the groups Social activity and Cultural activity, clusters of objects selected by the respondents in the northern and southern parts of the city are still noticeable, although the weight of objects in the southern part is smaller (Fig. 2b, 2d). In the case of the Inspirational group (Fig. 2c) and the Spiritual group, this division into the northern and southern parts becomes less noticeable (Fig. 2c, 2e) and, for example, numerous objects for the Spiritual groups were recorded only in the northern and central parts of the city (Fig. 2e).

The CES facilities indicated by tourists were less concentrated in comparison to the facilities selected by local residents. For tourists, in the northern part, the facilities were concentrated around the Saski Park, and in the southern part around the Zemborzycki Reservoir. Such a division was noticeable in the answers of tourists for the Physical and Social groups (Fig. 3a, 3b). On the other hand, the facilities selected by tourists for the Inspirational group are the largest and concentrated not only around the Saski Park and the Akademicki Park, but also around the Botanical Garden, Lublin Open Air Village Museum, Majdanek Museum and Zemborzycki Reservoir (Fig. 3c). The objects selected by tourists for Cultural and Spiritual groups had a different character, they spread from the north-east to the south-west (Fig. 3d, 3e)



Fig. 3. Kernel density map illustrating distribution of CES for tourists for activity groups: a – Physical, b – Social, c – Inspirational, d – Cultural, e – Spiritual

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and were concentrated close to the city center. The chi--square test showed that there is a difference between the CES categories for local residents ($x^2 = 265.602$, df = 5, p < 0.01) and tourists ($x^2 = 25.660$, df = 5, p < 0.01).

DISCUSSION

As research within the city of Lublin has shown, the relative importance of CES groups varied for local residents and tourists. For local residents in descending order of importance, these are Physical, Social, Cultural, Inspirational and Spiritual activity groups. These CES groups are also recognised in the literature as the main factors contributing to people's health and well-being (Cheng et al., 2019). Our order of importance is consistent with previous studies that have pointed to the importance of, for example, recreational (in our division, this is close to the Physical group) CES for residents and non-residents (Muñoz et al., 2019). For tourists in descending order of importance, these are Inspirational, Cultural, Spiritual Physical and Social activities that are different than for local residents. Research has found that the average number of objects indicated by local residents was higher than that indicated by tourists, possibly because local residents had a broader knowledge of the city. This contributed to their better perception of the assessed sites and to recognising more CES. Tourists indicated that although they had visited the city of Lublin many times, they had only visited a limited number of tourist sites and therefore had limited information about the city. Perhaps this is why they mentioned fewer CES than local residents. In this situation, it would be advantageous to increase the number and area of greenery sites in Lublin as CES sites, especially as the city of Lublin itself is below average in terms of urban greenery in Poland (Łachowski & Łęczek, 2020).

Spatial patterns of CES across the Lublin city are different between tourists and local residents. The objects indicated by tourists have a simpler spatial pattern than those indicated by local residents. These patterns for tourists, who choose popular tourist destinations mainly in the old part of the city, were relatively similar across CES groups and had a concentrate distribution. The core density map shows a higher concentration of them around the Saski Park, known for its beauty and various types of outdoor recreation, as well as Botanical Garden and Lublin Open Air Village Museum. However, to fully provide all 5 types of CES, additional activities may be needed for greater opportunities and safety especially for the elderly, as well as environmental education. To this end, it is necessary to take into account the differences in the types and locations of CES and their perception by residents and tourists. The most widespread and diverse were the positions indicated by local residents. Spiritual CES focused around the Museum at Majdanek, the Lublin Open Air Village Museum and the John Paul II Park. Here, the park as a cultural practice is a source of sacredness. This shows that religious beliefs, customs and traditions are important in providing CES. Often, after visiting churches, chapels, monasteries or a museum, the respondents visited the nearest parks. These findings are in line with the findings of other authors (Muñoz et al., 2019) who have argued that not only the biophysical characteristics of the area, but also the people experiencing CES influence the type of CES. In the parks, we surveyed most people on Sundays and weekends, and especially during the time after services in the Catholic churches and Orthodox churches (Tserkvas) closest to the parks, since after the mass some people went to the parks. It is worth noting that our study had some limitations because the survey was not sustainable. We only reviewed 2 groups, i.e. local residents and tourists. A more detailed breakdown of respondents, for example by type of business (Darvill & Lindo, 2015), could provide more data for participatory CES mapping. As the research carried out in Lublin showed, of how CES features are perceived by local residents and tourists would be valuable, and CES visualization could improve not only interpersonal contact, but also the decision-making process, with a view to the future development of tourism and well-being of the inhabitants. In the future, the diversification
of tourist destinations may reduce the concentration of visitors in the city. This has been mentioned in the literature (Bramwell, 2015). In Lublin, facilities visited by residents and tourists in the old part of the city overlap to the greatest extent. Therefore, taking this into account can prevent residents from opposing tourism development. As research in Lublin showed, the use of CES depended most on age and gender. Similar results have been reported in other studies (Fischer et al., 2018). Local residents in Lublin value Physical, Social and Cultural activity the most, which is also consistent with the results of previous studies (Syrbe et al., 2021; Ugolini et al., 2021; Xin et al., 2020). The importance of these activities is explained by their role in physical and mental well-being (Pinto et al., 2021). It is worth emphasizing the need to invest in the analysis of the relationship between man and nature, especially in multicultural communities, such as the city of Lublin. In this article, for the first time, it was possible to determine the nature of the perception of CES not only among residents, but also tourists in Lublin during a new phase of Russian military aggression against Ukraine, which has resulted in international armed conflict on the territory of Ukraine (Geneva Convention, 1949). In 2022, a lot of visiting Ukrainians were recorded in Lublin (Barometr turystyczny, 2022). This could have influenced the reception of the CES in Lublin. However, a separate analysis of Ukrainians who arrived to Lublin after 24 February 2022 and are subject to different (special) legal regime (Ustawa, 2022), in the perception of CES did not fall within the scope of our research, although it may be prospective in subsequent publications.

As our research has shown, the spatial distribution of the identified locations presents an aggregated image, particularly dense in the city center. This concentration is approaching the territory of the old city. It is also worth noting that most services are concentrated mainly in the northern and central parts of the city, and the density of CES perception decreases from the inner to the outer border of Lublin. Similar results were also obtained by other researchers (Rall et al., 2017). It has been noticed that people are actively looking for places to relax in the city, heading towards the Lublin Open Air Village Museum, Botanical Garden, Zemborzycki Reservoir or Dąbrowa, Stary Gaj or Rudki forests located within the borders of Lublin. This is beneficial for people's physical and mental health as, for example, forests have a high regenerative capacity (Nghiem et al., 2021). The densest zones of Spiritual Activity are more convergent with the central part of the old town, with a greater concentration of sacral buildings (Catholic and Orthodox churches, chapels). Future research should also consider expanding the number of CES assessment activities analyzed that could provide more detailed information needed for city governance. The publication is limited to 5 main activities to ensure efficient data management. In the future, it will also be interesting to focus on the assessment of respondents' motivation, because its analysis goes beyond the scope of this article. It is important to take into account both the preferences of residents regarding CES and the availability of CES for management (Almeida et al., 2018). Given the great interest in social activity of older people (60+), their social interactions should be promoted (Trzaskowska, 2023). For example, the installation of benches and the use of deciduous tree species to increase shade in summer and sunlight in winter. This is important due to the projected aging of the population (Artmann et al., 2017) and climate change (Klemm et al., 2016), as all these factors affect the well-being of older people. There is also a need to involve older users more in decision-making (Onose et al., 2020). This is important in the context of the UN Decade of Healthy Aging 2021-2030 (WHO, 2020). It is also worth thinking about the distribution of recreational facilities, expanding them more and more often beyond the central part of the old town. This is important to redistribute some users to avoid potential conflicts between recreation and conservation efforts. New areas of the city with recreational potential should be further explored and promoted as alternatives to the existing ones. Given the importance of physical and social activity, benches, fountains, sheds, exercise equipment and playing fields can be installed in new areas. Places that are popular

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in an Lublin area should be used to assist lift other near destinations to take more equitable cost-effective advance in the future. In the world there are examples of that activity using Placemaking Approach (Priatmoko et al., 2021).

CONCLUSIONS

The most relevant CES activities for local residents and tourists for the city of Lublin were identified. Local residents of the city most often chose Physical and Social activities. Tourists, on the other hand, most frequently selected the Inspirational activity. For local residents, the relative importance of the CES groups ranked in descending order of importance were Physical, Social, Cultural, Inspirational and Spiritual activities, and for tourists were Inspirational, Cultural, Spiritual Physical and Social activities. The PPGIS approach showed a greater number of locations indicated by residents (22) and a smaller number (6) by tourists. From this we can conclude that the tourist potential of the city of Lublin is not sufficiently used and that, for the time being, the perception of CES is higher by local residents compared to tourists. For local residents and tourists, perceptions of CES are influenced by gender, age, occupation and frequency of visits. The chi-square test showed that there was a difference between the categories of CES for local residents and tourists, and the Wilcoxon test showed that the total and average number of spaces identified by local residents was higher than for tourists. The spatial patterns of the CES identified by tourists were close to the northern part of the city of Lublin, with the exception of the Zęborzycki Reservoir in the southern part of the city for Inspirational, Physical, and Social groups activity. The concentration of objects indicated by tourists was much simpler than the concentration of objects identified by local residents. The objects selected by local residents were scattered in different parts of the city, mostly in the northern and southern parts. It seems very important that the sites chosen

by local residents for the CES go beyond those chosen by tourists. This may mean that future tourism development may have a negative impact on the well-being of Lublin's residents. This points to the need to find a compromise for tourists and local residents. It may be beneficial to expand the potential tourist base in various parts of the city in the future, especially in the southern part, where there are extensive forest massifs. A greater representation of the Stasin reserve in the southern part of the town for tourists may also be prospective. This could prompt further research into the contribution of protected areas and nature--related activities to the CES and lead to improvements in the health and well-being of the city's residents. The spatial distribution of the CES indicates that the green sites which are closest to the old part of the city, where there is a high concentration of cultural monuments, were most frequently visited by tourists. The intensity of use established is indicative of the strain on the central part of the city, and also highlights the need to take into account the interests of older people using the CES. The results of the study provide a better understanding of potential conflicts and may be of relevance to the city administration. The research results presented in the article and their analysis may help the authorities and interested partners in Lublin in making decisions that support the health and well-being of people.

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THE EUROPEAN UNION'S LEGISLATIVE PROCESS IN THE AREA OF ENVIRONMENTAL PROTECTION IN THE CONTEXT OF THE EUROPEAN ENVIRONMENTAL POLICY

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ABSTRACT

Motives: This research paper analyzes the legislative process and the implementation of the European Union's (EU) environmental law as one of the principal tools for achieving and maintaining global ecological safety.

Aim: The study was undertaken to determine how the priorities of the EU's foreign and internal policy are reflected in the legislative process in the area of environmental protection. The problems associated with law enforcement and the implementation of EU legislative acts in national legislation were also examined, and the current state and prospects for policy-making in the area of environmental protection were assessed. The paper considers environmental policy issues and legal regulations in Azerbaijan in the context of EU experiences. The research covers political and legal relations.

Results: An analysis of the historical transformation of the EU's environmental law from an institutional and constitutional perspective was combined with an analysis of the principal aspects and the main trends in the EU's environmental governance and lawmaking. The EU's contribution to the development of environmental legislation highlights its approach to the multi-layered dimension of environmental governance internally, in terms of the dynamic relationship between the EU and the Member States, as well as internationally. The EU's policy and legal regulations in the area of environmental protection can serve as a reliable example for countries in which the environmental agenda has not yet received due attention. The above applies to both strategic planning, regulatory issues, and law enforcement practices.

Keywords: ecology, environmental policy, environmental protection, European Union, legal regulation

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INTRODUCTION

The sustainable expansion and consolidation of the European Union's (EU) environmental actions are inextricably linked and reflect the EU's evolution and transformation since its establishment (Heinelt, 2018). European integration has led to the gradual expansion of the EU's jurisdiction over legal relations beyond the strict scope of the original economic mandate (Sands, 2017). In the context of environmental protection, the absence of a specific legal framework in the original Treaty establishing the European Economic Community (EEC) did not prevent further EU initiatives in this area amid growing environmental concerns. The EU's environmental legislation and policy have evolved over the years from a fragmented and uncoordinated set of measures related to the principal goals of market integration to a complex and detailed system of environmental regulation and multi-level governance (Rehbinder & Stewart, 2020; Van, 2023).

