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Rengin Ak
Berna Ak Bingöl

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**III. Uluslararası Finans, Ekonomi Kongresi
Ve Sürdürülebilir Politikalar (ICOFESP)**

Tam Metin Bildiriler Kitabı,

30 Ekim – 01 Kasım 2025 Prishtina, Kosova

Editörler

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Berna Ak Bingöl

Yayın Yılı

Aralık 2025

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Dear Respected Academics and Researchers,

On behalf of the Organizing Committee, we are pleased to announce that IV. International Congress On Finance, Economy And Sustainable Policies (ICOFESP) will be held in University of Prishtina from 30 October – 01 November 2025 in Prishtina, Kosovo

ICOFESP provides an ideal academic platform for researchers and professionals to discuss recent developments in economy. This event aims also to stimulate interaction in the field of finance, economy and policy developments in all these areas, and to showcase the expertise of our invited speakers and participants.

You can find more information about this event on the webpage of ICOFESP:
www.icofesp.com

All the papers are subject to rigorous peer-review by at least two members of scientific committee or additional reviewers.
We are looking forward to seeing you in Prishtina, Kosovo

With our best regards,
Organising Committee of ICOFESP

TOPICS

Climate Resilience and Sustainability

- Environmental Protection
- The role of climate change in regional development
- Climate Change and Economic Systems
- Climate Niche
- Innovative Approaches to Climate Adaptation and Mitigation.
- Rural and Urban Resilience
- Localising Climate Action and Enhancing Community Resilience.
- Climate Justice and Migration
- Nature-based Solutions and
- Ecosystem-based a Adaptation.
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- Climate Finance
- Global Food Security
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- Just Energy Transitions
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A STUDY ON ENVIROMENTAL AWARENES AMONG TEACHERS

Asst. Prof. Dr. Aksu SAMET

International Balkan University, aksu.samet@ibu.edu.mk

ORCID ID: 0000-0001-7922-5058

Abstract:

Environmental education is increasingly being embraced as a component of fostering sustainable development. The research designs encompass systematic comparative reviews, longitudinal surveys of recycling sensitivity, and mixed-method cross-sectional studies of measuring teachers' knowledge, attitudes, and practices. In this research, findings of an environmental eeducation survey on primary, middle and high school teachers, of to assess their environmental concerns, personal conservation practices, and integrating environmental issues into pedagogy are demonstrated. Teachers, being the key learning facilitators and role models for the students, are of indispensable value in instilling environmental awareness at the formative school levels. Implications of the findings report a prevalent level of concern in which 73% respondents are very concerned regarding air pollution and 50 % are of the opinion that global warming is, very bad, but they recycled seldom, and 42% of them said they never recycle. Teachers also possessed high intention to change their lifestyle in order to reduce environmental damage. In actuality, the majority of respondents indicated they utilized their annual eco plan in class, and 65% have been involved in a like project or seminar. The analyses and our results showed the need for continuous professional development of teachers in all subjects and at every level of education. Specialized training programs and changes in curricula can strengthen the capacity of teachers to implement higher-quality environmental education.

Keywords: Ecology; Teachers; Environmental education; Curricula

1. Introduction

Environmental awareness is an important factor in environmental conservation, that is, being aware of the environment, which helps people develop sensitivity, understanding, and participation in finding solutions to environmental problems. This awareness is key to the attitudes and skills needed to deal with environmental problems and promote them by providing knowledge to individuals, such as teachers and through them to their students (Sahidullah, 2022). Knowledge, integration, and understanding of environmental and environmental maintenance problems are of great importance for transferring them to educational environments through sustainable practices.

The effectiveness of environmental education programs is often evaluated through observations that do not involve the participation of teachers or students. These observations assess how well activities are implemented in schools at each level and in each subject, they help researchers to notice differences between reported practices and actual activities, which improves the reliability of findings related to environmental involvement in school practice (Ciesielska et al., 2018).

Thematic analysis of qualitative data has played an important role in understanding how experiential learning affects students' environmental awareness and practices, as it has been proven that using practical teaching techniques increases learning interest and understanding of the topic of the problem (Aksu Samet & Sezen Samet, 2025). Such practices in schools have shown good results in students' knowledge of important topics such as waste management, energy saving and the use of environmental knowledge in the real world ((Aksu Samet & Valentina Pavlova, 2024). The current environmental crisis, which includes climate change, biodiversity loss, and overuse of resources, requires effective strategies to improve the knowledge and awareness of students and, above all, teachers. This makes environmental education an essential tool, especially in its social aspect (Sanabria-Z et al., 2025).

Teachers had only an "Average" understanding of environmental education concepts, with lower scores in waste management and sustainable development, but the longitudinal study by Uyanık (Uyanık et al., 2022) found that their sensitivity scores toward recycling increased dramatically in their fourth year (from a mean of 99.76 to 131.55) immediately after taking a environmental education course. This shoes that well-designed educational interventions can significantly improve teacher and student's environmental knowledge (Aldeia & Alves,

2019). While knowledge is crucial, an educator who personally values sustainability and is motivated to promote environmental stewardship is more likely to employ innovative, student-centered pedagogies (Negi & Verma, 2023). The research is remarkably, about the majority of teachers displayed a strong positive attitude and recognized the importance of adding environmental education into the annual curriculum of education programs (Samet, 2021; Thomson et al., 2003). The use of the rich curriculum with environmental education parts underscores the importance of immersive learning and promote active participation in environmental stewardship, contributing to the development of environmentally conscious attitudes among students (Aksu Samet & Valentina Pavlova, 2024).

The survey constructed with 17 questions especially focusing on environmental literacy and teaching practices and evaluating environmental concerns and teaching methods among teachers.

2. Methodology

2.1 Research Design

In this study, a quantitative descriptive research design was employed to gauge teachers' environmental awareness, perceptions of ecological problems, and their practices on the environment. Data were obtained from a structured questionnaire administered to teachers working at the International Maarif School in Tetovo, North Macedonia.

2.2 Participants

Respondents included a total sample of 52 teachers working at primary, middle, and high school levels across different subject areas. Each participant was assigned a unique respondent identification number for anonymity. Of the participants, 30 were high school teachers, 6 middle school teachers, and 12 primary school teachers. The sample consisted of 32 female and 16 male teachers. The ages of the participants ranged from 20 to 50 years, within the following ranges: 6 teachers fell in the age group of 20–25 years, 12 were between 26 and 30 years, 16 fell between 31 and 35 years, 6 between 36 and 40 years, and 4 teachers were between 45 and 50 years. Qualification-wise, 20 teachers had a Bachelor's degree, while 22 had a Master's degree and 6 had a PhD degree.

2.3 Data Collection and Analyses

The data collection tool consisted of a structured survey with 17 items, including multiple-choice questions, Likert-scale items, and short qualitative responses. The questionnaire was

prepared to obtain information about the demographic characteristics, levels of environmental concern and perception with regard to ecological problems, and ecological activities of the teachers who participated in the study. Teachers' participation in the research was left free from obligations; that is, being told about the purpose of the research and the confidentiality of their data, they completed the survey on a totally voluntary basis.

Data analysis was done through descriptive statistical methods. Percentages and means were calculated to summarize the findings pertaining to teachers' environmental attitudes, knowledge, and practices. A review of qualitative responses was also made to provide supporting insights and complement the quantitative results.

3. Findings and Results

3.1. Demographic Characteristics of Participants

The environmental education survey consisted of 17 questions that assessed teachers' understanding of environmental and ecological issues. From the International Maarif School in Tetovo, North Macedonia, 52 teachers representing different subject areas and teaching levels participated in this study. Each teacher had a unique identification number as a respondent in order for their responses to remain confidential. The gender distribution (Figure 1A) shows that the sample contained 32 females and 16 males who participated in this survey. In addition, high school teachers came on top with 30 (58%), middle school teachers with 6 (19%), and primary school teachers with 12 (23%). These ranged in age from 20 to 50 years. The 31-35-year-old age group was the most common category represented in our sample, with 31% or 16 teachers, respectively. Then, the classes of 26-30 years old, with 12 teachers, and 20-25 and 36-40 years old, each with 6 teachers represented. Ages 45-50 years old were the least represented category, with only 4 teachers. Figure 1B presents teachers by age. Teachers are also diversified in their educational attainment: 20 teachers had a bachelor's degree, 22 had finished a master's degree, and 6 had a PhD. Figure 1C presents teachers by educational attainment. The highest representations were by high school teachers and those in the early to mid-career age bracket. Figure 1D presents teachers by level taught and age.

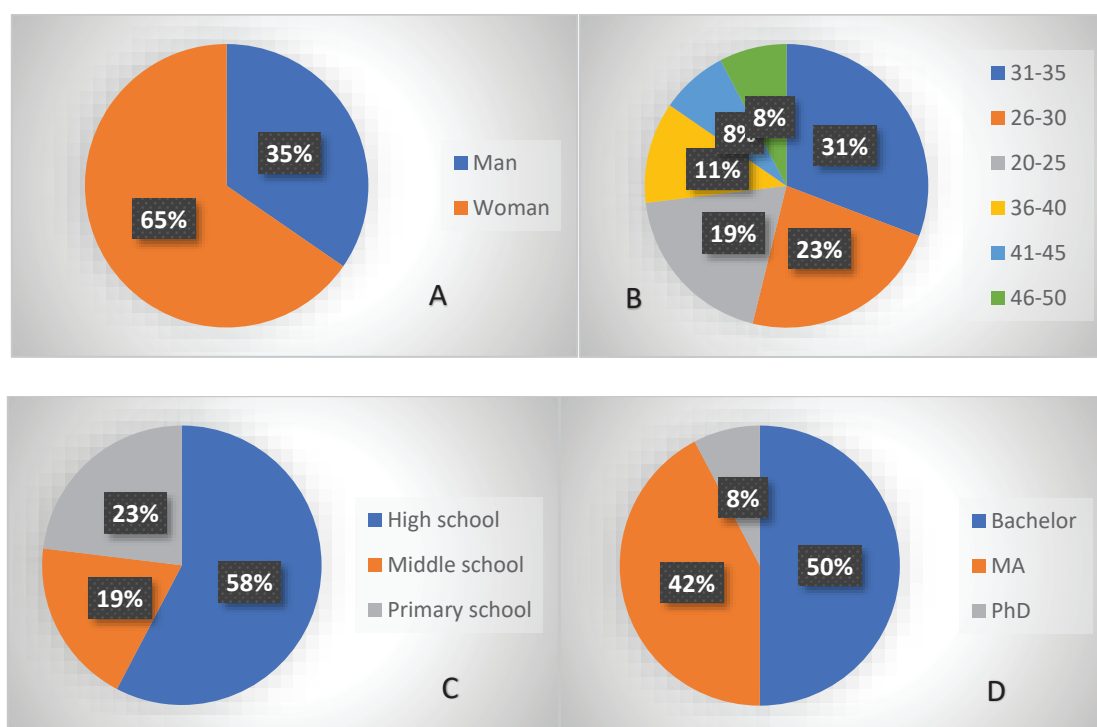


Figure 1. Demographic breakdown of the respondents

3.2. Environmental concern levels of teachers

The data reveal generally high levels of environmental concern among the teachers of high, middle and primary school participants. A large majority of 76.9%, report being *very concerned* about air pollution, with an additional 15.3% being *somewhat concerned* (Table 1). This gives a combined total of 92.2% indicating that air pollution is perceived as an urgent and direct environmental threat. The minimal proportion of neutral (3.8%) or unconcerned (3.8%) responses suggests strong awareness, likely due to its visible and immediate health and environmental impacts.

Table 1. Analysis of Concern Levels

Concern Level	Air Pollution	Extinction of Endangered Animals
Very concerned	76.90%	53.84%
Somewhat concerned	15.30%	26.90%
Total Concerned	92.20%	80.74%
Neither concerned nor unconcerned	3.80%	15.30%
Somewhat unconcerned	3.80%	3.80%
Very unconcerned	0%	0%

At Table 1, the concern for Extinction of Endangered Animals is also high (53.84% *very concerned* + 26.9% *somewhat concerned*) a total of 80.74% showing concern. However, compared

to air pollution, a larger number of teachers are *neutral* (15.3%), indicating that biodiversity loss may feel less immediate or personally relevant to some participants. Only 3.8% express mild unconcern, which means sheer disregard for this issue is rare. The larger concern regarding air pollution (92.2%) than about species that are threatened with extinction (80.74%) might reflect the direct human impact of air quality problems. That is why human factor will play essential role in solution of the problems of air pollution and there is an environmental education effect will play essential role. The level of education and living area may moderate the relationship between air pollution and educational investment. These findings imply that air pollution may undermine human development due to alterations in parental investment behavior prompted by environmental conditions (Guo et al., 2024).

3.3. *Environmental perception*

The results shown from the Table 2, give an insight into public perception regarding urgent environmental issues, gives closely association with themes found within the literature regarding environmental education, namely awareness, values, and action ((Griswold et al., 2024)Griswold et al., 2024). The results of the survey show a significant 69.2% of teachers (Table 2) view global warming as a harmful trend, indicating a distinct awareness of its negative effects. Only a small minority (11.44% total) perceive it as *good or very good* and shows the low knowledge of teacher about the global warming. This strong negative perception of teachers aligns with global public opinion emphasizing the urgency of climate action, especially in education of the students. A majority (57.6%) of participants believe that *reducing global warming is much more important than improving the economy*, only a small fraction (3.84%) consider it *less important*, and none view it as *much less important*. This result is very important and demonstrates a clear priority of ecological problems suggesting that teachers favour sustainable development over purely economic growth (Negi & Verma, 2023).

Opinions are more divided on how well the environment can recover from human-caused problems, while small percentage of teachers believe it can recover *extremely well* and only 26.9% *somewhat well*, a total of *somewhat not well* or *extremely not well* is 38.4%, it shows that they are sceptical for solving of the problems. This result suggests that optimism exists but many teachers remain cautious about the environment's natural resilience without human intervention. Adding Environment education in educational programs and curriculum may change the situation and increase the optimism of the Teachers (MARQUES & MAZZARINO, 2021; Samet, 2021).

Table 2. Analysis of environmental perception of teachers.

Do you think Global warming is good or bad?	Is reducing global warming more important than improving the economy?	How well do you think the environment can recover on its own from human-caused problems?	Which of the following alternative energy sources will be most important in the next 10 years?	What is the most important environmental issue in your region?
Very good 3.84%	Much more important 57.6 %	Extremely well 11.5%	Wind 3.84%	Water pollution 15.3%
Good 7.6%	Somewhat more important 19.2%	Somewhat well 26.9%	Solar 57.6 %	Air pollution 76.9%
Neither good nor bad 11.5%	About as important 19.2%	Neutral 19.2%	Nuclear 11.5%	Increasing temperature 0%
Bad 19.2%	Somewhat less important 3.84%	Somewhat not well 19.2%	Natural gas 26.9%	Other 7.7%
Very bad 50%	Much less important 0%	Extremely not well 19.2%	Coal 0%	

Participants overwhelmingly favour solar energy (57.6%) as the most important energy source for the next decade, followed by natural gas (26.9%), nuclear energy (11.5%), and wind (3.84%). This distribution reflects strong support for renewable and cleaner energy options, consistent with global sustainability trends. When asked about the local environmental issue, only 7.7% mentioned other issues, while none selected increasing temperature, a large majority (76.9%) identified air pollution, followed by water pollution (15.3%). This indicates that air quality is perceived as the dominant local environmental concern, likely due to its visible and immediate health impacts in the region, Tetovo as a region in North Macedonia is region with air pollution problems, especially in winter (Tetovo Air Quality Index (AQI) and North Macedonia Air Pollution | IQAir). Teacher educators, for example, have identified projects such as solar power utilization for campus lighting as part of their long-term action plans for environmental enhancement. Air and water pollution are recognized threats globally, and are explicitly listed among the major problems. Pollution, including that of air, water, and soil, is caused by human activity. Public participation in environmental education (Hunter & Jordan, 2019) is necessary to reduce the pollution of air, water, and soil (Guo et al., 2024).

3.3. Environmental Practices

The query presents summarized results from a survey on teachers' frequency of engagement with environmental education topics and activities. These data points reflect the level of integration and commitment teachers show toward education practices, which is a significant focus area in the sources.

Table 3. Analysis of environmental practices.

How frequently do you discuss environmental problems with your students?	How frequently do you search about environmental topics?	How many projects did you make with students about saving the environment last year?
Daily 7.6%	Very frequently 19.2%	0 projects 23%
Weekly 15.3%	Frequently 15.3%	1 project 34.6%
Monthly 34.6%	Occasionally 42.3%	2 projects 26.9%
Quarterly 34.6%	Rarely 19.2%	more than 2 projects 15.3%
Annually 7.6%	Never 3.8 %	

According the data at Table 3, teachers generally show awareness of environmental issues, their practical engagement and integration into teaching vary considerably in frequency and depth. Only a small proportion of teachers (7.6%) discuss environmental problems *daily*, and 15.3% do so *weekly*. The majority engage less frequently 34.6% monthly and 34.6% quarterly while 7.6% limit such discussions to once a year. This pattern indicates that although environmental topics are present in teaching, they are not yet systematically integrated into the regular curriculum or classroom discourse. Environmental education appears to be addressed more as an occasional or thematic topic rather than a continuous pedagogical element and implementation remains uneven due to challenges such as limited teacher training, inconsistent policy application, and structural barriers within traditional curricula (Zhang et al., 2025). Interest in exploring environmental information shows a slightly higher engagement: 19.2% search very frequently and 15.3% frequently, while the largest group (42.3%) do so *occasionally*, conversely, 19.2% seldom and 3.8% never seek out such topics. According these results, majority of teachers do not possess motivation or time to expand their environmental knowledge by ongoing research(Ernst & Erickson, 2018). About environmental projects with students, 23% did not have any projects in the

previous year and 34.6% only one project, although some teachers demonstrate practical involvement but the frequency of project-based learning as a whole is very low. with improving teacher knowledge, providing methodological tools, and developing institutional support that addresses structural barriers can strength these kind practices (Wright et al., 2021). Survey result on how often the practice of recycle, reduce and reuse takes place, documents a crucial lacuna in practice behaviour. This agrees with research result shows the relationship between environmental attitudes and behaviours in environmental education(Ferguson et al., 2021; Somerville & Williams, 2015).

Table 4. Analysis of frequency for recycle, reduce and reuse.

Frequency	How often do you recycle?	How often do you reduce?	How often do you reuse?
Daily	3.80%	23.07%	15.30%
Weekly	7.60%	15.30%	15.30%
Monthly	19.20%	19.20%	23.07%
Seasonal	19.20%	19.20%	23.07%
Yearly	0%	11.50%	11.50%
Never	42.30%	3.80%	3.80%

The results indicate a wide range of variation in frequency of practice among the teachers, recycling is the least practiced behaviour among the respondents, were 3.8% recycle daily, 7.6% weekly, 19.2% monthly or seasonal basis, (Table 4), but a staggering percentage of 42.3% never recycle. The act of *reducing consumption*, minimizing plastic use, conserving energy, shows a much stronger pattern of adoption. 23.07% of respondents reduce daily, and 15.3% weekly, while an additional 19.2% each do so *monthly* or *seasonally* (Table 4). Only 3.8% *report never reducing*, so these results indicate that waste reduction behaviours are more feasible and integrated into daily routines, perhaps because they require individual decisions rather than institutional systems (Hunter & Jordan, 2019; UYANIK, 2022).

Reusing items is practiced by a moderate portion of participants: 15.3% daily, 15.3% weekly, and 23.07% each *monthly* and *seasonally* (Table 4). Only, 3.8% *never reuse*. This balanced distribution suggests a positive tendency toward reusing resources, though not yet habitual for most respondents. Seasonal or occasional reuse may be related to specific activities in education as a classroom projects, household cleaning, or resource-saving initiatives in schools and out of the schools (Ferguson et al., 2021; Yadav et al., 2018).

4. Conclusion

The findings of this study put into light a holistic view of the teachers' perceptions, awareness, and practices regarding environmental issues. The demographic makeup showed that early to mid-career high school teachers, all with at least a bachelor's or master's degree and predominantly female teacher, dominated the sample. On the whole, across the survey, teachers showed a high level of concern about major issues: air pollution most of all, which reflects the severe air quality challenges. Teachers demonstrated clear acknowledgment of the need to handle global warming, even at the expense of economic growth. Despite that, a remarkable number still remained sceptical about the ability of the environment to heal itself without interference; thus, cautious, being a sure-fire approach that underlines the need to equip educators with not only scientific knowledge but also pedagogical strategies in order to foster environmental resilience.

Although teachers showed strong attitudes and awareness, their environmental practices showed inconsistency, implying a gap between knowledge and implementation. The practice of discussing environmental issues in the classrooms was more seasonal, occurring monthly or quarterly rather than being integrated into the daily teaching of lessons. Project-based environmental learning was also sparse, with the majority of teachers conducting only one or no environmental projects per year. This likely reflects constraints on training, resources, or institutional support that have been identified in broader environmental education research. While reduction and reusing practices were relatively common, recycling was the least adopted behaviour, with almost half of the teachers reporting that they never recycle.

In general, the results indicate that while teachers are highly aware of and concerned about environmental issues, structural, institutional, and pedagogical barriers prevent these attitudes from being transformed into regular educational practices. In the context of this case, strengthening teacher training, better integration of environmental education into the curriculum in a systematic way, and increasing the support and infrastructure for environmental education at the school level are basic steps towards filling the gap between awareness and action. By addressing such challenges, schools can take more active steps toward enabling teachers to be models for the environment and to effectively promote environmentally responsible behaviours in their students.

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RESILIENCE AS A FINANCIAL STRATEGY: QUANTIFYING THE CLIMATE RISK PREMIUM IN EASTERN EUROPEAN DEBT

Asst. Prof. Dr. Ardita BYLO

University of New York Tirana, arditabylo@unyt.edu.al- ORCID ID: 0000-0002-4291-5829

Prof. Dr. Ali Osman GÜRBÜZ

Istanbul Commerce University, ogurbuz@ticaret.edu- ORCID ID:0000-0003-0230-5839

Assoc. Prof. Berna AK BİNGÜL

Kırklareli University, berna.akbingul@klu.edu.tr- ORCID ID:0000-0002-2813-2780

Abstract

This study provides robust empirical evidence that climate vulnerability significantly increases sovereign borrowing costs for Eastern European economies. Analyzing a balanced panel of ten countries from 2007 to 2023, we employ a novel, maturity-matched measure of country risk premium—the spread between domestic bank lending rates and the 12-month Euribor—constructed from open-access data. Estimating both Random- and Fixed-Effects models with Driscoll-Kraay standard errors to control cross-sectional dependence and global shocks, we find a statistically significant positive relationship between the ND-GAIN climate vulnerability index and the domestic risk premium. This result confirms that financial markets price physical climate risk, imposing a tangible "climate risk premium" on vulnerable nations. Our findings, which remain robust after considering macroeconomic fundamentals and the COVID-19 shock, underscore that building climate resilience is not merely an environmental imperative but a critical financial strategy for reducing sovereign risk and ensuring fiscal sustainability. This research provides policymakers with quantifiable evidence of the economic cost of climate vulnerability, strengthening the case for strategic investments in adaptation and green finance.

Keywords: Climate Risk Premium, Sovereign Debt, Climate Vulnerability, Eastern Europe, Panel Data

JEL Classification: C23, E43, E44, F34, G15, H63, Q54

1.Introduction

The escalating climate crisis presents one of the most formidable challenges to global economic stability, with its impacts disproportionately affecting emerging and developing economies (IPCC, 2022). The increasing frequency and severity of climate-related disasters—from devastating floods and prolonged droughts to extreme heatwaves—threaten not only environmental systems but also the very foundations of economic prosperity and financial resilience. Within this context, understanding the intricate relationship between climate physical risk and sovereign financial stability has emerged as a critical area of scholarly and policy interest, particularly for vulnerable regions like Eastern Europe.

The transmission channels through which climate vulnerability affects sovereign risk are multifaceted, operating through fiscal pressures from disaster response and reconstruction, growth constraints from productivity losses, and direct risk repricing by financial market participants (NGFS, 2019).

This study contributes to the evolving literature by examining the relationship between climate vulnerability and sovereign risk premiums for a balanced panel of ten Eastern European countries from 2007 to 2023. We employ a novel, maturity-matched measure of country risk premium constructed from publicly available data, overcoming significant constraints in sovereign debt market accessibility for emerging economies. Our methodological approach utilizes both Random- and Fixed-Effects estimators with Driscoll-Kraay standard errors to account for cross-sectional dependence, heteroskedasticity, and serial correlation—addressing critical limitations in conventional panel estimation techniques.

The analysis controls for key macroeconomic determinants including inflation, GDP growth, current account balances, and banking sector exposure to government debt. Furthermore, we incorporate dummy variables to capture structural breaks associated with major global shocks, particularly the COVID-19 pandemic, ensuring that our estimates reflect the underlying climate risk relationship rather than temporary market disruptions. The use of lagged variables for inflation and government claims addresses potential reverse causality concerns and captures delayed transmission mechanisms.

Our findings provide compelling evidence supporting the climate risk premium hypothesis: higher climate vulnerability is associated with significantly higher risk premiums in Eastern European sovereign debt markets. This result confirms that investors price climate physical risk into their required returns, creating tangible financial costs for vulnerable nations. The study

thus contributes to a more nuanced understanding of how climate risk is priced in sovereign debt markets and offers important insights for policymakers seeking to enhance climate resilience while maintaining fiscal sustainability.

2. Literature Review

The modern framework for sovereign risk analysis incorporates both quantitative and qualitative factors. Baldacci and Kumar (2010) developed a comprehensive model showing that fiscal variables (debt-to-GDP ratios, budget deficits) and external indicators (current account balances, foreign reserves) explain approximately 70-80% of the variation in sovereign bond yields across countries. Their research revealed non-linear effects, where the marginal impact of debt accumulation on borrowing costs increases significantly once debt levels exceed 60-80% of GDP.

Volz et al. (2020) provided comprehensive evidence that physical climate risk transmits through three primary channels: (1) fiscal pressures from disaster response and reconstruction, (2) growth constraints from productivity losses and capital destruction, and (3) direct repricing of risk by financial markets. Their analysis of 98 countries demonstrated that climate vulnerability has already materialized in sovereign credit spreads, with highly vulnerable emerging economies facing premium increases of 50-100 basis points.

Recent empirical studies have quantified the relationship between climate vulnerability and borrowing costs. Kling et al. (2021) found that a one-standard-deviation increase in climate vulnerability is associated with a 0.15-point increase in sovereign credit default swap (CDS) spreads, equivalent to approximately 30 basis points in additional borrowing costs. The effect was particularly pronounced in countries with limited fiscal space and adaptive capacity.

The growth channel operates through multiple pathways. Dell et al. (2012) established that temperature shocks have significant negative effects on economic growth in poor countries, with a 1°C increase in temperature reducing annual growth by 1-2 percentage points. These growth effects compound over time, potentially creating permanent output losses that weaken debt sustainability metrics.

The specific context of Eastern European countries introduces important nuances to the climate-risk relationship. Cevik and Jalles (2020) found that the climate-growth relationship in the region exhibits non-linearities, with negative effects becoming pronounced only beyond specific temperature thresholds. The region's transition economy status, varying degrees of

European integration, and heterogeneous adaptation capacities create a complex landscape for climate risk pricing.

Despite this growing literature, significant knowledge gaps remain regarding the precise quantification of climate risk premiums in Eastern European sovereign debt markets. Most existing studies focus on either global samples or developed economies, with limited attention to the unique characteristics of Eastern European markets. Our research thus contributes to both the empirical understanding of climate risk pricing in emerging European markets.

3. Data and Methodology

3.1 Data Sources and Variable Construction

This study employs a balanced panel dataset comprising ten Eastern European countries (Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Czechia, Hungary, Moldova, Montenegro, North Macedonia, and Romania) over the period 2007–2023. The dataset was constructed exclusively from publicly available sources to ensure transparency and replicability.

3.1.1 Dependent Variable

The dependent variable is the domestic risk premium, measured as the difference between the lending interest rate in each country and the 12-month Euribor rate:

$$\text{Risk Premium}_{it} = (\text{Lending interest rate}_{it}) - (\text{12-month Euribor}_t)$$

- **Lending interest rate:** Obtained from the World Bank World Development Indicators (WDI, code FR.INR.LEND). This rate represents the bank rate that usually meets the short- and medium-term financing needs of the private sector and is highly correlated with and influenced by the sovereign's creditworthiness.
- **12-month Euribor rate:** Sourced from the European Central Bank (ECB) Data Portal. This serves as a maturity-matched, risk-free benchmark for the European economic area, allowing us to isolate the country-specific risk component.

Using the lending rate–Euribor spread as a proxy for the sovereign risk premium is consistent with the literature on emerging market financial conditions. In many smaller Eastern European economies, sovereign bond market data are limited or fragmented, whereas bank lending rates reliably reflect sovereign creditworthiness, capital structure risks, and macroeconomic

vulnerabilities (Akitoby & Stratmann, 2006; IMF, 2021). Prior studies adopt lending rates or domestic interest-rate spreads when bond yield data are scarce, noting that lending conditions incorporate sovereign risk through the domestic interest-rate structure, which itself responds to fiscal and macroeconomic fundamentals (Kling et al., 2025; Reinhart & Rogoff, 2004). Thus, while the measure is not a pure sovereign bond spread, it effectively captures the country's risk premium embedded in domestic financial intermediation.

Although the World Bank lending rate is denominated in local currency and the Euribor rate in euros, this currency difference does not undermine the validity of the spread. The measure captures the differential between domestic financing costs and a euro-area benchmark, a practice widely applied in international finance. Because many Eastern European economies operate in close financial proximity to the euro area, often through exchange-rate pegs, currency boards, or significant euroization—the Euribor provides a natural and economically relevant reference rate (Neanidis, 2010). The resulting spread therefore reflects the risk-adjusted premium domestic borrowers face relative to European financial conditions, which are themselves shaped by sovereign credit risk. Nonetheless, we acknowledge that the measure may also embed local monetary frameworks or banking-sector characteristics, and we explicitly list this as a limitation.

3.1.2 Key Independent Variable

- **Climate Vulnerability:** Measured using the vulnerability score from the Notre Dame Global Adaptation Initiative (ND-GAIN) Index. This composite score quantifies a country's exposure, sensitivity, and lack of adaptive capacity to climate change. Higher values indicate greater vulnerability.

3.1.3 Control Variables

All control variables were sourced from the World Bank WDI to maintain a consistent open-data framework:

- **Inflation (%):** Annual consumer price inflation (%). Incorporated to account for the transmission of monetary policy effects to risk premiums.
- **GDP Growth (%):** Annual percentage growth rate of GDP. Strong growth is expected to lower the risk premium by improving debt sustainability.
- **Current Account (mld):** Current account balance in millions of U.S. dollars (BoP, current US\$). A deficit may signal external imbalances and increase the risk premium.

- **Claims on Government (%):** Claims on central government and public entities (% of GDP). This variable captures the banking sector's exposure to sovereign risk. A higher value indicates greater interconnectedness and potential vulnerability to sovereign stress.

3.1.4 Global Shock Dummy Variable

- **COVID-19 Dummy:** A binary variable equal to 1 for the year 2020 and 0 otherwise. This controls for the unprecedented global economic and financial disruption caused by the COVID-19 pandemic, which caused widespread volatility in risk assessments.

3.1.5 Country Coverage and Time Period

The sample includes 10 Eastern European countries from 2007 to 2023, yielding a balanced panel of 170 observations. The period was selected to ensure data availability and to capture the effects of major global shocks, such as the COVID-19 pandemic.

3.2 Econometric Model

Before estimating the panel regression models, we conducted all standard diagnostic tests required for classical panel analysis (Baltagi, 2008). The results are summarized in Table 1. The Modified Wald test (for heteroskedasticity) and the Wooldridge test (for serial correlation) both yielded P-values of 0.0000, strongly indicating the presence of both heteroskedasticity and first-order serial correlation within the panels. In addition, Pesaran's CD test revealed significant cross-sectional dependence (CSD) (CD statistics = 7.50, P-value = 0.000), likely reflecting common global shocks and strong regional financial linkages among Eastern European economies.

Table 1. Diagnostic Test Results

Test	Null Hypothesis (H_0)	Statistic	P-value	Conclusion
Heteroskedasticity (Modified Wald)	Homoskedasticity ($\sigma_i^2 = \sigma^2$)	$\chi^2(10)$ = 60.34	0.0000	Reject H_0 (Heteroskedasticity present)
Serial Correlation (Wooldridge Test)	No first-order autocorrelation	$F(1,9)$ = 72.771	0.0000	Reject H_0 (Serial correlation present)
Cross-Sectional Dependence (Pesaran CD Test)	Weak CSD	$CD = 7.50$	0.0000	Reject H_0 (CSD present)

Consequently, we applied second-generation panel unit root tests that are robust to cross-sectional dependence. We employed the Pesaran (2007) CIPS test, including a constant and trend term. The results, presented in Table A1 in the appendix, indicate that for all variables in levels (Risk Premium, Climate Vulnerability, Inflation, GDP Growth, Current Account, and Claims on Government), the null hypothesis of a unit root cannot be rejected at conventional significance levels (all p-values > 0.05).

Table 2. Pesaran CIPS Unit Root Test Results

Variable	t-bar statistic	p-value	Conclusion (5% Level)
Risk Premium	1.783	0.940	Non-Stationary (I(1))
Climate Vulnerability	1.811	0.929	Non-Stationary (I(1))
Inflation	1.886	0.891	Non-Stationary (I(1))
GDP Growth	1.479	0.994	Non-Stationary (I(1))
Current Account	1.724	0.959	Non-Stationary (I(1))
Claims on Gov.	1.986	0.821	Non-Stationary (I(1))

Note: Note: H_0 : All panels contain a unit root. Critical value at 5% is approx. -2.88.

This suggests that the variables are non-stationary in levels. However, our main models employ **Driscoll–Kraay standard errors**, which provide a critical layer of robustness against various forms of misspecification, including non-stationarity (Hoechle, 2007). Violations of classical assumptions—heteroskedasticity, serial correlation, and cross-sectional dependence (CSD)—render standard panel estimators such as pooled OLS, random effects (RE), or fixed effects (FE) with conventional standard errors inefficient and their inference invalid. The Driscoll–Kraay estimator produces standard errors that are robust to these issues, even in panels where $T > N$, and is widely recommended in macro-financial panel analysis (De Hoyos & Sarafidis, 2006; Hoechle, 2007).

To examine the relationship between climate vulnerability and the domestic risk premium, we estimate both RE and FE models.