At present, environmental protection is a vital area of the EU's actions both at the national and international levels (Sands, 2017). Over the past four decades, the EU has adopted several hundred environmental acts with varied legal force (European Parliament, 2023). The EU is a party to more than 60 multilateral environmental agreements, and it often strongly advocates for environmental standards in the relevant negotiations (European Commission, 2023b). The Treaty of Lisbon reaffirmed the EU's commitment to environmental protection and sustainable development. At the same time, the Treaty explicitly highlights the internal and external aspects of the EU's actions in this area (Vandermeersch, 2017). Meanwhile, many essential challenges must be addressed for the EU to play a meaningful role in protecting the environment and establish itself as a leader in global environmental governance processes. Moreover, the new framework of international law imposes obligations and rights on both state and their citizens, and the EU's environmental law provides additional legal tools to ensure the rapid and efficient application of international environmental law in the

EU and in every Member State (a phenomenon known as the "Europeanization of international law"). By becoming a part of the EU legal order, international environmental law takes precedence over the provisions of the EU Member States' national legislation (Davies, 2017).

The EU's experience in developing and implementing environmental policies is of interest to many countries, and it can serve as a guideline in the process of developing specialized policies and legislative regulations (Tsebenko et al., 2023). The above generates interest in the EU's legislative process in the area of environmental protection and the associated political priorities, in particular in countries transitioning to a market economy. In these countries, significant differences can be observed in the process of setting environmental goals, as well as the opportunities to achieve them (Van, 2023). Recent greening trends in almost all sectors of the EU economy and public life also have an impact on the EU's policy towards its neighbors, including the countries of the Eastern Partnership with transition economies. The inclusion of environmental and climate priorities in the EU's policies and the increase in their scope, including at the global level, was triggered by the implementation of the European Green Deal (EGD). The EGD will have an impact on the climate policy of the Eastern Partnership countries, such as Georgia, Moldova, Ukraine, Armenia, and Azerbaijan (Tsebenko et al., 2023). It is worth noting that Azerbaijan is particularly interested in the EU's experiences relating to the legislative process in the area of environmental protection. At present, Azerbaijan is facing environmental challenges associated with farmland degradation, management of solid and hazardous waste, and decrease in biodiversity. Azerbaijan is rich in oil and natural gas resources, which is why soil pollution with oil and oil products is a relevant issue (Bayramli, 2020; Umudov, 2021).

Therefore, the aim of this study was to analyze the legislative process and the implementation of the environmental law in the EU as one of the essential tools to achieve and maintain environmental security

at the global level. The problems associated with the environmental policy and legal regulations in Azerbaijan were considered in the context of the EU's experiences. The research objectives were to:

- 1) analyze the evolution of the European Community's general environmental policy and describe the main stages of the legislative process;
- 2) analyze the key principles of the EU's environmental law and the main goals and objectives of the EU's environmental policy;
- 3) analyze the EU's environmental regulatory framework.

The study was undertaken to determine how the priorities of the EU's foreign and internal policy are reflected in the legislative process in the area of environmental protection. The problems associated with law enforcement and the implementation of EU legislative acts in national legislation were also examined, and the current state and prospects for policy-making in the area of environmental protection were assessed.

LITERATURE REVIEW

Many research studies examining the European Community's environmental law focus on public policies leading to the acceptance (or non-acceptance) of the EU policy or its practical implementation (or non-implementation). These studies highlight a significant gap in the existing research (Börzel & Buzogány, 2019). The existing studies focus on issues such as the adaptation of environmental legislation within the EU (Rehbinder & Stewart, 2017), the role of environmental principles in the EU's environmental policy (Macrory & Thornton, 2017), the environmental responsibility of the EU Member States and candidate countries (Palevic et al., 2019), the role of criminal law in ensuring environmental protection (Karpuntsov & Veresha, 2022; Kazić, 2018; Veresha, 2016), qualification and jurisdiction applicable to environmental crimes (Vinogradova, 2017), compliance with the EU's environmental legislation (Bondarouk & Mastenbroek, 2017; Hedemann-Robinson, 2015),

the role of criminal law instruments (Alua et al., 2023), the implementation of the European Green Deal in the Eastern Partnership countries (Tsebenko et al., 2023), compliance with the EU's environmental law (Börzel & Buzogány, 2019), and the theoretical and methodological underpinnings of environmental policy research (Leipold et al., 2019). Environmental populism has attracted significant research interest in recent years. In politics, the environmental theme is usually exploited for commercial interests, and environmental populism is unlikely to garner support for political forces (Buzogány & Mohamad-Klotzbach, 2022; Gorbachev, 2021). At the same time, the EU's environmental policy has never been analyzed holistically from a comparative or a foreign policy perspective, in view of the existing environmental initiatives.

The objectives of the EU environmental policy are to preserve, protect, and improve the quality of the environment; protect human health; ensure reasonable and rational use of natural resources; and promote action at the international level to address regional or global environmental issues and, in particular, combat climate change (Kalimo et al., 2012). Given that these objectives are broadly defined, it is almost impossible to clearly define the boundaries of the EU's environmental policy. The EU needs enough flexibility to adapt its ecological policy to new developments and emerging environmental issues and, as a rule, to ensure that this provision is interpreted without restrictions (Vogler, 2011). Furthermore, it can be said that this provision allows for measures that directly or indirectly lead to environmental improvements, such as conservation and restoration measures, as well as repressive, precautionary, preventive, and highly procedural conservation methods (Davies, 2017).

The EU's environmental law addresses issues that are pertinent to the implementation of its policy and environmental regulations (Kelemen, 2010). The objectives of the European Community's policy in the area of environmental protection are enshrined in the Treaty establishing the European Community, and the following groups of issues regulated at the EU level can be distinguished:

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- the state of the environment;
- public health;
- natural resources;
- international environmental issues on a regional and global scale (Vogler & Stephan, 2007).

This classification was introduced after the adoption of the Single European Act. The areas addressed by legal regulations were determined by the action programs initiated by the European Communities, as well as the introduced directives, regulations, and other documents. The sources of European environmental law are an external manifestation of the legal norms that are observed in the EU and regulate public relations in environmental protection (Krämer, 2012).

In addition, the sources of European environmental law include primary law, secondary law, legal precedents, international treaties, and the so-called tertiary or supplementary law (Jans & Vedder, 2012). All sources of European law belong to a hierarchical system, where primary law has the highest legal authority (Okereke & Ehresman, 2015).

The current environmental crisis has been brought on by gradual changes in climate and the Earth's atmosphere, air pollution and acid precipitation, desertification, destruction of the ozone layer, radioactive contamination of certain territories, pollution of oceans with heavy metals, complex organic compounds, oil products, and radioactive substances, increasing carbon dioxide levels in water bodies, decrease in biological diversity, deterioration of the living environment, and depletion of natural resources (Hildebrand, 2014). These phenomena pose a high risk for humanity because they can lead to irreversible environmental changes and, as a result, make the Earth uninhabitable (Lee, 2014).

The international community is aware of the need for joint action and collaborative activities in the area of environmental security in the face of resource depletion and the growing demand for natural resources (Jordan & Adelle, 2012). Integrated measures that introduce various programs and search for solutions to improve environmental security at the global level play an important role in this context (Marín Durán & Morgera, 2012). International cooperation is the most important mechanism that reflects the global nature of the existing environmental challenges and plays an indispensable role in preventing environmental degradation. This approach emphasizes the need to involve the largest possible number of countries in international legal cooperation to increase the effectiveness of the international community's efforts in combating environmental challenges.

MATERIALS AND METHODS

In the present study, seven environmental action programs implemented by the European Community were the main sources of information about the EU's environmental law. These programs have played a very important role in the process of formulating the EU's environmental law. The following documents were also examined in the study: the Single European Act (SEA) of 1986, the Maastricht Treaty on the European Union of 1992 (TEU), the Treaty of Amsterdam of 1997, and the Treaty of Lisbon of 2007, which became fundamental in the field of environmental standards.

The EU's environmental policy and laws were analyzed to examine the interdependence of the components of the environmental regulatory framework, the systematization of the European Community's ecological standards, and the mechanisms underpinning laws that establish liability for environmental damage. This approach was applied to analyze legal regulations and political initiatives relating to legal relations and challenges in the area of environmental protection. Within the framework of this paper, special emphasis was placed on political instruments and legal regulation that could be applied outside the EU.

The evolution of environmental policies in the EU countries was compared with the use of a retrospective comparison method to trace the main changes in the EU's environmental law from its establishment to the present day. In addition, to understand the legal challenges in environmental protection, a systemic and structural analysis of economic processes and phenomena was conducted, and the criteria, policy

factors, and administrative and legal regulations applicable to environmental protection in Europe were systematized. This study aimed to determine the development patterns of the European Community's environmental law, and to identify the main problems and solutions. To provide detailed answers to the formulated research questions, the authors relied on major findings in the environmental and ecological sciences and analyzed the impact of environmental restrictions on the European economy. The issues related to the development of a criminal law subsystem in the EU's environmental regulatory framework were among the unresolved problems in the research. To address this problem, the environmental protection law should be examined jointly with criminal law methods and in the context of the jurisprudence of the European Court of Justice and the courts of the EU Member States.

RESULTS

The role of supranational regulation and policy documents in the area of environmental protection within the framework of the EU's general environmental priorities

The environmental policy, programs, and strategic action plans constitute the attributes of systemic environmental management. The above also refers to the results of strategic ecological planning as one of the main functions of systemic environmental management. In the context of rapid globalization and integration at both the national and supranational levels, the international aspect of environmental policy comes to the fore, and it underpins the economic, environmental, social, and ethical activities of geopolitical actors which aim to change the existing trends or maintain the status quo in the natural environment in terms of developing international relations (Christoff & Eckersley, 2013).

Since its implementation, the EU's environmental law has responded to developments at the international level, either through parallel events unfolding at the

domestic level or through the EU's participation in negotiations and the adoption of major international conventions and multilateral agreements. However, the international and external aspects of environmental policy have been fully integrated in the EU's environmental principles only in the last two decades. While the EU's efforts to assert its international leadership are particularly pronounced in the area of climate change, the external impact of its actions is visible in other areas and various aspects of environmental policy (Van Calster & Reins, 2017).

The EU institutions, including the Council of Europe, the Council of Ministers, the European Commission, the European Parliament, the EU Court of Justice, and the European Environment Agency (EAPO), play an important role in the implementation of the EU's environmental policy and environmental security law. Their main goals and tasks in the area of environmental safety are to provide objective and reliable information, to implement measures to protect the environment, and to inform the public both within and outside the EU (Van Calster & Reins, 2017).

An analysis of the EU Member States' general environmental policies should focus on the EU's environmental regulatory framework which includes the founding treaties, as well as directives and action programs in this area. The main legal acts pertaining to environmental security and environmental protection in the EU include:

- The Treaty of Rome of 1957. Article 36 of the Treaty provided the EU Member States with the right to impose restrictions on imports, exports, and transit in commodity circulation, based on considerations of environmental safety;
- The Single European Act (SEA) of 1986 which sought to revise the provisions of the Treaty of Rome relating to environmental protection;
- The Maastricht Treaty on the EU of 1992 which secured the environmental goals of the organization by promoting regional and global environmental measures in the international arena. Three environmental declarations were annexed to the Maastricht Treaty (Industrial Emissions Directive, Directive on environmental impact assessment, and the Directive on the protection of animals);

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- the Treaty of Amsterdam of 1997 which introduced the duty to integrate environmental protection into all EU sectoral policies;
- the Treaty of Lisbon of 2007 which defined the fundamental objectives of the EU's environmental policy, including the preservation, protection, and improvement of the quality of the environment; protection of human health; prudent and rational use of natural resources; solving regional and global environmental problems; and combating climate change.

The Treaty of Lisbon entered into force on December 1, 2009, and it consists of two treaties: the Treaty on the European Union (TEU) and the Treaty on the Functioning of the European Union (TFEU). A joint decision becomes a regular legislative procedure. Article 194 of the TFEU introduces responsibility for energy which must be exercised considering the environment, the internal market, and solidarity among the Member States. The only change in the provisions relating to environmental protection involved a minor amendment in paragraph 1 of Article 191 of the TFEU. This provision states that the EU can promote measures at the international level to address regional or global environmental problems. In addition, the Treaty of Lisbon stipulates that such actions may, in particular, relate to climate change. Although the EU Charter of Fundamental Rights is only annexed to the Treaty, Article 6 of the TEU states that this document has full and binding legal force. The EU Charter introduces a high level of environmental protection and improvement which must be achieved in line with the principles of integration of environmental policies and sustainable development (Article 37 of the EU Charter).

The Treaty of Lisbon defines the EU's competence (Article 4.2 of the TFEU) and provides the EU and the Member States with general powers concerning environmental protection issues. The EU institutions must apply the principle of subsidiarity established in the Protocol on the Application of the Principles of Subsidiarity and Proportionality and embodied in the Treaty of Lisbon. National parliaments undertake to enforce the principle of subsidiarity in keeping with the procedure laid down in this Protocol. The positive and negative aspects of the principle of subsidiarity have stirred considerable debate in the EU expert community. Some researchers regard it as a threat to the sovereignty of nation states which weakens supranational power and generally runs counter to the European integration process. Others see it as a cornerstone of the EU's legal architecture, a functional principle for exercising regulatory powers at the most appropriate level of governance that the EU provides, and a valuable method for establishing an effective, yet flexible balance of power between the EU and its Member States (Pimenova, 2019).

Since 1973, European environmental measures have been based on action programs that were initially adopted every five years, and then every decade. After a blocking period, the 7th Environment Action Program (referred to as 7EAP) was finally approved in November 2013. The program was continued until 2020, and it set the environmental priorities for European political leaders during the economic crisis. However, the Treaty of Lisbon brought some changes that could be crucial in the long run. The main provisions of the EU Environment Action Programs are listed in Table 1.

Considering the responsibility for environmental offenses in the context of criminal law, it should be noted that political documents did not focus on this issue. In particular, 7EAP failed to address environmental crime explicitly, and it did not lead to the criminalization of acts that may harm the environment. However, 7EAP maximized the benefits of the EU's environmental legislation by improving its implementation as a priority objective. Therefore, the implementation of EU environmental legislation at the level of Member States will probably receive priority in the coming years. It is worth noting that the EU's Eighth Environment Action Program up to 2030 (8EAP), adopted in March 2022, remains in force today. The 8EAP aimed to accelerate the transition to a green environment fairly and inclusively with a long-term goal until 2050, as part of the "Living well, within planetary boundaries" slogan of the 7EAP. In July 2022, the European Commission adopted

Table 1. Characteristics of the EU environment action programs

Program	Characteristics
The First Environment Action Program, 1973–1976	 Coordinated the environmental activities of the Community in international organizations Council Directive 75/442/EEC on waste, Council Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States, and Council Directive 76/160/EEC concerning the quality of bathing water were adopted within its framework
The Second European Community Action Program entitled "Continuation and implementation of a European Community policy and action program on the environment", 1977–1980	 Introduced environmental research programs: Science and Technology for Environmental Protection (STEP) and the European Program on Climatology and Natural Hazards (EPOCH)
The Third European Community Action Program entitled "Continuation and implementation of a European Community policy and action program on the environment", 1981–1986	 Introduced new provisions concerning four aspects of Community environmental policy (need for further integration of environmental policy into other Community sectoral policies, need to strengthen the preventive aspects of environmental policy)
The Fourth Environment Action Program, 1987–1992	 Focused on areas such as the development of environmental standards; broad public access to information and dissemination of environmental information; efficient and comprehensive application of the existing legislation; management of all types of environmental impact; environmental education; protection of specific natural and urban areas; and creation of new jobs
The Fifth Environment Action Program for sustainable development entitled "Towards sustainability", 1993–2000	 Development of market tools, financial support mechanisms, and horizontal instruments, including statistical data, scientific research, and technological development Emphasized the significant role of non-governmental organizations in environmental safety
The Sixth Environment Action Program entitled "Environment 2010: Our Future, Our Choice", 2002–2012	 Promoting the integration of environmental interests into all Community policies and the achievement of sustainable development
The Seventh European Community Environment Action Program, 2013	 Implemented under the slogan "Living well, within the limits of our planet." Key issues and challenges: A rapidly changing external environment and the increasingly interconnected nature of environmental, economic, and social issues Increasing demand for natural resources and its consequences for the environment EU enlargement and a more diversified range of national characteristics and circumstances Increasing pressure on ecosystems; loss of biodiversity; and waste management Air quality in urban districts; water quality, environmental health threats, and securing the necessary investments in the environment and climate change policies
The Eighth Environment Action Program until 2030	 Decreasing the EU's material and consumption footprints Strengthening environmentally positive incentives Phasing out environmentally harmful subsidies, in particular fossil fuel subsidies

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a monitoring framework with core indicators for monitoring progress toward EU environmental and climate targets (European Commission, 2022; Lucas, 2018). By 2024, the Commission should conduct a mid-term review of the progress toward the thematic priority of the Program goals. With this document, the EU reaffirms its commitment to the vision of 7EAP by 2050.

It should be noted that the external aspect of environmental policy was reflected in Priority Goal 9 of the 7EAP: to increase the efficiency of the Union in addressing global challenges related to the environment and climate. Following the said goal, the EU expresses its commitment to sustainable development and the goals and targets adopted at the 2012 UN Conference on Sustainable Development in Rio de Janeiro. Moreover, in addition to translating these commitments into action at the local, national, and union levels, the Union will actively participate in international efforts to develop the solutions needed to ensure sustainable development on a global scale. In addition, many priority goals outlined in the 7EAP can only be achieved through a global approach, in cooperation with partner countries, and foreign countries and territories. For this reason, the EU and its Member States should demonstrate the utmost interest and make efforts to participate in relevant international, regional, and bilateral processes. The 8EAP remains broadly committed to the same goals as the previous Program. The document supports the goals of environmental and climate actions envisaged by the European Green Deal. This provides an opportunity for the EU, in general, to reaffirm its commitment to the vision of the 7EAP until 2050 (European Union -Central Asia Water, 2022).

The implementation and effectiveness of the environmental law are still the core issues. The European Commission has identified particular strategies to combine its enforcement powers with an "ex-ante approach" based primarily on preventing violations. Special attention was given to the development of legislation, including various actions and activities aimed at facilitating the dissemination of information, public consultations, and guidelines for public authorities on the specific application of EU environmental standards. Despite difficulties and limitations, the broad scope of the EU's environmental legislation provides a minimum common framework for the Member States. An analysis of recent developments in environmental law and policy at the European level indicates that environmental issues are increasingly incorporated into other policy areas (Aliev & Godzhaev, 2021; Scheuer, 2005).

The environmental regulatory framework in the context of EU political initiatives

The EU's climate change initiatives clearly indicate that an integrated approach towards environmental protection that addresses economic and social issues is more effective than tackling environmental problems in isolation. The inherent interdisciplinary and crosscutting nature of climate change has become a major driving force in the EU's focus on environmental and climate-related aspects of energy, transport, and industrial policies.

The achievement of different - often competing policy goals requires appropriate strategies to ensure coherence across various sectors and initiatives. The consistency and coherence of policies and the effective implementation of the integration principle constitute a significant and largely unresolved issue. Indeed, the Treaty of Lisbon contains numerous references to the principle of coherence as a general concept of European policy and actions implemented domestically and in external relations. Therefore, as regards the relationship between the environment and other policy sectors, coherence can support the integration principle by requiring that environmental aspects are included and considered in the development and improvement of the environmental regulatory framework. The introduction of environmental action programs and the relevant directives, as well as the implementation of various instruments in this regard are among the EU's greatest achievements in the area of environmental protection.

Balancing EU interests with the Member States' autonomy has been a central theme of environmental

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law research (Davies, 2017; Delreux & Happaerts, 2016; Jankuv, 2019). While ecological integration is considered a component of the international principle of sustainable development (Marín Durán & Morgera, 2012), the EU legislation regards such integration as a precursor of sustainable development (Morgera, 2012). Ecological integration is a mechanism for the practical implementation of sustainable development (Beckenbach & Kahlenborn, 2016) and a means of contributing to the achievement of the principle of prevention (Fajardo, 2010). Environmental integration is included in the general principles of the EU law and is formulated in an explicitly binding language. Its rationale lies in the realization that progress in environmental protection is insufficient and may inhibit developments in other areas of law that ignore environmental protection requirements (Jans, 2011).

The development of the EU's environmental law is also interesting in the context of its implementation in the legal systems of the Member States. However, it is conceptualized against the UK's exit from the EU (Vandermeersch, 2017). While the Member States have priority over the method of implementation, almost five decades of EU environmental law have profoundly influenced the substantive and procedural evolution of domestic law in the UK (Wurzel et al., 2013). Critical legislation has been developed on migratory birds, air quality, water and waste management, commercial trade in chemicals, emissions trading, as well as general sectoral policies in agriculture and fishery, which are the cornerstone of supranational and domestic environmental action (Norton, 2011).

The EU's general environmental and climate law, policy, and legal framework are deeply rooted in the environmental legislation of the UK. Furthermore, the process of transposing the entire framework into national law is challenging (Rehbinder & Stewart, 2017). Thus, it is not surprising that the UK, under the previous coalition government, concluded that the balance of competencies should be revised (Macrory & Thornton, 2017). During the negotiations preceding the treaties of Maastricht, Amsterdam, and Nice, several environmental campaigns were launched towards "greening the treaties" (Klöckner, 2015). These attempts addressed the role of environmental issues once the restrictions on the free movement of goods have been agreed upon and justified (Piris, 2010). The main argument was that the EU paid insufficient attention to environmental issues if they were balanced with domestic law considerations (Torsello, 2012). The drafting of the Treaty of Lisbon was a much less open and transparent procedure relative to the conclusion of the Constitutional Treaty.

Although the Treaty of Lisbon retains the procedure of the convention, it was drafted in the traditional intergovernmental manner, while high-level national representatives negotiated in relative obscurity (Hildebrand, 2014). As earlier noted, the Treaty of Lisbon and the Constitutional Treaty primarily deal with the institutional side of the EU and European integration. Substantive issues received far less attention in the agenda (Schmitt & Schulze, 2011). The proposed amendments to the EU's substantive law focus mainly on the so-called general services. The Treaty of Lisbon elaborates on EU Article 16 on a legal basis, although it fails to change the nature of this provision in the political declaration (Jans, 2011). The above led to the Protocol on Services of General Interest which is a primarily political declaration (Lee, 2014). This may mean a rebalancing between environmental protection and the domestic market, given the growing use of market-based instruments for such protection (Rehbinder & Stewart, 2017). However, the EU legislation in its current form is quite capable of balancing environmental concerns satisfactorily with the internal market (von Homeyer, 2009).

The support for European integration plays an important role in the EU's legislative process in the area of environmental protection. However, integration processes do not involve all European countries, and studies examining the influence of these processes on policy making attract criticism from the scientific community (Hedemann-Robinson, 2015; Palevic et al., 2019). At the same time, the success of collaborative efforts undertaken by the EU countries and the experience of cooperation at the supranational level testify to the significant impact of European integration.

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The Treaty establishing the European Community was implemented to address the "southern problem" after Greece, Portugal, and Spain had joined the EC in the 1980s. These countries experienced significant difficulties in complying with EU legislation, in particular, the EU's environmental policy. In this regard, it has been suggested that these problems stem from the shortcomings that divide the Mediterranean countries with regard to their administrative and political systems, the weakness of civil society (Alqodsi, 2021), and low levels of socio-economic development (Börzel & Buzogány, 2019). The subsequent enlargements of the EU gave rise to opinions that Central and Eastern European countries share many of the common symptoms of the "Mediterranean syndrome": inefficient administrations suffering from patronage and corruption, a legacy of authoritarianism, poorly organized public interests, and lower levels of socio-economic development (Börzel & Buzogány, 2019).

Despite the fact that the EU addressed environmental protection at the supranational level and that the acquis communautaire in environmental legislation was adopted into national legal systems, the EU institutions have not yet managed to achieve complete uniformity in the established regime of environmental responsibility or to overcome the difficulties associated with the effective integration of EU legislation and the realities of national legal systems.

It should be noted that the EU's policy in the area of law enforcement does not imply the relevant elements of national legislation must be replaced. The main goal is to create a supranational mechanism that leads to effective implementation of crime prevention laws in the Member States' legal systems (Palevic et al., 2019).

It should also be noted that no EU directive recommends specific punishments for environmental crime. This matter is left to the discretion of each Member State. However, if such a crime is committed by a legal entity, including by individuals who act on own behalf as well as on behalf of that entity, to derive material gain, liability will be borne not only by the individual who derived such gain, but also by the legal entity that perpetuated the crime. In accordance with paragraphs 1 and 2 of Article 6 of Directive 2008/99/EU, a legal entity's responsibility does not preclude the criminal prosecution of natural persons who were perpetrators, instigators or accomplices of the acts provided for in Article 3.4 of the Directive, in particular by imposing sanctions on a legal entity (Hedemann-Robinson, 2015).