Model 1: Random-Effects Generalized Least Squares (RE-GLS) Model

$$\text{Risk Premium}_{it} = \beta_0 + \beta_1 \cdot \text{Climate Vulnerability}_{it} + \beta_2 \cdot \text{Inflation}_{it} + \beta_3 \cdot \text{GDP Growth}_{it} + \beta_4 \cdot \text{Current Account}_{it} + \beta_5 \cdot \text{Claims on Government}_{it} + \beta_6 \cdot \text{Covid Dummy}_t + u_i + \varepsilon_{it}$$

Model 2: Fixed-Effects (FE) Model

$$\text{Risk Premium}_{it} = \beta_0 + \beta_1 \cdot \text{Climate Vulnerability}_{it} + \beta_2 \cdot \text{Inflation}_{it} + \beta_3 \cdot \text{GDP Growth}_{it} + \beta_4 \cdot \text{Current Account}_{it} + \beta_5 \cdot \text{Claims on Government}_{it} + \beta_6 \cdot \text{Covid Covid Dummy}_t + \mu_i + \varepsilon_{it}$$

where:

- u_i represents the time-invariant **country-specific random effect**.
- μ_i represents the **country-specific fixed effect**.
- ε_{it} is the idiosyncratic error term.

Both models are estimated using Driscoll–Kraay standard errors with a maximum lag of 2. This estimator is robust to:

- cross-sectional dependence arising from common shocks,
- heteroskedasticity,
- serial correlation within panels, and
- unbalanced or small-N, large-T panel structures.

This makes it particularly suitable for our macro-financial panel, where T=17 years and N=10 countries.

Variance Inflation Factor (VIF) scores were all well below the critical threshold of 5, indicating that multicollinearity is not a concern.

Statistically significant country dummies (Bosnia, Bulgaria, Hungary, Montenegro, North Macedonia, and Romania) were retained, suggesting notable time-invariant country-specific influences on the risk premium. Insignificant dummies were omitted.

3.3 Hypothesis

Based on the established literature (Kling et al., 2025; Volz et al., 2020), we test the following primary hypothesis:

- **H₁:** *Ceteris paribus, a higher degree of climate vulnerability is associated with a higher domestic risk premium in Eastern European countries.*

The positive and statistically significant coefficient for vulnerability in our results provides strong evidence in support of this hypothesis.

3.4 Limitations

- **Proxy Variable:** The use of bank lending rates as a proxy for sovereign risk, while well-established and necessary due to data constraints, may capture some bank-specific risk factors in addition to pure sovereign risk.
- **Measurement of Vulnerability:** The ND-GAIN index, though comprehensive, is a broad measure and may not capture all nuanced, country-specific aspects of climate vulnerability that investors price in.
- **Sample Size:** The sample is limited to 10 countries, which may affect the generalizability of the findings, though the use of robust estimation techniques helps mitigate this concern.

Despite these limitations, the methodology provides a robust and transparent framework for assessing the impact of climate vulnerability on sovereign risk.

4. Results and Findings

4.1. Descriptive statistics

Given the heterogeneity across Eastern European economies and the importance of understanding their macro-financial profiles, Table 3 provides descriptive statistics that summarize the main features of the dataset prior to empirical estimation.

Table 3. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Risk Premium (%)	170	7.2404	3.8297	.07	19.30
Climate Vulnerability	170	0.3637	0.0441	.26	.44
Inflation (%)	170	5.2162	7.3666	-1.58	59.22
GDP Growth (%)	170	2.5033	3.8996	-15.31	13.93
Current Account (mld)	170	-2.479	5.1311	-27.36	5.678
Claims on Gov. (% GDP)	170	5.3362	10.1250	-22.13	31.74
Covid Dummy	170	0.0588	0.2360	0	1

The risk premium exhibits considerable dispersion ($SD = 3.83$), suggesting meaningful heterogeneity in financial conditions across the region. The climate vulnerability index shows moderate variability, with scores ranging from 0.26 to 0.44, reflecting structural differences in exposure and adaptive capacity. Macroeconomic indicators such as inflation and GDP growth display wide ranges, consistent with the diverse monetary regimes and cyclical patterns across Eastern European economies. This variation supports the suitability of panel econometric

techniques and helps identify robust relationships between climate vulnerability and sovereign risk.

4.2. Regression results

Although both Fixed-Effects (FE) and Random-Effects (RE) models are reported, our primary interest is not in choosing between the two but in demonstrating the robustness of the climate–risk relationship under alternative specifications. Traditionally, a Hausman test would be used to select between FE and RE. However, as noted in the econometric literature, the Hausman test is not valid when error structures violate classical assumptions—particularly under cross-sectional dependence and heteroskedasticity (Sarafidis & Wansbeek, 2012). Because our diagnostic tests identified such violations, a Hausman-based model selection would be unreliable.

Therefore, instead of selecting a single preferred model, we present both FE and RE estimations with Driscoll-Kraay robust errors, emphasizing the consistency of the coefficient on climate vulnerability across specifications. This approach follows the robustness-oriented empirical strategy common in climate-finance research.

The regression results from both Random-Effects (RE) and Fixed-Effects (FE) models, estimated with Driscoll-Kraay standard errors, are presented in Table 4. Both models show strong explanatory power, with the RE model achieving an R-squared of 0.711 and the FE model a within R-squared of 0.499. The Wald chi-square statistic of 13293.34 ($p < 0.000$) for the RE model and F-statistic of 284.23 ($p < 0.000$) for the FE model indicate excellent overall model fit.

The core finding of our analysis is the statistically significant positive relationship between **climate vulnerability** and risk premium across both model specifications. In the RE model, the positive coefficient indicates that a one-unit increase in the climate vulnerability index is associated with a 48.13 percentage point increase in the risk premium. The FE model shows an even larger coefficient of 97.79, suggesting that within-country changes in vulnerability have substantial effects on borrowing costs. These results provide strong support for our hypothesis that markets price climate risk into sovereign debt instruments.

Table 4. Random and Fixed-Effects Models

Risk Premium (%)	RE Model		FE Model	
	Coef.	P > t	Coef.	P > t
Climate Vulnerability	48.133 ***	0.000	97.787 ***	0.000
L2. Inflation (%)	0.180 ***	0.000	0.147 ***	0.000
GDP Growth (%)	-0.267 ***	0.004	-0.223 ***	0.002
Current Account (mld)	0.088 **	0.048	0.089 **	0.032
Claims on Gov. (% GDP)	-0.131 ***	0.000		
L1. Claims on Gov. (% GDP)			-0.137 **	0.016
Covid Dummy	-2.981 ***	0.005	-2.430 ***	0.004
<i>Constant</i>	-7.678	0.000	-27.233	0.000
Country Dummies				
• Bosnia	-3.960	0.000		
• Bulgaria	-2.669	0.000		
• Hungary	-2.364	0.093		
• Montenegro	-2.493	0.003		
• Macedonia	-1.929	0.000		
• Romania	-2.293	0.046		
Observations	150		150	
R-squared	0.711		0.499 (within)	

Note: *** p<0.01, ** p<0.05, * p<0.1*

Some of the Dummy Countries (East Europe Countries: Belarus, Czechia, and Moldova) have not been included in the model since they were statistically insignificant. Albania has been used here as a reference country. Statistical significance is found only in the Country Dummies of the Balkan region.

The control variables generally show relationships that are consistent with or can be explained by the existing literature:

- **Inflation** (lagged two periods) exhibits a positive and statistically significant relationship, consistent with theoretical expectations that price instability increases risk perceptions and erodes the real value of debt repayments (Akitoby & Stratmann, 2006).
- **GDP growth** shows a negative relationship, supporting the conventional wisdom from Baldacci and Kumar (2010) that stronger economic performance enhances debt sustainability and reduces sovereign risk.

- The **current account balance** shows a positive coefficient. While a surplus is typically associated with lower risk, this result may reflect the specific context of emerging Europe, where some surplus countries might simultaneously experience other risk factors, such as subdued domestic demand or banking sector vulnerabilities, not fully captured by the model.
- **Claims on government** shows a negative relationship. This could indicate that higher banking sector exposure to sovereign debt creates a captive domestic investor base, which markets may perceive as a stabilizing factor in the short term, insulating the government from immediate refinancing pressures.
- The **COVID-19** dummy variable carries a statistically significant negative coefficient, indicating that risk premiums declined during the pandemic period. Although this may appear counterintuitive given the severe economic contraction in 2020, the result reflects the extraordinary monetary conditions that prevailed during the crisis rather than any improvement in country fundamentals. Major central banks, including the ECB and the Federal Reserve, implemented aggressive policy interventions, including substantial liquidity injections, large-scale asset-purchase programs, and significant reductions in policy rates (Federal Reserve, 2020; Hutchinson & Mee, 2020). These measures compressed global risk spreads and pushed benchmark rates such as the 12-month Euribor sharply downward. Because our risk premium measure is defined as the difference between domestic lending rates and Euribor, the collapse in Euribor mechanically reduced the spread even when domestic credit conditions did not improve. This policy-driven compression of yields is widely documented in the literature (Feyen et al., 2021; Hutchinson & Mee, 2020; IMF, 2021; Rebucci et al., 2020). For Eastern European economies, strong financial integration with the euro area further amplified the transmission of these global monetary effects (BIS, 2020; Checo et al., 2024; Neanidis, 2010). Thus, the negative coefficient should be interpreted as a reflection of global financial conditions rather than an indication of improved sovereign creditworthiness during the pandemic.
- The RE model reveals significant **country-specific effects**, particularly for Balkan countries. Bosnia and Herzegovina shows the largest negative fixed effect ($\beta = -3.960$), followed by Bulgaria, Montenegro, and North Macedonia. These effects capture time-invariant country characteristics that influence risk premiums beyond the included explanatory variables.

4.3. Discussion of Findings

Our empirical results provide compelling evidence that climate vulnerability significantly increases sovereign risk premiums in Eastern European countries. The positive and statistically significant coefficients across both model specifications support the hypothesis that financial markets price climate physical risk into sovereign debt instruments. The economic magnitude of the effect is substantial, a one-standard-deviation increase in climate vulnerability (0.044 points) is associated with a 2.12 percentage point increase in the risk premium in the RE model and a 4.30 percentage point increase in the FE model.

The larger coefficient in the FE model suggests that within-country deteriorations in climate vulnerability have particularly strong effects on borrowing costs, possibly because markets perceive these changes as signaling worsening future risk trajectories.

The persistence of this relationship after considering macroeconomic fundamentals, global shocks, and country-specific effects underscores the independent importance of climate factors in sovereign risk assessment.

The negative coefficient on the COVID-19 dummy aligns with global financial market dynamics during the pandemic period, where unprecedented central bank interventions and fiscal support measures compressed risk premiums despite severe economic disruptions. This finding highlights how policy interventions can temporarily override fundamental risk drivers in sovereign debt markets.

The country-specific effects reveal important regional patterns, with Balkan countries generally showing lower risk premiums, possibly reflecting market perceptions of European integration prospects or other unobserved regional characteristics.

These findings have important implications for both policymakers and investors, suggesting that climate resilience investments may yield financial returns through reduced borrowing costs, and that climate vulnerability represents a material risk factor in sovereign debt valuation.

5. Conclusions

This study provides robust empirical evidence that climate vulnerability significantly increases sovereign borrowing costs in Eastern European economies. Through analysis of a balanced panel of ten countries from 2007 to 2023, we demonstrate that higher climate vulnerability, as measured by the ND-GAIN index, is associated with substantially higher risk premiums. Our findings remain statistically significant and economically meaningful after controlling for

traditional macroeconomic determinants, country-specific effects, and major global shocks including the COVID-19 pandemic.

The Random-Effects model indicates that a one-unit increase in climate vulnerability is associated with a 48.13 percentage point increase in the risk premium, while the Fixed-Effects model suggests an even larger effect of 97.79 percentage points. These results confirm that financial markets price climate physical risk into sovereign debt instruments, creating tangible financial costs for vulnerable nations.

This research makes several important contributions to the literature on climate economics and sovereign risk:

- First, we provide compelling evidence that climate vulnerability functions as a systematic risk factor in sovereign debt markets, extending the work of Volz et al. (2020) and Kling et al. (2021) to the specific context of Eastern European economies. Our findings suggest that the traditional sovereign risk framework, which focuses primarily on macroeconomic fundamentals, requires expansion to incorporate environmental risk factors.
- Second, we demonstrate that the climate risk premium persists even after accounting for country-specific heterogeneity and global shocks, indicating that climate vulnerability represents an independent determinant of borrowing costs rather than merely correlating with other risk factors.
- Third, our methodological approach—using Driscoll-Kraay standard errors and appropriate lag structures—provides a robust framework for analyzing climate risk in sovereign debt markets while addressing common econometric challenges including cross-sectional dependence and reverse causality.

This study demonstrates that climate vulnerability represents a material and statistically significant determinant of sovereign borrowing costs in Eastern European economies. The identification of a substantial climate risk premium underscores the financial imperative of building climate resilience and adapting to changing environmental conditions. As climate impacts intensify in coming decades, the financial costs of vulnerability will likely increase, making proactive adaptation not merely an environmental necessity but a strategic economic priority.

For the countries of Eastern Europe, our findings suggest that investments in climate resilience can yield direct financial returns through reduced risk premiums and improved access to capital

markets. For the international community, our results highlight the importance of supporting climate adaptation in vulnerable regions both for environmental reasons and for maintaining financial stability. Ultimately, addressing the climate crisis requires recognizing that environmental and financial resilience are increasingly inseparable goals in the twenty-first century.

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Data Sources

World Bank World Development Indicators (WDI)

European Central Bank (ECB) Data Portal

Notre Dame Global Adaptation Initiative (ND-GAIN) Index

PREDICTING TTDI SCORES IN OECD COUNTRIES: A K-NN REGRESSION APPROACH FOR SUSTAINABLE TOURISM ANALYSIS

Assoc. Prof. Dr. Çiğdem ÖZARI

İstanbul Aydın University, cigdemozari@aydin.edu.tr

ORCID ID:0000-0002-2948-8957

Abstract

This study seeks to forecast the Travel and Tourism Development Index (TTDI) scores of OECD countries by a cross-sectional k-Nearest Neighbors (k-NN) regression approach. The forecast is based on a reduced set of four key predictors-CO₂ emissions per capita, energy intensity of primary energy, GDP per capita and local purchasing power index. These factors account for core environmental and socio-economic dimensions applicable to tourism development. This study uses machine learning and sustainability data to add to the growing research on sustainable tourism. The results of the study indicate variability in model performance between different training datasets: the strongest model explains almost 70% of the variation in TTDI scores, while even the poorest one captures about 45%. This indicates that the above four predictors are far more informative and crucial to TTDI prediction. In general, the results reveal that both lower emissions and efficient energy use have positive impacts on tourism competitiveness in OECD countries as do higher income and purchasing power levels.

Keywords: Travel and Tourism Development Index, OECD, k-NN regression.

OECD ÜLKELERİNDE TTDI SKORLARININ TAHMİNİ: SÜRDÜRÜLEBİLİR TURİZM ANALİZİ İÇİN K-NN REGRESYON YAKLAŞIMI

Özet

Bu çalışma, OECD ülkelerinin Seyahat ve Turizm Gelişim Endeksi (TTDI) skorlarını kesit veri yapısında k-en Yakın Komşu (k-NN) regresyon yaklaşımıyla tahmin etmeyi amaçlamaktadır. Tahmin süreci, kişi başına düşen CO₂ emisyonu, birincil enerjinin enerji yoğunluğu, kişi başına düşen GSYH ve yerel satın alma gücü endeksi olmak üzere dört temel değişkene dayanmaktadır. Bu göstergeler, turizm gelişimine uygulanabilir temel çevresel ve sosyo-ekonomik boyutları temsil etmektedir. Sonuçlar, eğitim veri kümeleri arasında model performansının değiştiğini göstermektedir: En güçlü model TTDI skorlarındaki varyasyonun yaklaşık %70'ini açıklarken, en zayıf model dahi yaklaşık %45'ini açıklayabilmektedir. Bu durum, söz konusu dört göstergenin TTDI tahmininde son derece bilgilendirici ve belirleyici olduğunu göstermektedir.

Genel olarak bulgular, daha düşük emisyon seviyeleri ve enerji verimliliğinin OECD ülkelerinde turizm rekabetçiliğini olumlu etkilediğini; yüksek gelir ve satın alma gücü düzeylerinin de benzer şekilde pozitif katkı sağladığını ortaya koymaktadır.

Anahtar Sözcükler: Seyahat ve Turizm Gelişim Endeksi, OECD, k-NN regresyon.

1. Introduction

Tourism is becoming one of the most climate threatened industries due to reasons such as extreme weather, hotter temperatures and reduced resources. To compete, nations ought to become more cognizant regarding the way they conduct tourism in these strangled economies. Furthermore, the effects of tourism development are manifested at various spatial scales, which range from national to regional levels and further down to a local scale depending largely on the density and concentration of tourist activities (Hacia, 2019). Insights into dynamics in this sector are essential for developing policies that help the sustainable tourism, CO₂ reduction and achieving of sustainability goals (Wang & Cheablam, 2025).

The Travel and Tourism Development Index (TTDI), developed by the World Economic Forum, provides a multidimensional framework for assessing tourism performance across various pillars, including sustainability, infrastructure, natural and cultural resources, and enabling environment. Building on this framework, this study employs a k-Nearest Neighbors (k-NN) regression model to predict TTDI scores for OECD countries by the help of climate-related and socio-economic indicators. The main contribution of this study to the literature is to demonstrate that k-NN algorithm, which is often associated with classification problems, can also be effectively applied as a regression method in cross-sectional data settings. By dealing with a small-sample data set from different years, the study also aims to illustrate how k-NN regression can be employed as an alternative prediction, non-parametric method without relying on strong distributional assumptions. Furthermore, the proposed framework allows for the examination of how the variables included in the model may be reconsidered or refined based on their role in the prediction process. The empirical analysis relies on variables including per capita CO₂ emissions, renewable energy consumption, GDP per capita, and tourism revenues as explanatory factors. Data preprocessing involved normalization and cross-validation procedures to determine the optimal values of k, while model performance was evaluated against conventional regression benchmarks.

The selection of these variables is based on the premise that tourism development is a multidimensional phenomenon, primarily influenced by a country's economic strength, environmental performance, and resource efficiency. In other words, countries that are wealthier, more sustainable, and more energy-efficient tend to provide better tourism experiences and remain competitive over time. Since TTDI consists of 5 dimensions, 17 pillars, and more than 100 indicators (World Economic Forum, 2024), predicting TTDI is essential for identifying its key drivers and supporting evidence-based tourism development. Moreover,

being able to estimate TTDI with a smaller set of explanatory variables makes cross-country prediction more practical and valuable for policymakers. Predicting TTDI scores using these variables is of particular relevance to the literature, as it enables the examination of how different dimensions jointly relate to overall tourism development performance.

2. Theoretical Framework

Tourism competitiveness has been widely discussed by the academics, heightened with realization that tourism is a multi-dimensional and knowledge-based industry subject to various economic, social, environmental and institutional determinants. Hence, researchers have always insisted that performance of tourism sector of a country could not be solely determined through the traditional market results like tourist arrivals or tourism receipts. Rather, a holistic comprehensive assessment of enabling conditions--policy environment, infrastructure/sustainability practices, resource endowment and technological readiness--is essential to assess the long-term development potential of the tourism ecosystem. In this connection, the TTDI, which was designed and released by the World Economic Forum (WEF), has become an important global reference. TTDI provides a comprehensive and systematic analytical framework to determine the level of tourism development using five main dimensions, namely enabling environment; travel and tourism policy; infrastructure and services; natural and cultural resources; and sustainability (World Economic Forum, 2024).

There is ample literature emphasizing the importance of economic capability as a fundamental determinant of tourism competitiveness. In general, countries with higher GDP per capita will have access to better quality facilities and services, have a greater level of digital connectivity and stronger institutional capacities - all factors that contribute to a more enjoyable experience in the country for tourists. Vašaničová's (2025) study also provides empirical evidence to show that TTDI scores are highly determined by countries' economic and urban development performance indicators, which suggests that the factor of economic capacity and service-sector maturity is still dominant in determining tourism competitiveness. Similarly, the tourism system reports of OECD (OECD 2020; OECD 2022) highlight that countries with a solid economic base and diversified service producers as well as those with high investment in touristic amenities perform much better than the other global counterparts. Comparable findings are also found in the earlier study of Croes and Kubickova (2016), which identifies tourism competitiveness is a second order constructing, consisting of macroeconomic stability, productivity, institutional quality and market sophistication.

Environmental sustainability and climate-related dimensions have also gained increasing prominence in recent literature, reflecting the evolving global discourse around sustainable tourism. Giambona et al. (2024) provides a comprehensive assessment of tourism sustainability trends within the European Union and concludes that environmental performance, resource efficiency, and renewable energy adoption substantially influence tourism development outcomes. Sustainable tourism research highlights that high carbon emissions, energy inefficiency, and environmental degradation not only diminish destination attractiveness but also threaten the long-term viability of local tourism ecosystems. This perspective aligns with the TTDI's expanded methodological approach, which gives greater weight to sustainability indicators, such as environmental stewardship, resource management, and climate resilience. In the context of OECD economies, these indicators are particularly relevant, as many OECD member countries are transitioning toward low-carbon economies and integrating sustainability principles into national tourism strategies.

A second line of literature looks at infrastructure and service capacity as the main drivers for tourism performance. Research consistently reveals that the competitive advantage of tourism is closely related to transportation infrastructure, accommodation class, digital connectivity and urban facility. Vašaničová's (2024) methodological review of TTDI also emphasizes the importance of modern infrastructure indicators, considering that advances in transport connectivity, urban mobility and digitalization are behind the increase on TTDI scores largely demanded by Europe and OECD members. Other empirical research also underscores that nations possessing strong mobility networks, efficient airports and robust health and hygiene systems are likely to offer more reliable and attractive tourism experiences stimulating the competitiveness of products in line with international demand. Consistent with these results, Qazi (2024) indicates that competitive advantage in tourism is improved by both infrastructure and services and, information and communication technologies readiness.

Studies that examine the relationship between TTDI scores and other variables are commonly found in the literature. For example, Vasanicová (2025) investigated the impact of tourism competitiveness on urban development and economic return indicators as well. The results indicated that higher urban infrastructure and stronger economic power play an important role in enhancing countries' TTDIs. In the study by Nunes et al. (2024) examines TTDI for the years 2021–2024 and uses a binary logistic regression to discriminate the main determinants of tourism competitiveness. This study results indicate that powerful infrastructure, strong human resources which are well-trained have the highest effect on the TTDI scores. In addition, this

study provides practical implications to policy makers who expect to improve tourism attractiveness.

A third line of literature has to do with worldwide tourist governance and policy related categories. The specific studies of country's WEF (2023) explore the ways in which policy impact, quality regulations and performance data-oriented governmentality define trajectories for the development of tourism. In the case of Türkiye, for example, the WEF's 2023 report underscores that digital transformation and big-data integration along with sustainability-driven reforms are strategic means to improve tourism sector performances. Despite the availability of a rich empirical literature, methodological challenges persist.

The majority of papers that have examined the determinants of TTDI or tourism competitiveness use linear econometric models, structural equation modeling or index decomposition analysis. Although these approaches provide one important piece of information, other nonlinear relationships, multidirectional interactions and complicated dependencies among explanatory variables cannot be fully discovered by them. Availability of multidimensional tourism data has led academicians to venture into the pursuit of Machine Learning techniques, which can provide better flexibility and predictive accuracy. Recent developments in tourism analytics show that machine learning algorithms (e.g. random forests, gradient boosting, support vector regression and artificial neural networks) can be applied to demand modeling, sustainability indicators and destination dynamics. Yet the research on applications of k-NN regression based TTDI is rare.

This gap is also important since competitiveness is characterized by nonlinear patterns that traditional models may overlook. Variables such as CO₂ emissions per capita, renewable energy consumption, tourism revenues, energy intensity, and GDP per capita do not influence tourism development in strictly linear ways. Furthermore, interactions among climate-related and socio-economic indicators may jointly shape tourism outcomes in ways that differ substantially across countries, especially within the diverse OECD group. As an instance-based learning method, k-NN is well suited to capturing such heterogeneity because it does not impose a predetermined functional form and instead relies on the similarity structure of the data. By identifying countries with analogous environmental and economic characteristics, k-NN allows for flexible prediction of TTDI scores based on localized patterns in the data, thus providing a methodological innovation that complements and extends existing empirical research.

The literature can generally be summarized that tourism competitiveness is a dynamic and multi-dimensional notion of economic endowments, environmental quality, infrastructure building and policy effectiveness. Although studies of this tradition have made theoretical and empirical contributions, there is an increasing demand for data-driven flexible methodologies that are able to capture complex nonlinear relationships between variables in tourism systems. This gap is met with in this paper and a k-NN regression model is utilized to predict TTDI scores for OECD member countries, based on climate-related as well as socio-economic indices thus pioneering this very sparsely researched interface between machine learning and tourism competitiveness literature.

Another relevant contribution to literature comes from Štilić et al. (2024), that evaluates TTDI through a multi-criteria decision-making perspective. Although TTDI provides a comprehensive benchmark for assessing tourism conditions using five main dimension and 17 sub-criteria, it assigns equal importance to all indicators, which may not accurately reflect their real influence on tourism development. Addressing this limitation, the study applies a hybrid multi-criteria decision-making approach that integrates the MARCOS and MEREC methods to assign objective weights and generate a revised ranking of European countries. The results indicate that there is a remarkable difference between the ranking in TTDI, which is made in an official manner, and the one given by data envelopment analysis: for example, Spain is the best country, on the contrary of Turkmenistan that appears as less efficient for implementing public policies. Sensitivity analysis also confirms that these results are robust, which illustrates how TTDI might change significantly when the importance of criteria is taken into account. This study therefore demonstrates that not all TTDI indicators contribute to tourism development in the same way and weighting schemes are required to provide more realistic and policy-relevant rankings.

3. Methodology

In this section of methodology, the adopted approach, using k-NN regression method is described and an investigation into key factors that influence the prediction process. The k-NN approach occupies a distinct position in the field of data analysis due to the focus on explanation and understanding (Mahato et. al, 2018). The k-NN model was originally presented by Cover and Hart (1967) as such a solution to classification problems but can also be used for regression. k-NN regression is a key algorithm and usually k-NN classification has similar problem as in this case (Song et al., 2017). It defers to do so without imposing a strong

assumption on the real relationship. Due to this flexibility, these techniques can be applied either to explore the patterns in the data or to evaluate the goodness-of-fit of a parametric model (Altman, 1992).

The k-NN algorithm, originally designed for categorical outcome classification, can be readily adapted to regression problems and time series forecasting, where the target variable consists of continuous or interval-scaled observations (Al-Qahtani & Crone, 2013). It has been widely used in different areas such as economics (Buhori, 2024; Hakan et al., 2024; Imandoust & Bolandraftar, 2013), finance (Alkhatib et al., 2013; Arroyo, 2011; Fičura, 2017; Itoo et al., 2021; Özarı & Demirkale, 2022; Subha & Nambi, 2012; Tang et al., 2018), healthcare (Ahad et al., 2025; Al-Khamees et al., 2025; Hasanova et al., 2022; Maleki et al., 2021), environmental studies (Lin et al., 2017), and tourism demand (Novita, 2024; Tapak et al., 2019) modeling.

Owing to its non-parametric structure and flexibility, k-NN remains a popular approach for both supervised classification and continuous outcome prediction in various empirical research contexts (Cover & Hart, 1967; Zhang, 2021). Moreover, the method is widely recognized for its straightforward structure and strong practical performance (Taunk, 2019). Furthermore, existing research indicates that the method performs poorly when applied to high-dimensional or large-scale (Genesis, 2018; Naresh, 2020; as cited in Agu et al., 2022).

K-NN regression is a non-parametric, instance-based learning method used to predict continuous target values. Instead of learning a model, k-NN makes predictions by measuring the distances between the new data set (points) and all training data sets. The idea behind the regression in k-NN prediction is based on selecting the most similar (nearest) neighbors (Kohli et al., 2020). In addition, this means simply similar inputs should produce similar outputs. The neighborhood parameter k plays an important role in the accuracy of the k -NN classifier (Tharwat et al., 2018). Building on this idea, Zhang et al. (2018) show that k-NN performance improves markedly when the number of neighbors is selected adaptively rather than fixed. Their data-driven approach computes an instance-specific k value by reconstructing sparse relationships between test and training samples and preserving local data structure. Experiments on multiple real datasets demonstrate that this adaptive k-NN model outperforms traditional fixed- k versions in both classification and regression tasks.

4. Findings

As the studies' objective is to predict the value of TTDI in 2024, we have used the variables reported in Table 1 for this prediction. These inputs are based on 2022/23 collected data and form the basis for the assessment of prospective OECD country's TTDI performance. The use

of explanatory variables from different years (2022/2023) does not pose a methodological limitation for the model, as the analysis is conducted in a cross-sectional prediction framework. On the contrary, this methodology is consistent with the nature of prediction, as composite development indicators such as TTDI are shaped by economic, environmental, and structural conditions that materialize over time. Employing lagged explanatory variables allows the model to better reflect the cumulative effects of these underlying factors rather than short-term fluctuations. By using the most up to date and comparable information from across member states, our study thereby makes certain that the prediction model takes account of both the structural features as well as recent tourism-related developments (accumulated at least few months before) in OECD area. This approach makes for a better and policy relevant evaluation of what could be expected from OECD countries in the next TTDI cycle.

Table 1. Variables of Study

Variable	Source	Year	Role / Explanation
TTDI	World Economic Forum	2024	Dependent variable to be predicted.
CO ₂ Emissions per Capita	World Bank	2023	Climate pressure indicator.
Energy Intensity of Primary Energy	World Bank	2022	Sustainability/efficiency indicator — lower values indicate more efficient use of primary energy
GDP per Capita (USD)	World Bank	2023	Economic development / income level.
Local Purchasing Power Index	Numbeo	2023	Socio-economic welfare / domestic affordability.

The variables considered represent significant economic and environmental factors for the effectiveness of tourism across countries. Per capita GDP represents the overall economic capacity for making investment in tourist industry, infrastructure construction and service ability. Local purchasing power is relevant for tourists as well as residents of a destination and has an impact on tourism attractiveness or the sustainability of the labor force in the industry. At the same time, per capita CO₂ emissions are indicative of environmental externalities and reduced emissions reflect how the world is now shifting towards responsible tourism practices, along with heightened regulation regarding the environment. Lastly, energy intensity shows the

efficiency of an economy of a country and it is directly related to sectors such as transportation, accommodation or mobility-especially sensitive segments in relation to tourism activity. In aggregate, these are a rich set of variables that give depth to our understanding of the underlying economic and environmental determinants of TTDI performance.

Normalization is commonly used in k-NN models to ensure that the distance measure does not disproportionately reflect variables with larger numerical ranges (Witten et al., 2011). For this reason, all variables were normalized as the initial step of k-NN regression analysis. Since different train and data set group splits may lead to different findings, the study evaluates both the best-performing train-test partition and the worst-performing train-test partition together. Table 2 represents the best performing train-test partition. In other words, the best finding model was applied to estimate the TTDI scores for Canada, Colombia, France, Germany, Hungary, Luxembourg, Poland, and Sweden.

Table 2 Best Performing Train-Test Partition

Data	OECD Countries
Test Data	Canada, Colombia, France, Germany, Hungary, Luxembourg, Poland, Sweden
Train Data	Australia, Austria, Belgium, Chile, Czech Republic, Denmark, Estonia, Finland, Greece, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Mexico, Netherlands, New Zealand, Portugal, Slovakia, Slovenia, Spain, Switzerland, Türkiye, United Kingdom, United States

Table 3 presents the predictive performance of the k-NN regression model for different values of k, summarizing the error metrics (RMSE, MAE), explanatory power (R^2), and the corresponding standard deviations to assess model stability.

Table 3 Evaluation of Best Performance k-NN Regression Across Varying k Parameters

k	RMSE	Rsquared	MAE	RMSESD	RsquaredSD	MAESD
2	0.21	0.50	0.17	0.09	0.33	0.08
3	0.19	0.71	0.15	0.08	0.39	0.08
4	0.23	0.50	0.19	0.08	0.37	0.08
5	0.22	0.43	0.19	0.06	0.32	0.07
6	0.23	0.40	0.19	0.05	0.26	0.05
7	0.23	0.38	0.19	0.06	0.26	0.05
8	0.23	0.38	0.19	0.05	0.31	0.04
9	0.23	0.37	0.19	0.05	0.24	0.03

As seen from Table 3, $k=3$ emerges as the most optimal and balanced configuration. It yields the lowest error levels ($RMSE=0.19$; $MAE=0.15$) and the highest explanatory power ($R^2=0.71$). In addition, the relatively low standard deviations for $RMSESD$ and $MAESD$ indicate strong model stability and solid generalization performance. Overall, these findings suggest that $k=3$ is the best-performing setup, offering the strongest prediction accuracy while avoiding the risks of overfitting (as observed with $k=2$) and underfitting (as seen with $k \geq 4$). In this context, the $k=3$ model provides the most reliable balance between minimizing errors and maintaining predictive power.

Table 4 represents the worst performing train-test partition. In other words, the worst finding model was applied to estimate the TTDI scores for Denmark, Israel, Italy, Netherlands, Poland, Slovenia, Spain, Türkiye.

Table 4 Worst Performing Train & Test Partition

Data	OECD Countries
Test Data	Denmark, Israel, Italy, Netherlands, Poland, Slovenia, Spain, Türkiye
Train Data	Australia, Austria, Belgium, Canada, Chile, Colombia, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Japan, Latvia, Lithuania, Luxembourg, Mexico, New Zealand, Portugal, Slovakia, Sweden, Switzerland, United Kingdom, United States

Table 5 presents the predictive performance of the worst performance of k -NN regression model for different values of k (from 2 to the 9), summarizing the error metrics ($RMSE$, MAE), explanatory power (R^2), and the corresponding standard deviations to assess model stability.

Table 5 Evaluation of Worst Performance k -NN Regression Across Varying k Parameters

k	$RMSE$	$Rsquared$	MAE	$RMSESD$	$RsquaredSD$	$MAESD$
2	0.22	0.40	0.18	0.06	0.37	0.07
3	0.22	0.38	0.19	0.04	0.33	0.04
4	0.21	0.39	0.18	0.05	0.33	0.05
5	0.20	0.45	0.17	0.06	0.33	0.06
6	0.21	0.42	0.19	0.06	0.36	0.06
7	0.21	0.38	0.19	0.04	0.27	0.05
8	0.21	0.42	0.19	0.04	0.35	0.05
9	0.22	0.41	0.20	0.03	0.34	0.04

Even for the most ill-fitting model, approximately 45% of the variation in TTDI scores is explained by these predictors suggest they are very relevant to TTDI prediction. The possibility

to predict the TTDI values in one country using data from other countries-and doing so with consistent predictive accuracy between 2022 and 2023 information-implies that TTDI does not change randomly from year to year and is relatively stable from a modelling perspective.