In the EU countries, regional and local environmental safety regulations are imposed within the limits set by the central government. The distribution of responsibilities for formulating and implementing environmental policies largely depends on the extent to which political power is centralized or decentralized in general (Davies, 2017). In highly centralized countries, such as France, the national government closely monitors local activities, while in traditionally decentralized countries (such as the Netherlands), local governments are given considerable leeway to adapt national guidelines to local conditions (Morgera, 2012).

An analysis of the EU Member States' experiences in implementing environmental regulations at the regional level indicates that special attention should be paid to the following mechanisms for the development of ecological democracy:

- organizational mechanisms that integrate initiatives, mechanisms, funds, research programs, and information for the conservation and improvement of the natural environment and landscape diversity;
- access to environmental information and public participation in the decision-making on environmental issues;
- administrative mechanisms that integrate the functional and long-term concept of regional planning. This mechanism is not just a set of planning rules, but it defines human rights in the context of regional development and accounts for local limitations and opportunities.

A comparison of the European and the U.S. governments' powers in the process of developing an environmental regulatory framework should consider the available legislative instruments (Duit, 2014). The first legal instrument for environmental policy is the action program which defines broad policy objectives.

Regulations and directives have been applied to implement the environmental policy. A regulation is a more legally binding instrument than a directive, as it is obligatory in its totality and directly applicable in all Member States (Lee, 2014). On the other hand, a directive is only binding with regard to the expected result, and the choice of methods is left to each Member State (Delreux, 2011). Moreover, a directive is binding on the Member States, not individuals.

Directives have been the essential method of implementing environmental laws for several reasons, although regulations have also been used for this purpose (Nachmany et al., 2015). Directives are particularly well suited to environmental policy implementation due to their flexibility. They also have the advantage of giving Member States certain leeway in implementation, which can be critical to achieving compliance with the directives.

The growing number of directives and the resulting burden on the European Community's institutions led to relatively weak monitoring of enforcement, which resulted in further changes in the implementation of Community directives in the Member States (Schmitt & Schulze, 2011). Thus, the federal power to regulate the environment is weakened by the need to transpose measures into national legislation.

Another difference in the legislative competence of the compared systems that unlike in the U.S., the EU's environmental law generally has no direct bearing on individuals. As noted earlier, the directive is the EU's main environmental policy instrument. Article 189(3) of the EC Treaty stipulates that the directive is only binding on the Member States which are obliged to transpose that directive into national law. Meanwhile, the doctrine of direct effect introduced substantial changes by bringing the EU's environmental legislation closer to the U.S. regulatory framework (Holder & Lee, 2007). The doctrine of direct effect, developed by the European Court of Justice, states that if a directive is unconditional and sufficiently precise, and if the time limit for its implementation by a Member State has expired, an individual can directly rely on such directive in a claim against a public authority in a Member

State court (Kulovesi et al., 2011). In addition, in the Francovich v. Italy decision, the European Court of Justice ruled that under certain circumstances, the EU Member States may be liable to pay compensation to individuals who suffered a loss as a result of a Member State's failure to comply with an EU directive (Craig & de Búrca, 2011). These developments greatly expand the scope of directives that meet the necessary criteria, which further strengthens central institutions.

In contrast, the U.S. government has a broader range of legislative strategies by which it can regulate the environment in all 50 states (Jinnah & Morgera, 2013). These strategies can be divided into four categories: federal standards with federal implementation and enforcement; federal standards with state implementation and execution; federal administration of federal lands and resources; and federal requirements or incentives for governments to adopt and enforce environmental protection measures (Capra & Mattei, 2015).

A comparison of the structure of European and U.S. environmental regimes reveals numerous similarities. However, there are at least as many significant differences that contribute to the problems of ecological federalism in each system (Hildebrand, 2014).

The similarities between the compared systems are apparent. The central institutions of the EU and the U.S. enforce environmental laws that differ significantly across regulated areas, making any attempt to establish a rigid central policy undesirable and impossible (Howorth, 2014). Both systems include a central government and robust regional structures resistant to central environmental regulation. These actors have the same environmental, economic, and political advantages and disadvantages of central regulatory bodies in policy development and the adoption of focal legislation (Sands, 2017). However, the strengths and weaknesses of these factors vary widely in each system. Furthermore, the implementation of central policy in both systems should, to a varied degree, depend on the performance of law enforcement agencies in the state (Puder, 2011).

It should be noted that a number of EU political initiatives that create the basis for legal regulation

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have undeservedly remained outside the academic discussion in Azerbaijan. The EU strategy on adaptation to climate change is one of such initiatives (European Commission, 2023a). This strategy was developed to help the EU countries adapt to the impacts of climate change. This document could be useful for studying and implementing the best foreign practices if Azerbaijan had an interest in developing its own climate change adaptation strategy. Although Azerbaijan can study European environmental policies to create its own policies for nature conservation and sustainable use of resources, work in this direction is very limited and requires significant expert support. Currently, Azerbaijan does not have strategic documents relating to environmental issues and combating climate change. A strategic approach to environmental policy-making in Azerbaijan is needed because it would integrate environmental protection into a broader national strategy to achieve sustainable development and ensure the long-term well-being of the country.

The issue of modernizing environmental legislation and adapting to modern challenges is of particular relevance for Azerbaijan. Since the 1870s, the expansion of oil exploration in Baku and the surrounding areas led to industrial pollution, which intensified in some areas in subsequent periods. Excessive fertilizer and pesticide use in cotton fields and the lack of proper irrigation also significantly contribute to environmental pollution (Bayramli, 2020). At the same time, environmental protection is not a political priority on the domestic agenda, which has been indirectly confirmed by national research (Umudov, 2021), direct analyses of the regulatory framework, and reviews of policy initiatives. The last international assessment of the prospects for environmental policy and its implementation in Azerbaijan was carried out in 2011 during the 2nd UNECE Environmental Performance Review. The UNECE report clearly stated that Azerbaijan should update its environmental policy. In particular, the report noted that economic goals were prioritized over environmental objectives, which is typical of most former Soviet bloc countries in the region. The report recognized that the country faced

a major challenge in mainstreaming environmental considerations into sectoral policies. The main challenge would be to mitigate the negative environmental impacts of economic sectors that significantly influence the environment, including the oil and gas industry (United Nations Economic Commission for Europe, 2011). Since then, several environmental protection initiatives have been introduced at the state level, in particular the State Program on the Use of Alternative and Renewable Energy Sources in the Republic of Azerbaijan, and the Action Program for Radon Risk Study and Reduction in the Republic of Azerbaijan in 2014–2018. In 2012, the "Azerbaijan 2020: A Look into the Future Development Concept" was adopted as a multisectoral policy document addressing political priorities in the field of environmental protection (Asadova, 2018). At the same time, the adoption of the document and the implementation of its goals were not accompanied by significant reforms in environmental legislation. At present, there are no strategic documents or programs defining long- or medium-term environmental goals.

While the EU is generally considered to have one of the most stringent and ambitious environmental policies in the world, there are a number of challenges to its implementation and effectiveness (Börzel & Buzogány, 2019). Insufficient funding is one of the key issues. This is not a purely legal factor, but it always undermined the achievement of political goals. Ultimately, insufficient funding for the implementation of environmental policies can lead to limited success in achieving the goals (Kettner & Kletzan-Slamanig, 2020). The failure to observe environmental laws is also a noteworthy problem. Not all Member States strictly enforce laws related to the protection of nature and biodiversity. In some cases, this is due to the lobbying influence of certain sectors of the economy (Bergkamp, 2021).

Inconsistent internal rules (policies) and insufficient coordination between the states (Morgera, 2012) also decrease the effectiveness of European environmental policy. In some cases, EU policies may come into conflict with each other, which hinders

the implementation of environmental regulations. For example, environmental protection policies may conflict with industrial development policies (Baker, 2012). Nature "does not recognize borders", therefore nature protection requires cooperation between states. However, effective coordination is not always possible, which obstructs the implementation of environmental protection measures. According to some researchers, climate justice issues are not duly addressed: the EU's environmental policy does not always take into account the interests of the most vulnerable groups who are affected by climate change and environmental problems (Pasetto et al., 2019). The lack of public support is also a considerable problem. Nature conservation requires broad public support which is often lacking, which could compromise the effectiveness of the environmental policy (Rousseau & Deschacht, 2020). In conclusion, the EU's environmental policy does not always readily adapt to rapidly changing conditions. The existing approaches and strategies should be modified to address climate change, the spread of invasive species, and other threats (Morgera, 2012). However, despite these challenges, the EU's environmental policy remains one of the most ambitious in the world and continues to attract attention and support from the international community.

CONCLUSIONS

Summing up, despite a threefold increase in the number of the EU Member States over the past two decades, the gap in the implementation of the EU's environmental policy has decreased. The practice of applying environmental legislation shows that there is no serious conflict between deepening and expanding the implementation of environmental regulations in the EU countries, at least when it comes to compliance with common European standards. In addition, this positive effect is due to the fact that compliance primarily depends on administrative capacity, and not on political will. The EU's environmental law has become a testing ground for the principles and innovative methods

of regulation. Although the EU continues to apply internal and external legislative measures to support and improve the implementation of international environmental law, these complex strategies have not yet yielded positive results.

The environmental protection and ecological safety system (organizational structure, forms, methods, tools, and mechanisms) should be reformed consistently in observance of the administrative-territorial structure, interbudgetary relations, and the legal framework for the implementation of the basic requirements of EU environmental law into the relevant legislation of individual countries. Environmental requirements are included in the program documents of all European and national political parties. The EU's environmental policy and regulations can serve as a reliable example for Azerbaijan, where the environmental agenda is still neglected. In pa ticular, this applies to both strategic planning and regulatory and law enforcement practices. The strategic approach in planning long-term environmental measures implemented by the EU can be used by countries in transition (in particular Azerbaijan) to develop their own political and legal documents in the area of environmental protection. A number of documented political initiatives (Action Programs), strategic documents (such as the EU Biodiversity Strategy) can help Azerbaijan develop its own policy and legislative regulation in the area of environmental protection and sustainable resource use. The European Community has made the environmental dimension an integral part of its strategies and programs, and it is striving to become the most dynamic community in the world and to achieve this goal without harming the environment or preventing future generations from meeting their needs. The EU continues to improve its environmental regulatory framework. Finally, the EU has acquired significant experience in democratizing environmental safety regulations by introducing various legal instruments, forms, methods, and organizational structures to control the ecological safety of the region. At the same time, the results of the study indicate that despite considerable attention to environmental protection

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at the supranational level and the implementation of the EU's environmental legislation into national legislative norms, the EU's governing bodies and institutions have not been able to fully achieve uniformity in relation to the established regime of environmental liability or to overcome the difficulties associated with the effective integration of EU legislation and the obstacles resulting from the specificity of national legal systems. Environmental legislation is a product and the main form of securing the national environmental policy. Therefore, the environmental policy should be urgently improved by adopting new laws that meet the existing challenges.

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DETERMINING THE ROLE OF ECO-TOURISM SERVICE QUALITY, TOURIST SATISFACTION, AND DESTINATION LOYALTY: A CASE STUDY OF KUAKATA BEACH

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ABSTRACT

The impact of eco-tourism service quality (ETSQ) and destination loyalty on beach tourism, particularly Kuakata Beach in Bangladesh, was examined. The present study builds upon the initial research on ETSQ to assess tourist satisfaction and destination loyalty at Kuakata Beach. Data for the analysis were obtained from 284 tourists who visited Kuakata Beach. The obtained data were processed with the use of SPSS 26 and smartPLS 3. The study demonstrated that ETSQ is significantly linked with tourist satisfaction and destination loyalty. The findings revealed a robust relationship between ETSQ, tourist satisfaction, and commitment to a specific destination. The study has practical implications for eco-tourism promotion by the government, semi-governmental, and non-governmental organizations in Kuakata, other tourist attractions in Bangladesh, and tour operators who could design ETSQ to provide tourist satisfaction tools and recommend tourist destinations.