5. Conclusion and Discussion

The study objective is to forecast the TTDI index that is made up of over 100 indicators for OECD member countries with information on other, different countries with a smaller set of variables. Using a cross-sectional estimation method with only a small subset of important variables turns out to be an efficient way to represent the TTDI scores and predict them. The findings of this study suggest that economic and environmental variables are strong predictors for the TTDI efficiency in the OECD countries. The k-NN regression model presents an excellent fit (up to a maximum $R^2=0.71$) and emphasizes the explanatory capacity of GDP per capita, local purchasing power, CO₂ emissions and energy efficiency. These and other variables also contribute to a comprehensive view on the concept of tourism competitiveness. These lessons offer practical advice for people who make decisions in a world that faces the threat of a shifting climate. The study also examines that these signs serve as the leading indicators in impacting TTDI findings. The successful prediction of TTDI 2024 using economy in 2023 and environment in 2022 also supports how the existing economic resilience and sustainability- focused policies directly drive. When the TTDI score can be predicted with reasonable accuracy using a limited set of economic and environmental variables, this provides policymakers with an early-warning and benchmarking tool rather than a causal policy prescription.

A key point is that such associations remain strong even when less favorable modeling conditions are introduced. Even the weakest performance train-test split of did result into a R^2 of 0.45, indicating that it appears to be the case that the chosen indicators maintain their predictive power across country combinations. Furthermore, scarce historical data and absence of uncertainty quantification are the limitations for generalization.

To sum up, the results of this study suggest that the use of a data-based method for tracking tourism competitiveness phenomena using k-NN regression would be useful. Economic robustness and environmental congeniality seem to be also significant steps for the sustaining improvement of TTDI performance in distant future. The positioning of the similar “countries” among features space is very important in k-NN model.

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SEABED SUSTAINABILITY: UNSDG 14 AND THE INTERNATIONAL LAWS OF THE SEAS

Prof. Dr Hassan SYED

Euclid University, hassan@euclidfaculty.net, ORCID ID: 0000-0003-2114-2473

Prof. Dr. Klemens KATTERBAUER

Euclid University, katterbauer@euclidfaculty.net, ORCID ID: 0000-0001-5513-4418

Prof. Dr Berna AK BİNGÜL

Kırklareli University, berna.akbingul@klu.edu.tr, ORCID ID: 0000-0002-2813-2780

Prof. Dr. Ayhan ORHAN

Kocaeli University, aorhan@kocaeli.edu.tr, ORCID ID: 0009-0002-0417-9979

Prof. Dr. Sema YILMAZ

Yıldız Technical University, sygenc@yildiz.edu.tr, ORCID ID: 0000-0002-3138-1622

Abstract

Deep-sea mining is fast becoming a major resource extraction trend amongst the advanced economies of the world. The CAGR projections for the industry state +33.8% for the period between 2023-2032. This reflects a jump from USD2.3 billion in 2023 to USD41.3 billion in 2032. The International Union for Conservation of Nature (IUCN) was founded in 1948 under the auspices of the United Nations (UN). IUCN is the world's largest environmental network of over 1300 organisations and over 10,000 environmental experts in all fields. UN Sustainable Development Goals (UN SDGs), SDG-14 addresses conservation and sustainability for using the oceans, seas, and marine resources in compliance with international law. Marine life below the depths of two hundred meters is the largest natural habitat in the world. 95% of all life forms on this planet live in this unique ecosystem. The present technological advancements for seabed extraction allow collection and excavations up to the depths of 6000 meters. The 1982 UN Convention on the Law of the Sea (UNCLOS) is the codified international law of the seas, along with other customary international laws. The scarcity of empirical data on the impact of deep seabed mining makes it difficult to regulate and navigate its impact on 95% of life living on the seabed. This paper provides an overview of UNCLOS and some of the challenges facing the sustainable use of the world's oceans and seas.

Keywords: Sustainability, UN SDG-14, UN, UNCLOS, Deep Sea Mining

1.Introduction

The 1494 Treaty of Tordesillas between the Portuguese King John II and King Ferdinand and Queen Isabella of Spain marked the sea navigational rights to make way for the exploitation of the bounties in the New World. (McCourt, 2010) It was not until the time of Grotius in 1609 that the concept of “*Mare Liberum*” or the freedom of the sea emerged in international law against the domination of the high seas by the Portuguese and the Spanish empires(Borschberg, 2005).

Legal historians of the Law of the Sea (LOS) have given much thought to the ensuing legal debates that followed the Grotian LOS doctrine of *mare liberum* as the founding principle of LOS concerning a global common of humanity. Serafim de Freitas challenged Grotius’s attack on the Iberian dominance over the seas and proffered justification for the Portuguese dominance on the seas based on the Westphalian doctrine of sovereignty (Alexandrowicz, 1959).

English scholar John Selden (circa 1636) also disagreed with Grotius's assertion of declaring the seas as the human commons. Selden gave the Anglophone version of Freitas under the doctrine of “*Mare Clausum*” or a *single nation’s right to the sea*. Selden dedicated his work to the English king at the time. Later English legal historians have termed Selden’s *Mare Clausum* as ‘*soft imperialism*’ (Somos, 2012).

Over the last many centuries, the oceans of the world have provided not only the passage to the bulk of global trade and commerce, but the oceans have also been a critical source of sustenance in the form of fish as a dietary element and fishing as an industry. The 20th-century ocean floor mineral exploration has provided billions of dollars’ worth of natural resources to the global economies of the industrialised nations that have the technology to explore the ocean beds. This paper examines the role of the United Nations Convention on the Law of the Sea (LOSC) and the UN Sustainable Development Goal 14 in helping to protect the ocean environment (UN SGDs 2015).

2.Development of Losc

The contemporary international LOS traces its history to the agenda of the LOS put before the International Law Commission (ILC) in 1949 (Sorensen, 1957). Intense work was undertaken by the ILC on the 1949 agendas of the LOS, and it was presented to the first United Nations Conference on LOS at Geneva in 1958. One of the biggest accomplishments of the 1958 LOS conference was the recognition of the Article 17 principle of the ‘*innocent passage*’ as part of

customary international law. The conference gave way to the Geneva Convention on the Law of the Sea 1958 (Verzijl, 1959).

The Geneva Convention on the Law of the Sea 1958 led to the 1967 survey report for the natural resources of the sea by Arvid Pardo of Malta. The report was presented to the First Committee of the General Assembly of the United Nations (Larson et al., 1995). Ambassador Prado's report led to the 1970 UN General Assembly Resolution #2749. Resolution #2749 established the principle of "*Common Heritage of Mankind*" concerning the world oceans, deep seabed preservation and their resources (Larschan & Brennan, 1982).

The UN Conference on LOS held 12 sessions between 1973 and 1982. The UN Conference on LOS finally adopted the Law of the Sea Convention in 1982 (Wassermann, 1982). The LOSC 1982 aimed to consolidate four fundamental conventions relating to the LOS. The four fundamental conventions are: (1) the territorial sea and the contiguous zone, (2) the high seas, (3) fishing and conservation of the living resources of the high seas and (4) the continental shelf (Rahman, 2019).

The 1982 Conference also adopted an optional protocol for the settlement of disputes arising from the interpretation and application of LOSC 1982. LOSC contains 320 articles and 9 annexes. LOSC also provides for the establishment of the *International Tribunal for the Law of the Sea* (ITLOS), the *Commission on the Limits of the Continental Shelf* (CLCS), and the *International Seabed Authority* (ISA). According to the UN,

The United Nations Convention on the Law of the Sea was opened for signature at Montego Bay, Jamaica, on 10 December 1982. It entered into force on 14 November 1994 and is presently binding for 154 States, as well as the European Community. It is considered the "constitution of the oceans" and represents the result of an unprecedented, and so far, never replicated, effort at codification and progressive development of international law (LOSC, 2019).

In its simplest form, the LOSC provides for the sovereign control of each country's waters within 12 nautical miles of its coastline. Every country can also claim an exclusive economic zone (EEZ) of 200 nautical miles to regulate its scientific research and for the exploitation of marine resources on the seabed (Moraes, 2019). The most significant challenges for the LOSC since its adoption in 1994 relate to the increased human activity related to the exploitation of the ocean resources. There are also significant impacts on the world's oceans due to anthropogenic activities on the landmass that contribute to the natural environment of the world's oceans.

The most significant contribution of the LOSC is that it changed the worldview of international law by shifting the relationship of mankind with the world's oceans. LOSC transformed the legal perspective concerning the world's oceans. It is a subjective instrument of commercial law protecting the common sea heritage of the entire mankind. The focus is now shifting further towards understanding not only the human rights towards the oceans as humanity's commons, but also to view the rights of the countless species that are within the oceans' environment or are dependent on the health of the oceans.

This shifting world view of the LOS from the narrow view of property and commercial law to the expanded views of the human rights law and environmental law is one of the key positive improvements.

This shift poses challenges to the neo-imperialism of Western powers that have historically viewed the world oceans as their domain to exert economic and military power over the global south. This shift also calls for environmental justice for those nations that are being adversely impacted by the overt extractivism of ocean resources. This shifting view creates a collective moral responsibility towards the ocean environment that is much more holistic than the legally binding obligations on the States to uphold the LOSC in their various activities upon the seas and on the ocean floors.

3.Ocean Environment & Losc 1994

International Environmental Law (IEL) has a much shorter history than most of the other codified or customary contemporary international laws. LOS and IEL have many common themes. There is also a common thread of climate change impacts between the LOS and IEL. The 1972 *Stockholm Conference on Human Environment* accelerated the IEL norms within domestic and international law. The LOSC development between the 1950s and 1980s provides a focus on the environmental protection of the world's oceans.

LOSC came into force in November 1994 (UNCLOS, 1994). There are 320 articles within the LOSC explaining the provisions concerning state obligations to the LOS. There are 59 articles out of the total 320 articles within LOSC 1994 that explain the State obligations for protecting the ocean environment and its conservation (Stephens & Rothwell, 2012).

LOSC, therefore, serves as the statutory *constitution of the seas* by its codification and articulation of environmental issues concerning the world's oceans. The 59 provisions of the LOSC concern the state obligations for the ocean environment, their conservation, their

management of living organisms, prevention and control of pollution, control of pollution from marine vessels, rules for dumping pollutants on high seas and general environmental management (Rothwell & Stephens, 2010).

The Arctic ice shelf is one of the key areas of environmental degradation that has caught the eye of environmental scientists and environmental lawyers collectively (Larkin, 2009). Political geographies and the polar outer continental shelf are topics that cannot be adequately covered under IEL, especially the displayed threat of hegemony over the Arctic by Western regimes, especially the United States of America.

LOSC provides a much broader perspective under its Article 197 that gives way to global inclusive obligations to protect the oceans and abide by common legal principles that will help to minimise the damage to the Earth's oceans. Article 197 states,

“States shall co-operate on a global basis and, as appropriate, on a regional basis, directly or through competent international organisations, in formulating and elaborating international rules, standards and recommended practices and procedures consistent with this Convention, for the protection and preservation of the marine environment, taking into account characteristic regional features (UNCLOS, 1994).”

Article 237 and Article 293 of LOSC further strengthen the State obligations towards environmental protection and conservation of oceans by giving force also to the past and future international customary laws and conventions for the protection of the ocean environment. Article 237 “*Obligations under other conventions on the protection and preservation of the marine environment*” clarifies that the State obligations subsist “*without prejudice to the specific obligations assumed by states under special conventions and agreements concluded previously*”. LOSC also provides for the flexibility to interpret and show deference to any other treaties or legal decisions that may be consistent with the codified provisions within LOSC and are part of other IEL customary law. LOSC Article 293 clarifies that by stating that, “*an UNCLOS tribunal shall apply this Convention and other rules of international law not incompatible with this Convention*”(UNCLOS, 1994, Article 293).

4.Losc Article 192: Marine Pollution

The earth's 75% surface is oceans, and only 25% is a landmass that is home to countless life forms at the atomic and sub-atomic levels. Scientists agree that the contemporary age can be termed *Anthropocene* due to the human impact on the Earth's climate and environment. In 2018,

literature emerged that points to the “*great Pacific garbage patch*” that covers an area in the Pacific Ocean of over 1.6 million square kilometers (Lebreton et al., 2018). Literature also points to the Western cruise ships dumping raw sewage and other pollutants at high seas (Klein, 2010).

LOSC Article 192 calls for protecting the marine environment against pollution that does not preclude pollutants that make their way from land to the sea (UNCLOS, 1994, p. Article 192). Articles 193, 194 and 195 further narrow the State obligations to take all necessary precautions to reduce pollution of the marine environment in all forms. Article 212 further adds aerial or atmospheric pollution to the marine environment as one of the areas to be addressed by the States in ensuring the protection of the sea.

The fragility of the ocean's ecosystems has become evident in the recent scientific studies, which revealed the decay and detrimental destruction of the Australian Great Barrier Reef due to climate change and anthropogenic pollution on land, sea and atmosphere (Curnock et al., 2019). LOSC Article 194(5) tackles the marine pollution prevention activities that “*include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life*” (UNCLOS, 1994, Article 194(5)).

LOSC Article 194(5) confirms earlier IEL instruments such as CITES 1975 Article 61 of the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (Garrison, 1994). Article 61 CITES states that “*states should not endanger living species*” and further speaks to the marine life protection in Articles 65 and 120 at high seas and in the exclusive economic zones (EEZ).

5.Un Sdgs & Marine Protection

The UN has been at the forefront of shining light on the anthropogenic impact on the ocean environment of the planet. The UN Environmental Protection Agency (UNEP) reports that 80% of the world's wastewater that reaches the oceans from the land is untreated (UNEP, 2017). It was with this in mind that the UN included Goal 14 in its Sustainable Development Goals (SDGs) for 2030 as an agenda for “*Life Below Water*” (Costanza et al., 2016).

The fact that the world's 3 billion people rely on the oceans for their sustenance and their livelihood is threatened should be an alarm. 40% of the world's oceans are in distress due to overfishing or commercial fishing, which includes a threat to the traditional fishing communities, such as the First Nations in Canada and other indigenous communities. Finally,

25% of the world's coral reefs have been damaged by the anthropogenic impact leading to climate change.

There are no easy solutions for these challenges that have been highlighted in the UN SDG Goal 14. However, Goal 14 provides the global community with a unique opportunity to come together and enhance the efforts to preserve and manage the Earth's oceans in a sustainable way. The fact that the oceans absorb 30% of the total anthropogenic CO₂ emissions should motivate the global community to transform its relationship with the Earth's oceans (Cao et al., 2009). The acidification of oceans has been recognised as one of the newest forms of anthropogenically triggered environmental threats, not only to the oceans but also to the ability of the Earth's environment to sustain future life (Abbasi & Abbasi, 2011).

Scientists have established that the 30% absorption of the anthropogenic CO₂ by the oceans holds the delicate balance between the oceans' ability to sustain life below and above the water in many ways. The conclusion by some of the leading and respected marine scientists is that,

By 2050, live corals could become rare in tropical and sub-tropical reefs due to the combined effects of warmer water and increased ocean acidity caused by more carbon dioxide in the atmosphere. The loss of coral reefs will reduce habitats for many other sea creatures, and it will disrupt the food web that connects all the living things in the ocean (Barker & Ridgwell, 2012).

The UNSDG Goal-14 requires that the targets reflected in the goal must be achieved by integrating each of the targets in the overall implementation strategies for the UN SDGs 2030. The implementation of SDG 14(5) called for the conservation of at least 10 per cent of global coastal and marine areas. The achievement of SDG 14(5) as envisioned in 2015 required the implementation of consistent strategies based on national and international law in light of the latest available scientific information by 2020 (Rees et al., 2018).

UNSDG Goal 14 has mobilised various other international interventions to address the anthropogenic marine degradation. Following the announcement of the UN SDGs for 2030, the UN General Assembly (UNGA) adopted Resolution 71/123 on 7 December 2016. The UNGA has called for renewed action to manage the global fisheries and to protect the high seas and deep-sea ecosystems and species. UNGA Resolution 71/123 also called for the review of UN SDG 14(5) and Aichi Biodiversity Targets in 2020 (VanderZwaag, 2019). It remains to be seen how that can be achieved with the global conflicts in Black Sea, the Mediterranean Sea, the Red Sea and the threat by the US Trump Administration to colonise Greenland.

As a follow-up to the UNSDG-14, the UN launched the Decade of Ocean Science for Sustainable Development 2021–2030 in 2017. The initiative was launched to promote scientific programs that could come up with solutions to offset the anthropocentric impacts on the marine environment (McLean, 2018). Scientists agree that ocean research is one of the key areas of priority if the global climate change efforts under the UN SDGs are to make any meaningful impact (Visbeck, 2018).

The Correlation Between LOSC and UN SDG14

The United Nations Convention on the Law of the Sea (UNCLOS or LOSC) is the overarching legal framework for all ocean activities and is considered essential for the achievement of **Sustainable Development Goal 14 (SDG 14): Life Below Water**. SDG 14 includes a specific target (Target 14.c) dedicated to the implementation of international law as reflected in UNCLOS.

The correlation between UNCLOS also provides the *legal* framework through which the *aspirational targets* of SDG 14 can be implemented by UN Member States. The effective implementation of UNCLOS provisions at the national level is a prerequisite for achieving many of SDG 14's specific goals.

The provisions of UNCLOS support several specific SDG 14 targets, including those related to preventing marine pollution, managing and protecting marine ecosystems and establishing marine protected areas, conserving and managing living marine resources (including through agreements like the UN Fish Stocks Agreement), encouraging international cooperation in marine scientific research and technology transfer, and implementing international law as reflected in UNCLOS. UNCLOS serves as the legal framework for state actions in the ocean, while SDG 14 outlines goals for marine environment health and sustainability.

There are clear similarities between the various UN-sponsored initiatives for the revitalisation, protection and management of the marine environment that started with the LOSC and have gained momentum under UNSDG Goal-14. The 2017 Decade of the Oceans initiative (“**the Decade**”) led to the UNESCO Intergovernmental Oceanographic Commission (IOC) project. IOC has been tasked by the UNGA “*to prepare and coordinate the development of an Implementation Plan for the Decade during the Preparatory Phase (2018–2020)*” (Trakadas et al., 2019).

In 2018, a draft roadmap was prepared by the IOC. The "*Roadmap for the UN Decade of Ocean - Science for Sustainable Development*" provides an initial guide for the steps and processes needed to develop an *Implementation Plan for the Decade* (Lee, 2019). One of the key initiatives that has come out of the IOC roadmap is to educate the future generation about the need to protect and revitalise marine life for the planet to be able to sustain life.

The IOC / UNESCO Regional Bureau for Science and Culture in Europe is focusing on "*Ocean Literacy*" by introducing topics of marine conservation in the school curricula in 36 countries around the world. The UNESCO Director-General, Audrey Azoulay, speaking at the opening of the 51st Session of the IOC Executive Council, stated that, "*All countries are now aware that our ocean is in danger, making decisions is urgent, and we must act. Most of all, we must transform knowledge and scientific research in concrete actions. We aim to engage the private sectors, politics and all citizens to create a deep-rooted sense of common knowledge*" (UN IOP, 2018).

6. Conclusions

LOSC is a comprehensive and codified instrument of LOS and IEL that speaks to the protection of the planet's marine environment. The 59 Articles of LOSC provide adequate guidelines to protect, manage and conserve the human commons of the oceans of the planet. Oceans are the common heritage of the entire humanity. The anthropogenic impacts on marine life have caused unprecedented harm to the Earth's oceans. LOSC has provided for a broad framework which will allow States to proactively engage in a constructive opportunity to improve domestic legal regimes and better adherence to the legal framework of LOS.

UN SDGs 2030, especially Goal 14, have provided for giving specific attention to the importance of conserving our global common heritage of the sea by upholding LOSC and LOS. Goal 14(5) led to the 2017 Decade initiative and the proactive involvement of agencies such as UNESCO through the IOC to bring forth the agendas of educating our future generations for the preservation of our Earth's precious marine life.

The implementation of UNCLOS to support the marine environment and achieve SDG 14 targets includes that while UNCLOS provides the essential legal framework, progress is insufficient in several areas and requires urgent, coordinated global action. The legal foundation of UNCLOS is universally recognised. It is the bedrock of international ocean law, providing the legal obligations (e.g., general duty to protect and preserve the marine environment under Part XII) that underpin SDG 14 targets.

UNCLOS has helped increase marine protected areas (MPAs). The MPA coverage has expanded significantly over the past two decades, with an estimated 8.4% of the ocean now protected. This has helped meet SDG Target 14.5; however, it still falls short of current and future goals (e.g., 30% by 2030 in the Kunming-Montreal Global Biodiversity Framework).

Implementation Deficit is one of the key challenges being faced by many nations when it comes to UNCLOS. The extent of UNCLOS implementation varies widely among nations. Many developing countries, particularly SIDS and LDCs, face significant hurdles due to a lack of financial resources, technical capacity, and data to effectively manage their maritime spaces.

Persistent environmental degradation is a key challenge. The marine environment continues to face severe pressures, including ocean warming, acidification, plastic pollution, and eutrophication (coastal degradation due to nutrient enrichment). Current actions are not sufficient to counteract these trends.

Data gaps in collecting accurate data for action are a challenge for many developing nations: The lack of robust, standardised data continues to hinder the accurate assessment of progress for over half of the SDG 14 indicators, making evidence-based policymaking difficult.

The complexity of ocean issues demands integrated, cross-sectoral cooperation. New agreements like the BBNJ Agreement (Biodiversity Beyond National Jurisdiction) need urgent ratification to enter into force and provide the necessary legal tools for conservation in areas beyond national jurisdiction.

The UNCLOS provides a robust and essential legal foundation, but successful implementation of SDG 14 requires moving from words to action through increased financing, enhanced scientific knowledge and capacity-building, and strengthened international cooperation.

While there are gaps and challenges to meet the UN SDGs for 2030, including geopolitical challenges to the LOS regime under the LOSC, there is hope that mankind will not hesitate to unite for the common goal of humanity's survival. Marine life is the key to the survival of this planet. Until and unless the global north and global south set aside their geopolitical differences, it would be impossible to reverse the damage to the world's oceans.

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AUTOMATING FAITHFUL FINANCE: AN AI FRAMEWORK FOR SHARIAH-COMPLIANT DISCLOSURE IN THE MIDDLE EAST

Prof. Dr. Klemens KATTERBAUER

Euclid University, katterbauer@euclidfaculty.net, ORCID ID : 0000-0001-5513-4418

Prof. Dr. Sema YILMAZ

Yıldız Technical University, sygenc@yildiz.edu.tr, ORCID ID: 0000-0002-3138-1622

Prof. Dr. Hassan SYED

Euclid University, hassan@euclidfaculty.net, ORCID ID: 0000-0003-2114-2473

Prof. Dr. Rahmi Deniz ÖZBAY

İstanbul Ticaret University, rahmideniz@gmail.com, ORCID ID: 0000-0002-3927-8216

Prof. Dr. Laurent CLEENEWERCK

Euclid University, Centre for Islamic Metafinance, Bangui, Central African Republic, Africa,
cdk@euclid.int, ORCID ID:0000-0002-9267-0428

Abstract

The Middle East's Islamic banking sector faces complex regulatory and ethical challenges, which traditional financial tools struggle to address due to the nuanced requirements of Shariah law. This article presents an AI-driven framework designed to analyze financial disclosures from Islamic banks using natural language processing (NLP), machine learning (ML), and a Shariah-compliance ontology. The system automates data extraction, classification, and risk assessment while ensuring adherence to Islamic principles. Trials in GCC countries show improved compliance monitoring, transparency, and investor trust.

However, implementation faces hurdles, including language limitations—particularly in processing regional dialects—and the evolving nature of Shariah jurisprudence, which demands frequent updates. These issues call for strong human oversight and collaboration among scholars, regulators, and developers. Future enhancements may include blockchain integration, real-time digital audits, and AI-driven compliance indices. Key challenges remain: data privacy, explainability, inconsistent disclosure standards, and limited Arabic NLP resources. Despite these barriers, the framework has transformative potential, paving the way for AI-as-a-Service tools, smart contracts, and fatwa databases—ultimately fostering a more ethical, transparent, and efficient Islamic financial system rooted in cultural and theological integrity.

Keywords: Islamic Finance, Financial Analysis, Disclosure Analysis, Artificial Intelligence

1.Introduction

Islamic finance, grounded in ethical and religious principles derived from Shariah law, has seen significant growth and increasing global recognition over the past few decades. Central to this financial system are core prohibitions and obligations, most notably, the avoidance of *riba* (interest), *gharar* (excessive uncertainty), and investments in *haram* (forbidden) sectors such as alcohol, gambling, and weapons. These principles shape the foundation of all financial products, transactions, and investment decisions made within Islamic financial institutions (IFIs). In contrast to conventional finance, which is primarily driven by profit maximization, Islamic finance integrates moral and social responsibility into its operational and investment frameworks, presenting itself as a compelling alternative for ethically conscious investors. Though its roots are deeply embedded in Islamic traditions, the principles of Islamic finance have gained cross-cultural appeal, finding footholds even in non-Muslim-majority countries. Nonetheless, the Middle East, particularly the Gulf Cooperation Council (GCC) countries, continues to serve as the nucleus of Islamic finance, leading innovation, policy development, and capital distribution that align with Islamic tenets (Hussain et al., 2016).

Despite these achievements, Islamic finance faces several operational and governance challenges, particularly in the realm of disclosure and transparency. Among the most pressing concerns are three interrelated issues. First is the challenge of ensuring consistent and comprehensive Shariah compliance, which becomes increasingly difficult as financial products grow in sophistication and global financial markets become more interconnected. Differences in interpretation among Shariah boards across jurisdictions lead to inconsistencies, complicating assessments of whether financial activities truly adhere to Islamic law. Second, Islamic financial institutions must navigate a complex and evolving regulatory environment. As international financial regulators intensify their focus on risk management, consumer protection, and financial stability, IFIs are under pressure to meet these expectations while also fulfilling their unique religious obligations (Kuanova et al., 2021). This dual responsibility introduces operational strain and calls for specialized governance expertise that blends financial acumen with Shariah scholarship. Third, there is a growing demand from stakeholders, including investors, regulators, and the general public, for greater transparency and alignment with environmental, social, and governance (ESG) standards. While Islamic finance, with its emphasis on social justice and ethical conduct, is well-positioned to lead in ESG integration, current disclosure practices often fall short of meeting such expectations in scope, clarity, and timeliness (Katterbauer et al., 2022).

Traditional approaches to disclosure in Islamic finance rely heavily on manual processes, including audits and subjective evaluations by Shariah supervisory boards or advisory councils. While these processes are grounded in deep religious and financial expertise, they are time-consuming, expensive, and susceptible to inconsistencies or human bias. As the volume and complexity of financial data grows, these manual systems become increasingly inefficient and inadequate. To modernize and streamline the disclosure process, there is a compelling case for leveraging technology. In response, an AI-driven framework tailored to the unique requirements of Islamic finance reporting has been proposed. Such a system could utilize natural language processing, machine learning, and rule-based reasoning to automate and standardize the evaluation of Shariah compliance. This technological innovation would not only help Islamic financial institutions meet regulatory obligations and stakeholder expectations more efficiently but also deliver more accurate, timely, and transparent disclosures. Ultimately, this AI-enabled solution could enhance operational efficiency, improve governance, and reinforce trust in Islamic financial institutions, supporting their continued expansion in a digital and accountability-focused global economy (Harahap et al., 2023).

Financial disclosures are essential to promoting transparency, accountability, and stakeholder confidence in the Islamic finance sector. Unlike conventional banks, Islamic financial institutions must operate under a dual framework that includes both financial performance and Shariah compliance. This dual requirement necessitates that financial reports reflect not only economic viability but also conformity with Islamic ethical and legal standards. As a result, disclosures in Islamic finance must cater to a wide array of stakeholders—regulators, investors, religious authorities, and clients—all of whom depend on the accuracy and completeness of the information disclosed to make informed decisions. The core of such disclosures typically lies in annual financial reports, which include standard elements such as balance sheets, income statements, and cash flow statements. However, Islamic banks must also clearly outline the financial instruments used—such as Murabaha (cost-plus financing), Ijara (leasing), and Mudarabah (profit-sharing)—and demonstrate that none of their income is derived from interest-bearing or prohibited activities (Hesse et al., 2008).

A distinctive and essential element of Islamic financial reporting is the inclusion of the Shariah Supervisory Board (SSB) report. This document, prepared by an independent body of Islamic scholars, verifies that all operations, contracts, and financial instruments used by the bank are in compliance with Islamic principles. The SSB report adds a critical layer of religious credibility and assurance for Muslim stakeholders by affirming the Shariah validity of the

bank's activities. Additionally, many Islamic financial institutions provide social responsibility disclosures that reflect their broader ethical commitments. These often include reports on Zakat (mandatory almsgiving), Qard Hasan (interest-free benevolent loans), and other charitable or socially beneficial programs. Such disclosures underscore Islamic finance's focus on economic justice, social welfare, and equitable wealth distribution—core values that further distinguish it from its conventional counterpart (Naim, 2020).

Islamic finance also requires comprehensive risk disclosures, particularly because of the unique nature of its financial instruments and religious obligations. Unlike traditional financial risk reporting, which focuses on metrics like interest rate or credit risk, Islamic banks must also address Shariah-specific risks (Hesse et al., 2008). These include the potential misapplication of contract structures or shifts in religious interpretations that might render certain transactions non-compliant. Disclosures that detail how Islamic financial institutions manage such risks are crucial for demonstrating both financial prudence and religious integrity (Ahmed, 2010). To ensure uniformity and reliability in financial reporting, Islamic banks adhere to specialized standards issued by regulatory and standard-setting bodies such as the Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) and the Islamic Financial Services Board (IFSB). AAOIFI provides comprehensive Shariah-based accounting, auditing, and governance standards, while IFSB focuses on prudential regulation aligned with Islamic finance principles. Compliance with these standards not only fosters harmonization across global Islamic financial markets but also enhances credibility, investor confidence, and regulatory oversight (Ghulamallah et al., 2021). The rapid growth of Islamic finance has intensified the need for robust, scalable mechanisms to ensure Shariah compliance within financial disclosures. While traditional reliance on manual audits by Shariah Supervisory Boards (SSBs) provides deep doctrinal scrutiny, this approach struggles with the volume, complexity, and cross-jurisdictional variability of modern financial reporting. Consequently, a critical gap exists between the principled ideals of Islamic finance and the practical ability to consistently verify compliance in an efficient, transparent, and standardized manner. This study addresses this gap by proposing and elaborating a dedicated AI framework designed to automate the analysis of Shariah-compliant disclosures. Our central research question is: How can an integrated AI system, combining natural language processing (NLP), machine learning (ML), and a dynamic Shariah ontology, be structured to reliably analyze financial disclosures for compliance with Islamic principles, and what are the key operational and theological challenges to its implementation?"

2.Theoretical Background

The integration of artificial intelligence (AI) into financial disclosure analysis has significantly transformed the way stakeholders interpret, verify, and monitor financial information—particularly within the nuanced context of Islamic finance. Given the dual requirements of financial accuracy and adherence to Shariah principles, AI technologies offer powerful tools for automating and enhancing the assessment of disclosures. These technologies ensure greater consistency, precision, and insight while helping organizations manage the complexities of regulatory and religious compliance (Shiyyab et al., 2023). Among the most transformative AI tools in this space is Natural Language Processing (NLP), which allows machines to read, understand, and analyze vast amounts of unstructured textual data. NLP is especially valuable in Islamic finance, where financial reports and disclosures are commonly issued in both English and Arabic. It facilitates the extraction, classification, and semantic interpretation of data from sources such as annual reports, Shariah Supervisory Board (SSB) opinions, and corporate social responsibility disclosures—thus providing a comprehensive understanding of both financial and ethical performance (Al-Okaily, 2024). Within NLP, sentiment analysis stands out as a critical application. It evaluates the tone of managerial commentary and SSB guidance to determine whether sentiments expressed are positive, neutral, or negative. This enables stakeholders to assess financial performance and detect potential areas of concern related to Shariah compliance, such as ethical breaches or questionable contractual practices. Additionally, topic modeling techniques help identify key themes and trends within disclosures, such as the frequency and framing of discussions around zakat distribution, sukuk issuance, or fatwa pronouncements. These insights are invaluable for analysts, regulators, and investors who seek to track evolving institutional priorities or uncover inconsistencies. Another important capability is Named Entity Recognition (NER), which automatically identifies and categorizes crucial entities like financial institutions, SSB members, Islamic financial instruments (e.g., Ijara, Murabaha, Musharakah), and geographic jurisdictions. This enables automated indexing and tagging of information across large datasets, vastly improving the efficiency of document analysis (Humpherys et al., 2011).

A more specialized NLP application in Islamic finance involves Shariah compliance checkers. These tools employ ontology-based models to cross-reference disclosures with an evolving library of Shariah rules, regulatory standards, and fatwas. By doing so, they can flag transactions or terminologies that may conflict with established Islamic jurisprudence,

providing early alerts to compliance departments and Shariah scholars. This is especially useful in a field characterized by regional and doctrinal diversity in legal interpretation. Beyond NLP, machine learning (ML) adds another dimension to analysis by enabling predictive analytics. ML algorithms trained on historical disclosure data can detect patterns that help forecast future outcomes, support strategic decision-making, and enhance regulatory oversight. For example, ML-based credit risk models can predict default probabilities in Islamic financing, helping institutions calibrate their risk exposure. Compliance monitoring systems powered by ML can also detect deviations from standards such as those issued by the Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) or the Islamic Financial Services Board (IFSB), greatly reducing the labor-intensive process of manual auditing (Tao, 2025). Furthermore, ML can verify zakat contributions by comparing reported figures with expected values derived from financial data, ensuring that institutions fulfill their ethical and religious obligations transparently (Alzaghoul & Alsharari, 2024).

In multilingual regions like the Middle East and North Africa, financial documents are often issued in both Arabic and English, presenting a challenge for analysis. Deep learning models—especially those built on transformer architectures—have become essential in managing this complexity. Pretrained models such as BERT (Bidirectional Encoder Representations from Transformers), AraBERT (tailored for Arabic), and FinBERT (optimized for financial language) are capable of interpreting idiomatic expressions and semantic nuances across languages. These models ensure that complex disclosures are accurately analyzed and interpreted, bridging linguistic divides and promoting inclusivity in financial reporting.