Keywords: tourism, eco-tourism, eco-tourism service quality, destination loyalty, tourist satisfaction

INTRODUCTION

Kuakata sea beach is renowned nationally and internationally as the ocean's daughter (Rahman et al., 2015). It contributes significantly to Bangladesh's tradition, culture, history, society, economics, and environment (Ahammad et al., 2023). This beach is visited by approximately five million tourists annually, which might reach 13 million by 2023 (Karim, 2022). Before the Padma Bridge, Dhaka was 350 kilometers away; today, it is 294 kilometers. The southernmost tip of Bangladesh is home to the stunningly beautiful

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Kuakata, also known as Sagar Kannya (Daughter of the Sea), by the locals. About 30 kilometers in length and 6 kilometers in width, Kuakata is in the Latachapli union and is policed by the Kalapara Police Station in the Patuakhali district. Dhaka and the Patuakhali district are both reachable by road and ship. Barisal can be reached by road, water, or air. From there, a road trip or a boat ride to Kuakata or Patuakhali. The Bangladesh Road and Transport Corporation (BRTC) now offers a direct bus route between Dhaka and Kuakata, bypassing the city of Barisal. In addition, guided package tours from Dhaka to Kuakata can be arranged upon request by the Bangladesh Parjatan Corporation, National Tourism Organization. Kuakata is one of the rare places where the crimson sun rises and sets over the Bay of Bengal without disturbing the quiet. For this reason, Kuakata could be considered one of the world's most unique beaches. Kuakata's expansive beach is set in a picturesque, natural setting. The sand beach gently dips into the Bay of Bengal, making for an enjoyable bathing experience that also lends itself to strolls and scuba dives.

Kuakata is a proper, untouched stretch of sand in Blue Bay that serves as a sanctuary for migrating birds during the winter. The forest, the colorful sails of boats roaming the Bay of Bengal, the fishing, the cliffs, and the waves all leave an indelible impression on every tourist here. Sources of great delight are the long-standing customs and cultural past revealed by the traditions and apparel of the "Rakhyne" tribal family and the approximately one-hundred-year-old Buddhist temple. Kuakata is a sacred location for the local Hindu and Buddhist communities. Many believers flock here for the annual "Rush Purnima" and "Maghi Purnima" celebrations. People partake in a holy bath on these two days, and festivals based on local traditions are organized. The beach is more appealing to visitors due to these enhancements to the area's overall appeal. Government campaigns, cultural celebrations, and other events can boost annual tourist numbers.

As is common knowledge, the tourist business in the globe today creates services, goods, foreign money, jobs, and investments (Dwyer, 2022; Talukder, 2020a). Eco-tourism can become essential for sustainable tourism development if local communities are educated, trained, and motivated to adopt ETSQ as an alternative and additional activity that facilitates and promotes environmental conservation via its service quality (Talukder et al., 2023). Most research on ETSQ has used the SERVQUAL or SERFPERF instrument created for the eco-tourism sector (Ban & Guruge, 2021). However, few research concentrates on ETSQ and its implications on the comfort and loyalty of beach visitors in Bangladesh (Sahabuddin et al., 2021). These studies are primarily based on the SERVQUAL model or it is modified and expanded version, the ECOSERV model.

In addition, most past research on eco-tourism has focused on its influence on the natural environment, the regional economy, and the quality of community life, as well as the driving forces and expertise of eco-tourists and the exploration of eco-tourism segmentation. Most field studies have used ECOSERV, which has emerged as an essential evaluation method for ETSQ characteristics (Aksu et al., 2022). SERVQUAL and ECOSERV models propose destination loyalty based on an implied relationship between service quality parameters and tourist satisfaction (Preziosi et al., 2022). This indicates that enjoyment is proportional to the performance of service dimensions and that tourists have a high degree of satisfaction (Talukder & Bhuiyan, 2021); hence, a destination is a recommended location where all service dimensions are well met. To gather information that would be valuable to future researchers for additional research, the researchers review a thorough investigation of the consequences of ETSQ on beach tourist satisfaction and destination loyalty on Kuakata Beach in Bangladesh. Based on service quality models like SERVQUAL or ECOSERV, it may also build the most efficient method for investigating the associations between service excellence and characteristics and customer satisfaction (Shapoval et al., 2018).

LITERATURE REVIEW

Eco-Tourism

There is no specific explanation for eco-tourism in scholarly writings. Combining ecology with tourism creates the literary word eco-tourism, which refers to ecologically responsible travel (Goodwin, 1996). It entails going to places not overrun by people or industry to take in the historical and contemporary landscapes with awe and wonder (Iskakova et al., 2021). Sustainable development and economically disadvantaged communities are two of the primary beneficiaries of eco-tourism (Rahman et al., 2022), which places a premium on the conservation of natural resources at eco-tourism sites and the environmental literacy of its tourists. This study expands upon the original concept of eco-tourism (Alauddin et al., 2021) by including eco-tourism incentives for natural, cultural, discoverable, daring, and responsible experiences. Most tourism management researchers agree with (Khan et al., 2022, pp. 109-124) that eco-tourism is "purposeful time spent in the environment to interact with nature, learn about and perceive other cultures, and economically support local communities that work toward the preservation of the ecosystem." There may be a direct clash between the urge to exploit the rising tourist business and the needs of financially bankrupt communities in developing nations where eco-tourism has substantial practical significance (Ramaano, 2022). It seeks to create a successful and sustainable tourist industry

while reducing the environmental impact of all these operations (Mair & Smith, 2022). The eco-tourism structure is shown in Figure 1.

ECO-TOURISM SERVICE QUALITY

ECOSERV evaluates eco-tourism service quality depending on the eco-tourist experience, which includes six experiential dimensions. Eco-tourism is defined as eco-tourist activities such as motivations for natural, adventurous, cultural, soft, discoverable, and responsible tourism activities and experiences (Rezaeinejad & Khaniwadekar, 2021). In the prior research, the quality of customer service in the tourist industry was evaluated using SERVQUAL, SERVPERF, LODGSERV, RECQUAL, DINESERV, HOLSAT, HOLSERV, ECOSERV, IPA, SERICSAT, RENTQUAL, RESERVE, and ECOPERF. The SERVPERF model was established to explain the change made to the SERVQUAL scale (Akdere et al., 2020). They redesigned the SERVQUAL measures by removing any elements based on predefined expectations and concentrating instead on the aspects of service quality solely based on performance (Ban & Guruge, 2021). In addition to the five characteristics of SERVQUAL, which are dependability, responsiveness, assurance, empathy, and tangibles, an additional component called eco-tangibles is included (i.e., Accommodation service, food service, and transport facilities related to the environment). This study has new tourism service attributes to eco-tangible (Aseres & Sira, 2020) to gain a more comprehensive view of ETSQ, such as beach



Fig. 1. The structure of eco-tourism *Source*: own preparation based on Eagles & Higgins (1998).

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tourist contentment and geographic commitment. Considering the limitations of ECOSERV, the authors of this study made these additions. According to the findings of Shafiq et al. (2019), the elements that offered tourists the highest level of satisfaction were the staff's eagerness to assist, their promptness, their attention, and their ability to make the tourist feel better overall (Perovic et al., 2018). According to findings from earlier research on the quality of eco-tourism services, tourists reported feeling more content when they met other individuals who shared their interests. In conclusion, empirical data demonstrating the connection between eco-tourism quality, inferences on customer happiness, and continued destination loyalty were offered (Sahabuddin et al., 2021). In addition, researchers presented a chronological order of the

Table 1. Tourism industry's service competence

	I I I I I I I I I I I I I I I I I I I	
Author	Overview	Method
Knutson et al. (1990)	Describes how hotel customers feel about their stay	LODGSERV
Crompton & MacKay (1991)	The general leisure industry uses RECQUAL	RECQUAL
Fick & Brent Ritchie (1991)	SERVQUAL is used in the tourism industry. Having the ability to make it easier to compare multiple service segments	SERVQUAL
Knutson et al. (1996), Talukder et al. (2023)	Measures the quality of service in quick-service restaurants	DINESERV
Tribe & Snaith (1998)	Gain knowledge about holiday satisfaction	HOLSAT
Wong et al. (1999)	SERVQUAL adds three more ways to gauge the level of service	HOLSERV
Cunningham et al. (2002)	The Republic of Korea and the United States compare aviation service dependability and risk	SERVPERF
Dean et al. (2002)	Using the SERVQUAL metric to assess the service level at a tourist attraction	SERVQUAL
Khan (2003)	Using SERVQUAL as a way to measure service quality expectations at eco-tourism destinations	ECOSERV
(Fedman et al., 2023)	Getting a sense of what nature-loving travelers to Cheju Island in the Republic of Korea want in terms of service quality	ECOSERV
Hudson et al. (2004)	Both combination scales—IPA, SERVQUAL, and SERVPERF – are good in tourism	IPA, SERVQUAL & SERVPERF
Hudson et al. (2004)	Controlling the procedure and the result of excellence in hospitality operations	SERVPERF
Nadiri & Hussain (2005)	Getting a sense of how good the service is in hotels in North Cyprus	SERVPERF
George et al. (2007)	Evaluate how delighted customers are with service recovery	SERICSAT
Ramsaran-Fowdar (2007)	Check the SERVQUAL scale, but the hotel industry in Mauritius needs more ways to measure service quality	SERVQUAL
Ekiz et al. (2009)	Car rental services	RENTQUAL
Said et al. (2013)	In the Niah National Park in Sarawak, Malaysia, there were disparities in the quality of service that existed within what people thought and what they expected	ECOSERV
Su et al. (2015)	Using the SERVQUAL scale to measure the quality of service at a tourist destination	SERVQUAL
Oh & Kim (2017)	Scholars have paid much interest to this model in hospitality and tourism	SERVQUAL
Aseres & Sira (2020)	Utilize a new iteration of the ECOSERV model in an eco-tourism setting	ECOSERV
Ban & Guruge (2021)	Measures of eco-service quality as a means of forecasting eco-tourism customers' levels of satisfaction	ECOPERF
Tissera & De Silva (2021)	Satisfaction of eco-travelers staving at eco-hotels	ECOSERV

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level service approaches in tourism, as indicated by the prior study literature. Table 1 describes many approaches to assessing service quality. Researchers have used it in the past in the tourist and hospitality business.

TOURIST SATISFACTION

According to the research, tourist satisfaction results from tourists' evaluations and comparisons of how well products and services met their expectations (Mohammad et al., 2023). When the actual outcome exceeds what was anticipated, vacationers are happy. Tourists are unsatisfied when their expectations are higher than the level of service they receive (Anabila et al., 2021). Because it influences the decision-making process of a beach resort, tourist satisfaction is crucial to beach destination promotion. Tourist satisfaction can be measured by comparing what tourists expected from a destination and how they felt about it. Understanding tourist satisfaction is essential for judging the standard of goods and services offered at seaside locations (Sahabuddin et al., 2021). So, destination officials need to track how satisfied tourists are so they can get feedback and find the exact problems that make tourists dissatisfied, which could affect their next trip (Kumar et al., 2020). So, knowing the role of tourist satisfaction with kuakata, the standard of commodities and facilities offered by beach resorts improve tourist beach trips and develop a good marketing plan for a goal that will satisfy tourists and keep them coming back.

DESTINATION LOYALTY

In travel writing, "destination loyalty" means that tourists return to the same place and tell their friends and family about it (Sangpikul, 2018). Tourism researchers have looked into the idea of "destination loyalty" for a long time to find ways to get more people to visit destinations (Lv & McCabe, 2020). So, destination loyalty is essential in improving a goal's competitive advantages and an effective marketing strategy (Liat et al., 2020). Tourists' satisfaction with a place can be used to measure their loyalty to that place (Cossío-Silva et al., 2019). Tourists who have a pleasant experience are much more inclined to suggest a location to their close companions and come again. From these two measures, Sangpikul (2018) says that repeat visits strongly indicate future behavior. Destination loyalty is essential in eco-tourism because it affects tourist excitement and time spent, the destination's reputation, the scenery, and the place's climate (Baek et al., 2021; Slathia & Chauhan, 2022). This makes tourists return and encourages them to visit destinations and the areas around them by word of mouth (Ahmed Kamel, 2021). However, getting tourists to return is one of the hardest things to do, especially for shore sea destinations (Wang et al., 2021). Understanding what keeps people returning to a beach destination will aid developers of eco-tourism and make it more competitive (Amissah et al., 2022).

FACTORS INFLUENCING ECO-TOURISM SERVICE QUALITY, TOURIST SATISFACTION, AND DESTINATION LOYALTY

Based on the analysis conducted on the issue, several factors affect the quality of eco-tourism services at Kuakata Beach, tourists' satisfaction, and their loyalty to the area (Hasan, 2014). Attributes that heavily influenced destination loyalty also included tourist satisfaction with the place (Sangpikul, 2018). In the case of Kuakata sea beach, it was found that the quality of eco-tourism service is associated with tourist satisfaction and loyalty to a place (Kalam & Hossen, 2018). The current research demonstrated that destination loyalty and satisfaction are essential, independent factors that affect the quality of ecotourism services at Kuakata sea beach. The study of the Kukata area found that the quality of eco-tourism services significantly affects how satisfied tourists are, affecting how loyal they are to a place (Karim, 2018).

The research also found that tourists' satisfaction is a critical factor that affects how likely they are to recommend and return to a destination (Ramesh & Jaunky, 2021). The researchers looked at the

relationships and differences between the effects of ETSQ (Yoon & Cha, 2020) on security, timely service, willingness to help, personal attention, appropriate facilities, environmental safety, clean beach, better feeling, facilities of transportation, accommodation, food & beverage service, and keeping hygiene in all areas of the kuakata sea beach. It was found that the tourists differed from the locals in what they expected, how satisfied they were, and how loyal they were to the destination (Deng & Pierskalla, 2011). The study also showed that the value that is believed to be present at a destination affects the loyalty of first-time tourists and those who have been there before (Sangpikul, 2018). Rahman et al. (2021) looked at the effects of ETSQ, ensuring the highest level of tourist satisfaction and beach destination loyalty at Kuakata. They found that choice of destination, enjoyment, satisfaction of needs, attractions, expectations, money and time, friendly equipment, and washrooms near the sea directly and indirectly affected destination loyalty. Studies have shown several things that affect tourists' happiness with a place. These include how exciting the place is, how much time tourists spend there, its reputation, scenery, and weather (Lv & McCabe, 2020). The exact characteristics of the tourist experience (Hossain, 2013) that may contribute to better the degree of happiness reported by tourists and assure destination loyalty at beach locations have not been the subject of many studies outside of Kuakata beach attractions. More study is needed to determine how these explanatory factors influence the relationships between the three variables and kuakata beach tourist loyalty (Hasan et al., 2019).

OBJECTIVES

The current research had three objectives:

- 1. To identify the critical factors within eco-tourism service quality and tourist satisfaction.
- 2. To investigate the functions of tourist satisfaction and destination loyalty.
- 3. To find out the connection between eco-tourism service quality and destination loyalty.

HYPOTHESIS

Previous literature has shown that high-quality eco-tourism services have a beneficial effect on tourist satisfaction and repeat visits. It confirmed that the quality of an eco-tourism business's services has a beneficial impact on the satisfaction of its customers. The caliber of eco-tourism offerings in Bangladesh's tourism sector is also hypothesized to impact tourist satisfaction significantly (Zhou et al., 2021). This research examined the factors influencing tourists' decisions to return to Kuakata Beach, such as how well their eco-tourism services were provided. Pictured in Figure 2 is an example of the suggested model.

Based on the literature, we hypothesized the following:

- H1: There is a significant relationship exists between ETSQ and tourist satisfaction.
- H2: There is a significant relationship exists between tourist satisfaction and destination loyalty.
- H3: There is a significant relationship between ETSQ and destination loyalty.

RESEARCH METHODOLOGY

Research Philosophy

This study was done in a country in South Asia called kuakata beach in Bangladesh. It is on the Bay of Bengal (Haque et al., 2021). Kuakata is commonly referred to as "the daughter of the ocean," and more and more tourists are coming to see it. Beach areas along the seashore are now the country's most popular places to visit (Rakib et al., 2022). These beaches stand out because they have miles of fine sand, high cliffs, waves that can be surfed, views of the sunrise and sunset, rare conch shells, and tasty food. Eco-tourism has changed these places' social and economic lives in a way that can be seen. The local community and other interested parties seem to have benefited financially and in kind (Thompson, 2022). So, the Kuakata beach area in Bangladesh is chosen as the study area because of its important social and economic roles in the country's tourism industry (Amin, 2021).



Fig. 2. Conceptual model, Dimensions of different variables, and hypothesis diagram

Development of Questionnaire

A preliminary questionnaire was developed for information-gathering purposes. It had measurement items for ETSQ, tourist satisfaction with beach tourism, and destination loyalty. These were empirically validated measurement items based on previous research concepts (Bushra et al., 2021). Since this study was about eco-tourism, academic experts and pilot testing chose and improved many measures under each construct (Hossain & Islam, 2019). During this process, a few things were taken out, and the wording of others was changed to make them fit better with the new context. Then, a final questionnaire was made with clean measures and a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree).

Measurement Items

Twelve items were modified for inclusion in the final survey from Carvache-Franco et al. (2019), Dagustani et al. (2018), Hassan (2021), and Perera et al. (2022) to measure ETSQ. Indicators of visitor experience were modified to eight (Li et al., 2021). Geographical preference was quantified with eight items developed by Li et al. (2021) and Joo et al. (2020).

Data Collection and Sampling Methods

This research gathered empirical data through a survey given by hand. Using a simple sampling method, tourists who went to Kuakata Beach between January 2022 and July 2022 were chosen for the sample population. Before the data collection, each respondent was given a sheet of paper with the study's goals. At first, there were 411 responses. Of 411 questionnaires, 27 were thrown out because essential parts were missing, missing values were over 25%, or the answers were not thoughtful. The remaining 284 questionnaires were used as individual units in the final analysis. We have included the respondent's information about gender, age, education, and monthly income in Table 2. As we collected data during and immediately after the pandemic, we consider taking responses from domestic tourists only.

Table 2. Respondents' traits

Characteristics	n	%		
Gender of the participants				
Female	127	44.7		
Male	157	55.3		
Age o	of the participants			
18-25	143	50.4		
26-35	84	29.6		
36-45	45	15.8		
46 and upper	12	04.2		
Educatio	on of the participan	ts		
Vocational College	32	11.3		
Bachelor's degree	121	42.6		
Postgraduate	130	45.8		
PhD	01	0.4		
Montl	hly income (Taka)			
< 20000	67	23.6		
20000-30000	58	20.4		
30000-40000	125	44.0		
40000-50000	27	9.5		
>50000	7	2.5		
Total	284	100		

RESULTS OF DATA ANALYSIS

Structural Equation Modeling using Partial Least Squares (PLS-SEM) technique was applied using the SmartPLS software version 3.2.9. According to Purwanto and Sudargini (2021), the PLS is an advanced and trustworthy statistical technique for estimating structural models that perform well in challenging circumstances. Two distinct varieties of models exist measurement models and structural models in the PLS-based SEM (Sarstedt et al., 2020). The respondent's demographic profile was examined using SPSS version 26, Statistical Package for Social Sciences.

This section will show and analyze the empirical data based on the theoretical concepts.

Based on the respondent's gender, males comprise 55.3%. With 44.7%, women are in second place. The people between the ages of 18 and 25 have the most people, with 50.4%. With 29.6%, those between the ages of 26 and 35 are the next highest age group. Those between 36 and 45 are in third place with 15.8%, and those over 46 have 4.2%. Most people who answered were postgraduates (45.8%), and individuals with a bachelor's degree (42.6%) were in second place. The respondents with a vocational are the third most numerous demographics, with 11.3% of the total. Those with a PhD get the rest, which is 0.4%. The average monthly income is between Tk 30,000 and Tk 40,000, which is 44.0%.

Reliability Test

Cronbach's alpha was applied to the survey to determine its level of reliability. Table 3 shows the findings of the reliability analyses conducted on the parameters. Since none of the dependability estimates was lower than 0.70, the results indicate the test's reliability is satisfactory. Scale reliabilities varied from fair ($0.7 \le \alpha < 0.9$) to outstanding ($\alpha \ge 0.9$) (Fernandez et al., 2018).

Test Categories	No. of items	Cronbach's Alpha
Eco Tourism Service Quality	12	0.959
Tourist Satisfaction	8	0.947
Destination Loyalty	8	0.948
Total	28	0.940

Assessment of Measurement Model

The measurement model depicts a latent construct's association with pertinent criteria (Al-Emran et al., 2019). When judging the PLS-SEM reflective measurement model, the first thing to consider is how reliable and valid the measures are (Hair et al., 2021). Concerning construct reliability, the measurement model results (Table 4) showed that Cronbach's results were marginally over the desired level of 0.70, and the composite reliability (CR) scores for all items fell within the acceptable range, proving the validity of the items. Additionally, all constructs' CR values were within the capacity of all other constructs (Lee & Kim, 2021). For convergent validity, each reflective indicator's item loadings exceeded the advised 0.70 threshold (Hair et al., 2021). The AVE statistics for each construct vary from 0.693 to 0.736 (Table 4), superior to the proposed threshold of 0.5 (Hair et al., 2021).

Table 4. Measurement model assessment results

Constructs	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Eco-tourism service quality	0.959	0.965	0.964	0.693
Destination loyalty	0.948	0.950	0.956	0.734
Tourist satisfaction	0.948	0.957	0.957	0.736

This means that all of the constructs have adequate convergent validity. Most researchers have used the Fornell–Larcker criterion to check for discriminant validity (Hair et al., 2021). However, newer research has questioned whether the Fornell–Larcker

Table 6. Path coefficient results for hypotheses testing

criterion is an excellent way to find discriminant validity (Radomir & Moisescu, 2019). Muharam et al. (2021) suggested the Heterotrait–Monotrait ratio (HTMT) of the correlations as a solution. This is the ratio of the correlations between traits to the correlations within features.

Hair et al. (2017) the HTMT criterion is the best way to measure discriminant validity in the PLS-SEM (Table 5). All of the HTMT values of latent constructs in Table 5 were between 0.276 and 0.332, less than the 0.90 threshold value (Henseler et al., 2015). So, based on the Heterotrait–Monotrait ratio (HTMT) criterion, the constructs do not have any problems with their ability to distinguish between groups.

Table 5. Outcomes of Heterotrait-Monotrait ratio (HTMT)

Constructs	(1)	(2)	(3)
Eco-tourism service quality	-	-	-
Destination loyalty	0.276	-	-
Tourist satisfaction	0.332	0.276	_

In Table 6, all of the HTMT values of latent constructs were between 0.201 and 0.324, less than the threshold value of 0.90 (Rita et al., 2019). So, based on the Heterotrait–Monotrait ratio (HTMT) criterion, the constructs do not have any problems with their ability to distinguish between groups. The path coefficient will be significant if the T-statistic is more than 1.96 (Yang et al., 2022). So, all the variables have been shown to work by statistics. Even so, we can see that all paths work for the p-value in every way p0.01 (Kusumawati & Saputra, 2022).

No statistically insignificant result for any of the route coefficients indicates that the assumptions are correct. In addition, the PLS Algorithm was used

Tuble 0.1 attreeterne results for hypotheses testing					
Hypothesis path directions	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
Eco-tourism service q ality > Destination loyalty	0.202	0.205	0.061	3.303	0.001
Eco-tourism service quality > Tourist satisfaction	0.324	0.327	0.060	5.400	0.000
Tourist satisfaction > Destination loyalty	0.201	0.204	0.070	2.874	0.004

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* Highlights: Path coefficient P < 0.50, Inner model path coefficient, Outer model outer loadings, Constructs R square **Fig. 3.** Structural model's path coefficient

to compute the effect size of 2, which states that f2 values of 0.041, 0.041, and 0.117, respectively, are modest, medium, or substantial impacts of independent factors on dependent variables. These values were determined based on the PLS Algorithm (Kusumawati & Saputra, 2022). F2 values less than 0.02 are too tiny to be considered, nevertheless. The effect size of ETSQ on tourist satisfaction is shown in Table 7 (f2), and the effect of ETSQ on loyalty to a destination was medium (f2 = 0.117). Moreover, the effect of eco-tourism services' level of quality on how satisfied tourists are with a place is not significant

Table 7. Effect size (f2) results

Constructs	(1)	(2)	(3)
Eco-tourism service quality	-	0.041	0.117
Destination loyalty	-	-	-
Tourist satisfaction	-	0.041	-

enough to keep them coming back. On the other hand, other exogenous variables have a negligible effect on their endogenous variables.

Highlights: Endogenous variable – Eco-tourism service quality, Exogenous variables – Tourist satisfaction and Destination loyalty.

DISCUSSION

Analysis of ETSQ's impacts is the primary goal of this study, tourist satisfaction, and destination loyalty on a particular beach in Kuakata. The study shows the quality of eco-tourism services and how satisfied tourists are affected by how likely they are to return to Kuakata Beach. Giving tourists reasonable assistance can make them more comfortable and more likely to return to a place. Furthermore, in the Kuakata beach tourism context and the study's objectives,

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findings demonstrate that satisfied tourists are strong predictors of destination loyalty. Same as ETSQ, it has a substantial impact on destination loyalty. These results align with what Tasci et al. (2022) found: how spectators felt about the quality of eco-tourism service and how to satisfy tourists were essential predictors of destination loyalty. Also, (Azis et al., 2020) found that tourists' satisfaction greatly affected their commitment to a place. On the other hand, Sangpikul (2018) said that place-based ETSQ significantly affects how loyal people are to a destination.