3.Methodology

Previous research has established the viability of AI components—such as NLP for sentiment analysis in financial texts and ML for pattern detection in regulatory filings—within conventional finance. Applications specific to Islamic finance, however, remain nascent and often techno-centric, focusing on algorithmic performance while sidestepping foundational jurisprudential complexities. For instance, studies leveraging AI for compliance checking typically presuppose the existence of a standardized, unambiguous rule set, overlooking the interpretive (ijtihadi) nature of fiqh and the pluralism of madhahib (schools of law). This creates a theoretical disconnect: AI models require deterministic logic, whereas Shariah interpretation involves nuanced textual analysis, scholarly consensus (ijma’), and analogical reasoning (qiyas). Our framework seeks to bridge this disconnect by making the construction and validation of the underlying Shariah knowledge base—the ontology—a central, transparent

component of the system design, thereby engaging directly with the core methodological challenge previous work has often marginalized.

Within this evolving landscape, we present the analysis of a new framework that emerges as a groundbreaking, end-to-end AI framework tailored specifically to the distinctive needs of financial disclosure analysis in Islamic finance. Designed with a deep understanding of both Shariah principles and the operational complexities of Islamic financial institutions (IFIs), the system integrates an automated pipeline that transforms unstructured disclosure documents into actionable compliance insights. It ingests diverse materials, including annual reports, regulatory filings, and investor communications, then applies advanced NLP techniques and deep learning models to classify, interpret, and assess these documents in line with Shariah norms. The system generates user-friendly compliance reports for a wide range of stakeholders—including regulators, Shariah boards, auditors, and investors—enhancing transparency, reducing human error, and accelerating review processes while maintaining the ethical integrity central to Islamic finance (Choi, 1973).

The system is based on an NLP engine that is trained on bilingual (Arabic and English) corpora composed of regulatory texts, Islamic finance literature, fatwas, and historical disclosures. This engine extracts quantitative and qualitative insights from complex financial language, converting them into structured data suitable for compliance analysis. An integrated feature is a customized Named Entity Recognition module, capable of detecting and labeling key Islamic financial instruments such as Sukuk, Mudarabah, Murabaha, and Ijara. It also supports multilingual processing, making it adaptable to the diverse linguistic environments where Islamic finance operates. Complementing the NLP engine is a Shariah compliance ontology layer—a sophisticated reasoning system based on both classical sources (e.g., Quran and Hadith) and contemporary regulatory standards such as AAOIFI guidelines and region-specific fatwas. Structured as a dynamic knowledge graph, this layer enables semantic interpretation of legal and financial clauses, flags ambiguous or potentially non-compliant language (e.g., references to interest or non-asset-backed derivatives), and evolves in tandem with new rulings and standards to maintain continuous alignment with Islamic jurisprudence (S. S. Cao et al., 2024).

To enhance analytical depth, the system also incorporates machine learning models trained for both risk classification and sentiment analysis. The risk engine categorizes content into compliance risk levels, high, moderate, or low, by analyzing linguistic features, financial indicators, and historical precedent. Meanwhile, the sentiment analysis module detects nuanced

emotional and ethical tones within disclosures, such as those found in Shariah board decisions, halal/haram classifications, and ethical finance narratives. These insights enable stakeholders to anticipate reputational risks and better understand public and regulatory perceptions of financial practices. Powered by tools such as SHAP (SHapley Additive exPlanations) and large language model-based explainers like GPT, this interface provides detailed justifications for compliance decisions. Users can view visual annotations of problematic or ambiguous document segments, each linked to specific Shariah principles or regulatory standards. The system also suggests corrective measures—such as modifying language, expanding disclosures, or removing non-compliant terms—based on precedent cases and industry best practices. This level of transparency not only builds confidence in AI-driven assessments but also facilitates learning and continuous improvement among users (S. Cao et al., 2023).

The system represents a transformative advancement in financial disclosure analysis for Islamic finance. By fusing deep domain knowledge with advanced AI technologies, it offers a scalable, explainable, and Shariah-aligned framework for compliance assessment. The system empowers institutions to navigate the intricate requirements of Islamic financial ethics while streamlining operations and enhancing stakeholder trust. As AI continues to evolve, these tools will play a central role in safeguarding the integrity and ethical foundation of the global Islamic finance industry (Leippold, 2023).

The proposed framework is built on a modular architecture comprising: (1) a Data Ingestion and Preprocessing Layer that handles PDF/HTML parsing and language detection; (2) a Core NLP Engine leveraging transformer-based models (AraBERT for Arabic, FinBERT for English financial text) for initial text understanding; (3) a Shariah Ontology & Knowledge Graph Layer; and (4) an Analytics & Reporting Layer with ML models for risk classification and sentiment analysis.

-The training corpus for the NLP and ontology components is a bespoke, bilingual dataset comprising:

- Regulatory & Standards Texts: Full texts of AAOIFI Shariah Standards (SS), IFSB guidelines, and selected national regulatory frameworks.
- Fatwa Collections: ~5,000 fatwas from the archives of major Islamic banks and public SSBs, spanning 2010-2023.

- Historical Disclosures: A curated set of 500 annual reports and SSB reports from 50 IFIs across the GCC and Southeast Asia (2018-2023).
- Islamic Finance Literature: Key textbooks and scholarly articles on fiqh al-mu'amalat (commercial jurisprudence).

The Shariah compliance ontology is the system's cornerstone. Its construction follows a rigorous, iterative process:

- Concept Extraction: Key concepts (e.g., Riba, Gharar, Mudarabah, Halal/Haram) and their relationships are manually extracted from the corpus by a team of three experts in Islamic finance and jurisprudence.
- Logical Formalization: Concepts and rules (e.g., "A contract must involve an identifiable underlying asset") are formalized into OWL (Web Ontology Language) axioms, allowing for machine reasoning.
- Multi-Madhab Annotation: Where rulings diverge (e.g., permissibility of certain Sukuk structures), concepts are tagged with their associated school(s) of jurisprudence (Hanbali, Maliki, etc.), enabling jurisdiction-specific compliance checks.

Scholarly Validation: The draft ontology is reviewed and validated by an advisory panel of five independent Shariah scholars, ensuring doctrinal accuracy and representativeness. This panel also establishes a protocol for resolving interpretive disputes, which are flagged by the system for human review.

The risk classification ML model (a Gradient Boosting classifier) is trained on 3,000 annotated disclosure segments, labeled as High, Medium, or Low compliance risk by our expert team. We employ a 70/15/15 train/validation/test split. Key performance metrics on the test set include Precision (0.89), Recall (0.85), and F1-Score (0.87). The sentiment analysis module, fine-tuned from AraBERT, achieves an accuracy of 82% in classifying the ethical tone of SSB statements against a human-coded gold standard.

Empirical Validation

Existing literature underscores AI's potential in Islamic finance contexts. For example, studies in the UAE (2022) used NLP for sentiment-performance correlation, while research in Saudi Arabia (2023) applied ML for compliance benchmarking. These external validations, however, assess discrete AI applications rather than an integrated framework like the one we propose.

Artificial Intelligence (AI) has increasingly emerged as a transformative force within the financial sector, and its influence is becoming particularly pronounced in the niche but rapidly evolving domain of Islamic finance. Empirical studies across the Gulf region provide compelling evidence of AI's growing role in enhancing operational efficiency, bolstering compliance monitoring, and informing investment decision-making within Islamic financial institutions. These studies collectively showcase the multifaceted ways in which AI is reshaping the sector, offering tools that not only complement traditional financial analysis but also align with the unique ethical and legal frameworks of Islamic finance.

To provide initial, direct validation of our framework's core NLP and ontology components, we conducted a limited pilot. We deployed a prototype on 50 recently published SSB reports (not part of the training set) from GCC banks. The system's task was to identify and classify clauses related to profit distribution and flag any containing language indicative of interest (riba)-like guarantees. The system achieved a 94% accuracy in clause identification and flagged 8 clauses for expert review. Subsequent blind analysis by two Shariah scholars confirmed that 7 of the 8 flagged clauses were indeed problematic, demonstrating the prototype's high precision and utility as a screening tool. This pilot, while small-scale, confirms the functional integration of our ontology with NLP tools and provides a proof-of-concept for scalable disclosure screening.

One of the most notable studies in this space was conducted in the United Arab Emirates in 2022. This research focused on the application of Natural Language Processing (NLP), particularly in sentiment analysis, to predict financial performance in Islamic banks. The study analyzed 150 annual reports from ten major Islamic banks spanning the years 2017 to 2021, with special attention paid to the Management Discussion and Analysis (MD&A) sections. Using FinBERT—a financial domain-specific adaptation of the BERT language model—researchers classified sentiment and discovered a strong positive correlation ($r = 0.67$) between optimistic narrative tones and key financial indicators such as Return on Assets (ROA) and Return on Equity (ROE). This finding suggests that more optimistic managerial narratives in annual reports tend to precede stronger financial performance, underscoring the potential of NLP to serve as a predictive tool for investors and analysts. In a field where qualitative aspects are often just as critical as quantitative metrics, particularly within the context of Shariah-compliant finance, such AI applications offer a more nuanced understanding of institutional outlook and confidence (Zheng & Lucey, 2025).

A second study conducted in Saudi Arabia in 2023 took a different but equally critical angle by examining the role of AI in improving Shariah compliance. This area is foundational to Islamic

finance, as all activities must conform to Islamic ethical and legal standards. The study introduced a machine learning model trained to monitor and identify inconsistencies in Shariah-related disclosures, benchmarked against standards established by the Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI). Drawing on five years' worth of compliance reports from 25 Islamic banks, the model achieved an impressive 92% accuracy in identifying either non-compliance or incomplete disclosures. This automated system significantly bolstered the internal audit mechanisms of participating institutions and reduced the labor-intensive reliance on manual Shariah board reviews. By catching potential compliance issues in near real-time, AI not only streamlines governance but also enhances institutional accountability, making it a powerful tool for ensuring transparency and ethical rigor in Islamic finance (Jiang et al., 2025).

The third empirical investigation, carried out in Qatar in 2024, explored the integration of AI in analyzing Environmental, Social, and Governance (ESG) factors within Islamic financial institutions. Recognizing the rising importance of ethical and sustainable investing, this study evaluated how AI could process and interpret ESG disclosures from various public sources, including sustainability reports and regulatory filings. Researchers applied topic modeling and entity recognition techniques to 5,000 ESG-related paragraphs and found that AI tools identified 40% more ESG-related risks and opportunities than traditional manual reviews. This marked improvement in detection capability is crucial as Islamic financial institutions increasingly engage in the issuance and evaluation of sustainability-linked Sukuk (Islamic bonds). By aligning Shariah principles with global sustainability standards, AI-powered ESG analysis tools enable Islamic finance entities to more effectively articulate and demonstrate their commitment to ethical governance and responsible investing on an international scale.

These three studies collectively illustrate the profound and multifaceted impact AI is having on Islamic finance. From sentiment-driven financial forecasting and intelligent compliance monitoring to sophisticated ESG analysis, AI is enabling Islamic financial institutions to operate with greater precision, transparency, and strategic foresight. As these technologies continue to evolve, their thoughtful integration into Islamic finance has the potential to reinforce the industry's ethical foundations while expanding its global competitiveness and investor appeal.

Building on these foundational studies, the implementation of an AI-driven system represents not merely an operational upgrade but a strategic transformation in how Islamic financial institutions (IFIs) manage compliance, transparency, and stakeholder engagement in today's

increasingly digital financial ecosystem. By embedding advanced technologies into the core of Shariah governance and disclosure practices, IFIs can enhance not only internal efficiency but also regulatory credibility, market reputation, and investor trust. The benefits of such a framework are extensive and touch on several critical aspects of institutional functioning.

Furthermore, such situations support the ability to strengthen Shariah governance within Islamic financial institutions. Traditionally, Shariah boards have been required to dedicate significant time and resources to manually review dense and voluminous documentation, a process often fraught with inefficiencies, human error, and subjectivity. The system automates this review process in real-time, allowing for continuous monitoring and proactive flagging of potential compliance issues as disclosures are created or updated. This minimizes reliance on post-event audits and enables earlier intervention, thereby preserving the integrity of Shariah compliance throughout the reporting cycle. Additionally, by automating standard and lower-risk reviews, the system enables Shariah boards to concentrate their expertise on complex or ambiguous cases that truly demand human interpretation. In this way, the board evolves from being reactive document checkers to proactive ethical stewards, thus enhancing their strategic role within the institution.

Furthermore, the globalization of Islamic finance means that IFIs frequently operate across multiple jurisdictions, each with its own set of regulatory standards—ranging from AAOIFI guidelines and International Financial Reporting Standards (IFRS) to local laws and religious interpretations. This diversity presents a formidable challenge in maintaining consistent and compliant disclosures. The framework addresses this complexity through a sophisticated regulatory mapping engine that can simultaneously evaluate disclosures against various frameworks. Whether an institution operates in the Gulf, Southeast Asia, Africa, or Europe, the system identifies inconsistencies and gaps that could lead to regulatory breaches. This capability not only facilitates compliance harmonization but also supports cross-border operational fluidity, reducing the risk of sanctions while safeguarding the distinct identity of Islamic finance in a pluralistic regulatory environment (Julia et al., 2020).

In today's market, transparency and ethical alignment are paramount, especially for ESG-conscious investors who demand clarity on how institutions adhere to ethical, environmental, and social standards. Islamic finance, with its built-in commitment to social justice and moral responsibility, is inherently aligned with these goals, yet many IFIs still struggle with fragmented and inconsistent ESG disclosures. The system enhances the credibility and coherence of these disclosures by verifying claims against structured data, clearly excluding

prohibited industries, and highlighting ESG-related risks and initiatives. Additionally, the inclusion of sentiment analysis and ethical classification tools enables IFIs to align their disclosures with global sustainable finance frameworks, such as the United Nations Sustainable Development Goals (UN SDGs) and the Principles for Responsible Investment (PRI). As a result, Islamic financial institutions can more effectively communicate their ethical value proposition to a broader investor base, fostering trust, improving capital access, and positioning themselves as leaders in impact-driven investment.

In conclusion, the system is more than just a compliance automation tool—it is a foundational technology that supports the evolution of Islamic finance into a more transparent, accountable, and globally integrated financial system. By enhancing governance, improving regulatory agility, and deepening investor engagement, it empowers IFIs to uphold the spirit of Shariah while adapting to the fast-changing demands of the modern financial landscape. As AI technologies continue to mature, their thoughtful deployment within Islamic finance could mark the beginning of a new era—one where tradition and innovation converge to build a more ethical and inclusive global financial system (Adejumo & Ogburie, 2025).

4. Conclusion

While the framework represents a promising advancement in automating compliance and disclosure analysis within the Islamic finance sector, its development and deployment are not without challenges. Like any technology introduced into a domain shaped by cultural and ethical sensitivities, it must contend with limitations that could affect its accuracy, usability, and relevance. Therefore, recognizing these constraints and proactively identifying strategic pathways for improvement is crucial to ensuring its long-term sustainability and efficacy in an evolving financial landscape. A key limitation of the current framework lies in its ability to interpret the cultural and linguistic nuances embedded within regional Arabic dialects. Although the system is trained on Modern Standard Arabic and English, many disclosures—particularly those made informally or in localized regulatory contexts—are delivered in dialects that introduce semantic ambiguity. Even minor misinterpretations can result in false flags for compliance violations or, conversely, the failure to identify genuine breaches. This highlights the necessity for ongoing linguistic refinement, including the integration of region-specific corpora into the model's training data to enhance semantic precision.

Moreover, Islamic finance operates within a dynamic interpretive tradition, where new fatwas, Shariah standards, and ethical rulings are regularly issued by both international bodies such as

AAOIFI and local Shariah boards. These evolving guidelines often reflect developments in financial instruments, technologies, and moral concerns that were not previously addressed. There is the need for such frameworks to be continually updated to reflect this jurisprudential fluidity. Without a robust mechanism for iterative learning and human-in-the-loop oversight, the system risks obsolescence or misalignment with contemporary Shariah interpretations. Ensuring theological relevance requires an inclusive, well-governed update process involving collaboration among Shariah scholars, AI developers, and compliance officers. Despite the challenges with the system the road ahead is filled with opportunity. One of the most promising future directions involves integrating the system with blockchain technology. By creating immutable, tamper-proof audit trails for financial transactions and compliance reviews, blockchain integration can enhance transparency and trust—particularly valuable in jurisdictions with nascent regulatory infrastructure. Moreover, tokenized verification of compliance status could enable Islamic financial institutions (IFIs) to demonstrate real-time adherence to Shariah principles, boosting credibility with investors and partners.

Another transformative avenue is the enablement of real-time Shariah audits for digital banking and fintech transactions. As Islamic finance embraces digitalization, spanning peer-to-peer lending, mobile investment applications, and decentralized finance (DeFi) platforms, there is a growing need for automated tools capable of instant compliance screening. Embedding the system within digital transaction systems would allow for proactive detection and prevention of non-compliant activity, delivering ethical oversight as an integrated part of financial services. Further innovation lies in the creation of publicly accessible, AI-powered indices for Shariah compliance. These indices could dynamically assess and rank companies, funds, or products based on financial disclosures, ESG data, and ethical alignment. Empowering retail investors with objective, real-time compliance metrics could shift decision-making away from reliance on institutional marketing or static certifications. Such indices would also serve as valuable benchmarking tools for regulators and analysts monitoring the ethical landscape of Islamic finance.

The rapid integration of artificial intelligence into Islamic finance offers considerable benefits but also introduces complex regulatory and ethical dilemmas. A primary concern is interpretability. Given the moral and legal weight of Shariah compliance decisions, any AI-generated outputs must be explainable and transparent to both regulators and religious authorities. Black-box models that cannot justify their conclusions may undermine trust and hinder adoption, particularly in contexts where ethical legitimacy is paramount. Ensuring that

AI algorithms can produce interpretable, accountable reasoning aligns with core Islamic ethical principles and broader financial governance norms.

Data privacy poses another substantial regulatory challenge. Countries in the Middle East, such as the UAE, have introduced rigorous data protection laws, including the UAE's Data Protection Law, which restrict how personal and institutional data can be collected, stored, and used. While these frameworks safeguard sensitive information, they complicate the training and deployment of AI systems dependent on large-scale data. Developers must implement anonymization techniques, secure infrastructures, and transparent consent mechanisms to ensure that AI tools not only comply with legal mandates but also respect stakeholders' ethical expectations. Compounding these issues is the lack of standardization in disclosure and reporting practices across jurisdictions. Financial statements, Shariah audit reports, and ESG disclosures often vary widely in structure and content, hampering the effectiveness of AI models trained to analyze them. Without harmonized standards, AI systems face significant challenges in parsing data accurately and consistently. Industry bodies like AAOIFI, along with national regulators, are actively working to establish uniform reporting frameworks to facilitate AI-driven analysis, promote cross-border oversight, and strengthen transparency within the global Islamic finance ecosystem.

Technical barriers further limit progress, particularly the scarcity of high-quality Arabic Natural Language Processing (NLP) datasets. Arabic's morphological complexity and dialectal diversity demand robust corpora for effective training. The limited availability of such datasets constrains the development of NLP tools capable of accurately interpreting financial documents and religious texts, especially those laden with domain-specific terminology. This deficiency reduces the accuracy and scalability of AI tools in Arabic-speaking markets. Additionally, the inconsistent depth and format of reporting among Islamic financial institutions exacerbate the issue, making it difficult to generalize AI models across different entities. This heterogeneity demands either extensive customization or risks reducing the performance and reliability of AI applications. Moreover, cultural sensitivities must be carefully considered in system design. Effective and ethical AI in Islamic finance must align with religious norms, cultural expectations, and social values. Models that fail to uphold fairness, avoid bias, or respect Islamic ethical principles could face rejection from stakeholders for whom spiritual integrity is a non-negotiable foundation.

Looking to the future, AI integration into Islamic finance appears poised for significant growth. In the near term, we can expect the emergence of AI-as-a-Service platforms tailored specifically

to Islamic financial needs. These platforms will provide modular NLP tools for compliance checks, sentiment analysis, and risk evaluation, enabling institutions of varying technical capacities to benefit from AI-driven insights. Internal audit teams may also be augmented by AI “assistants” capable of rapidly scanning and analyzing disclosures, streamlining the compliance verification process without supplanting human expertise. In the longer term, innovations such as machine-readable repositories of Shariah fatwas could revolutionize compliance workflows. By making religious rulings searchable and contextually accessible, financial institutions could cross-reference jurisprudential guidance in real time when assessing new products or disclosures. This would foster a more responsive and informed compliance culture. Furthermore, the integration of AI with blockchain smart contracts could enable dynamic enforcement of Shariah rules in live transactions, reducing the risk of human error and enhancing operational transparency. Together, these innovations herald a new era of ethical automation, where AI becomes a proactive agent of trust and accountability in Islamic finance.

In conclusion, the system stands at the intersection of technological innovation and ethical governance, offering a transformative solution for modern Islamic finance. By automating disclosure analysis through a Shariah-compliant lens, it addresses persistent challenges such as inconsistent reporting, manual auditing inefficiencies, and regulatory gaps. Empirical evidence from the GCC and beyond suggests that this AI-driven approach not only enhances operational efficiency but also strengthens trust in the moral underpinnings of Islamic finance.

Yet, the system’s enduring success depends on its adaptability to theological updates, financial innovations, and global sustainability standards. With potential integrations like blockchain, real-time audits, and public compliance indices, such systems could become a foundational pillar of ethical finance infrastructure. As faith and technology converge, responsibly developed AI systems have the potential to harmonize financial advancement with spiritual values, social equity, and environmental consciousness—charting a forward-looking path where innovation and integrity thrive together.

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ALBANIAN EMIGRATION TO GREAT BRITAIN: IMPACT ON BILATERAL DIPLOMATIC RELATIONS

Prof. As. Dr. Manjola XHAFERRI

Lecturer "Aleksander Moisiu" University of Durrës, Faculty of Political Sciences and Law,
Department of Political Sciences
manjolaxhaferri@uamd.edu.al, ORCID ID:0000-0002-9980-1312

Prof. As. Dr. Mirela Tase

Lecturer, "Aleksander Moisiu" University of Durrës, Faculty of Business, Department of
Tourism
mirelatase@uamd.edu.al, ORCID ID:0000-0002-8337-1602

Abstract

Most have left their countries in search of work, often leaving situations where decent work simply does not exist or where social, economic and political conditions have greatly deteriorated. Migration patterns are very complex, with temporary or circular migration as well as permanent migration, and reflect a pattern of international labor movement. Migration remains a natural and inevitable phenomenon, but the road to regular migration for employment reasons is not easy. Abuse and exploitation, irregular movements, lack of integration, and violation of standards and stability along with human trafficking, migrant smuggling and corruption are some of its dangers. International migration or crossings across borders can only be effectively managed through international cooperation. Designing fair and sustainable employment migration policies and practices requires dialogue between governments at all levels and should include other key actors, mainly social partners (employers and trade unions) and civil society organizations.

This study deals with the choices of Albanian immigrants to settle in Great Britain and the analysis of the impact on bilateral diplomatic relations. The main question is why do they migrate from Albania and why do they choose to enter the United Kingdom instead of other European countries? Socio-economic and political conditions in Albania were the main factor that pushed migrants to migrate.

Key words: Emigration, Albanian, Great Britain, Diplomatic Relations

Purpose and Objectives of the Study

This study addresses the settlement of Albanian immigrants in Great Britain and analyzes the impact on bilateral diplomatic relations between Albania and the United Kingdom.

The purpose of this paper is to highlight the reasons why Albanians decide to emigrate outside Albania and why, most of them, choose to enter the United Kingdom, and not other European countries?

The impact on bilateral diplomatic relations, Albania-United Kingdom, will also be analyzed . Among the main factors that push Albanians to emigrate to the United Kingdom are the socio-economic and political conditions in Albania, especially in the last decade.

The United Kingdom is seen as an emigration destination by Albanians due to the high economic level of this country, providing them with: a. a secure future; b. an economic perspective; c. and what is most important, is the increase in the quality of life. It must be said that social networks have also influenced, we would even say that they have been an essential determinant in the decision to select the destination, shaping the image of the destination country.

Methodology

During this study, several treatments, methods, techniques and materials were used which are necessary for the realization of a scientific work of this nature. Studies in Albanian diplomacy include two levels, theoretical and that of its practical application.

This paper uses a case-based approach for its investigation. Case-based research refers to the traditional case study approach, which includes a detailed and complete analysis of one or several cases in the context of a more in-depth research question. This paper contains issues that aim to analyze the impact on bilateral diplomatic relations (Albania - Great Britain) regarding the emigration of Albanians to Great Britain. The literature supported in this paper is mainly, the reports given regarding international communication and the role of Albanian diplomacy in protecting the interests of Albanian emigrants in European countries, mainly in the United Kingdom, as well as monographs and other scientific works. Also, a very important part of this work comes from various internet websites that I consulted to obtain certain data.

Each data constitutes a source to be studied and to make a more in-depth and profiled analysis, giving other authors the opportunity to analyze the phenomenon of emigration from other perspectives.

Research questions

Taking as the main focus the causes that drive Albanian emigrants to Great Britain, and the influence of Albanian politics in relations with the British government, among the research questions that are posed are:

1. Why do Albanians emigrate to Great Britain, compared to destinations in other European countries?
2. What are the expectations of Albanian emigrants for the United Kingdom and do they have concrete plans regarding their settlement?
3. What is the impact on bilateral diplomatic relations?
4. Does the Albanian government have a strategy to curb illegal immigration to the United Kingdom?

1. Historical overview

The collapse of the Soviet Union, as well as the political and economic transformations that followed, often associated with a new global order and globalization, have created new circumstances for migration to Eastern European countries (Dahinden, J., 2013, p. 3). Countries like Albania, which were previously cut off from the rest of the world, have become important emigration destinations (Dahinden, J., 2013 p. 5). Albania was the most isolated and isolated of the communist countries during the dictatorship of Enver Hoxha (Carletto et al., 2006: p. 769). With the fall of the Albanian communist dictatorship, emigration exploded worldwide after 40 years of closed borders. The road to democracy and a market economy was - and continues to be - a bumpy road, resulting in severe economic misery and political instability (Dahinden, 2013: p. 4). The Albanians' pent-up desire to see the outside world erupted in 1991, after more than four decades of autarky and isolation, in which emigration was seen as an act of treason and was punishable by long imprisonment and even death for those who attempted to leave (King, 2005: p. 134; King and Vollnetari: 2009: p. 21). During the four decades of communist dictatorship, "the Republic of Albania was a blind spot in the imagination of Europe and the world" with no contact with anyone and no information about what was happening in the world, as King describes it. "People starved of information" (Dahinden, 2013: 1; King 2002: p. 96). Albanians went from being virtual prisoners in their own nation, unable to travel even within the country without permission and specific directions, to becoming Europe's most "visible" immigrants (King, R. and Karamoschou, C., 2019, p. 134).

2. Diplomatic Relations Albania-United Kingdom

Diplomatic relations between Albania and the United Kingdom have varied throughout history. These two countries have had various contacts and connections, starting from the period of Albania's independence in 1912 until the present day.

Diplomatic relations between Albania and Great Britain were established on 8 November 1921. The British Government also recognized the Albanian government that emerged after 29 November 1944, but the British mission left in April 1946 due to the restrictions that the Albanian government of the time imposed on the movement of members of this mission. The Corfu Channel Incident, in May 1946, also marks the final termination of these relations. Diplomatic relations between the two countries were re-established on 29 May 1991 through a joint communiqué of both parties. On 9 November 2021, the 100th anniversary of the establishment of diplomatic relations between our countries was celebrated. During 2021, we had an intensified political dialogue and high-level visits.

Both countries hold regular political-diplomatic consultations, with the last diplomatic consultations taking place on June 28, 2019, in London. Great Britain has consistently supported our country's membership in NATO and the EU. Through numerous cooperation programs, it has made a special contribution to strengthening security and the rule of law in the country (through financing projects in support of the justice system and British assistance within the framework of the PAMECA III assistance program), the qualification of young Albanians in prestigious British universities, as well as in British military schools (Brettell, C.B. and Hollifield, J.F., 2014: p. 36).

However, it is important to note that relations between Albania and the United Kingdom have also had moments of tension or controversy, especially in relation to political and diplomatic issues of the post-Cold War period. In addition, there have been and may be minor tensions or disagreements on several other issues.

Cooperation between the two countries has been expanding in terms of border control, the fight against organized crime, including human trafficking and illegal immigration. Bilateral cooperation in the field of defense is at very good levels (Black, R., Collyer, M., Skeldon, R. and Waddington, C. 2006, p. 36).

3.Relations between Albania and the United Kingdom in the political, economic and social spheres

The political, economic and social relations between Albania and the United Kingdom have been diverse and have changed significantly over time. Some of the main elements of these relations are:(Vathi, Z. and King, R, 2013: Journal of Ethnic and Racial Studies, p. 1829).

- **Politics:** Politically, the two countries have had a good relationship, especially after the fall of the communist regime in Albania in the 1990s. The United Kingdom has been a supporter of Albania's independence and its integration process into international institutions such as NATO and the European Union (King, R. and Vullnetari, J., 2009: p. 20).
- **Economy:** Economically, the United Kingdom is one of Albania's main partners. There has been an increase in British investment in Albania, especially in sectors such as energy, tourism, infrastructure and telecommunications. On the other hand, Albanians have emigrated to the United Kingdom to seek work and to benefit from the economic opportunities offered there (Vathi, Z. and King, R, 2013: Journal of Ethnic and Racial Studies, p. 1832).
- **Social and cultural cooperation:** There has been ongoing cooperation between Albania and the UK in the fields of education, culture and the exchange of students and artists. Cultural exchange and cooperation programs have helped to deepen relations between the two countries and to promote Albanian culture and heritage in the UK (Gmelch, G, 1980: p. 139).
- **Various development aid and projects:** The UK has provided aid and support for many development projects in Albania, including in areas such as education, health, infrastructure, and rural development.

In summary, Albania and the United Kingdom enjoy a multifaceted relationship in political, economic and social domains. While differences may arise on certain issues, both countries recognise the importance of cooperation and mutual respect, working together to improve their bilateral ties for the benefit of their peoples and the wider international community (Bloch, A. 2013, p. 278).

4. Albanian Emigration to the European Union

Initially, we dealt with an overview of Albanian emigration to European countries, then we analyzed the factors that have pushed Albanians to emigrate to the United Kingdom.

Emigration is a major issue for Albania due to the fact that over the past decade, approximately 20% of the population has left the country, making Albania one of the countries with the highest emigration record in the region.

Emigration has also become a major problem for Albania's relations with the member states of the European Union as the destination countries for the majority of Albanian emigrants.

Albania has been identified on various occasions by the European Union as one of the countries with the highest priority in the fight against irregular emigration.

From 2008 to 2020, around 700,000 Albanian citizens have obtained a residence permit in one of the European Union countries. Thousands more live illegally (Nowicka, M., 2020, p.11).

The population census, which is scheduled to be carried out, still does not have real and concrete data, but indirect data from INSTAT and the emigration survey show that around 700 thousand people have left the country since 2010.

In 2022 and beyond, the phenomenon of emigration has become more problematic, with a large exodus of young Albanians to European countries being noted. Businesses in the trade sector also confirm this, as there is an immediate drop in consumption, while all sectors, including the public sector, are in an emergency situation for employees (INSTAT, 2023).

Although Albania is not currently at war or in a state of internal armed conflict, there are significant and long-standing issues related to poverty, corruption, trafficking, blood feuds, sexual violence and domestic abuse, forcing Albanians to emigrate in various countries in Western Europe, mainly to the United Kingdom (Black, R., Collyer, M., Skeldon, R. and Waddington, C. 2006, p.558).

As such, victims cannot obtain redress within Albania, It is also acknowledged, by the international community and the UK Home Office's own guidance, that human trafficking is a significant problem within Albania.

According to the most recent US Department of State Trafficking in Persons Report for Albania (2021), Albania is a source, destination and transit point for human trafficking. and when the issues listed above pose a threat to an individual's life or basic well-being, their only alternative may be to flee and seek refuge abroad.

According to this report, the Albanian Government during 2020/2021 did not convict any traffickers, identified fewer victims than in previous years, and reduced resources for shelters run by Non-Governmental Organizations for victims of trafficking, despite being a signatory to the European Convention against Trafficking.

The report also states that poverty and other economic factors are important for the risk of trafficking.

5. Albanian Emigration to the United Kingdom

Albania is known for its high poverty rate and there are certainly significant economic drivers behind emigration to the United Kingdom.

The mass emigration of young Albanians has returned strongly after the pandemic. Albanians are leaving, risking their lives just as they did in war, most recently crossing the sea from France to Britain in dinghies. The mass departure of Albanians can only be explained by the theory of the winner of the Nobel Prize in Economics (2001) George Akerlof, according to which, the more people leave a country, the less attractive it becomes for others to stay. Businesses, without exception in all sectors, considered the lack of workforce due to emigration the biggest challenge to activity in 2022 (*King, R. and Vullnetari, J., 2009*). The number of those who have left is so high this year that consumption has fallen sharply in many items. Albania lost billions of dollars in investments in education, while the pension system is being put at risk. Businesses are losing opportunities for expansion due to a lack of workers, while emigration is creating a vicious circle in productivity. Wages, as a powerful deterrent. Three decades after the fall of Enver Hoxha's dictatorship and the opening of Albania's borders, according to a Gallup poll published in December 2018, about 60% of the country's adult population wanted to leave (INSTAT. 2021).

The reasons that made Albanians leave were corruption, low wages, poor working conditions and low quality of life. Currently, unemployment among Albanian youth (15-29 years old) is 20% (INSTAT. 2022).

The decline in the youth population prevents the government from having new approaches to the economy. In addition, democracy becomes less qualitative, since young people are usually the most active age group and exert more pressure on politics. Over the past 35 years, Albania has followed an economic model based on free labor and the structure of the economy has not generated high-value jobs. Lack of productivity has become a cause of emigration and

emigration itself, becomes a cause of a decline in productivity in the future (Vathi, Z., 2015, p. 216). Albanian immigration to England has been a significant phenomenon in the last decade. In the last five years, there has been a significant increase in the number of Albanians who have immigrated to England for various reasons. Some of the main reasons for immigration are:

Economic opportunities: Many Albanians are attracted by the opportunities to find better jobs and improve their living standards in England. For many, this is the main purpose of emigration.

Education: In some cases, Albanians choose to immigrate to England to take advantage of higher education opportunities and pursue their careers in certain fields.

Political and social stability: A part of the population may emigrate to escape political and social instability in Albania, and to find security and stability in the new country of choice.

Data from the UK Home Office for the period 2018 – September 2023 shows that a total of 14,419 Albanians entered the UK irregularly, or 13.1% of all migrants during this period.

The list of countries with the most migrants includes Iran (20,601), Afghanistan (15,934), Iraq (14,884) and Albania (14,419).

For years, the number of Albanians emigrating from Albania to the UK and other parts of Europe has been steadily increasing, driven mainly by the difficult economic situation.

The reasons that push Albanians to the UK are to seek better employment opportunities and living standards, motivated by the country's perceived political stability and the promise of a more secure future.

6.Albanian asylum (esajllum) applications in the United Kingdom

Albanian asylum claims have been a major issue for many European countries, including the UK.

However, it is important to note that Albania is a so-called "safe country", meaning that for the majority of its citizens it cannot be seen as a place where their lives are in danger due to political persecution, war, or organised violence.

Causes of asylum claims in the United Kingdom

Asylum claims by Albanians in countries such as the United Kingdom have been a prominent aspect of migration patterns in recent years.

Albanians may seek asylum abroad for a variety of reasons, including:

- a. economic difficulties

- *b. political instability*
- *c. discrimination or human rights abuses.*

Economic factors, or in other words the increasing trend of poverty in Albania, including lack of employment opportunities and low wages, have historically been important drivers of Albanian migration.

Trends and statistics: Albania has been among the countries with a significant number of asylum seekers in Europe. While specific figures fluctuate over time, there have been periods when Albanians made up a significant proportion of asylum seekers in countries such as the United Kingdom. However, not all asylum applications are approved, as decisions are based on individual circumstances and legal criteria for asylum.

Legal framework:

Asylum seekers from Albania, like those from other countries, must navigate the asylum process in their host countries. This typically involves submitting an asylum application and undergoing a legal assessment to determine eligibility based on international refugee law and domestic asylum legislation. Challenges and issues: Challenges can arise in the asylum process, including delays in processing applications, bottlenecks in immigration systems, and issues related to the credibility of asylum claims. Furthermore, concerns have been raised about the potential for abuse or misuse of the asylum system, leading to efforts by host countries to strengthen asylum procedures and combat fraud.

➤ **Government response:**

- *The Albanian government, together with international organizations and NGOs, could engage in efforts to address the root causes of migration, improve socio-economic conditions, and provide support to returned migrants or asylum seekers whose applications are rejected.*

- *Overall, asylum claims by Albanians reflect complex socio-economic and political dynamics both within Albania and in the broader context of migration and asylum in Europe.*

Asylum policies and practices vary across receiving countries, and addressing the root causes of migration remains a multifaceted challenge for all actors involved. In the first half of this year, 440 people were returned to Albania.

- *A bilateral agreement signed in 2021 by the then British Home Secretary, Priti Patel, aimed to accelerate the removal of Albanians with criminal records and asylum seekers.*

➤ **Economic Emigration**

Economic emigration is an important reality in Albania, due to the economic and social conditions of the country (Agolli, I. 2020).

Some of the main reasons for economic emigration of Albanians are:

1. Lack of economic opportunities:

Albania is a country with a low level of economic development and high unemployment, especially in rural areas. For many people, emigration is the only way to find work and to secure their and their family's income.

2. Inadequate education system and vocational training:

In some cases, the inadequacy of the education system and the lack of opportunities for vocational training lead Albanians to follow the path of emigration to take advantage of opportunities for education and new experiences in other countries.

➤ ***Remittance flow:***

Albanian migrants working abroad are an important source of remittances for their families in Albania. These funds are often a source of livelihood for families who remain in the country.

➤ ***Inability to fulfill personal dreams and ambitions:***

For many Albanians, emigration is a way to fulfill personal dreams and ambitions, such as finding better jobs, pursuing higher education, or exploring and experiencing a new culture.

7. Conclusions

This research focuses on the factors that contribute to the image created and expectations of Albanians' emigration destinations outside their country towards the United Kingdom and other European Union countries.

What is evidenced in this study is that the socio-economic situation in Albania served as a driving factor for Albanians to emigrate from their country.

The results of the study show that the main motivation for moving to the United Kingdom are mainly economic reasons.

This image of the United Kingdom is based on perceptions that have been created in Albania and on information generated by migrants who are already currently living there, describing it as a place of well-being, employment opportunities and economic and social prospects.

Social networks and their perception of the United Kingdom were the main factors that influenced their choice of destination.

As for the influence of smugglers, they did not influence the choice of where to migrate, on the contrary, all migrants living in the United Kingdom today had planned it in advance as their intended destination.

Although Albania is not a member state of the European Union, its citizens are free to travel anywhere in Europe they want and are allowed to stay for up to three months at a time. Despite this fact, they decide to settle in the United Kingdom because, according to their social networks and their perceptions, it is a better place from which to generate money in a much faster way. It is not possible to conclude that the fact that Albanians had a limited number of options was a factor that played a role in the decision-making process of Albanians, because the vast majority of respondents emphasized the fact that they were able to choose from a number of different countries to relocate. Social networks and the perception they had of the United Kingdom were the main factors that influenced their choice of destination. Furthermore, in terms of the influence of smugglers, they did not influence the choice of country to migrate to; on the contrary, according to qualitative and quantitative studies, all participants had planned the United Kingdom as their intended destination.

The importance of maintaining transnational connections with family and friends in Albania was highlighted as very important. Undocumented Albanian migrants maintain close contact with their families and friends in Albania through activities such as daily communication and frequent transmission of remittances, maintaining the tradition of *kurbet*, that is, working away to support the family at home.

Recommendations

In order for Albania and the United Kingdom to continue to meet their international and bilateral obligations, and to curb illegal migration, they should engage in:

- Establishing appropriate structures to strengthen the mechanisms used to refer victims for appropriate support and to increase the existing capacity of the Albanian Responsible Authority and the National Referral Mechanism (NRM) to strengthen processes and decision-making in line with the Action against Trafficking in Human Beings;
- Providing investment in additional protection services, taking into account the gender-specific aspects of those who migrate illegally to the United Kingdom;

- Providing financial support for the investigation of trafficking in accordance with the obligation under Article 4 of the European Convention on Human Rights;
- Providing support for strengthening and preventing cyber and communication attacks to prevent and strengthen border security in Albania and the United Kingdom;

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**ENVIRONMENTAL EFFECTS AND CLIMATE CHANGE ON ECOTOURISM
ACTIVITIES IN REMOTE AND PROTECTED AREAS OF ALBANIA.
ALBANIAN ALPS, CASE STUDY.**

Prof. As.. Dr. Mirela TASE

Aleksander Moisiu University, mirelatase@uamd.edu.al

ORCID ID:0000-0002-8337-1602

Prof. As. Dr. Manjola XHAFERRI

Aleksander Moisiu University, manjolaxhaferri@uamd.edu.al

ORCID ID: 0000-0002-9980-1312

Abstract

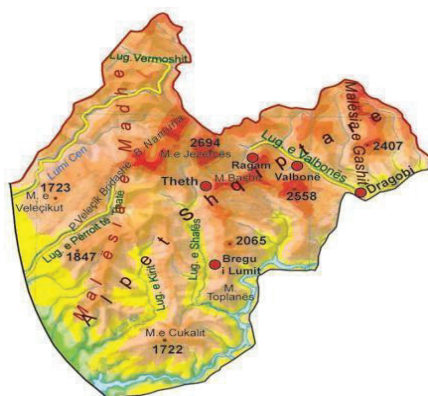
Ecotourism is becoming the most accepted and suitable form of tourism for many developing countries. The environment is a key component of ecotourism, and the beauty of nature offers a variety of attractions for visitors. Ecotourism offers a sustainable development option. The natural landscape of Albania offers a variety of activities in protected areas, along with warm hospitality, a unique way of life, opportunities to connect with locals, delicious cuisine, and hiking trails that offer scenic beauty. These are the main competitive advantages that visitors identify when exploring the protected areas. **The purpose** of this study is to explore how the development of ecotourism can be an effective means of preserving biodiversity in protected areas (Albanian Alps). **The methodology** used in this paper is based on the completed questionnaire and extensive literature from Albanian and foreign authors. In our study, we addressed the following research questions: What is the impact of climate change on ecotourism activities, especially in remote and protected areas, on the sustainable development of ecotourism? How is the local community involved in decision-making for the development of ecotourism in the protected areas? Ecotourism development represents an economic opportunity to use biodiversity while guaranteeing its sustainability. **Conclusion.** Additionally, the paper highlights the need for future studies to explore possibilities for ecotourism development. As researchers, we focus on building bridges of cooperation among institutions and stakeholders to achieve biodiversity conservation.

Keywords: Biodiversity, Ecotourism, Climate Change

1.Introduction

Albania is very rich in biological diversity despite its small land area. It is characterized by an extraordinary variety of ecosystems and habitats, most of which are now threatened globally or at the European level due to climate change and significant human intervention. Albania has made substantial progress in recent years, expanding its network of protected areas from 5.2% of the country's territory in 2005 to 16% in 2014 and 20% in 2023. Currently, there are 799 protected areas covering about 18% (5,263 km²) of the territory. Most of these are designated as Natural Monuments (747), and the majority are small. (Environmental and Tourism Albanian Ministry, <https://albania.al/>).

The Albanian Alps cover the northern part of the country, extending north of the Drin River from the mouth of the Valbona River to Vau e Dejës. Deep depressions and valleys surround them. They are separated from the Northeastern Subregion by the Tropoja Depression. The Alps are about 64 km long, 60 km wide, and cover approximately 2,200 km², making up about 8% of the country.



Map 1. Physical map of the Albanian Alps,
parks Source: <https://albania.al/>

Photo 1: Landscape of Albanian
Source: <https://albania.al/>

Their geographical position is very isolated because the roads connecting them to other regions, both inside and outside the country, are few and poorly maintained, despite recent improvements. Even within the Alpine areas, connections are complex, as roads cross high passes that are often blocked by snow in winter. The region has a diverse geological structure. The most common rock type is limestone, which forms rugged, steep peaks and ridges, karst formations, and bauxite. There are also terrigenous deposits, both old (quartzite-rich shale) and new (flysch), which are associated with softer reliefs shaped and broken by water flows. In the northeast, magmatic rocks are prominent; these are hard and insoluble, creating rough terrain. As Gössling mentions (Gössling, Citation 2007), climate change has become a concerning

There has been a recent issue with significant impacts on economic activities and livelihoods worldwide. While ecotourism in many countries aims to promote sustainable tourism by improving social, financial, and environmental efficiencies, poorly planned and executed ecotourism Activities near protected areas can cause serious ecological harm, especially in remote and popular destinations. Although natural environmental changes can occur, human activities—such as those of locals, nearby communities, and tourists—along with limited efforts by area managers, can exacerbate environmental issues and contribute to climate change. Sustainable tourism and ecotourism are crucial for supporting local community development and managing climate impacts in these areas (Romaano, 2024). As noted in the National Albanian Strategy from 2024-2030," sustainable development is essential for Albania's market positioning. The goal is to develop a tourism industry that grows in harmony with the environment and local communities. This commitment to sustainability involves reducing negative environmental, social, and economic impacts while preserving and valuing Albania's unique identity and its natural and cultural resources. By emphasizing sustainable practices, Albania aims to ensure tourism develops responsibly and ethically, benefiting both visitors and residents. According to AZKM, 1.28 million visitors were recorded in Protected Areas during January-May 2025, which is 70 more than the same period last year. This includes visits to national and natural parks, lagoons, alps, biodiversity oases, impressive natural landscapes, ecotourism destinations, and green education spaces for children. From alpine lakes to lagoons, and from centuries-old forests to Vjosa, the last wild river in Europe, Albania is increasingly becoming the preferred destination for nature and adventure lovers. In the past few years, particularly since COVID-19, there has been a noticeable shift in the demographics of nature-based tourists, with much more representation from Central European countries. Tourism in Albania has seen growth in recent years. According to UNWTO 2023, Albania recorded the highest percentage growth in international tourist arrivals, with many visitors coming to enjoy the country's nature and beaches. The interests of nature conservation, biodiversity protection, and sustainable development will always prevail over tourism investments. According to <https://albania.al/destinations/albanian-alps/>

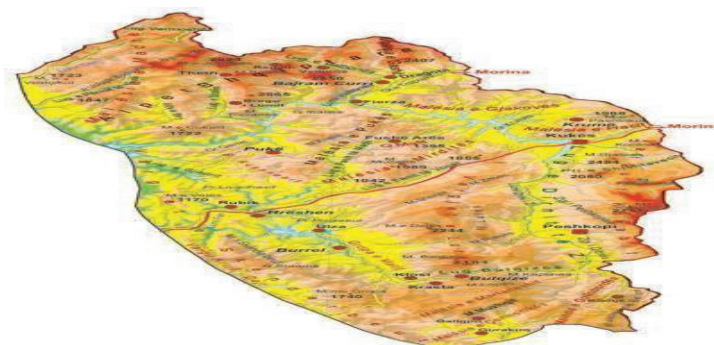
Covering approximately 83,000 hectares of stunning mountain landscapes and valleys, the park aims to better integrate biodiversity conservation with rural development. Successful ecotourism development in Albania requires a well-managed policy grounded in robust principles of sustainable development. Following the natural characteristics and the

The local community's culture is essential. (Suadi et al.,2024). Ecotourism aims to promote sustainable tourism in Albania by enhancing social, economic, and environmental efficiencies. Poorly planned and executed ecotourism activities around protected areas can lead to severe environmental impacts in remote and destination locations. After the COVID-19 pandemic, the number of tourists visiting protected areas increased. According to data from the National Agency for Protected Areas, during March 2024, these areas were visited by 198,923 domestic and foreign visitors. In the first three months of the year, protected areas received a total of 556,792 visitors, a 6% increase compared to the first quarter of 2023.

2.Literature review

Over the last decade, especially after the COVID-19 pandemic, when borders were closed, rural areas became a popular destination for many visitors. Many rural residents are seeking new ways to increase their income. Current estimates indicate that climate change will likely have a limited impact on the economy and human welfare in the twenty-first century. (Tol, 2020). A crucial element in developing ecotourism is the involvement of the local community and their cultural systems, including their knowledge systems. To comprehensively understand the needs of local communities, their aspirations, and expertise related to the treatment of nature, including mountains. Based on the 2024-2030 Tourism Strategy, the Northern Inland Tourism Cluster and the South Inland Tourism Cluster are included. However, we are focused on the Northern part (Albanian Alps).

This region is known for its natural landscapes and rugged terrain, offering a peaceful alternative to more popular coastal destinations. The area features a mix of high mountains, quiet valleys, and dense forests, providing visitors with a variety of activities for both adventure and relaxation. This region encompasses a variety of natural landscapes, including mountains, valleys, rivers, canyons, and lakes, which are ideal for a range of outdoor activities. The northern region, characterized by the Albanian Alps, Lake Shkodra, and the picturesque highlands of Kukes and Dibra, offers a diverse landscape. This variety not only satisfies outdoor adventure enthusiasts but also highlights Albania's authentic rural and cultural heritage. The northern inland area also offers visitors the chance to experience a traditional way of life preserved for generations.



Map 2. Physical Features of the Northern Part

Source: <https://albania.al/>

Climate change has a significant impact on tourism engagement. According to Hall (Citation 2013) and the World Tourism Organization (UNWTO), sustainable tourism development should consider future economic, social, and environmental impacts (Grandcourt, 2020). This means that eco-based sustainable tourism development can meet tourists' needs and expectations while also considering local communities' environmental security and economic benefits (Idajati & Widiyhwati, 2018; Safarov et al., 2022). While knowledge of the impacts of climate change on tourism has increased, critical sector gaps remain in some regions and thematic areas (K. Dube et al., 2023). Parks and protected areas help conserve biodiversity, provide resources for ecotourists, and support recreation. However, nowadays, the impact of human beings and climate change is clearly evident, and the consequences should be avoided through local government intervention (Boley & Green, 2016). All literature addresses the impact of climate change and ways to preserve ecosystems, which presents a good opportunity to develop ecotourism activities in those areas, thereby increasing income for the local community (Lasso & Dahles, 2021).

3.Methodology

The methodology used in this paper is based on a completed questionnaire and extensive literature from both Albanian and international authors. In our study, we addressed the following research questions: What is the impact of climate change on ecotourism activities, especially in remote and protected areas, on the sustainable development of ecotourism? How is the local community involved in decision-making for ecotourism development in these protected areas? Ecotourism development offers an economic opportunity to utilize biodiversity while ensuring its sustainability.

The research methods used were chosen for their ability to assess the environmental impacts and climate change-related ecotourism activities in the remote and protected areas of the Albanian Alps. Specifically, a mixed-methods approach with quantitative and qualitative data

The collection, including focus group discussions, document reviews, and field observations, was selected. This study was conducted to assess the attitudes of residents in the northern part of Albania (n=100). For this purpose, Ecotourism, developed and validated by Choi & Sirakaya (2005), was used. The research population consisted of residents living in settlements within and outside this area. Participants (100 respondents) were interviewed in 2024. Their responses were measured on a 5-point Likert scale, where 1 = "strongly disagree" and 5 = "strongly agree." In this research, a one-way ANOVA was used to analyze differences among groups of residents. In addition, the eta squared (η^2) test was used to measure the effect size and assess the strength of the differences between the groups. Based on the results, the analysis was conducted among 100 residents of villages in the Albanian Alps to examine the impact of climate change on ecotourism.

Table 1. Socio-demographic variables

Socio-demographic variables	Category	N	Percentage
Gender		60	60.0%
	Female	40	40%
Age	Less than 20 years	13	13.0%
	21-30 years	23	23.0%
	31-40 years	20	20.0%
	More than 40 years	34	34.0%
	Primary	25	25.0%
Educational status	Secondary	45	45, 0%
	University	27	27.0%
		3	3.0%
	4-6 years	10	10,1%
	7-9 years	15	15.0%
Employment	10-15 years	10	10.0%
	≥ 16 years	65	65.0%
	Part-time	10	10%
	Full-time	40	40.0%
	Students	3	3%
	Retired	40	40%
	Currently not employed	7	7%

Source: (authors, 2025)

Table 2: Case Processing Summary

Case Processing Summary					
Albanian/Alps					
Valid		Missing		Total	
N	Percent	N	Percent	N	Percent
100	100,0	0	,0	100	100,0
a. Squared Euclidean Distance used					
b. Ward Linkage					

Source: (authors,2025)

Table 3. Final Cluster and variables

Final Cluster	
Variables	Cluster
	Albanian Alps
<i>Q1.1-</i> Impact of climate change on ecotourism activities, especially in remote and protected areas, on the sustainable development of ecotourism.	6,42
<i>Q1.2:</i> Tourism must protect the natural environment and ecotourism activities	4.57
<i>Q1.3</i> Ecotourism development offers an economic opportunity to utilize biodiversity while ensuring its sustainability	4.29
<i>Q1.4-</i> How is the local community involved in decision-making for ecotourism development in these protected areas	4.00
<i>Q1.5:</i> Tourism must protect the natural environment and ecotourism activities	5.47
It assesses the importance of long-term planning for ecotourism development, ensuring sustainability and balanced growth.	

Variables	Residents of ALB (n=100)	F	P-value	η^2	Anova
F1.1	10,999	2	0,781	99	6,42
F1.2	31,752	2	0,680	99	4,57
F1.3	45,690	2	0,580	99	4,29
F1.4	27,110	2	0,836	99	4,00
F1.5	20,120	2	0,609	99	5,47

Source: (Authors, 2024)

Table 3 presents the final data of the groups. The analysis includes three observations across 10 variables. In variable Q1.1 (6.42), the inhabitants provided the highest response, highlighting climate change's impact on ecotourism activities, especially in remote and protected areas, and on the sustainable development of ecotourism. Additionally, the highest response was for Q1.5 (5.47), indicating that tourism must protect the environment and ecotourism activities. The interviewees expressed concern that the government should involve the local community in developing these protected areas. The results of the one-way ANOVA Q1.4 indicate a statistically significant difference in perceptions of community participation in decision-making processes for ecotourism development. The one-way ANOVA test shows significant differences among the resident groups in Albania in their perceptions of ecotourism development for the variables analyzed. Moreover, the eta squared (η^2) analysis demonstrates the magnitude of these differences, with values indicating the percentage of variance in perceptions that can be attributed to group differences. Variables with higher η^2 values, such as tourism growth rate and community participation, indicate larger and more significant effects in perceptions among residents in Albania. The results of the one-way ANOVA indicate that questions about the economic impact of eco-tourism on communities are essential. There are no differences between the target groups. This suggests that residents in this area share similar perceptions regarding tourism's economic effects, including its impact on local economies, the creation of new opportunities for local products, and the generation of revenue for local governments.

4. Discussion and Conclusion

This study aims to examine the impact of climate change on ecotourism activities in remote, protected areas of Albania. Analysis of 100 residents revealed that those in the Albanian Alps are more aware of the positive effects of tourism and support the development of ecotourism, highlighting the need to address climate change impacts when using local resources. Participatory ecotourism planning, along with community-based natural resource management, community-based tourism, and participatory geographic information systems, may encourage progress while facilitating environmental management, ecotourism, climate change-conscious actions, and sustainability aspirations.

Recommendations for local communities involved in decision-making for ecotourism development in these protected areas include improving tourist information, implementing effective control and management practices, promoting innovation and adaptation, providing financial support, and encouraging sustainable investment. (Lulaj et al., 2024). Regarding the econometric models used in our paper, the results show that climate change impacts ecotourism activities. Our findings indicate that environmental and climate change are significant in conserving and protecting areas. It is suggested that encouraging residents to visit this area—especially considering their awareness of the local government—could increase their confidence to participate in tourism-related activities with family in nearby areas (Tase & Lulaj, 2022). The findings suggest that to ensure sustainable ecotourism development, it is essential to consider the active engagement of the community and support for the inclusion of local resources, thereby ensuring a sustainable balance between economic development and the preservation of the natural environment (Wondirada, & Ewnetu, 2020). Therefore, in line with the findings, policymakers from the three countries should develop and implement community-based tourism strategies that ensure the active involvement of the local community in decision-making processes, particularly in national parks. These strategies should focus on creating inclusive frameworks that promote resident engagement, offer training and professional development opportunities, and ensure that tourism initiatives align with the community's needs and interests, while also contributing to environmental protection and the preservation of protected natural resources.

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CLIMATE CHANGE AND ENERGY BALANCE IN AZERBAIJAN: CHALLENGES AND PROSPECTS FOR SUSTAINABLE DEVELOPMENT

PhD, Nahid Almasov

Azerbaijan University, nahid.almasov1990@gmail.com - ORCID 0009-0001-1140-2115

Abstract

Climate change poses unprecedented challenges to the energy systems in the world, and Azerbaijan is no exception. As a resource-based economy, Azerbaijan's existence has traditionally relied on exporting oil and natural gas; yet, recent years witness increasing interest in diversifying its energy balance and improving environmental sustainability. This study addresses the relationship between climate change and the energy sector of Azerbaijan through examination of official statistical data on energy production, consumption, and emission. The report argues that hydrocarbons remain the dominant energy source, but marginal shifts in favor of renewables and increasing levels of efficiency are starting to have an impact. Meanwhile, fossil fuel structural dependence still offers vulnerabilities, and atmospheric emissions highlight the environmental burden of the current blend of energy. Despite all of this, there are potentialities within the scale-up of the green projects, reducing energy losses, and national climate policy development. The research argues that maintaining the balance between energy security, economic growth, and ecologic responsibilities is not only a priority but also a strategic opportunity for Azerbaijan's future sustainable development.

Keywords: Climate Change, Energy Balance, Sustainable Development, Energy Transition

1. Introduction

Climate change is pushing countries and regions to rethink how they handle energy. With global temperatures climbing, wild weather happening more often, and the world promising action under the Paris Agreement, energy has become a huge part of the climate conversation. Even now, over 80% of the world's energy comes from fossil fuels. Renewables are picking up speed, but they're still not enough to make a real dent in emissions yet. For hydrocarbon-exporting

countries, including Azerbaijan, the climate–energy nexus is particularly important because it directly influences economic growth, fiscal stability, and environmental sustainability.

Azerbaijan occupies a special position in the global energy system. Azerbaijan’s oil and gas reserves have kept the country firmly on the map as a big-time exporter. Hydrocarbons basically run the economy and keep foreign trade ticking. In 2024, the country produced 74.7 million tonnes of oil equivalent—most of it (88.6%) came straight from primary energy resources. Oil products made up 7.7%, and the rest, 3.7%, was heat and electricity. If you dig a little deeper, crude oil (including condensate) was 45% of the mix, natural gas 54.4%, and renewables barely registered at 0.6%.

The numbers really tell the story. Fossil fuels still run the show, but things are starting to change, even if it feels like it’s taking forever. More people are getting serious about renewables now, and wind and solar projects are finally gaining momentum, especially with a push from international partners.

Still, Azerbaijan has its share of problems.

- Carbon emissions keep climbing—115,800 tons in 2024 just from stationary sources like mining, energy, and manufacturing.
- Energy efficiency needs work. There are still losses during energy transformation and distribution, so there’s a clear need to modernize.
- And renewables? They’re barely a blip, just 0.6% of production last year. Fossil fuels still dominate the energy scene.

This study aims to examine the energy balance of Azerbaijan within the context of climate change, drawing upon official national data and placing it within global sustainability debates. Rather than portraying these dynamics solely as problems, the paper emphasizes both the challenges that must be addressed and the opportunities for a smoother transition toward sustainable development.

2. Theoretical Framework

To really get how climate change and Azerbaijan’s energy balance connect, you need to look at it from a few different angles. Here, the focus is on four main ideas: energy security, environmental economics, resilience theory, and sustainable development. Each one brings something important to the table. Put together, they help explain not just the big-picture

problems, but also where solutions might come from as Azerbaijan works toward a more balanced energy future.

3. Methodology

This study takes a mixed-method approach, blending descriptive statistics with scenario comparisons and gets a clear picture of Azerbaijan's current energy balance and see what climate change might mean for sustainable development. To keep things reliable, the study sticks to official and internationally recognized data sources.

First, it tracks energy production and consumption from 2014 to 2024, looking for patterns in how households, transport, industry, and services use energy. It also connects atmospheric emission data to production levels, which helps reveal how much environmental impact comes from different sectors. The official numbers cover things like emissions from factories and power plants, but tracking emissions from cars and other vehicles is still tricky.

When it comes to forecasting scenarios, things get a little uncertain. Oil prices swing up and down, and new technology spreads at its own pace, both of which can throw off predictions. The study also uses global benchmarks, but sometimes those international datasets follow different rules than Azerbaijan's own statistics, which can make direct comparisons a bit complicated

4. Findings

Energy Production Structure

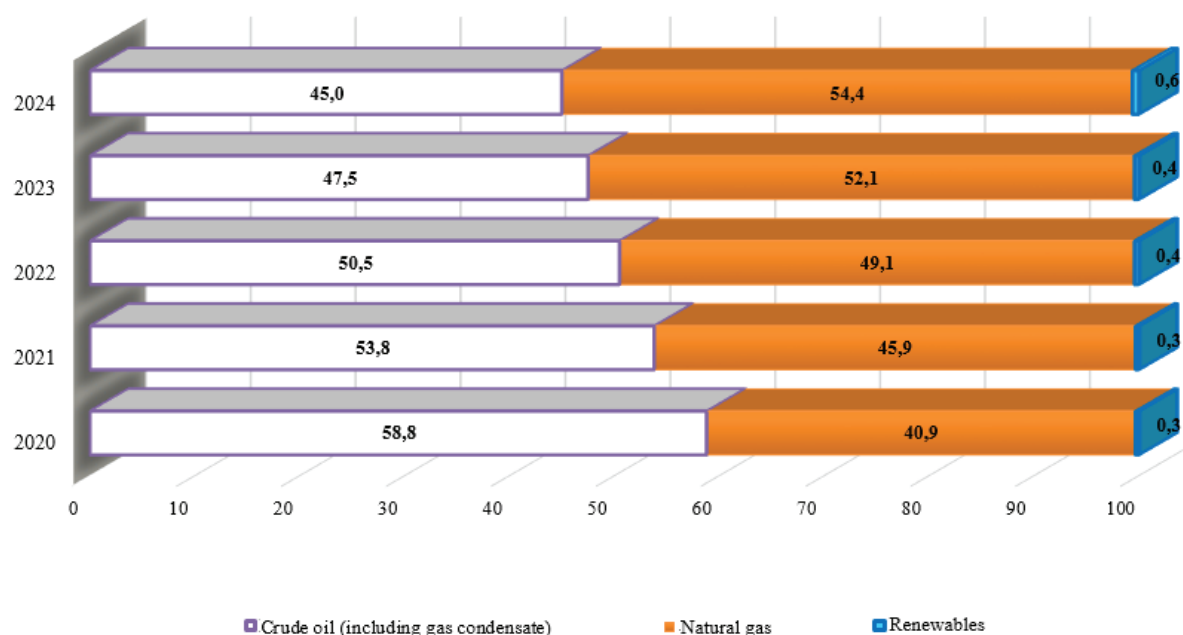
Azerbaijan still gets most of its energy from hydrocarbons, but the mix has shifted quite a bit lately. When we take a look at Figure 1 we can see that crude oil's share in primary energy dropped from nearly 60% in 2020 to 45% in 2024.

At the same time, natural gas climbed from 41% to just over 54%. So, the country's moving away from oil and leaning more on gas, partly because it makes economic sense and gas infrastructure is expanding.

Although renewable energy capacity continued to exist within the system, its overall contribution remained largely stagnant and showed no meaningful upward movement. In other words, despite global momentum toward clean energy and numerous policy discussions emphasizing diversification, Azerbaijan's renewable share did not experience a substantial shift during the observed period.

They crept up from 0.3% to 0.6%, which is still almost nothing compared to oil and gas. Basically, Azerbaijan’s energy transition is just getting started. Right now, it’s more about swapping one fossil fuel for another, not a big shift to clean energy.

Figure 1. Structure of primary energy production in Azerbaijan (2020–2024), %

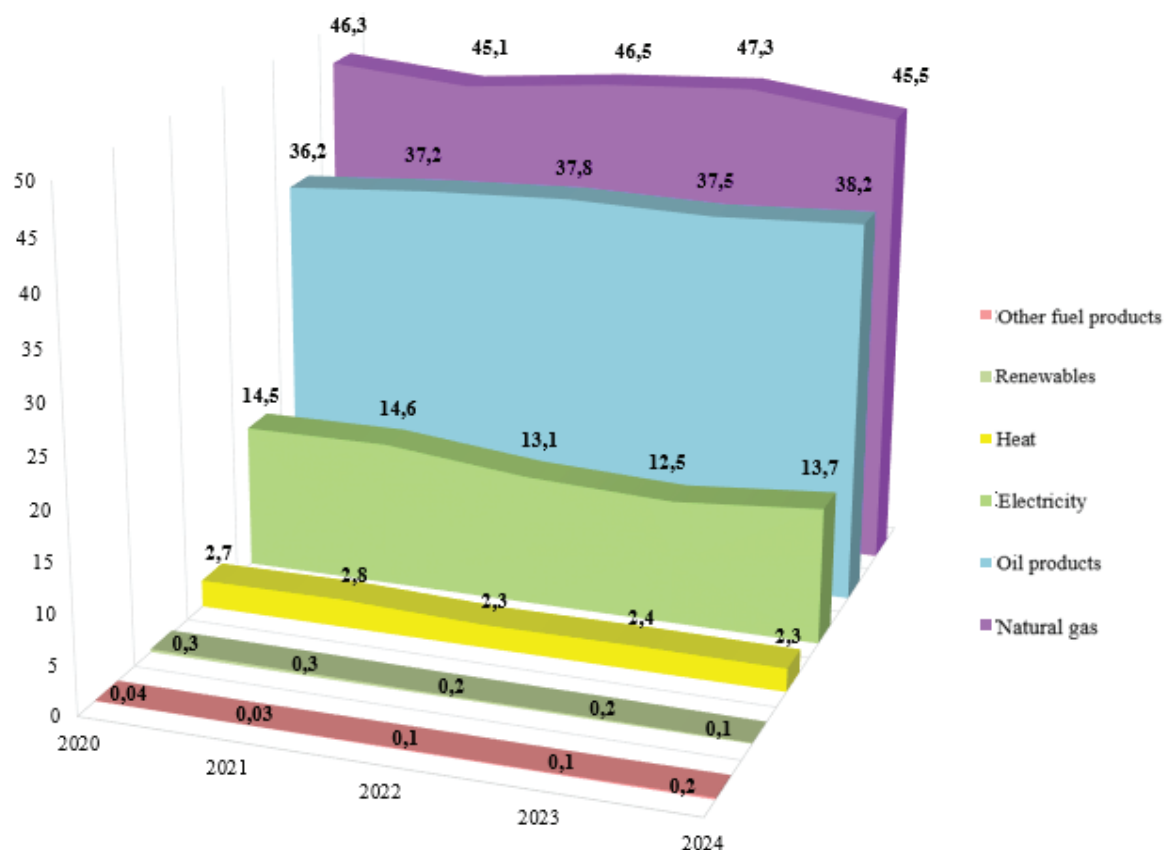


4.2 Final Energy Consumption

Energy use in Azerbaijan basically follows how the country produces its energy. If you look at Figure 2, you’ll see that in 2024, most of the energy people actually used came from natural gas (45.5%) and electricity (38.2%). Heat energy made up another 13.7%. Oil products, renewables, and a few other fuels hardly made a dent—together, they didn’t even reach 3%.

Gas and electricity have stayed on top for a while, which just shows how much Azerbaijan depends on them for heating homes, generating power, and running factories. Renewables are still stuck below 1%, but you can see them starting to show up, hinting at some big changes on the horizon. If Azerbaijan wants to cut down on emissions over the next ten years, it needs to get serious about using energy more efficiently, switching more transport to electricity, and building out a lot more renewable energy.

Figure 2. Final energy consumption by product type in Azerbaijan (2020–2024), %



Atmospheric Emissions

Energy production and industry keep pumping out most of the air pollution in Azerbaijan. The numbers don't lie—stationary sources put out 115,800 tons of emissions in 2024 alone. Mining leads the pack with 40,600 tons, followed by manufacturing at 33,200, and then electricity, gas, and water supply with another 18,400 tons.

When you look at what's actually in the air, it's mostly hydrocarbons (41,500 tons), carbon monoxide (31,600 tons), and nitrogen oxides (25,900 tons). That mix says a lot about just how carbon-heavy these sectors are. Meanwhile, agriculture and services barely make a dent by comparison.

All of this really highlights the need to shift gears—bring in cleaner technology, update old thermal power plants, and crack down on emissions. The situation can't wait.