These results show that how people feel about the quality of eco-tourism services makes them more likely to want to visit the destinations. This makes them feel more confident about returning to the place or telling others to go there (Jin et al., 2020). These findings corroborate the favorable correlation between the two established in earlier studies. One significant impact is that security for tourists is more important than service quality (Mary et al., 2020) when it comes to making people want to go to beach destinations, even though previous research found a link between tourists' attention values and attitudes (Ashraf et al., 2020). Evidence supports the link between service--based perceived expectation value and traveler's perspectives (Vishwakarma et al., 2020), confirming revisit in this study.

In addition, ETSQ significantly influenced vacationers' overall satisfaction in seaside hotspots which accords with the findings of other investigations done before that found a link between ETSQ, satisfaction of visitors and devotion to their location (Kumar et al., 2020). So, these results strengthen the connection between how satisfied tourists are with the quality of service in eco-tourism and how satisfied tourists are with beach tourism. Furthermore, this study demonstrated a substantial direct effect on how loyal people are to the beach as a destination. These findings are consistent with other research, which found that satisfied visitors tend to repeat to a destination. These results support the prior empirical findings in a new context, beach tourism, where travelers' enjoyment is directly linked to their loyalty to a destination (return, recommend).

Even though destination loyalty is one of the main reasons why people go back to the same place (Kumar et al., 2020), there are still questions about how tourists see beaches in developing countries like Bangladesh and how they feel about going there (Hasan et al., 2019a). So, these results show that policymakers should consider creating a positive image and philosophy before making plans to make tourists happier with beach destinations. This study also found that attitudes about security and commitment greatly affected how satisfied tourists were.

CONCLUSIONS AND RESEARCH IMPLICATIONS

The impacts of ETSQ, destination loyalty, and tourist satisfaction were investigated in this research. The study focused on the relationship between these factors. The findings of this research indicate that a tourist's satisfaction level with the eco-tourism services provided by a location and their level of loyalty to that location significantly impact the likelihood that the visitor would revisit that location and suggest it to others. According to the findings, the following beneficial contributions to management techniques have been made because of this research: (1) The outcome of this study indicates that the whole scale employed in the study is trustworthy (Cronbach's Alpha is more than 0.7). It might be used in subsequent investigations; (2) The above factors impact how satisfied vacationers are with the service they receive in Kuakata. In particular, the study found 12 factors that affect how satisfied tourists are: safety, prompt service, willingness to help, personal attention, facilities that fit the environment, making sure facilities are safe for the environment, a clean beach, making tourists feel better, transportation, lodging, food and drink, and cleanliness and sanitation; (3) The current findings have important implications for future research that will help to learn more about the destination loyalty process, focusing on beach tourism destinations in Kuakata.

Theoretical and Practical Implications

The Implication of ETSQ Dimensions

This paper examines how Kuakata beach's service quality is affected by ETSQ and general service dimensions. Sarker (2023) says this study will help determine if ETSQ dimensions alone are an excellent way to measure Kuakata Beach's service quality. This paper examines whether ETSQ dimensions are a perfect way to measure service quality in Kuakata. To learn about this further, tourists staying in various areas of Kuakata were requested to complete a web survey. Most participants indicated willingness to participate in this study's questionnaire. According to Silva et al. (2023), this study's main goal was to develop a short version of the ECOSERV scale, which we did. This study looked at essential parts of ECOSERV (eco tangibles). Based on our results, the ETSQ of ECOSERV alone is an accurate and meaningful way to measure the difference in how satisfied tourists are.

Also, adding the general service dimension does not make the service quality measure much better at predicting the future. Future studies would contemplate using the abbreviation ECOSERV to measure the quality of offerings and services for eco-tourism (Silva et al., 2023). The results give important information about how to judge the quality of offerings and services in the eco-tourism industry, including kuakata beach. Also, our results are vital to understanding how destination loyalty changes over time. We found that the Eco-friendly practice factor scored the highest compared to other factors. This shows that tourists care about and expect good practices for the environment. The results give ecotourism business owners a key marketing direction that will help them bring more tourists to Kuakata (Sarker, 2023). As our data shows, security, prompt service, willingness to help, personal attention, facilities that fit the environment, facilities are safe for the environment, a clean beach, tourists feel comfortable with the services, transportation, lodging, food and drink, and cleanliness and sanitation are all essential.

The Implication of Tourist Satisfaction Dimensions

Eco-tourism products and experiences, on the other hand, are a mix of goods and services (Biju, 2006). So, tourist satisfaction with eco-tourism products, or in this case, beach tourism experiences, is made up of tourist satisfaction (Bimonte, 2023), with the individual dimensions or all of the sizes that make up the experience during the tourist's trip to Kuakata. Over the years, there have been many ways to categorize how satisfied tourists are. Previous research highlighted tourist satisfaction into four main groups (Li & Yang, 2022). Core services are the main products or services that a service provider offers. The results showed the most critical aspects of tourist satisfaction and other factors of destination loyalty (Elbaz et al., 2023). This study also helps business owners working with tourists figure out what requires being fixed and how to take advantage of what tourists like. However, on a more detailed level, these results show eco-tourism hotel managers how eco-initiatives and programs affect how satisfied their guests are. Theoretically, this study explains how tourist satisfaction models and eco-tourism service providers relate to beach tourism in Kuakata. This place was chosen because Kuakata is known to have beautiful beaches.

The Implication of Destination Loyalty Dimensions

The results showed that Kuakata Beach is still the most critical factor (Uddin et al., 2023). This finding backs up research that shows how vital destination loyalty is for bringing tourists back to beach destinations (Hasan et al., 2020). Nayak et al. (2023) said that the beach's reputation directly influenced why tourists decided to go back or make a recommendation. Also, the quality of natural attractions and their surroundings can create more value and directly affect how loyal people are to them (Kim & Brown, 2012; Talukder, 2020a). In this way, the splendor of nature of beach destinations
remains the top priority that keeps tourists returning (Bhattacharya et al., 2023). More importantly, the previous study done by Lv and McCabe (2020) suggests the study has shown that tourist satisfaction is essential in keeping people returning to the same place.

The finding supports what other studies have found: a close link between tourists' happiness and their loyalty to a place. Uddin et al. (2023) said that ensuring standard service and quality satisfies tourists, possibly making them return to a particular destination. According to Kahraman & Cifci (2022), the loyalty coefficient to a destination compares favorably to the cost of other beach activities. This shows that the quality of eco-tourism services and how satisfied tourists are with them are still important and influential factors that significantly affect how loyal tourists are to many places. Another key finding from the research is that visitors' satisfaction levels are mainly related to the standard of eco-tourism facilities available there. There is a strong correlation between tourist satisfaction and destination loyalty in the case of Kuakata as a beach destination, and the findings of the three constructs contribute to the field of tourism and shed light on the relationships between quality of service and loyalty to a destination (Kahraman & Cifci, 2022; Talukder & Hossain, 2021). This study examined how ETSQ dimensions affect tourist satisfaction and commitment to a destination (Gabriel-Campos et al., 2021). Kuakata Beach was used as a place to study. The current findings could help the kuakata tourism industry develop a better way to manage and market goals. Experiences at beaches stood out as the single most crucial factor in determining return visits. The scenery and natural attractions of the beach, the beach's reputation with tourists, it being a fun and exciting place to visit, the beach's climate and weather, spending time and money to go back to the beach, planning to go back to the beach, encouraging others to visit this beach, and going to other eco-tourism sites in kuakata are some things to mention. This finding revealed that destination managers need to keep the beaches and natural environment of Kuakata Beach to keep the significance of this trip's central experience that

makes the destination competitive (Uddin et al., 2023). The study done by Talukder and Kumar (2023) on tourism strategies can be used to bring back tourists by pointing out how beautiful the beaches and nearby islands are and how good beach tourism in Kuakata is. Many respondents emphasized the importance of product quality in determining overall service excellence, how satisfied tourists are, and what they plan to do in the future (Nayak et al., 2023; Talukder, 2020b). The high standard of many beach destinations significantly influences their popularity. Furthermore, the study done by Uddin & Alauddin (2021), as ecotourism puts beach preservation first, is a different approach to preserving Kuakata's beaches in pristine condition by protecting the landscape and its environment and putting eco-tourism or sustainable tourism development into place.

Future Research Directions

This study gives important information about Kuakata beach's natural environment and ETSQ. So, besides the one study mentioned, more could be done on the quality of services in eco-tourism. From a beach tourism point of view, studies could be done on more than just how satisfied and loyal they are to their destinations. Tourism and hospitality could be measured by looking at the quality of food service, how satisfied guests are, and how likely they are to return. In this same context, the next step in the research is to look at the data using mediating and moderating variables in another model like ECOPERF. Our results will help researchers figure out how to run and evaluate the ECOSERVE in a way that predicts ETSQ, tourist satisfaction, and loyalty to a destination. We suggest some general considerations when using this measure in different eco-tourism settings. We hope that the ECOSERVE's short length will encourage practitioners to research eco-tourism and evaluate the quality of services. We also hope this paper will show how important it is to consider an environmentally friendly practice service attribute in the local and global tourism industry.

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PROVIDING ASYLUM – SPATIAL DISTRIBUTION OF ACCOMMODATION FACILITIES FOR UKRAINIAN REFUGEES AGAINST THE BACKGROUND OF LOCAL CONDITIONS IN A LESS DEVELOPED POLISH REGION

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ABSTRACT

Motives: The war in Ukraine has led to the need to help millions of refugees. Poland has issued the highest number of first residence permits to Ukrainian refugees, and it is the second most popular destination country for the Ukrainians taking long-term refuge. Polish society has shown commendable solidarity – individuals have hosted Ukrainian refugees in their homes, businesses provided shelter in tourist sites, and other organizations – in their facilities. This study highlights an important issue that is usually overlooked in academic studies. Many refugees benefited from the assistance of reception points for accommodation and were directed to places where accommodation was arranged. As a result, thousands of refugees were directed to less developed regions with higher unemployment rates and lower income levels.

Aim: The study aimed to present the spatial distribution of the currently used accommodation financed by the Polish state in a less developed region against its socio-economic characteristics. The study focused on powiats (counties), the second-level unit of administration in Poland.

Results: The spatial distribution of accommodation facilities was not based on the favorable socio-economic attributes of the area but solely on the availability of premises that could be promptly adapted for shelter purposes.

Keywords: refugees, migration, spatial distribution, local communities

INTRODUCTION

War always means geopolitical, economic, and social change. It generates groups of winners as well as whole swathes of the disadvantaged. War produces large death tolls, disrupts human and physical capital accumulation, and uproots entire populations from their lands. As a result, millions of people are displaced from their homes (Almasri, 2023; Baez, 2011; Davies & Isakjee, 2019; Dustman et al., 2017; Tefera, 2021; Zhou et al., 2023). War produces a new social group called refugees. They arrive in large numbers and in vulnerable conditions, traumatized by war, without almost any assets, as they cannot transfer them to the host country (Altındağ et al., 2020).

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On February 24, 2022, Ukraine experienced a full-scale invasion from Russia, which is believed to be a continuation of Russia's preparation in October 2021 (Esonye et al., 2023). Ukrainian civilians in the cities and villages have faced bombardment and artillery fire, and as a result - lack of security, food, water, and shelter. They experienced forced separation from family members (Karatzias et al., 2023). They lost their lives, their relatives, their health, and their homes, i.e., in December 2022, the Russian army launched 52 attacks on Kyiv, and 120 Kyiv citizens died, 495 were injured, more than 600 buildings were damaged, and critical infrastructure was destroyed (Lotzin et al., 2023). The Russian aggression against Ukraine violated international law and the basic principles and norms of international relations developed after the Second World War (Bajor, 2023).

The attacked country, Ukraine, is the second largest country in Europe, with an area of over 600,000 km² and a population of 45.5 million. The recent war has disrupted the daily lives of a significant number of people (Artzi-Medvedik et al., 2024). Refugees fleeing this war represent Europe's most significant wave of migration since World War II - the number of international and internal migrants likely exceeds 12-14 million (United Nations High Commissioner on Human Rights, 2022). This is over a quarter of the country's population (Andrews et al., 2023). Poland, as a country directly neighboring Ukraine, naturally became a place of refuge. Already since the beginning of the Russian aggression, EU countries neighboring Ukraine have widely opened their borders to refugees, setting up reception points offering the necessary legal and logistical information in the Ukrainian language (Szymańska, 2022). In a short period of time, several million refugees of different ages and with different health needs have arrived in Poland (Biesiada et al., 2023; Źróbek-Różańska et al., 2023).