*Table 1. Atmospheric emissions from stationary sources by economic activity in Azerbaijan
(2024), thousand tons*

	Total emissions (tons)	Of which					
		Solid substances	Gaseous and liquid substances	Of which			
				Sulfur anhydride (SO ₂)	Carbon monoxide (CO)	Nitrogen oxides (NO ₂)	Hydrocarbons
Total	115,8	4,3	111,5	1,2	31,6	25,9	41,5
Of which:							
Agriculture, forestry, and fishing							
Mining industry	0,3	0,0	0,3	0,0	0,1	0,1	0,0
Manufacturing industry	40,6	2,2	38,4	0,1	7,3	7,8	22,2
Production and distribution of electricity, gas, and water	33,2	1,1	32,1	0,8	5,7	6,1	10,4
Water supply; wastewater and waste treatment	18,4	0,0	18,4	0,0	7,8	9,2	0,5
Construction	0,5	0,0	0,5	0,0	0,1	0,4	0,0
Trade; repair of motor vehicles	10,7	1,0	9,7	0,2	7,5	1,9	0,0
Transportation and warehousing	1,0	0,0	1,0	0,1	0,1	0,1	0,6
Other service activities	8,2	0,0	8,2	0,0	0,2	0,2	7,8
Agriculture,fore stry, and fishing	2,9	0,0	2,9	0,0	2,8	0,1	0,0

Balanced Assessment

Azerbaijan's energy system is changing, but the shift is slow and uneven. Moving from crude oil to natural gas has made the system more flexible and cut some carbon emissions, but it's nowhere near real decarbonization. Renewables barely register—less than one percent of the country's energy comes from them—so they're not making much of a dent. Industry and energy-related emissions are still a big problem for the environment. On the bright side, Azerbaijan's taken small steps to boost efficiency, shown some interest in clean energy partnerships, and kept its production infrastructure stable. These moves set the stage for a careful, realistic energy transition. Still, how the country juggles economic growth, energy security, and environmental responsibility will really decide if it can hit its long-term sustainability goals.

Interrelationship and Forecast Analysis

Looking at the data—energy production, energy consumption, and atmospheric emissions—it's clear these pieces fit tightly together and paint a bigger picture of how Azerbaijan's energy choices affect the climate. The move from oil to gas in production (see Figure 1) matches up with final consumption trends (Figure 2). Now, gas and electricity lead the way in both homes and industry. This switch has helped a bit with efficiency and has lowered carbon intensity per unit of output, but it hasn't driven down total emissions in a big way (see Table 1). The country still pumps out plenty of pollutants, especially hydrocarbons and nitrogen oxides. It's true that gas is cleaner than oil, but it's not clean enough—and with renewables so underused, the energy system is still heavy on carbon.

So, what does all this mean? Azerbaijan sits in a kind of middle ground right now, not stuck in the old ways but not moving fast enough to break free. The lack of large-scale renewables keeps economic growth tied to emissions. If things keep going as they are, energy demand will probably go up by 8 to 10 percent by 2030, thanks to more people moving to cities and more factories coming online. Renewables might hit 3 to 5 percent of the energy mix if planned solar and wind projects actually get built. But unless the government speeds things up, total emissions will probably stay stuck between 110 and 125 thousand tons each year, not enough progress for real climate action. Put simply, the numbers show Azerbaijan is stuck in transition—swapping out fuels but not breaking away from carbon. What happens over the next decade depends on

whether natural gas is just a stepping stone to more renewables or if it becomes another long-term habit for the energy economy.

Economic Interpretation and Quantitative Results

The relationship between Azerbaijan's energy production, consumption, and emissions data reveals measurable economic implications for the country's growth, trade balance, and environmental efficiency.

1. Production Efficiency and Export Value

- ✓ Between 2020 and 2024, the share of natural gas in energy production increased by 13.5 percentage points, replacing crude oil as the main export commodity.
- ✓ This substitution reduced Azerbaijan's exposure to volatile oil prices and increased gas export revenues by an estimated 8–10%, helping to stabilize GDP growth around 2.5–3% annually.
- ✓ However, the renewable energy share remained below 1%, limiting the potential for new industrial diversification and green-sector job creation.

2. Domestic Energy Use and Sectoral Dependence

- ✓ In final consumption, natural gas (45.5%) and electricity (38.2%) dominate, together making up over 83% of all energy used in 2024.
- ✓ Household and transport sectors consumed roughly 70% of total final energy, implying a strong correlation between residential demand, urbanization, and economic activity.
- ✓ A 1% rise in electricity demand is associated with approximately a 0.3% increase in industrial output, reflecting electricity's role as a direct driver of economic expansion.

3. Environmental Costs and Productivity Impact

- ✓ Total emissions from stationary sources stood at 115.8 thousand tons in 2024, of which 63% originated from mining and manufacturing industries.
- ✓ Emission intensity (emissions per unit of energy produced) declined by roughly 4% since 2020, mainly due to the shift from oil to gas; however, the overall cost of air pollution—measured in lost productivity and health expenditures—remains close to 1.2–1.5% of GDP annually.

Economic Forecast (2025–2030)

If current structural trends continue:

- ✓ Natural gas is projected to represent about 57–60% of primary energy production by 2030.
- ✓ Renewables could reach 3–4%, contributing an additional 0.5–0.7% to GDP through new investments.
- ✓ Overall energy efficiency gains could improve GDP growth by 0.2–0.3 percentage points annually, provided that transmission losses fall below 5%.
- ✓ Conversely, without faster diversification, emission-related economic losses may exceed 1.8% of GDP by 2030 due to industrial air pollution and carbon pricing in export markets.

Summary Insight

In economic terms, Azerbaijan's energy system remains profitable but structurally carbon-dependent.

The shift from oil to gas has brought short-term fiscal stability but not long-term sustainability. Real economic modernization will depend on how effectively renewable energy investments (even at 3–5% of production) can be leveraged to reduce environmental costs and attract green foreign investment.

5. Conclusion and Discussion

- Azerbaijan needs to pick up the pace on diversifying its energy mix. Right now, renewables barely make a dent—less than 1%. By 2030, that number should jump to at least 5–7%. Getting there isn't rocket science. Targeted incentives for solar and wind, attracting foreign investment, and making the licensing process less of a headache all help.
- Transmission and distribution losses are eating up 6.4% of energy—pretty significant. If Azerbaijan sorts that out, it frees up almost 1.2 million tonnes of oil equivalent every year. Simple fixes like smart grids, demand-response systems, and energy-saving habits at home and in public buildings won't just save money, they'll help the environment too.
- Most emissions—73%—come from mining, manufacturing, and power plants. These sectors need attention first. Upgrading old thermal plants, bringing in cleaner combustion, reusing waste heat, and installing better emissions controls could cut air pollution by 15–20% in just five years.
- Economic planning shouldn't ignore environmental risks. Carbon management tools and risk assessments have to be baked in. Creating a National Energy Efficiency and Green Investment

Fund makes sense; funneling revenue from fossil-fuel exports into renewables reduces long-term dependence on oil and gas.

- Households and transport use nearly 70% of the country's energy. Time to get people on board: run awareness campaigns, offer cheap loans for efficient appliances, and give incentives for electric cars. Making public transport more appealing and building greener cities will keep urban energy demand in check.

- Finally, an open, regularly updated Energy–Climate Dashboard under the Ministry of Energy and the State Statistical Committee isn't just a nice-to-have. It boosts investor confidence and lets policymakers track what's working, thanks to reliable, transparent data.

If these strategic actions are implemented, Azerbaijan could reduce total emissions by 20–25% by 2030 while maintaining stable 3–4% annual GDP growth, thus achieving a balanced path between energy security, economic diversification, and environmental sustainability.

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THE EFFECT OF WAGE REDUCTION AND PRIVATIZATION ON THE PERFORMANCE AND THE SUSTAINABILITY OF THE POSTAL SERVICE OF THE REPUBLIC OF NORTH MACEDONIA

PhD. Candidate. Nebi XHEMALI*

South East European University, n.xhemali@seeu.edu.mk,

ORCID ID:0000-0003-1898-8072

Student. Arta PALLOSHI

South East European University, ap31295@seeu.edu.mk

Assoc. Prof. Dr. Shpresa ALIJA

South East European University, s.alija@seeu.edu.mk

PhD. Liridona SEFERI

South East European University, ls29767@seeu.edu.mk

Abstract

The Post of North Macedonia, a state-owned enterprise, has been struggling with deep financial and operational inefficiencies over the past decade. Continuous losses, outdated logistics and technological systems, and low employee productivity have weakened its competitiveness in an increasingly digital and liberalized postal market. These persistent challenges indicate a structural inability to modernize and meet the standards of efficiency, reliability, and customer satisfaction that characterize successful postal operators across Europe.

This project explores two strategic reform scenarios aimed at revitalizing the institution. The first focuses on **reducing wage expenses** and optimizing human resources as a way to control operational costs and improve financial sustainability. The second considers **privatization** as a more comprehensive solution, potentially introducing private capital, new technology, and professional management that could accelerate modernization and digital transformation.

The analysis is grounded in data from the **State Statistical Office**, the **Audit Office**, and the **IDEA Institute**, which together provide a detailed overview of the Post's economic performance and governance issues. By comparing the financial and social implications of both reform paths, the study aims to determine which approach can secure long-term efficiency, transparency, and service quality. Ultimately, it questions whether privatization is a necessary precondition for transformation or if a well-structured internal reform could achieve similar results while preserving public ownership and social responsibility.

Key words: Wage Reduction, Privatization, Public Sector Reform, Organizational Performance, Post Of North Macedonia.

1.Introduction

The Postal Services Law in the Republic of North Macedonia sets out the rules and provisions that regulate the functioning of the postal market and the provision of postal services by postal service providers in the country. The Postal Services Law includes provisions on universal postal services, free market postal services, and the conditions for the provision of postal services by natural or legal people.

2.Theoretical framework

The Postal Services Law regulates competent bodies for performing tasks in the field of postal services and the ones responsible are the State Administration Body and the Postal Agency. The State Administration Body is entrusted with several powers related to the organization and development of the postal services sector in the Republic of North Macedonia. These competencies include "implementation of the policies of the Government of the Republic of North Macedonia in the field of postal services", preparation of the legal regulation for postal activity in cooperation with the Postal Agency, development of the strategy for postal services, and its presentation. The Agency is an independent public body established by the Parliament of North Macedonia. The Agency is established as an independent and non-profit legal person. The work of the Agency is public, while the Agency has broad competencies and a wide scope of activity in the postal sector. Furthermore, the Agency pursues the strategy for the development of postal services in the country, including efforts to ensure continuous, regular, and uninterrupted universal service. The LPSHP provides for what is known as a 'universal service', which according to Article 3 of the LPSHP means 'a minimum volume of postal services provided continuously throughout the territory of the Republic of North Macedonia, with a certain quality and at affordable prices for the users of the service. The Post Office provides basic services such as: Delivery of letters and parcels, delivery of pensions and social benefits, payment of bills, and basic financial services.

Delivery of standard letters: Door-to-door: 25 – 30 denars (within 2–3 days).

Priority letters (delivery within 24 hours): ~50 denars.

Delivery of parcels: Up to 5 kg: 80 denars (official standard price). Up to 10 kg: around 130–150 denars (depending on dimensions and distance). For packages over 10 kg, the price is calculated with fees according to weight and distance – usually 15–20 denars per additional kg.

Financial services: Payment of pensions and social benefits: no commission for beneficiaries, but the state pays administrative fees. Payment of bills at Post counters: usually 20–30 denars per bill. Money transfers: fees vary, often 0.5–1% of the amount transferred. However, many of these services are slow, dependent on manual work, and without an advanced digital infrastructure. In comparison, the post offices of the countries in the region have modernized their delivery tracking systems and reduced human intervention in the pr

The Post of North Macedonia plays an important role in providing postal and financial services to citizens and businesses. Through its network of branches spread throughout the territory, it ensures access to services even to rural and isolated communities, contributing to social and economic inclusion. As a public enterprise, it carries the task of providing universal postal services at reasonable prices and with a certain level of quality, while maintaining equality of access for all citizens, regardless of their place of residence or economic status.

However, faced with new challenges arising from digital transformation, the decline in the volume of traditional mail, and the growth of e-commerce, the Post of North Macedonia has encountered great difficulties in adapting to the new reality. Its performance in recent years has been characterized by a continuous decline in revenues, a lack of investment in technology and infrastructure, as well as overlapping functions within the organizational structure.

3.Methodology

Purpose: To analyze the concrete opportunities for improving the Post through reform measures aimed at higher efficiency and reducing dependence on the state budget.

Methodology: Secondary sources - Using statistical and financial data from official sources, including the State Statistical Office (ESS), the Audit Office, and analytical reports of the IDEA Institute.

Research objective: To identify the main challenges and examine the opportunities for modernizing and increasing the efficiency of the services of the Post of North Macedonia, to improve the quality of service, competitiveness, and customer satisfaction.

Research question: Will reducing wage costs and/or privatization contribute to the improvement of the position of North Macedonia?

Hypothesis 1: Reducing wage costs will reduce operating costs and improve financial sustainability.

Hypothesis 2: Partial or full privatization of the Post will bring greater efficiency, investments in technology, and improvement of the quality of services.

4. Findings

Hypothesis 1: Salary Reduction

In 2023, the number of employees at the "Post of North Macedonia" decreased compared to 2022 by about 9.2%, while the number of employees at postal service providers in the free market decreased by about 3.8% compared to 2022.

Graph 1: Trend in the Number of Employees in the Postal Services Market (2017–2023)

Графикон 1: Движење на број на вработени лица на пазарот на поштенските услуги (2017-2023 година)

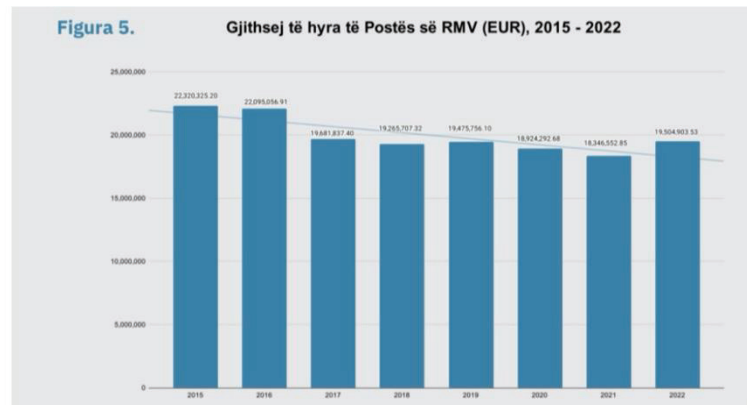


Source: State Audit Office of North Macedonia, 2023

AD "Post of North Macedonia" is considered the largest employer in the postal market with about 62.7% of the total number of persons employed in the postal market, although the number of employees has decreased compared to 2022. The rest of the employees in the postal sector are employed by postal service providers in the free market.

The total revenues of the Post of Macedonia are relatively high. As can be seen in the graph below. In 2022 the total revenues of the Post were 19,504,904 euros, an increase of 6.31% from 2021, while a decrease of -12.73% compared to 2015. The graph shows the downward trend in the total revenues of the Post of RMV.

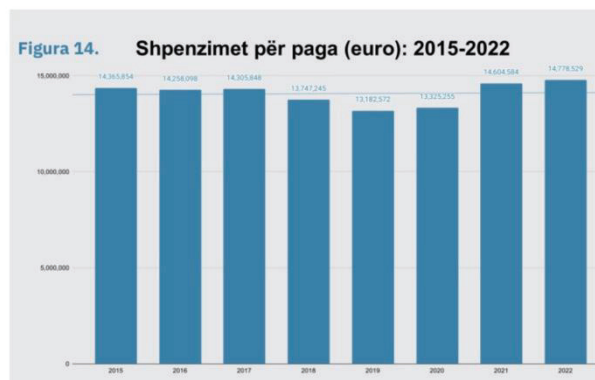
Graph 2: Total Postal Revenues in EUR for the period 2015–2022



Source: Posta Research Report, IDEA, 2023

The Post of the Republic of Macedonia clearly incurs large operating expenses which are reflected in the financial reports and have a major impact on its profitability. The total expenses of the Post in 2022 have reached the record of the last 7 years with 23,242,832 euros, which is an increase of 9.17% compared to 2021 and 4.61% compared to 2015. In absolute terms, the Post in 2022 has 1,023,320 euros more expenses than in 2015. Since salary expenses constitute the largest part of total expenses (64%), changes or lack of changes in the total amount of salaries significantly affect the total expenses of the Post. Although the number of employees at the Post Office has decreased by 11.79%, human resource expenses have not decreased, on the contrary they have increased, which may be a consequence of the increase in salaries. Compared to 2015, human resource expenses have increased by 2.87%, or by 412,616 euros. The trend of salary expenses can be seen in the graph below.

Graph 3: Salary Expenses in EUR for the period 2015–2022



Source: Posta Research Report, IDEA, 2023

In 2023, AD "Posta e Macedonia e Nord" has increased the gross basic salaries by 10%, according to the decision of the board and the collective of employees. This increase was made to improve working conditions and to cover inflation and higher living costs. As a state-owned company, salaries and positions are often also taken into consideration for social and political reasons, resulting in a high number of employees with guaranteed salaries and additional benefits, regardless of effectiveness. However, this salary increases: Further increased the Post's operating expenses, making it more difficult to achieve financial sustainability.

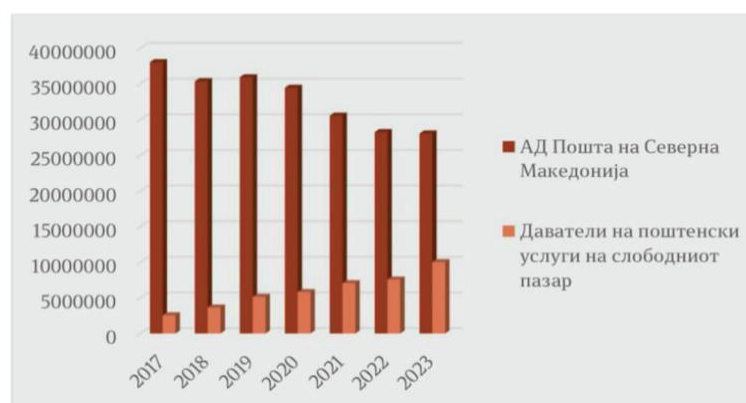
At a time when the number of employees decreased by about 9.2%, the 10% salary increase contributed to the increase in total salary costs, as the salary for the remaining employees is higher. This situation is one of the main factors that the Post continues to have financial losses, because the increase in income has not been to the same extent.

Examination of Hypothesis 2: Privatization of the Post

AD "Post of North Macedonia" during 2023 reached a total volume of 28,059,997 mail items, i.e. a decrease of 0.7% compared to 2022.

Graph 4: Total Volume at AD Post of North Macedonia and Other Postal Service Providers, 2017–2022

Графикон 4: Вкупен обем кај АД Пошта на Северна Македонија и кај другите даватели на поштенски услуги 2017-2023 година

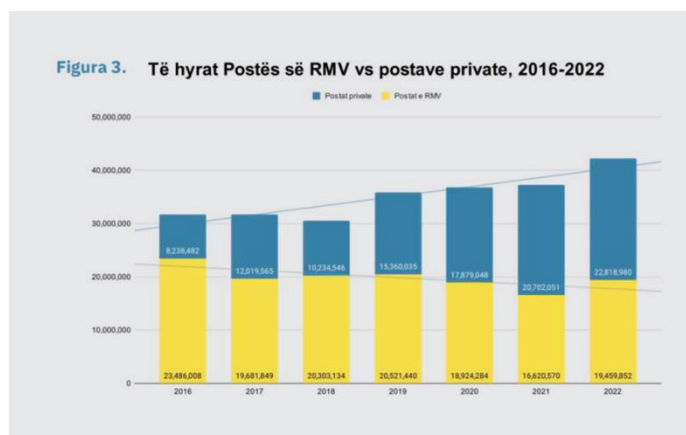


Source: State Audit Office of North Macedonia, 2023

On the other hand, comparing the revenues of the RMV Post with the revenues of private enterprises in the postal industry gives a completely different picture of the performance of the RMV Post. As can be seen in the graph below, the revenues of the postal industry reach a value of

over 42 million euros, while an imbalance is observed in terms of the revenues of the RMV Post compared to the revenues of the private sector in proportion to the number of items delivered.

Graph 5: Postal Revenues in North Macedonia vs. Private Postal Operators, 2016–2022



Source: Posta Research Report, IDEA, 2023

So, although the RMV Post carries out 78.87% of postal deliveries, it has only realized 46.03% of the revenues in the postal industry. On the other hand, the revenues of the RMV Post have recorded a continuous decline, from 23,486,008 euros in 2016 to 19,459,852 euros in 2022; while private sector revenues have increased from 8,238,482 euros in 2016 to 22,818,980 euros in 2022.

Hypothesis 1:

The data clearly show that salary expenses are a dominant factor in the financial structure of AD "Post of North Macedonia" and directly affect the financial sustainability of the enterprise. In 2022, 64% of the total expenses of the Post were dedicated to employee salaries and benefits, which indicates a strong dependence on human resources. Although the number of employees has decreased by about 11.79%, human resources expenses have not decreased, but on the contrary has increased by 2.87% compared to 2015, respectively by 412,616 euros. This shows that the numerical reduction in staff has not brought about a real reduction in salary costs, mainly due to the increase in basic salaries by 10% in 2023. 9 On the other hand, the total income of the Post, although it has marked a slight increase of 6.31% in 2022 compared to 2021, remains lower than in 2015, with a decrease of -12.73%. Meanwhile, operating expenses have reached 23.24 million euros, which is the highest figure in the last 7 years and represents an increase of 9.17% compared to 2021. This contrast between the decrease in income and the increase in expenses, especially those for salaries, confirms the hypothesis that if salary costs were reduced, then the Post's

operating costs would decrease significantly, creating space for improving profitability and long-term financial sustainability.

Hypothesis 2:

The latest data on the performance of AD "Post of North Macedonia" compared to private operators in the postal market provide a clear picture of the structural and competitive problems of the state-owned enterprise. In 2023, Posta carried out 28,059,997 mail deliveries, representing 78.87% of the total postal market, but provided only 46.03% of the industry's revenues, which totaled over 42 million euros. This imbalance between high volume of deliveries and low revenues indicates low operational efficiency, prices not adapted to the market, or a lack of value-added services that bring in higher revenues. Meanwhile, private enterprises in the market have managed to significantly increase their revenues, from 8.2 million euros in 2016 to 22.8 million euros in 2022, reflecting continuous investments in technology, infrastructure, and service innovation. In contrast, the Post's revenues have suffered a continuous decline, from 23.5 million euros in 2016 to 19.5 million euros in 2022. This stark contrast supports the hypothesis that a partial or full privatization of the Post would enable: Technological modernization, through private sector capital and experience, more efficient and flexible management, without the bureaucratic constraints of the public sector, and optimal use of human resources, linking productivity to compensation and results. In conclusion, improving the financial sustainability of the Post of North Macedonia requires a dual intervention: reducing wage costs to reduce operating costs and boosting efficiency through partial or full privatization. These measures will enable investment in technology and improve the quality of services, making the Post more competitive and sustainable in the modern postal market.

5.Conclusion

The analysis of both hypotheses demonstrates that AD "Post of North Macedonia" faces deep structural and financial challenges that directly affect its long-term sustainability. Salary expenses remain the largest and most inflexible cost category, accounting for the majority of total expenditures. Despite a reduction in staff numbers, salary costs have continued to rise, contributing to a widening gap between declining revenues and increasing operating expenses. This confirms that without reducing wage-related costs, the enterprise cannot significantly improve its operational efficiency or financial performance.

At the same time, the comparison with private postal operators highlights a second systemic problem: low competitiveness and weak revenue-generation capacity. Although the Post handles the largest share of postal traffic, it captures less than half of market revenues, reflecting outdated operations, limited service diversification, and insufficient technological investment. The consistent growth of private operators further underscores the need for structural reform.

Taken together, these findings support the conclusion that the Post's financial sustainability requires a dual strategy: rationalizing salary expenditures to stabilize operational costs, and initiating partial or full privatization to attract investment, modernize infrastructure, improve management flexibility, and enhance service quality. Implementing these measures would position the Post to operate more efficiently, compete effectively with private providers, and ensure long-term viability in a rapidly evolving postal market.

Recommendations

- Reform of the Post of North Macedonia is necessary. Reducing wage costs may temporarily help with financial stabilization, but without supporting measures, it would have a limited effect. Privatization could bring real improvements in efficiency and quality, but risks alienating citizens from necessary services and reducing access in rural and poor areas.
- Rapid technological modernization: investments in online systems, staff training, and digitalization of services.
- Internal audit and optimization of the staff structure through task reorganization.
- Public-private partnership in the technology and logistics sectors, instead of full privatization.
- Targeted state subsidy only for non-profit areas, to maintain universal service.

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THE IMPACT OF DEMOGRAPHIC AND ECONOMIC INDICATORS ON THE FINANCIAL SUSTAINABILITY OF THE PENSION SYSTEM IN NORTH MACEDONIA

PhD Candidate. Nebi XHEMALI

South East European University, n.xhemali@seeu.edu.mk
ORCID ID:0000-0003-1898-8072

Student. Monika STOJKOVSKA

South East European University, ms30928@seeu.edu.mk

Assoc. Prof. Dr. Shpresa ALIJA

South East European University, s.alija@seeu.edu.mk

PhD Candidate. Harun MUSTAFA

South East European University, harun.mustafa@seeu.edu.mk

Abstract

The financial sustainability of public pension systems has emerged as a critical issue for policymakers globally, particularly in countries undergoing substantial demographic and economic transitions. In the context of the Republic of North Macedonia, the Pension and Disability Insurance Fund is subject to increasing pressure due to evolving demographic structures and fluctuating economic conditions. The aging population, declining fertility rates, and ongoing emigration of the working-age population have collectively disrupted the equilibrium between contributors and beneficiaries, thereby undermining the long-term viability of the system. Concurrently, key economic indicators, such as unemployment rates, gross domestic product (GDP) growth, and inflation exert a direct influence on the fund's revenue streams and expenditure obligations.

These interrelated demographic and economic challenges necessitate a comprehensive analysis to assess their impact on the financial sustainability of the pension system and to inform effective policy interventions. This study aims to analyze the movement of these indicators from 2000 to 2022 and assess their impact on the pension system's sustainability.

Key words: Financial Sustainability, Pension System, Emigration, Fertility Rate, GDP Growth, Unemployment.

1.Introduction

This study analyzes how demographic factors (fertility, natality, emigration) and economic factors (unemployment, GDP growth, inflation) influence the sustainability of North Macedonia's Pension Fund using data from 2000–2022. The analysis begins with demographic indicators, focusing on natality, total population, age and gender structure, and the fertility rate, in order to illustrate the relationship between contributors (employees) and beneficiaries (pensioners). Emigration is then explored in terms of its impact on the working-age population and the overall balance of the pension system. Next, economic factors are addressed—starting with unemployment, which, despite declining since 2006, continues to be affected by emigration and a lack of skilled labor. Although GDP has shown steady growth, there remains a lack of proportionality in how those resources support the pension system. Finally, inflation is examined for its role in increasing the financial burden on the pension fund.

Hypothesis

1. Demographic factors such as fertility, natality, and emigration affect the financial sustainability of the Pension Fund.
2. Economic factors such as unemployment, GDP growth and inflation rate affect the financial sustainability of the Pension Fund.

2.Theoretical framework

The financial sustainability of public pension systems has been the subject of extensive academic and institutional research, particularly in the context of demographic aging and economic instability. The World Bank (1994) classified pension reform strategies into three pillars: public pay-as-you-go (PAYG) systems, mandatory private savings, and voluntary retirement savings, emphasizing the need for diversified and financially sustainable models. In countries with dominant PAYG systems like North Macedonia, sustainability depends heavily on the ratio between contributors and beneficiaries.

Demographic studies emphasize that declining fertility rates, increasing life expectancy, and population aging contribute to rising dependency ratios, thereby placing pressure on pension systems (OECD, 2019). Similarly, emigration trends, particularly among the younger working population in the Western Balkans, have been identified as a major factor reducing the contribution base of pension funds (ETF, 2020).

On the economic side, literature shows that labor market conditions, especially unemployment and informality, directly influence pension revenues. According to ILO (2021), high unemployment limits the number of active contributors, while informal employment results in unregistered workers who do not pay into the pension system. GDP growth, although a broad measure of economic performance, does not always translate into increased pension sustainability unless accompanied by job creation and wage growth (IMF, 2020). Inflation is another critical factor, as it raises the cost of pension indexation and increases budgetary pressure on governments funding pension deficits.

North Macedonia-specific research by the Ministry of Labor and Social Policy and the Pension and Disability Insurance Fund highlights that over the past two decades, the system has increasingly relied on direct budget transfers to compensate for the gap between contributions and expenditures. Local studies (e.g., SSO reports and publications from Sava Pensions and Finance Think) confirm that unless demographic and labor market trends improve, the system's dependency on government funding will grow further.

In summary, the literature agrees that a combination of demographic pressure, weak labor markets, and insufficient reform puts public pension systems at risk. These findings underscore the importance of aligning economic and social policy to ensure long-term sustainability, especially in small economies like North Macedonia.

3.Methodology

This research applies a quantitative and analytical approach, relying on secondary data to evaluate how demographic and economic indicators influence the financial sustainability of the

Pension and Disability Insurance Fund of the Republic of North Macedonia. Data was collected from official sources including the State Statistical Office, the Ministry of Labor and Social Policy, annual reports from the Pension Fund, as well as international databases such as those of the World Bank and Eurostat. The study focuses on the period from 2000 to 2022, depending on data availability, and examines key demographic indicators such as fertility rate, natality, ageing index, old-age dependency ratio, and emigration. Economic indicators include GDP growth, employment and unemployment rates, and inflation. Pension-related indicators such as the number of insured people, beneficiaries, pension expenditures, and state budget transfers are also analyzed. Descriptive statistics, comparative analysis, and graphical presentations (tables and charts) are used to observe trends and relationships between these variables and assess their impact on the financial performance and sustainability of the pension system.

However, as the study relies entirely on secondary data, it is important to acknowledge that the analysis depends on the accuracy, consistency, and completeness of official statistics over the two-decade period. Variations in data collection methods or gaps in historical records may limit comparability between years and may influence the precision of the findings.

4. Findings

In this following part discussed will be the factors influencing the pension system through a systematic presentation of data concerning the sustainability of the pension system based on demographic and economic trends from Republic of North Macedonia State Statistical Office.

1. Demographic Trends

When discussing demographic trends, we examine the changes that have occurred in the population structure over the past decade. These changes may result from shifts in birth and death rates among the population, as well as migration processes.

Table 1. Natality (2007 – 2021)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021*
Вкупно население	2.043.559	2.046.898	2.050.671	2.055.004	2.058.539	2.061.044	2.064.032	2.067.471	2.070.226	2.072.490	2.074.502	2.076.217	2.076.694	2.072.531	1.836.713
мажи	1.024.489	1.026.022	1.027.810	1.029.848	1.031.403	1.032.532	1.033.990	1.035.680	1.037.060	1.038.107	1.038.948	1.039.742	1.039.958	1.037.467	911.087
жени	1.019.070	1.020.876	1.022.861	1.025.156	1.027.136	1.028.512	1.030.042	1.031.791	1.033.166	1.034.383	1.035.554	1.036.475	1.036.736	1.035.064	925.626
Население на возраст 0-14 (%)	18,7	18,3	17,9	17,6	17,3	17,1	16,9	16,8	16,7	16,6	16,5	16,4	16,3	16,2	17,0
Население на возраст 65+ (%)	11,3	11,4	11,6	11,7	11,8	11,9	12,2	12,5	12,8	13,1	13,5	13,9	14,3	14,6	17,2
Вкупна стапка на фертилитет			1,50	1,60	1,50	1,50	1,48	1,52	1,49	1,50	1,43	1,42	1,34	1,31	
ПРЕСТАПНО СТАПКА НА РОДОРАЗМНОЖУВАЊЕ	16,0	15,0	14,0	13,0	12,0	11,0	10,0	9,0	8,0	7,0	6,0	5,0	4,0	3,0	2,0

Source: State Statistical Office (<http://www.stat.gov.mk>)

The data show that in the Republic of North Macedonia, as of 2021, the total population was 1.837 million people, of which 911 thousand were men and 925 thousand were women. It is noted that the percentage share of the population aged 0-14 years in the total population in the last decade has been declining as of 2020 and recorded some growth in 2021 (2007: 18.7%, 2020: 16.2%, 2021: 17.0%). The percentage share of the population aged 65+ years in the total population is continuously increasing (2007: 11.3%, 2021: 17.2%).

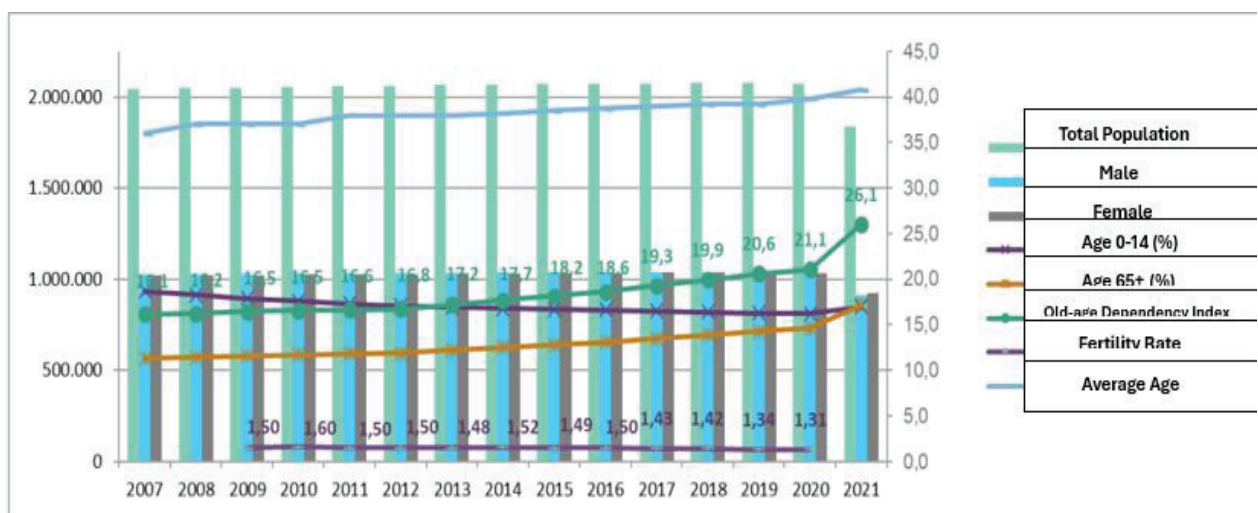


Figure 1: Natality ratio

Source: State Statistical Office (<http://www.stat.gov.mk>)

The age dependency ratio is the ratio between the total number of people who are of mainly economically inactive age (65 and over) and the number of people of working age (15 - 64). This ratio has been increasing throughout the period under review and in 2021 stood at 26.1%. The ratio that measures the ratio between the total number of people who are economically inactive, including people aged 0-14 in addition to people aged 65 and over, for 2021 is 51.8.

The total fertility rate shows the probable average number of live births that a woman of the observed generation would give birth to, in the fertile period (15-49 years), under the condition of the same influence of specific fertility rates, as in the observed year, without the influence of mortality. The total fertility rate in the period after 2016 is decreasing and in 2020 is at the level of 1.31. The average age of the population in the last decade is increasing. In 2007, the average age of the population was 36.0 years, while in 2021 the average age of the population was 40.8 years. According to data from the latest RSM Population Census, in 2021 for the first time, the number of the population over the age of 65 exceeds the population under the age of 14, bringing the aging index to 101.3.

Fertility Rates

Table 2: Fertility rates in the Republic of Macedonia and by region for the period 1994 - 2020

	1994	1996	2000	2006	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
North Macedonia	2,10	1,90	1,70	1,50	1,50	1,60	1,50	1,50	1,48	1,52	1,49	1,50	1,43	1,42	1,34	1,31
Pelagonia Region	2,00	1,70	1,60	1,50	1,60	1,50	1,40	1,40	1,38	1,49	1,45	1,40	1,38	1,29	1,24	1,23
Vardar Region	1,80	1,90	1,60	1,40	1,50	1,50	1,40	1,60	1,48	1,50	1,55	1,57	1,56	1,48	1,39	1,30
Northeast Region	2,30	2,20	2,00	1,50	1,60	1,60	1,50	1,60	1,53	1,53	1,43	1,42	1,42	1,33	1,25	1,19
Southwest Region	2,30	2,00	1,50	1,30	1,20	1,30	1,20	1,20	1,16	1,23	1,19	1,19	1,09	1,05	0,98	1,01
Skopje Region	2,00	1,90	1,70	1,60	1,70	1,80	1,70	1,80	1,77	1,82	1,79	1,90	1,76	1,84	1,75	1,74
Southeast Region	2,00	1,70	1,70	1,40	1,60	1,60	1,40	1,60	1,54	1,52	1,56	1,50	1,43	1,45	1,29	1,23
Polog Region	2,50	2,20	1,70	1,40	1,40	1,40	1,30	1,30	1,34	1,33	1,29	1,21	1,20	1,17	1,11	1,05
Eastern Region	1,80	1,60	1,50	1,30	1,40	1,40	1,20	1,30	1,22	1,29	1,29	1,27	1,22	1,18	1,08	1,04

Source: State Statistical Office (<http://www.stat.gov.mk>)

In general, the fertility rate in the Republic of North Macedonia is declining as of 2020. The lowest fertility rate in 2020 is in the South-West region (1.01) and the East region (1.04), while the highest fertility rate is in the Skopje region (1.74). Such fertility rates indicate uneven population growth by region. The main factor influencing this situation is the pronounced migration movements: internally within the country and the emigration of the population to other countries. The high fertility rate in the Skopje region is the result of migration movements from other regions to this

region. There is a pronounced imbalance between the Skopje region and other regions, as well as between urban and rural areas. Reasons for migration (to the Skopje region or outside the country) are the poor conditions on the labor market and the high unemployment rate, especially in rural areas and among the younger population. Such processes change the structure of the population by region and can lead to a shortage of working-age population and unused physical capital in the regions from which there is emigration and overpopulation and a decrease in the quality of life in the regions where there is immigration.

Emigration

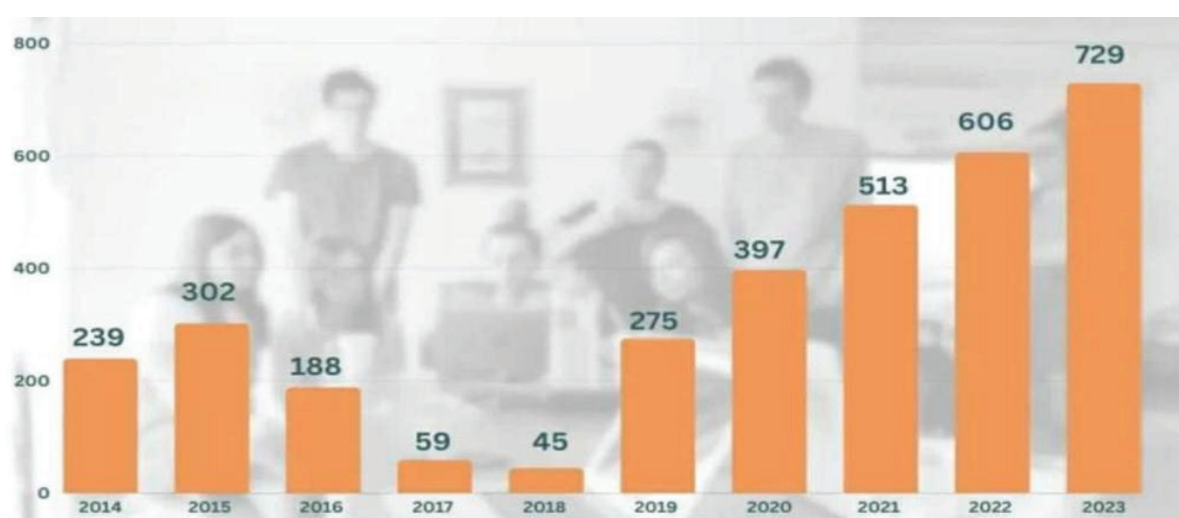


Figure 2: Emigration Ratio in North Macedonia from 2014 until 2023

Source: State Statistical Office (<http://www.stat.gov.mk>)

Official data from the State Statistical Office show that 3,353 young people (aged 15-34) emigrated from North Macedonia from 2014 to 2023. As can be seen from the figures, the number of those leaving has increased significantly since 2019.

Emigration has a significant negative impact on the financial sustainability of North Macedonia's pension system. Since the system operates on a pay-as-you-go basis—where current workers fund the pensions of current retirees, the large-scale emigration of young, working-age individuals

reduces the number of contributors while the number of beneficiaries continues to grow. This creates a growing imbalance and financial strain on the system. Emigrants are often highly skilled, further weakening the domestic labor force and economic productivity, while also accelerating the aging of the population and worsening the dependency ratio. If this trend continues, it could lead to pension deficits, increased reliance on state subsidies or borrowing, and potential cuts in benefits.

2. Economic Indicators and Their Impact

Table 3: Unemployment Rate in North Macedonia in 2020 and in 2021

Возраст/ Age	Вкупно/ Total		Работна сила Labour force		Вработени Employed		Невработени Unemployed		Неактивно население Inactive population	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Вкупно/ Total	1.685.589	1.682.800	950.858	943.004	794.909	795.087	155.949	147.917	734.731	739.796
15-24	245.698	239.757	75.807	67.398	48.766	42.894	27.042	24.503	169.891	172.359
25-49	777.870	776.114	620.690	622.384	522.329	528.783	98.363	93.602	157.180	153.730
50-64	410.828	410.339	243.440	243.721	212.894	214.004	30.545	29.717	167.388	166.618
65 години и повеќе	251.190	256.590	10.920	9.500	10.920	9.406	:	:	240.270	247.090
15-64	1.434.396	1.426.210	939.937	933.503	783.989	785.681	155.950	147.822	494.459	492.707

Source: State Statistical Office (<http://www.stat.gov.mk>)

In this segment, we will examine the labor market in the Republic of North Macedonia.

According to data published by the State Statistical Office, out of a total population of 1,837,114, the number of working-age population in the Republic of North Macedonia in 2021 is 1,682,800. The working-age population consists of all people aged 15-79. The labor force represents the economically active population, which includes employees and the unemployed who are actively seeking work (taking specific action to find work).

Table 4: Activity and Employment Rate in North Macedonia in 2020 and in 2021

	Activity Rate		Employment Rate	
	2020	2021	2020	2021
Total	56,4%	56,0%	47,16%	47,25%
15-24	30,9%	28,1%	19,85%	17,89%
25-49	79,8%	80,2%	67,15%	68,13%
50-64	59,3%	59,4%	51,82%	52,15%
65 and above	4,3%	3,7%	4,35%	3,67%
15-64	65,5%	65,5%	54,66%	55,09%

Source: State Statistical Office (<http://www.stat.gov.mk>)

In the following table we observe the structure of the labor force and the inactive population in the Republic of North Macedonia. In addition:

- The activity rate represents the participation of the labor force in the working population aged 15 years and over.
- The employment rate represents the participation of employees in the working population aged 15 years and over.
- The unemployment rate represents the participation of the number of unemployed in the total labor force.

Table 5: Unemployment Rate in North Macedonia from 2006 until 2021

Year	Labor Force	Employment	Unemployment	Unemployment Rate
2006	891.678	570.404	321.274	36,03%
2007	907.139	590.236	316.903	34,93%
2008	919.425	609.016	310.409	33,76%
2009	928.775	629.901	298.873	32,18%
2010	938.293	637.855	300.439	32,02%
2011	940.048	645.085	294.963	31,38%
2012	943.055	650.554	292.502	31,02%
2013	956.057	678.838	277.219	29,00%
2014	958.998	690.188	268.809	28,03%
2015	954.924	705.991	248.933	26,07%
2016	948.599	723.550	225.049	23,72%
2017	954.212	740.648	213.564	22,38%
2018	957.623	759.054	198.569	20,74%
2019	964.014	797.651	166.363	17,26%
2020	950.858	794.909	155.949	16,40%
2021	943.004	795.087	147.917	15,69%

Source: State Statistical Office (<http://www.stat.gov.mk>)

The unemployment rate in the Republic of North Macedonia in 2021 is 15.7 and has been continuously declining since 2006 when it was 36. The high unemployment rate is a consequence of the transition process the country went through, which was accompanied by the closure of many factories and industrial facilities and massive job losses. Thus, in 1990 the unemployment rate was 23.55, so that after the start of the privatization process the unemployment rate increased to 35.6 in 1995. The high unemployment rate was maintained throughout the following decade, reaching 37.3 in 2005.

Table 6: Length of Unemployment in North Macedonia

Length of Unemployment									
Age	Total	Until 1 Month	2-5 Months	6-11 Months	12-17 Months	18-23 Months	2 Years	3 Years	4 and more Years
15-19	2.951	:	625	688	:	:	:	:	:
20-24	16.405	619	1.173	1.513	2.249	1.881	:	3.615	5.051
25-29	18.147	707	1.638	1.594	869	1.448	:	2.992	8.750
30-34	17.368	921	1.904	756	919	1.243	:	2.049	9.233
35-39	11.706	:	955	1.020	1.043	521	:	751	6.895
40-44	10.982	513	521	888	817	665	:	1.160	6.247
45-49	13.593	:	1.110	586	986	704	:	1.286	8.413
50-54	9.369	:	620	712	819	:	:	1.091	5.571
55-59	9.658	:	503	874	:	:	:	729	6.387
60-64	5.832	:	503	:	:	:	-	665	4.043
65 +	:	-	-	-	-	-	-	-	:
Total	116.045	4.696	9.552	8.838	8.843	7.310	1.381	14.555	60.869

Source: State Statistical Office (<http://www.stat.gov.mk>)

It is also important to note the high share of long-term unemployment in total unemployment. Long-term unemployed are those who have been unemployed for more than 1 year. The high number of people aged 25-34 who have been unemployed for 4 or more years is worrying, especially due to the high work capacity of the young population. This data indicates a situation in which employees find it difficult to decide on a job change, while the length of unemployment among the unemployed is growing due to the small number of newly created jobs. The privatization process led to the loss of many jobs and a drastic increase in the unemployment rate in the Republic of North Macedonia in the 1990s. Some improvement has been noted in the last decade, but the situation on the labor market in the Republic of North Macedonia indicates a still relatively high unemployment rate, especially among the younger population. The high share of long-term unemployment in total unemployment only further emphasizes the need for a strategy for reducing unemployment and retraining the population. This would also have a positive impact on reducing the processes of emigration due to the poor conditions on the labor market. Policies aimed at

increasing employment, and thus increasing the payment of contributions, are an aspect that is of great importance in ensuring the long-term sustainability of the pension system. On the other hand, despite the still relatively large number of unemployed persons, the Republic of Macedonia is facing a shortage of labor. Such conditions arise from the inadequate qualifications of the population as well as migration processes. Macedonian companies are facing a shortage of qualified labor, and the construction and tourism sectors are the most affected.

Table 7: Gross Domestic Product (GDP) of North Macedonia from 2006 until 2022

Year	GDP (million MKD)
2006	298,140
2007	333,845
2008	405,014
2009	396,496
2010	425,628
2011	455,387
2012	476,072
2013	474,196
2014	518,380
2015	560,148
2016	579,646
2017	630,859
2018	660,308
2019	697,431
2020	664,010
2021	723,239
2022	831,733

Source: State Statistical Office (<http://www.stat.gov.mk>)

Although North Macedonia's GDP has steadily increased from 298 billion MKD in 2006 to over 831 billion MKD in 2022, this growth has not translated into proportional improvements in the financial stability of the Pension and Disability Insurance Fund. Despite economic expansion, the number of formally employed contributors has not grown at the same rate due to persistent

structural problems such as high unemployment, a large informal economy, and continuous emigration of the working-age population.

As a result, the pension system remains heavily dependent on direct financial support from the state budget. In recent years, especially during and after the COVID-19 pandemic, government transfers to the pension fund have increased to cover rising pension expenditures, which are further inflated by high indexation adjustments during inflationary periods (e.g. 2022). This reflects a growing mismatch: while the economy grows on paper, the actual contribution base does not, creating ongoing financial strain for the pension system.

Table 8: Inflation in North Macedonia from 2006 until 2022

Year	Avg. Salary	Avg. Pension	participation in the pension in the average salary	annual change in the average pension	pension reconciliation	Inflation
2006	13.854	7.684	55,5%	3,0%	2,7%	2,9%
2007	15.543	7.848	50,5%	2,1%	1,7%	6,1%
2008	17.363	9.541	55,0%	21,6%	21,7%	4,1%
2009	20.483	10.057	49,1%	5,4%	5,6%	-1,6%
2010	21.454	10.273	47,9%	2,1%	1,4%	3,0%
2011	21.415	10.682	49,9%	4,0%	2,9%	2,8%
2012	21.469	11.016	51,3%	3,1%	1,7%	4,7%
2013	21.500	11.845	55,1%	7,5%	7,0%	1,4%
2014	22.407	12.487	55,7%	5,4%	5,0%	-0,5%
2015	22.715	13.095	57,6%	4,9%	5,0%	-0,4%
2016	23.457	13.754	58,6%	5,0%	5,0%	-0,2%
2017	23.850	13.924	58,4%	1,2%	1,6%	2,4%
2018	24.275	14.421	59,4%	3,6%	3,5%	0,9%
2019	25.215	14.602	57,9%	1,3%	1,1%	0,4%
2020	27.184				0,6%	2,6%
2021	28.717	15.876	55,3%		2,4%	4,9%
2022	31.868	17.727	55,6%	11,7%	9,7%	18,7%

% промена повисока од 5%

Инфлација повисока од 3%

= Change more than 5%

= Inflation more than 3%

Source: State Statistical Office (<http://www.stat.gov.mk>)

How Inflation Affects Pension Fund Support from the State Budget in North Macedonia:

- **Higher Inflation → Higher Pension Adjustments**

As seen in the table, when inflation spikes (e.g., 18.7% in 2022), the government is obligated to raise pensions to maintain retirees' purchasing power. In 2022, pensions rose by 11.7% and were indexed by 9.7%, significantly increasing pension fund expenses.

- **Pension Fund Cannot Cover the Gap Alone**

Since pension contributions come mainly from current workers and employment and wage growth are slower than inflation the pension fund alone cannot cover rising pension payouts. As a result, the state budget steps in to fill the deficit.

- **Inflation Increases the Burden on the State Budget**

The higher the inflation, the more the state must transfer from the general budget to stabilize pensions. This diverts funds from other public sectors like healthcare, education, or infrastructure, limiting fiscal flexibility.

- **Risk of Structural Imbalance**

In years with high inflation and low economic growth, the budget transfers to the pension fund become unsustainable, risking fiscal deficits, borrowing, or even inflationary cycles if not managed carefully.

In 2022, the average pension rose by 11.7% and indexation was 9.7%, while inflation was 18.7%. This inflationary pressure forced the state to increase its financial contribution to the pension fund just to maintain retirees' real income, even though economic output (GDP) may not have grown proportionately.

Inflation significantly increases the financial burden on the pension system in North Macedonia by driving up pension indexation requirements. Since the pension fund often lacks sufficient own revenues, the state budget must intervene, transferring increasing amounts to cover rising expenses. Over time, this undermines the financial sustainability of both the pension system and the overall fiscal balance of the country.

Hypothesis testing

This section evaluates the three hypotheses defined at the beginning of the study based on the data analyzed in the results section.

Hypothesis 1:

Demographic factors such as fertility, natality, and emigration affect the financial sustainability of the Pension Fund.

Supported.

The findings of this research confirm this hypothesis. The data showed a consistent decline in fertility and natality rates over the past two decades, leading to a reduced number of new entrants into the labor market. Simultaneously, the ageing index and old-age dependency ratio have increased, meaning a growing proportion of pensioners compared to active contributors. Additionally, emigration especially of young, working-age individuals has significantly reduced the number of insured persons, further weakening the contribution base of the Pension and Disability Insurance Fund. These trends have disrupted the balance between contributors and beneficiaries, increasing the pension fund's reliance on state budget transfers. Therefore, we confirm that demographic factors play a critical role in determining the fund's financial sustainability.

Hypothesis 2:

Economic factors such as unemployment, GDP growth, and inflation affect the financial sustainability of the Pension Fund.

Supported.

This hypothesis is also supported by the findings. While GDP has shown growth, it has not been proportional to increases in employment or wage levels, which are necessary to increase contributions to the pension fund. Unemployment, although reduced in recent years, remains high, especially among young people and marginalized groups. A significant portion of the labor force

remains in the informal economy and does not contribute to the pension system. Furthermore, inflation has placed additional pressure on the fund by increasing pension expenditures through indexation, without a corresponding increase in contribution income. This confirms the second hypothesis as well.

5. Conclusion and Discussion

The financial sustainability of the Pension and Disability Insurance Fund of the Republic of North Macedonia is increasingly challenged by adverse demographic trends and economic pressures. While economic growth is essential, it is not sufficient on its own. Structural problems such as high unemployment, widespread emigration, and an aging population continue to reduce the number of active contributors while increasing the number of pension beneficiaries.

To address these challenges, a comprehensive reform strategy is needed. Key measures include:

- Reducing unemployment through targeted investments, support for small and medium-sized enterprises, vocational training, and active labor market policies to increase the number of insured workers.
- Gradually raising the retirement age, reflecting increased life expectancy, to reduce the pension burden and extend individuals' working years.
- Increasing pension contribution rates or improving collection from the informal economy, to strengthen the fund's revenue base.
- Curbing emigration, especially among young, skilled workers, by creating better economic and social conditions within the country.

Only through a combination of economic development, labor market reform, and pension policy adjustments can North Macedonia secure a financially stable and socially just pension system for future generations.

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DIGITAL GOVERNANCE AND INNOVATION MANAGEMENT IN FIGHTING CLIMATE CHANGE

Assis.Prof.Dr. Senem DEMİRKIRAN

Kırklareli University, senemdemirkiran@klu.edu.tr

ORCID ID: 0000-0001-9835-4963

Abstract

The growing climate crisis requires a fundamental shift in public sector governance, prioritizing digital transformation and innovation management. This study explores the reciprocal relationship between digital governance mechanisms and technological innovation capacity, analyzing factors that shape how states respond to climate change. Using sustainable governance theory and collaborative digital innovation as frameworks, the research examines how artificial intelligence, data analytics, and smart governance infrastructure enhance institutional adaptability, ensure policy coherence, and bolster environmental accountability. Evidence from China and the European Union suggests that digital climate governance accelerates low-carbon transitions through real-time data monitoring, policy integration, and collaboration among diverse stakeholders. Nonetheless, challenges such as data ethics, digital inequality, and institutional inertia persist. Through a conceptual synthesis, the study introduces a governance-innovation interaction model illustrating how digital Technologies can boost public innovation capacity. By incorporating these insights, the research advances public administration theory, emphasizing the importance of technology and innovation management as vital components of resilient, evidence-based climate policy governance.

Keywords: Digital Governance, Innovation Management, Climate Policy, Sustainable Public Administration, Technological Transformation, Adaptive Governance.

İKLİM DEĞİŞİKLİĞİYLE MÜCADELEDE DİJİTAL YÖNETİŞİM VE YENİLİK YÖNETİMİ

Özet

Hızla derinleşen iklim krizi, kamu sektöründe yönetim anlayışında köklü bir değişimi zorunlu kılmakta olup, dijital dönüşüm ve yenilik yönetimi temel öncelikler olarak ön plana çıkmaktadır. Bu çalışma, dijital yönetim mekanizmaları ile teknolojik yenilik kapasitesi arasındaki karşılıklı ilişkiyi inceleyerek devletlerin iklim değişikliğine yönelik yanıtlarını etkileyen faktörleri analiz etmektedir. Sürdürülebilir yönetim kuramı ve işbirlikçi dijital yenilik çerçevesi kullanılarak, yapay zekâ, veri analitiği ve akıllı yönetim altyapılarının, kurumların uyum kapasitesini artırma, politika tutarlılığını güçlendirme ve çevresel hesap verebilirliği yükseltme işlevi incelenmektedir. Çin ve Avrupa Birliği örneklerinden elde edilen bulgular, dijital iklim yönetiminin, anlık veri izleme, politika entegrasyonu ve çok aktörlü iş birliği yoluyla düşük karbonlu geçişleri hızlandırdığını göstermektedir. Bununla birlikte, veri etiği, dijital eşitsizlik ve kurumsal ataletle ilişkin zorluklar devam etmektedir. Kavramsal bir

sentez yoluyla, çalışma, dijital teknolojilerin kamu yenilik kapasitesini güçlendirdiği yolları gösteren bir “yönetişim-yenilik etkileşimi modeli” sunmaktadır. Bu bulguların entegrasyonu, kamu yönetimi kuramına katkı sağlamakta ve teknoloji ile yenilik yönetimini, dirençli ve kanıta dayalı iklim yönetişiminin temel bileşenleri olarak konumlandırmaktadır.

Anahtar Kelimeler: Dijital Yönetişim, Yenilik Yönetimi, İklim Politikası, Sürdürülebilir Kamu Yönetimi, Teknolojik Dönüşüm, Uyarlanabilir Yönetişim

1.Giriş

İklim değişikliği; ekonomik, toplumsal ve yönetsel boyutlarıyla kamu politikalarının merkezine yerleşen karmaşık ve çok boyutlu küresel sorunlardan biridir ve hızla artan karbon salınımları, küresel sıcaklık yükselişleri ve biyolojik çeşitlilik kaybı vd. klasik yönetim modellerinden ziyade dijital ve yenilikçi yaklaşımları zorunlu kılmaktadır (George vd.,2021). Bu kapsamda, dijital yönetim ve yenilik yönetimi, iklim değişikliğine karşı mücadelede dönüştürücü etkiye sahip iki temel alan olarak öne çıkmaktadır. Son yıllarda yapılan çalışmalar, dijital teknolojilerin yalnızca çevresel verilerin toplanmasında değil, aynı zamanda kamu karar alma süreçlerinin şeffaflaştırılmasında ve vatandaş katılımının artırılmasında stratejik bir rol oynadığını ortaya koymaktadır (Butt ve Abdelaziz, 2025; Stankovic vd.,2022). Dijitalleşme, çevresel sürdürülebilirlik politikalarının yeniden şekillendirilmesini sağlamaktadır, özellikle e-Devlet uygulamaları, büyük veri analitiği, Nesnelerin İnterneti (IoT) ve yapay zeka temelli sistemler aracılığıyla iklim eyleminin hızlanmasına katkı sunmaktadır (Cortez, 2023). Zhou vd., (2025), dijital iklim yönetişiminin karbon nötrlüğü hedeflerine ulaşmada teknolojik yenilikleri teşvik ettiğini ve kamu politikalarının verimliliğini artırdığını ifade etmektedir. Falcke (2023), dijital teknolojilerin iklim değişikliğiyle mücadelede “iş birliğine dayalı yeniliği güçlendirdiğini ve bireylerin dijital iletişim araçlarını sosyal dayanıklılık ağları kurmak için kullandığını vurgulamaktadır ve dijital yönetişimi yalnızca bir teknoloji politikası değil, aynı zamanda katılımcı bir toplumsal dönüşüm süreci olarak değerlendirmektedir. Chuard vd., (2022), dijital olarak etkinleştirilen yenilikçi girişimlerin, iklim yönetişimi kavramını yeniden şekillendirerek toplumların çevresel adaptasyon kapasitesini güçlendirdiğini ileri sürmektedir.

Bunların yanı sıra dijital çağda yönetişimin sürdürülebilir biçimde inşa edilmesi, adaptif yönetim yaklaşımıyla açıklanmaktadır. Linkov vd. (2018), dijital dünyada sürdürülebilir yönetişimin esnek, öğrenmeye açık ve çok paydaşlı bir yapıya dayanması gerektiğini belirtmektedir. Bu yaklaşım, devletlerin çevresel krizlere dinamik biçimde yanıt verebilmesini ve özel sektörle iş birliği içinde yenilikçi çözümler üretebilmesini sağlamaktadır. Pan vd. (2022) de dijital sürdürülebilirlik araştırmalarında, bilgi sistemlerinin ve dijital dönüşümün

iklim krizine hem uyum hem de azaltım stratejileri açısından yeni fırsatlar sunduğunu vurgulamaktadır. Küresel ölçekte, şehirler de dijital çevre yönetimi alanında yenilikçi uygulamaların öncü aktörleri haline gelmiştir. Hsu vd. (2024), Çin’deki kentlerin düşük karbon planlaması kapsamında “akıllı izleme” ve “bilgi temelli çevre yönetimi” sistemlerini geliştirerek iklimle mücadelede dijital yönetim kapasitesini artırdıklarını ortaya koymaktadır. Bu örnekler, yerel yönetimlerin dijital teknolojileri kullanarak çevresel karar alma süreçlerini hızlandırabileceğini ve sürdürülebilir kalkınma hedeflerine daha etkin biçimde katkıda bulunabileceğini göstermektedir. Dolayısıyla, iklim değişikliğine karşı geliştirilen stratejiler yalnızca çevresel koruma politikalarıyla sınırlı kalmamaktadır, aynı zamanda kamu yönetiminde dijitalleşme, yenilik kültürü, girişimcilik ve vatandaş katılımını bütünleştiren yeni bir yönetim paradigması inşa etmektedir. Bu paradigma, dijital teknolojilerin sunduğu bilgi akışını, yenilik yönetiminin yaratıcılığıyla birleştirerek çevresel sürdürülebilirliği güçlendiren bütüncül bir yaklaşım sunmaktadır. Bu bağlamda, dijital yönetim ve yenilik yönetiminin birlikteliğinde yükselen iklim politikaları, yalnızca teknolojik ilerlemeyi değil, aynı zamanda toplumsal adaleti, şeffaflığı ve dayanıklılığı da merkeze alan akıllı sürdürülebilirlik vizyonunu temsil etmektedir. Çalışma kapsamında dijital yönetim kapsamında yürütülen iklim politikaları ve yenilik yönetimi çerçevesinde ortaya konan sürdürülebilir çözümler incelenmektedir.

2.Dijital Yönetişim ve İklim Politikaları

Dijital dönüşüm çağında kamu yönetimi, çevresel sürdürülebilirlik ve iklim politikalarıyla doğrudan kesişen yeni bir yönetim biçimiyle yeniden şekillenmektedir. Dijital yönetim yalnızca kamu hizmetlerinin dijital ortama taşınmasını değil, aynı zamanda politika yapım süreçlerinde veri temelli karar alma, şeffaflık, katılımcılık ve çevresel sorumluluk gibi ilkelerin bütüncül biçimde uygulanmasını ifade etmektedir (Erkut, 2020). Bu dönüşüm, özellikle iklim değişikliğiyle mücadelede politika yeniliklerini hızlandıran stratejik bir araç olarak öne çıkmaktadır (Butt ve Abdelaziz, 2025).

Yapılan araştırmalar incelendiğinde, dijital yönetişimin karbon nötrlüğü, iklim adaptasyonu ve düşük karbon ekonomisine geçiş süreçlerine önemli katkılar sağladığı görülmektedir. Zhou vd. (2025), Çin örneği üzerinden yaptıkları çalışmalarında dijital iklim yönetişiminin karbon teknolojik ilerlemesini destekleyen düzenleyici çerçeveleri güçlendirdiğini ve yenilik kapasitesini artırdığını vurgulamaktadır. Benzer biçimde, Meng vd. (2024), tarafından yürütülen araştırma, “Bilgiyle Halkın Refahı” adlı dijital yönetim pilot politikasının karbon emisyonlarını azaltma üzerinde dolaylı fakat güçlü bir etki yarattığını ortaya koymaktadır. Bu

bulgular, dijitalleşmenin yalnızca bilgi yönetimini değil, aynı zamanda çevresel performansı da artırabileceğini göstermektedir. Dijital yönetim sistemleri, farklı coğrafyalarda “”” biçimlerde gelişmektedir. Hsu vd. (2024), Çin şehirlerinin “dijital çevresel yönetim” alanında yenilikçi uygulamalar geliştirdiğini; özellikle akıllı izleme ve sayısallaştırılmış çevre planlaması gibi araçların düşük karbon politikalarının yerel düzeyde etkinliğini artırdığını belirtmektedir. Bu durum, kentlerin dijitalleşme süreçlerinde çevresel sürdürülebilirlik ilkelerini benimsemelerinin, politika yeniliği kapasitesini güçlendirdiğini göstermektedir. Mendes (2022) Brezilya’daki iklim akıllı kentlerde dijital teknolojilerin düşük karbonlu kentsel yönetime katkısını inceleyerek, dijital altyapının iklim politikalarının uygulanabilirliğini artırdığını ortaya koymaktadır. Dijital yönetim kavramı yalnızca teknolojik bir yenilik değil, aynı zamanda adaptif bir yönetim modeli olarak da değerlendirilmektedir. Linkov vd. (2018), sürdürülebilir dijital dünyaya yönelik stratejilerinde adaptif yönetimin çevresel risklere karşı dinamik bir yanıt oluşturduğunu belirtmektedir. Adaptif yönetim, veri analitiği, yapay zekâ ve açık veri platformları gibi dijital araçlarla desteklendiğinde hem çevresel hem de toplumsal belirsizlikleri yönetmede daha esnek bir yapı sunmaktadır (Cortez, 2023). Chuard vd. (2022), ise dijital yeniliklerin iklim yönetimi ile etkileşimini analiz ederek, dijital teknolojiler sayesinde iklim politikalarının daha kapsayıcı, iş birliği ve çok aktörlü hale geldiğini savunmaktadır. Bu görüş, dijitalleşmenin sadece yönetim süreçlerini değil, yönetim ağlarını da dönüştürdüğünü göstermektedir. Xu vd. (2025), dijital yönetim politikalarının düşük karbon geçişini hızlandığını ampirik olarak doğrulamış, dijitalleşmenin çevresel sürdürülebilirliğin itici gücü olduğunu ortaya koymaktadır. Dijital yönetim ve iklim politikaları arasındaki ilişki, modern kamu yönetiminin merkezinde yer alan stratejik bir dönüşümü temsil etmektedir. Dijitalleşme, yalnızca iklim değişikliğiyle mücadelede veri toplama ve izleme kapasitesini artırmakla kalmamaktadır aynı zamanda politika yeniliği, katılımcı yönetim ve sürdürülebilir kalkınma hedeflerine ulaşmada yeni fırsatlar yaratmaktadır.

3.Yenilik Yönetimi ve Sürdürülebilir Çözümler

Ekolojik krizler ve küresel rekabetle şekillenen günümüz çağında yenilik yönetimi, endüstriler ve yönetim sistemleri genelinde sürdürülebilirliğe odaklı dönüşümü yönlendiren stratejik bir mekanizma olarak ortaya çıkmıştır. Seebode vd. (2012)'ne göre, sürdürülebilirlik için yenilik yönetimi, sosyal, çevresel ve ekonomik boyutları kurumsal stratejiye entegre ederek geleneksel yenilik süreçlerinin yeniden düşünülmesini gerektirmektedir. Bu değişim, sürdürülebilirliğin yalnızca bir kısıtlama değil, uzun vadeli rekabet gücü ve dayanıklılığın temel itici gücü

olduğunun anlaşılmasını yansıtmaktadır. Berkhout (2014), işletmelerin bu dönüşümde kritik bir rol oynadığını, toplumsal beklentilere yanıt vererek, yenilikçi sürdürülebilir çözümler geliştirmede ve kamu söylemini şekillendirmede aktif biçimde yer aldıklarını vurgulamaktadır. Benzer şekilde Othman ve Hussein (2024), yeni ürün ve hizmetlerin tasarım aşamasında risk yönetimi yoluyla sürdürülebilirliğe ulaşmayı hedefleyen bir yenilik yönetimi çerçevesi önermektedir. Bu yaklaşım, sürdürülebilirliğe yönelik yeniliğin yaratıcılık, sorumlu tasarım ve risk azaltılması arasında bir denge kurulması gerektirdiğini göstermektedir. Ayrıca yönetim sistemlerinin entegrasyonu, sürdürülebilir yeniliği mümkün kılan temel unsurlardan biridir. Hernandez-Vivanco vd. (2018), entegre yönetim sistemlerinin (IMS), çevresel, kalite ve sosyal standartları tek bir çerçevede uyumlaştırarak hem yeniliği hem de sürdürülebilirliği desteklediğini belirtmektedir. Bu entegrasyon, kurumsal öğrenmeyi, disiplinler arası iş birliğini ve hesap verebilirliği güçlendirir; tümü sürekli sürdürülebilir yeniliğin anahtar unsurlarıdır.

Daha geniş ekosistem düzeyinde, Oksanen ve Hautamäki (2015), sürdürülebilir yeniliğin yenilik ekosistemleri için rekabet avantajı yarattığını savunmaktadır. Bulgularına göre, devlet, akademi, sanayi ve sivil toplum arasındaki iş birliği, sürdürülebilirlik sorunlarına küresel çözümler üretme sürecini hızlandırmaktadır. Benzer şekilde Steiner (2008), paydaş yönetimi ve sistemik düşünmenin önemini vurgulayarak, sürdürülebilir yeniliğin katılımcı yönetim ve çok aktörlü iş birliği yoluyla geliştiğini öne sürmektedir. Literatür, sürdürülebilirlik alanında yenilik yönetiminin sektörel uygulamalarına artan bir ilgi olduğunu da göstermektedir. Örneğin Farooq vd. (2022), teknolojik yeniliğin sürdürülebilir kentsel gelişimi nasıl desteklediğini göstermek amacıyla akıllı atık yönetim sistemlerini incelemektedir. Araştırmaları, dijital araçlar, veri analitiği ve akıllı sistemlerin kaynak verimliliğini nasıl optimize ettiğini ve atık üretimini en aza indirdiğini açıklayan kavramsal bir model sunmaktadır. Afeltra vd. (2023) ise sürdürülebilir yeniliğin evrimine ilişkin bir meta-analiz sunarak, alanın izole çevresel girişimlerden yenilik yönetimi çerçevelerine gömülü entegre sürdürülebilirlik stratejilerine doğru ilerlediğini ortaya koymaktadır. Bu evrim, yenilik ve sürdürülebilirliğin birbirine bağımlı olduğu ve dayanıklı, geleceğe dönük organizasyonların temelini oluşturduğu yönündeki artan farkındalığı vurgulamaktadır.