The first refugees resided in villages near the Polish-Ukrainian border or headed to the west of Poland (as far from the border as possible) and the big cities (Górny & Kaczmarczyk, 2022; Wojdat & Cywiński, 2022). The rapid urban population growth (by 15% in Warsaw and 23% in Krakow) in a short period led to a housing market shock. Polish cities' housing market could not have absorbed the mass inflow of Ukrainian refugees over one month (Trojanek & Głuszak, 2022). Therefore, many refugees found temporary rent-free accommodation in the homes of Polish citizens and shelters prepared by central and local governments. However, their location was not inconsiderate of the refugees. Refugees have been most likely to settle in Poland's largest cities. However, among the refugees, people without family or friends in the cities agree to go to the accommodation indicated at the reception points. In turn, the reception points can only offer currently available places. Thus, refugees also arrived at accommodation located in a less developed region the Warmian-Masurian Voivodeship. It is worth noting that the region has a geographical disadvantage, as it is directly adjacent to the Königsberg region (Russia).

The study aimed to present the spatial arrangement of actually used accommodation financed by the Polish state in a less developed region against its socio-economic characteristics. The research aims to fill a gap in the current level of knowledge. Most studies and reports focus on the national scale – statistics on refugees in the countries concerned are given (i.e., UNHCR or Eurostat websites) or concern major cities. In contrast, this study takes a different approach. The focus is on examining accommodation sites and the number of people using them, which are located in a region that is simultaneously:

- 1. "undesirable";
- 2. less economically developed;
- 3. less developed in terms of communication.

In the study presented here, most data concerns the powiat level. The accommodation is located in particular villages, but the primary consideration was ensuring security through maintaining anonymity about the location of places of collective accommodation. Data on the number of people staying in places of collective accommodation organized in individual powiats of the Warminsko-Mazurskie voivodeship was collated with data on the individual characteristics of these units.

DATA AND METHODS

Some of the refugees have come to relatives working and living in Poland, while others seek accommodation in Warmia and Mazury because they have no one and need help. Accommodation bases prepared by the voivode are dedicated to them. These are contracted subsidized accommodation. There, they are provided shelter, food, all necessary personal hygiene items, and access to a doctor, if required. Data on the location and number of people using this type of shelter was obtained from the voivodship office. The governor enters into term contracts. To date, three agreements have been concluded for specific funding periods. Accordingly, data are presented in three time frames: the first round of contracts related to the first wave of refugee influx (accommodation launched during March-May 2022), the second round of contracts (accommodation launched or continued from March 2023 to 24 August 2023) and the third round of contracts (from 25 August 2023). Unit data for particular collective accommodation was cumulated to the district level. Data were collected on the labor market condition, average gross wages, and business entities for these districts. Data on communication were presented on a regional basis. These data were obtained from Statistics Poland and related to the investigated terms. This study opted for a data visualization method. The data are presented in cartograms, where a gradation of the color of the contour filling of each powiat represents the intensity of a given phenomenon.

RESULTS

Warmian-Masurian Voivodeship is situated in the north-east of Poland. Due to its natural beauty, it is considered one of Poland's most beautiful regions. The voivodeship is the fourth largest region in Poland, with an area of over 24,000 square kilometers. More than 1.4 million people inhabit the region; most live in the Olsztyn, Ostróda, and Iława powiats. The population density is the lowest in Poland – 59 people per square km. The voivodeship is adjacent to the Königsberg region of the Russian Federation. This over 200 km long section of the Polish-Russian border is the external border of the European Union. The unemployment rate in the voivodeship is relatively high: in October 2023, it was 7.9%. On the other hand, the average gross monthly salary in the enterprise sector was PLN 6,174.36 (EUR 1,425). The voivodeship is dominated by powiat and municipal roads. Poorer quality road connections, therefore, hamper accessibility. Comparing hard-surfaced roads per 100 km², the indicator for the region was 60.4 in 2022 and 101.5 in Poland.

Based on this data, it is possible to confirm the assumptions that the region from the point of view of refugees was:

- undesirable geographical location directly at the border with the Königsberg region;
- less developed economically the high unemployment rate is indicative of a shortage of labor demand, which, as a derived demand, implies a shortage of production relative to available labor resources and lower wages;
- less developed in terms of care fewer physicians, smaller hospitals, and less developed daycare for small children.

However, people needing shelter aid chose to migrate to this destination (Fig. 1).

The geographic location, highlighted in the cartogram (Fig. 1), argues why the region can be called 'undesirable'. The refugees, who live in the western, southern or central part of Ukraine, coming to Warmia and Mazury, found themselves closer to the border with Russia than previously.

Due to its unfavorable characteristics, the first influx of refugees into the region started in March 2022 and continued with high intensity until May 2022, after which it relatively stabilized. In the entire voivodeship, places were made available in:

- boarding schools and dormitories;
- educational and sports centers;
- senior citizens' homes;
- holiday centers belonging to Christian foundations;
- holiday centers belonging to secular foundations;
- private hotels and resorts;
- seminaries;
- government resorts.

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Fig. 1. Ukrainian refugees' escape route to the Warmia and Mazury region

Most people used the accommodation prepared in the olsztyński, ostródzki, and mrągowski powiats (Fig. 2, the darkest shading).



Fig. 2. Visualization of the spatial distribution of refugees after the outbreak of war (Warmia and Mazury region)

In March 2023, the Warmińsko-Mazurskie Voivode signed a second round of agreements to subsidize accommodation for war refugees. The agreements were valid until 25 August 2023. In this round, the most significant number of people were accommodated in the powiats of Olecko and Mragowo (Fig. 3, the darkest shading). It is worth mentioning, however, that in the olsztyński and ostródzki powiats, some people continued to live in their initial accommodation.



Fig. 3. Visualization of the spatial distribution of refugees according to contracts concluded from March to August 2023

August 2023 was uncertain for refugees using contracted accommodation and for the owners of these facilities. Contracts were running out this month, and information was awaited on whether they would be renewed. This was because the demand for accommodation was changing – some refugees had rented accommodation on the private market, some had returned to Ukraine, and some had left for other regions or abroad. On the other hand, some landlords decided to end the provision of premises for refugee assistance. At the end of August, new contracts were contracted. This time, most people used the sites in olecki powiat (Fig. 4, tha darkest shading).



Fig. 4. Visualization of the spatial distribution of refugees according to contracts concluded in August 2023

It is noticeable that the most intensively used accommodation units are located in the relatively unfavored powiats from the side of adaptation of refugees. One of the essential factors facilitating adaptation to a new environment is economic independence. The possibility of taking up temporary work allows for obtaining current income, which can be spent following individual preferences (in accommodation centers, refugees most often receive meals in the form of collective meals prepared for everyone by employed cooks). Table 1 shows the unemployment rate, the number of employees per 1,000 working-age people, and the number of job offers. The data concerns the year 2022 and the following powiats: the city of Olsztyn, olsztyński, ostródzki, olecki, and mrągowski. For comparison, data on the most attractive migration cities with powiat rights were added: Warsaw, Kraków and Wrocław.

(202	.2)		
Powiat	Unemploy- ment rate	Working per 1000 working-age people	Work offers in the year
Warszawa	1.4	904	40948
Wrocław	1.6	706	22258
Olsztyn	2.0	641	5316
Kraków	2.3	771	35243
Olsztyński	7.2	290	3256
Ostródzki	9.1	335	4428
Mrągowski	9.3	307	1757
Olecki	10.9	351	1523

 Table 1. Chosen labor market characteristics in selected powiats

 (2022)

Source: own elaboration based on data from Statistics Poland.

Comparing the extremes, it can be noted that the unemployment rate in the Olecko powiat was ten times higher than in Warsaw, where there were three times fewer professionally active people and twenty-seven times fewer job offers.

Analyzing the data in Table 2, it can be noted that the population living in the powiats located in the Warmian-Masurian Voivodeship receives, on average, a lower salary than in large Polish cities.

 Table 2. Average monthly gross salary and business entities in selected powiats (2022)

Powiat	Average monthly gross salary (EUR*)	Average monthly gross salary to the national average (%)	Business entities (medium and large) per 1k residents
Warszawa	1984	127	5.4
Kraków	1895	122	6.4
Wrocław	1717	110	8.5
Olsztyn	1511	97	3.9
Olsztyński	1362	88	3.6
Ostródzki	1255	81	3.7
Olecki	1254	81	3.3
Mrągowski	1231	79	5.2

* According to exchange rate announced by National Bank of Poland in 15th December 2023.

Source: own elaboration based on data from Statistics Poland.

These counties are also characterized by a lower rate of business entities related to fewer job offers or a higher unemployment rate.

It should be taken into account that refugees are mainly mothers with children (including small children) who have traveled from Ukraine in adverse climatic conditions. They have come with their children to places of collective accommodation, where they are housed in rooms with strangers - other mothers and children - including a cafeteria. The timing of their arrival coincided with the end of the Covid-19 pandemic. In this situation, all refugees have been exposed to health problems, especially children and seniors. Therefore, access to health care is very important. Comparing powiats with extreme rates - the number of doctors per 10,000 people is ten times higher in Warsaw than in olecki powiat. The second issue is care for young children. In order for mothers to work, they must have safe care for their children. Table 3 shows the availability of care places for young children. In contrast, our own research shows that municipalities have risen to the challenge and organized additional places in kindergartens and elementary schools. On the other hand, traumatized mothers who were eyewitnesses to the murders of children in their localities were unwilling and unable to put their surviving children in care.

Table 3. Healthcare and childcare in selected powia	Table 3.	Healthcare	and	childcare	in	selected	powia
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Tuble 5. Healtheare and enhactive in selected pownats					
	Physicians	Beds	Places in childcare		
Powiat	per 10k	in general centers per 1k child			
	population	hospitals	under 3 years of age		
	(2021)	(2021)	(2022)		
Warszawa	112.7	12956	352		
Kraków	106.1	5648	436		
Wrocław	103.8	4646	427		
Olsztyn	87.5	1907	313		
Olsztyński	20.6	438	135		
Mrągowski	14.1	113	145		
Ostródzki	12.6	264	135		
Olecki	11.4	96	105		

Source: own elaboration based on data from Statistics Poland.

CONCLUSIONS

War uproots entire populations from their lands and displaces people from their homes. War refugees arrive in host countries in large numbers and vulnerable conditions, without almost any assets, and in massive need of shelter and care. The outbreak of the Russian invasion of Ukraine caused a mass emigration of civilians. Some refugees had a specific destination. These individuals were fleeing to family, friends, and acquaintances. Another group used contacts established earlier - asking for help from foundations and associations that had organized trips and summer camps for their children in the pre-war years, for example. Furthermore, among the refugees, it is possible to distinguish a large group of people who had never been to Poland before and have no relatives or acquaintances in this country. These people used the accommodation offered at the reception points.

Over time, with the next wave of refugees, places in the large cities in the south and west of Poland have been depleted. Refugees were offered shelter in facilities located in the Warmian-Masurian Voivodeship. Geographically, these places were not desirable - due to their proximity to the Russian border (Königsberg region), these places appeared dangerous. In addition, it is worth noting that the region is less attractive regarding economic development and care. Despite the disadvantages, refugees have settled in centers located in the powiats of Warmia and Mazury. Most people found shelter in the olsztyński, ostródzki, mrągowski and olecki powiats. They took advantage of these places despite relatively high unemployment rates, low labor force participation, and fewer job opportunities. In addition, earnings are statistically lower, and there are fewer employers even after taking up a job. Furthermore, health care is more difficult to access (fewer doctors and hospital beds), as is care for young children. Despite all these characteristics, refugees chose to take refuge in the region, and some stayed from March 2022 until the date of this research (August 2023).

The research carried out led to the following conclusions: war produces refugees from all social groups, regardless of their social networks. There are groups of refugees who need assistance in obtaining shelter in the form of accommodation. These people, in the absence of better offers, use accommodation in the regions regardless of their geographical or socio-economic characteristics. As a result, clusters of refugees are also formed in local environments characterized by low labor market absorption and poorer access to health care.

However, the limitations of the study must be taken into account: the number of people using shelter in an area is constantly changing – many people leave, some return and new refugges arrive. There is a lack of data on people who stay in these places throughout their stay in Poland. It would therefore be recommended to monitor migration trends at the local level in order to adapt the amount of public services to realistic demand forecasts.

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