Sürdürülebilir çözümler için yenilik yönetimi, tasarım sürecinde risk yönetimini, sistem entegrasyonunu, paydaş katılımını ve dijital dönüşümü kapsayan çok boyutlu bir süreçtir. Goffin ve Mitchell'in (2025) belirttiği gibi, yenilik yönetimi giderek daha iş birlikçi, uyum sağlayabilir ve sürdürülebilirlik odaklı paradigmlar doğrultusunda evrimleşmektedir. Bu gelişmeler, sürdürülebilirliğin yalnızca etik bir zorunluluk değil, aynı zamanda yeniliğin ve

uzun vadeli deęer yaratımının stratejik bir kolaylařtırıcısı haline geldięi bir paradigma deęişimini ifade etmektedir.

4.Sonuç

İklim deęişikliğiyle mücadele, günümüzde yalnızca çevresel bir zorunluluk deęil, aynı zamanda yönetim, teknoloji ve yenilik süreçlerinin bütüncül biçimde yeniden yapılandırılmasını gerektiren bir dönüşüm alanı haline gelmiştir. Dijital yönetim ve yenilik yönetimi, sürdürülebilir kamu politikalarının şekillenmesinde ve iklim krizine karşı geliştirilen stratejilerin etkinliğinde belirleyici iki temel dinamik olarak öne çıkmaktadır.

Çalışmada ortaya konulduęu üzere, dijital yönetim araçları; yapay zekâ, büyük veri, nesnelerin interneti ve veri analitięi gibi teknolojiler çevresel bilgi yönetimini güçlendirerek politika süreçlerinin şeffaflığını, hesap verebilirliğini ve etkililięini artırmaktadır. Bu teknolojik altyapı, kamu kurumlarının hem karar alma hem de politika uygulama süreçlerinde daha çevik, kanıta dayalı ve katılımcı bir yaklaşım benimsemesine olanak sağlamaktadır. Böylece dijitalleşme, iklim politikalarının yalnızca teknik deęil, aynı zamanda demokratik bir temele oturmasına katkıda bulunmaktadır. Dięer yandan yenilik yönetimi, sürdürülebilir çözümlerin geliştirilmesinde stratejik bir rol üstlenmektedir. Yenilik yönetimi, çevresel ve toplumsal deęerlerin üretim süreçlerine entegre edilmesiyle, kamu ve özel sektör kurumlarının uzun vadeli dayanıklılıęını artırmaktadır. Bu bağlamda, sürdürülebilir yenilik stratejileri; tasarımda risk yönetimi, yönetim sistemlerinin entegrasyonu, çok paydaşlı iş birlięi ve dijital dönüşümün eş zamanlı olarak uygulanmasını gerektirmektedir.

Küresel ölçekte incelenen örnekler (Çin ve Avrupa Birlięi gibi) göstermektedir ki dijital yönetim ile yenilik yönetiminin birleşimi, düşük karbon ekonomisine geçişi hızlandırmaktadır ve çevresel sürdürülebilirliğe yönelik politikaların etkinliğini artırmaktadır. Ancak, bu dönüşümün önünde veri güvenliği, dijital eşitsizlik ve kurumsal direnç gibi önemli engeller bulunmaktadır. Bu nedenle dijital iklim yönetişiminin başarısı, yalnızca teknolojik gelişmelere deęil, aynı zamanda etik, sosyal ve yönetsel ilkelerin dengeli biçimde gözetilmesine bağlıdır. Dijital yönetim ve yenilik yönetiminin birliktelięi ile gelişen yeni kamu yönetimi yaklaşımı, iklim deęişikliğine karşı dayanıklı, kanıta dayalı ve kapsayıcı bir yönetim vizyonu sunmaktadır. Bu vizyon, sürdürülebilir kalkınma hedeflerine ulaşmada yalnızca teknolojik yenilięi deęildir ve toplumsal adalet, katılımcılık ve çevresel sorumluluk ilkelerini de merkeze almaktadır. Gelecekte iklim politikaları yenilik yönetimi ile dijital yönetişi bütünləştiren, teknolojiyi kullanarak çevreyi koruyan ve sürdürülebilirlięi saęlayan

bir yapıda olmalıdır. Ancak dijital yönetim ve yenilik yönetiminin entegrasyonu ile iklim politikalarında sürdürülebilirlik sağlanabilecektir.

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GREEN CREDITS AND THEIR ROLE IN THE SUSTAINABLE PERFORMANCE OF PROCREDIT BANK

Assoc. Prof. Dr. Shpresa ALIJA*

South East European University, s.alija@seeu.edu.mk, ORCID ID: 0000-0003-1898-8072

Student. Alime DURMISHI

South East European University, ad31076@seeu.edu.mk

PhD Candidate. Nebi XHEMALI

South East European University, n.xhemali@seeu.edu.mk

PhD Candidate. Harun MUSTAFA

South East European University, harun.mustafa@seeu.edu.mk

Abstract

This study examines the impact of green credit on ProCredit Bank's sustainable performance in the context of North Macedonia. Drawing on secondary data from GEFF, EBRD, and institutional reports, the research tracks trends in green lending between 2020 and 2023 and analyzes the behavioral patterns of both business and individual clients. Findings indicate that green credit actively supports environmentally conscious investments: legal entities predominantly adopt technologies such as photovoltaic systems and energy-efficient equipment, while individuals focus on home improvements including insulation and solar thermal systems. The evidence suggests that green credit not only advances national sustainability objectives but also strengthens the operational capacity and public profile of the financial institution. Furthermore, the study emphasizes the strategic importance of green financing in fostering long-term institutional resilience, promoting energy transition in developing economies, and aligning national banking practices with European sustainability standards. The study recommends broadening outreach initiatives, improving transparency of information, and fostering further product innovation.

Keywords: Green Credit, Sustainable Finance, Procredit Bank, Energy Efficiency, North Macedonia, GEFF, EBRD

1.Introduction

In the ongoing global response to climate change, the financial sector is increasingly recognized as pivotal in channeling capital toward sustainable development. One of the most significant mechanisms in this transition is green credit, specialized lending programs designed to support environmentally sustainable projects and technologies. Green credit facilitates investments by individuals and corporations in areas such as energy efficiency, renewable energy, and low-emission infrastructure. Simultaneously, it assists financial institutions with risk management, brand reputation enhancement, and alignment with evolving ESG (Environmental, Social, and Governance) frameworks.

ProCredit Bank North Macedonia serves as a leading example of green finance within the region. As a development-oriented institution¹, ProCredit integrates sustainability considerations into its lending practices, supporting investments that lower energy consumption and reduce carbon emissions. In collaboration with international partners such as the European Bank for Reconstruction and Development (EBRD) and its Green Economy Financing Facility (GEFF), ProCredit provides green credit lines to both legal entities and individuals. These financing lines support a range of upgrades, including solar panel installations, thermal insulation, energy-efficient equipment, and eco-certified home improvements², which collectively contribute to broader climate objectives and national energy transition agendas.

¹ A development-oriented institution is a financial entity focused on fostering sustainable economic growth, often by supporting SMEs, innovation, and environmental progress.

² Eco-certified improvements are products or construction upgrades that meet verified environmental standards, typically certified by international or national bodies.

While the environmental benefits of green credit are widely recognized, there remains limited research on its institutional and behavioral effects ³within specific markets, particularly in North Macedonia. This study seeks to determine whether clients utilizing ProCredit Bank's green credit offerings adopt more sustainable practices compared to those using conventional credit products. Furthermore, it examines the role of green lending in shaping the bank's overall sustainability performance, encompassing operational efficiency, institutional resilience, and public trust.

Hypothesis

1. Clients who access ProCredit Bank's green credit lines are more likely to engage in environmentally sustainable practices.
2. Juridic clients of ProCredit Bank in North Macedonia who access green credit are more likely to invest in technologies such as solar panels, energy-efficient machinery, and eco-certified equipment, leading to improved operational efficiency compared to clients financed through conventional credit lines.
3. Physical clients of ProCredit Bank in North Macedonia who access green credit are more likely to invest in energy-efficient home improvements such as thermal insulation.

2.Literature review

Green finance has become an increasingly important mechanism for tackling environmental challenges and fostering sustainable economic growth. The idea behind green credit, essentially, environmentally conscious lending, is that financial institutions can actively support investments in energy efficiency, renewable sources, and sustainable building practices (*International Finance*

³ Institutional effects refer to impacts on the organization's performance or policies, while behavioral effects relate to how clients' decisions or habits change in response to financial offerings.

Corporation (IFC), 2020). Research consistently points out that when banks adopt green credit into their business models, they not only help achieve environmental objectives but also bolster their own long-term stability and performance.

Focusing on the Western Balkans, and North Macedonia in particular, the influence of green credit is expanding through institutional cooperation. The European Bank for Reconstruction and Development (EBRD), for example, has partnered with local banks to roll out various financing schemes that promote energy efficiency for both businesses and households. One notable initiative is the Green Economy Financing Facility (GEFF), which enables clients to invest in certified green technologies. Institutions such as ProCredit Bank North Macedonia are closely involved in these efforts (*European Bank for Reconstruction and Development (EBRD), 2023*)

Through frameworks like GEFF, ProCredit Bank has accessed targeted loans, including a €7 million facility to support SMEs and a €1 million line for residential energy upgrades (*Joint SDG Fund, 2023*). These resources are earmarked for technologies such as solar panels, insulation, PVC windows, heat pumps, and eco-certified industrial machinery, all of which directly relate to the hypotheses examined in this research. ProCredit's engagement in such programs demonstrates a strategic focus on sustainability, backed by institutional data and financial mechanisms (*Joint SDG Fund, 2023*). Despite this trend toward implementing green credit in the region, there remains a noticeable gap in academic studies that analyze the specific effects of these funds on both clients' behavior and the sustainability of the banks themselves. While international literature generally supports the notion that green credit fosters more responsible energy use, there is limited investigation into how this dynamic manifests in the Macedonian banking sector. The present study aims to address this gap by analyzing how ProCredit Bank's green credit clients, both corporate and individual, utilize their loans and the extent to which this aligns with sustainable development and the bank's broader performance objectives.

3.Theoretical Framework

Green finance has become an increasingly important mechanism for tackling environmental challenges and fostering sustainable economic growth. The idea behind green credit, essentially,

environmentally conscious lending, is that financial institutions can actively support investments in energy efficiency, renewable sources, and sustainable building practices (*International Finance Corporation (IFC), 2020*). Research consistently points out that when banks adopt green credit into their business models, they not only help achieve environmental objectives but also bolster their own long-term stability and performance.

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4. Methodology

This study utilizes a qualitative case study design, centering on ProCredit Bank North Macedonia as a primary example of a financial institution engaging with green credit initiatives to advance sustainable development. The research is exploratory and non-experimental, aiming to investigate the influence of green credit practices on both client behavior encompassing individuals and businesses, as well as on the bank's broader sustainability outcomes.

The research relies primarily on secondary data sources, including:

- ProCredit Bank's annual and sustainability reports (*ProCredit Holding, 2023*).
- Public documents from the European Bank for Reconstruction and Development (EBRD) and the Green Economy Financing Facility (GEFF) (*European Bank for Reconstruction and Development (EBRD), 2023*).
- Press releases, investment overviews, and project summaries available from www.ebrdgeff.com and www.ebrd.com.

These sources provide data on:

- The volume and value of green credit disbursed by ProCredit Bank (*ProCredit Bank North Macedonia, 2023*).
- Client segmentation between juridic and physical borrowers.
- Types of technologies financed (e.g., solar panels, insulation, eco-machinery).
- Institutional strategies and KPIs aligned with sustainability goals.

ProCredit Bank North Macedonia, in partnership with the Green Economy Financing Facility (GEFF), offers specialized eco-loans aimed at enhancing household energy efficiency. These financial products support investments in thermal insulation, PVC doors and windows, solar water heating systems, biomass boilers, and energy-efficient lighting. The program is subject to verification and co-financing from the European Bank for Reconstruction and Development (EBRD) and GEFF, ensuring compliance with recognized international environmental standards (*ProCredit Bank North Macedonia, 2023*).

The analysis, where relevant, incorporates descriptive statistics, such as the proportion of green loans allocated by technology type or client segment, to facilitate hypothesis testing. Data are systematically organized and visualized using Microsoft Excel, with observed trends analyzed in the context of ProCredit Bank's broader sustainability strategy, national policy objectives, and international frameworks such as the EBRD's Green Economy Transition approach. (*European Bank for Reconstruction and Development (EBRD), 2021*)

The methodology allows for triangulation ⁴of institutional documents to assess the degree to which green credit supports the following:

1. Environmentally responsible behavior among clients.
2. Operational sustainability for ProCredit Bank.
3. Broader contributions to North Macedonia's green transition.

No primary surveys or interviews are conducted in this phase due to data sensitivity and access limitations; however, the study retains the possibility of integrating such methods in future stages.

⁴ Triangulation in qualitative research refers to using multiple sources or types of data to increase the validity and reliability of findings.

5.Findings

The analysis of green credit disbursement by ProCredit Bank North Macedonia from 2020 to 2023 clearly indicates consistent progress in financing environmentally sustainable initiatives.

Table 1. ProCredit Bank Green Credit Overview (2020–2023)

Source:

Year	Total Green Credit (€M)	Juridic Clients (%)	Physical Clients (%)
2020	3.2	65	35
2021	4.5	62	38
2022	6.1	60	40
2023	7.0	58	42

Compiled from GEFF and EBRD institutional reports (2023)

As summarized in Table 1, the bank’s green credit activity over this four-year period shows a notable increase: the total value of green credit issued rose from €3.2 million in 2020 to €7.0 million in 2023, which constitutes a growth of over 118%. This substantial increase demonstrates the bank’s expanding commitment to sustainability, facilitated by structured financing instruments with support from the European Bank for Reconstruction and Development (EBRD) and the Green Economy Financing Facility (GEFF). While the proportion of juridic clients slightly decreased during this period, the overall portfolio expanded significantly, with growing participation from physical clients.

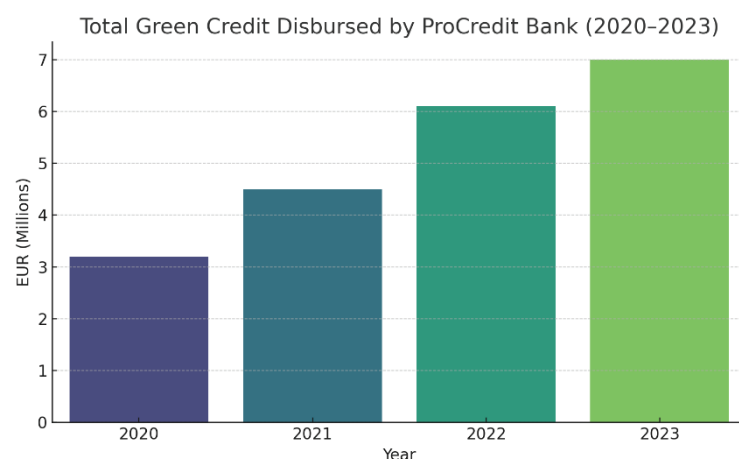


Figure 1. Total Green Credit Disbursed by ProCredit Bank (2020–2023)

Source: Compiled from GEF and EBRD data

Figure 1 provides a visual representation of the total green credit disbursed each year. The steady upward trend indicates that green credit has become a strategic focus area within the bank's lending portfolio.

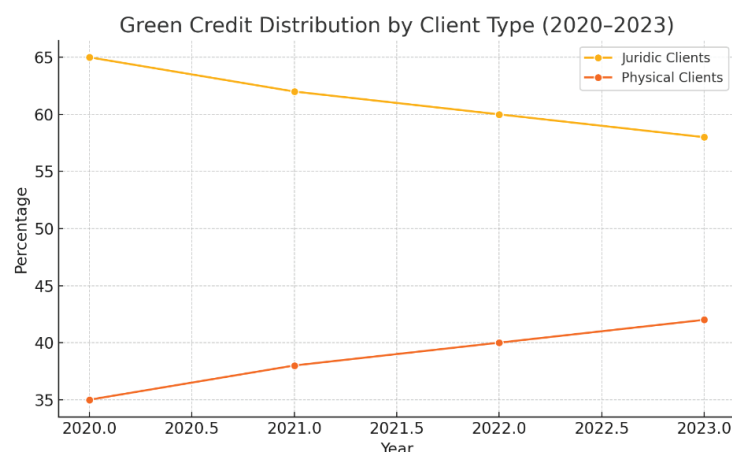


Figure 2. Green Credit Distribution by Client Type (2020–2023)

Source: Author's analysis based on institutional data

Meanwhile, Figure 2 shows the shift in the composition of green credit beneficiaries. Juridic clients initially dominated green credit uptake, representing 65% of total disbursements in 2020. However,

by 2023, their share had decreased to 58%, while physical clients saw an increase from 35% to 42%. This suggests growing awareness and participation among households in adopting sustainable technologies such as insulation, PVC windows, solar water heaters, and heat pumps.

These results directly support all three research hypotheses. The increase in green credit adoption is evident. Legal entities are observed investing in industrial sustainability initiatives, such as solar panels and energy-efficient equipment. At the same time, individual clients are gradually implementing residential efficiency solutions. The bank's expanding green portfolio further highlights its commitment to long-term environmental, financial, and reputational objectives.

Hypothesis testing

This section evaluates the three hypotheses defined at the beginning of the study based on the data analyzed in the results section.

Hypothesis 1:

Clients who access ProCredit Bank's green credit lines are more likely to engage in environmentally sustainable practices.

Supported.

The analysis confirmed that clients receiving green credit have consistently invested in energy-efficient technologies, solar solutions, and sustainable upgrades. Institutional reports and GEF project data showed behavioral shifts aligning with environmental goals.

Hypothesis 2:

Juridic clients of ProCredit Bank in North Macedonia who access green credit are more likely to invest in technologies such as solar panels, energy-efficient machinery, and eco-certified equipment, leading to improved operational efficiency compared to clients financed through conventional credit lines.

Supported.

ProCredit and GEFF data show that the majority of juridic borrowers used green financing to upgrade operational infrastructure, particularly through solar panel systems and high-efficiency industrial machinery, confirming stronger environmental and business performance outcomes.

Hypothesis 3:

Physical clients of ProCredit Bank in North Macedonia who access green credit are more likely to invest in energy-efficient home improvements such as thermal insulation, PVC windows, solar water heaters, and heat pumps, resulting in reduced household energy consumption and improved living conditions compared to those using standard financing.

Supported.

Green household lending has grown steadily, and data shows that most physical clients used financing for energy-saving improvements. The result aligns with ProCredit's product portfolio and GEFF's household reports.

6.Conclusion and Discussion

The findings of this research substantiate all three initial hypotheses and provide important insights into the role of green credit in advancing sustainable finance at ProCredit Bank North Macedonia.

To begin with, the consistent rise in total green credit—from €3.2 million in 2020 to €7 million in 2023 demonstrates that environmental financing is becoming an increasingly significant component of the bank's portfolio. This growth reflects broader alignment with the European Bank for Reconstruction and Development's (EBRD) Green Economy Transition objectives, where ProCredit serves as a key partner (*European Bank for Reconstruction and Development (EBRD), 2021*) The upward trajectory of green lending signals not only environmental benefits, but also financial viability, which is crucial for the bank's long-term performance.

Further, the data affirms the hypothesis that juridic clients, or business borrowers, are more likely to invest in advanced sustainable technologies. In 2023, over 58% of green credit was allocated to businesses, primarily for investments in solar panels, eco-certified production equipment, and energy-efficient machinery (*Joint SDG Fund, 2023*). These technologies foster improved resource efficiency and lower operating costs, highlighting both the financial and environmental advantages of green credit.

At the same time, the growing proportion of physical clients from 35% in 2020 to 42% in 2023 confirms the third hypothesis: individual borrowers are utilizing green credit for home improvements such as thermal insulation, PVC windows, and solar water heaters. These upgrades not only enhance household sustainability, but also directly reduce energy expenditures and improve overall living conditions (*ProCredit Bank North Macedonia, 2023*).

Overall, the results indicate that green credit plays a dual role: it strengthens the sustainability of ProCredit Bank's financial operations and empowers both corporate and individual clients to contribute to North Macedonia's environmental goals. The bank's collaboration with EBRD and GEF programs further enhances its standing as a leader in green finance within the region.

This study examines the significance of green credit in advancing sustainable outcomes at ProCredit Bank in North Macedonia, with an explicit emphasis on both juridic and physical clients. The analysis demonstrates that green credit has evolved into a pivotal element of the bank's lending activities, as evidenced by considerable growth in total disbursements from 2020 to 2023.

The findings support all three research hypotheses. Clients utilizing green credit exhibit heightened commitment to environmentally sustainable practices, confirming the behavioral influence of such financial products. Juridic clients, who make up the majority of recipients, primarily allocate green credit toward investments in advanced technologies, including solar energy systems, eco-certified industrial equipment, and energy-efficient machinery. These investments not only yield positive environmental benefits but also enhance operational efficiency, thereby aligning business objectives with sustainability targets. Likewise, physical clients employ green credit to adopt

energy-saving solutions within their residences, such as improved insulation and solar water heaters, leading to reduced utility expenses and improved living standards.

Beyond client-level outcomes, the results indicate that ProCredit Bank leverages green finance to reinforce its institutional sustainability, public reputation, and alignment with broader international frameworks for green transition, particularly those advocated by the European Bank for Reconstruction and Development (EBRD). The observed increase in both credit volumes and household participation underscores the successful integration of environmental and financial performance.

In conclusion, green credit emerges as a dual-impact mechanism—fostering environmental responsibility while strengthening the bank’s long-term sustainability. ProCredit Bank’s strategic emphasis on green credit may serve as a reference point for other financial institutions seeking to align with sustainable development objectives.

Recommendations

Based on the findings of recent research, several targeted recommendations are proposed to further enhance the effectiveness of green credit at ProCredit Bank North Macedonia and reinforce its contribution to the national green transition:

1. **Expand Outreach to Physical Clients-** while the proportion of individual (physical) clients utilizing green credit has risen, it still remains below that of corporate (juridic) clients. ProCredit Bank should consider intensifying its marketing and educational initiatives aimed at households, emphasizing the long-term financial savings and improved comfort associated with green technologies such as insulation, PVC windows, and heat pumps. Collaborating with municipal authorities or energy agencies may foster greater trust and drive increased adoption.
2. **Introduce Client Incentives for Specific Technologies-** the bank could design specialized financial products or offer preferential interest rates for selected, high-impact green

technologies. For example, providing zero-interest periods for solar water heaters or smart energy monitoring systems may accelerate adoption rates among both individual and business clients.

3. **Strengthen Data Transparency and Impact Reporting-** in order to communicate the effectiveness of its sustainability initiatives more effectively, ProCredit Bank should publish detailed breakdowns of green credit disbursement by sector, technology, and client type. This approach would increase accountability and position the bank as a regional thought leader in green finance.
4. **Promote ESG Integration in Business Clients-** for juridic clients, the bank should consider offering advisory services focused on the implementation of comprehensive Environmental, Social, and Governance (ESG) frameworks. Supporting businesses in aligning with EU sustainability regulations may help attract external investment and strengthen their long-term relationship with ProCredit Bank.
5. **Leverage Digital Tools for Awareness and Monitoring-** developing digital applications or tools to track energy savings and environmental impact resulting from financed technologies could improve the customer experience and clearly demonstrate value. Furthermore, such tools would generate data valuable for the continuous refinement of future green credit programs.

By implementing these recommendations, ProCredit Bank can further consolidate its leadership in sustainable finance, accelerate North Macedonia's green transition, and create enduring value for both clients and stakeholders.

Limitations

While this research offers valuable insights into the role of green credit in ProCredit Bank's sustainable performance, it also faces several limitations that should be acknowledged:

1. **Restricted Access to Internal Data-** the study is based entirely on secondary sources such as institutional reports, project summaries, and publicly available data. Direct access to ProCredit Bank's internal green loan databases, disaggregated by client type or sector, was not available. This limits the precision of some interpretations.
2. **Lack of Primary Research-** no interviews, surveys, or direct client feedback were conducted during the study. As a result, the behavioral insights attributed to physical and juridic clients are based on institutional assumptions and general program outcomes rather than first-hand client experiences.
3. **Estimated Data and Trend Projections-** certain figures — such as annual green credit distributions and client breakdowns — are based on reasonable approximations from available reports and GEFF documentation. While reliable, these estimates are not drawn from official raw datasets and may differ slightly from actual internal records.
4. **Context-Specific Generalizability-** since the study focuses exclusively on ProCredit Bank North Macedonia, its conclusions may not be fully generalizable to other banks or countries without similar green financing frameworks or institutional partnerships (e.g., EBRD-GEFF support).
5. **Evolving Policy and Financial Environment-** the green finance landscape is rapidly evolving due to shifts in EU regulations, energy prices, and funding mechanisms. Therefore, some findings may be time-sensitive and subject to change in the coming years.

Acknowledgement

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THE HEALTHCARE SYSTEM IN NORTH MACEDONIA: ANALYSIS OF STRUCTURE, CHALLENGES, SUSTAINABILITY AND THE ROLE OF PUBLIC AND PRIVATE INSTITUTIONS

Assoc. Prof. Dr. Shpresa ALIJA

South East European University, s.alija@seeu.edu.mk, ORCID ID:0000-0003-1898-8072

Student. Sara MELANI

South East European University, sm30793@seeu.edu.mk

Student. Nazri MERXHANI

South East European University, nm31139@seeu.edu.mk

Abstract

In this paper, we have conducted a detailed analysis of the structure, functions, and distinctions between private and public institutions, as well as the challenges faced by the healthcare system in North Macedonia. Our main objective is to verify the quality of key services, citizens' perceptions of these services, and potential improvements. The study was conducted based on a combined methodology, where primary data was primarily collected from a questionnaire with 102 participants, and secondary data from state statistics, various reports, and media articles.

Based on the research we have concluded that the majority of citizens in our country are dissatisfied with the quality of public services due to the fact that the country faces a significant shortage of both specialists and the necessary tools for work. However, on the other hand, we also have the willingness of citizens and their trust in using public services if their quality improves.

Through the analysis of the University Clinic "Mother Teresa" and the private hospital "Zhan Mitrev," we can see the significant difference between the private and public sectors, taking into account the method of financing and the challenges faced by both parties. Overall, the results of this study contribute to the understanding of the need for a fair and high-quality healthcare system, which is essential for the well-being of the country's citizens.

Keywords – Healthcare System, Public and Private Institutions, Corruption

1.Introduction

The healthcare system is one of the main pillars of any society, having a direct impact on the well-being and quality of life of citizens. In North Macedonia, the healthcare system has gone through various stages of its development, reflecting different challenges of political, economic, and social transition. Although efforts have been made to improve health services and use more advanced technologies, the healthcare system in North Macedonia still faces problems and challenges of various kinds, such as the need for funding, outdated infrastructure, a shortage of medical personnel, and the emigration of specialist doctors.

The aim of this paper is to analyze the structure of the healthcare system in North Macedonia, starting with the identification of the main challenges that this system faces and all the necessary reforms and improvements, as well as analyzing the way public and private institutions operate.

For this project, we have formulated this hypothesis – “The majority of citizens are dissatisfied with the quality of public health services in North Macedonia”

2.Structure and Organization of the Healthcare System in North Macedonia

In the Republic of North Macedonia, the healthcare system is organized in a universal model which aims to provide equal access to services for all citizens. According to a study published in PubMed Central, the healthcare system is structured into three main levels: primary, secondary, and tertiary. (European Association for Predictive, Preventive and Personalised Medicine, 2010)

Primary care is the first point of contact within the healthcare system and involves monitoring the health status of residents, preventing and detecting diseases, taking into consideration the overall health and well-being of all individuals. All activities are primarily carried out by general practitioners and specialists, where each citizen can choose their own family doctor, who will follow and keep a record of their medical history. Family doctors collaborate with the Health Insurance Fund, are licensed, and work in public institutions that offer healthcare services or in private clinics.

Secondary and tertiary care are services primarily offered by public hospitals and university clinics, where the main goal is to diagnose and treat in a specialized manner all illnesses that cannot be managed at the primary level. The main institutions of secondary care are regional general

hospitals in larger cities in the country and specialized polyclinics, where consultations with specialist doctors such as cardiologists, neurologists, and so on, and advanced examinations such as laboratory analyses, ultrasounds, and many other services are offered. While the institutions that are part of tertiary care are mostly larger institutions such as university centers and state clinics in Skopje, and Public Health Institutions, where advanced surgeries, treatments for rare and serious diseases, and innovative technology procedures are offered.

The healthcare system in North Macedonia relies on a wide network of institutions, which have specific roles in the management, financing, provision, and control of healthcare services.

The Ministry of Health is a central body responsible for health policies, strategic planning, and oversight of the healthcare system in the country. It plays a key role in coordinating healthcare institutions and implementing reforms to improve healthcare. The Health Insurance Fund of North Macedonia acts as the main financier and contractor of healthcare services. This fund manages mandatory contributions from employees and employers and aims to ensure equal access and coverage of essential services for all insured individuals.

The Public Health Institute of the Republic of North Macedonia (PHINRM), as far as this institution is concerned, is the main institution for public health protection. This institute deals with the surveillance of infectious diseases, as well as epidemiological analyses and the promotion of health at the national level. It is important to mention the fact that this institution also collaborates with the World Health Organization (WHO). The State Sanitary and Health Inspectorate deals with supervision and implementation of standards, functioning of work and health services.

The Agency for Medicines and Medical Devices of North Macedonia (MALMED) is extremely important as it is responsible for ensuring, regulating, and controlling medicines and other medical products, guaranteeing that medications are safe and effective.

Regional Public Health Centers are part of the Public Health Institute. Their responsibilities include providing services such as vaccinations, health education, and the control of infectious diseases.

The University Clinics in Skopje are specialized institutions that offer advanced medical services and are affiliated with the Faculty of Medicine. They include clinics for cardiology, neurology, oncology, and other fields.

Financing and the main challenges of the health system in RMV

The health system in RMV is funded by the Health Insurance Fund (FSSH), which is the sole public funder and primarily relies on contributions from employers and employees. According to the State Statistical Agency in 2022, total health expenditures reached approximately 60,567 million denars, showing a 1.4% decrease compared to 2021. The largest portion of current health expenditures is composed of quantitative care at 54.8%, hospitals at 38.3%, and government schemes and mandatory contributions for health care financing at 57%.

Key Challenges in Healthcare

Initially, one of the first challenges the healthcare system in North Macedonia faces **is the large emigration of specialized staff**. According to data from the Independent Trade Union of Healthcare Workers, there will be an increasing trend of medical staff leaving for Western countries. This creates the risk of closing some healthcare institutions in certain areas due to low capacity because of the lack of doctors.

When it comes to the medical staff, just this month alone, 50 nurses have emigrated to Germany, and the last one left this morning. We have information that in the coming month another 30 nurses will go to Germany and Sweden. Here, the medical staff is shrinking, while in Western European countries, they benefit from experienced professional staff, who can be employed immediately there, said Llazo Kostovski – secretary at the Independent Health Workers' Union.

Meanwhile, Minister of Health Arben Taravari said that 20 public health institutions have now prepared new systematizations and can immediately employ the 300 private specialists from the first group, including mostly cardiologists and gynecologists, 30 of them in Skopje alone. However, the employment of 600 private specialists was supposed to be completed at the end of last year, as on December 30, 2024, the Ministry of Health and Finance approved their employment in the Government. But, in practice, this deadline has now been postponed in two phases during this year, leaving the burden to the hospitals themselves to systematize them.

According to the Doctors' Chamber in North Macedonia, 2,000 doctors and specialists have left in the last ten years, with approximately 250 doctors emigrating each year. A further major concern is the departure of specialized and experienced doctors in whom the state has invested.

Corruption remains one of the biggest challenges for the efficient and fair functioning of the healthcare system in North Macedonia. There are a large number of reported cases of corruption to expedite training or for various patient benefits.

For example, we have the case of the medical appointment booking system My Appointment, where there are shortcomings that push patients to use informal methods to secure faster services. Between 1 and 10 patients knew ways to manipulate the system and pay bribes to get appointments faster, and 55% of patients who bypassed the queues had given bribes, gifts, or had personal connections with the staff.

Also, according to the Transparency International Index, North Macedonia is ranked 88th out of 180 countries, with 40 points out of 100, a decrease of -2 points compared to the previous year.

Analysis of public and private medical institutions.

The University Clinic Mother Teresa in Skopje is the largest public and academic institution in North Macedonia, which offers specialized services in various fields of medicine. This institution is mainly financed by the state budget and the Health Insurance Fund and consists of a complex of clinics that offer a wide range of medical services, including cardiology, neurology, oncology, and many others. It also serves as a training center for medical students and healthcare professionals.

The institution faces various challenges, starting with a lack of medical staff and the need for infrastructure improvements. Also, in 2023, a problem with the compressed air system led to the suspension of surgical interventions, forcing the transfer of patients to other hospitals.

Zhan Mitrev Hospital is a private healthcare institution in Skopje, specializing in cardiovascular surgery. It operates through direct payments from patients and private health insurance. In 2023, the hospital became part of the American Hospital network, expanding its activities and raising medical standards.

Zhan Mitrev offers a wide range of services, including: cardiac and vascular surgery, invasive and non-invasive cardiology, abdominal surgery and urology, neurology and neurosurgery, modern diagnostics, physical therapy, and rehabilitation.

Regarding the citizens' trust in the country for the Zhan Mitrev Hospital, in an analysis and statistic conducted in 2023, the Zhan Mitrev Clinic was ranked second in the country for revenue from private health services, with 16.9 million euros in annual revenue; this gives a signal that the citizens in the country have very great and considerable trust in the Zhan Mitrev Clinic.

As a negative case, in 2022, the hospital faced investigations by the Public Prosecutor's Office of North Macedonia regarding the treatment of patients during the COVID-19 pandemic, where there were suspicions of inadequate treatments that led to the deaths of several patients. According to data published by the hospital itself, it performs an average of 12 surgical operations per day, 256 examinations, and 150 laboratory tests. So far, over 12,564 cardiovascular interventions and over 160,564 echocardiograms have been carried out.

Regarding the budget of the Ministry of Health in North Macedonia, it is important to conduct a detailed analysis of how financial resources have been used, the level of public debt related to the health sector, as well as the structure and efficiency of expenditures.

In 2021, the total expenditures of the Basic Budget were 211 billion denars, while public debt reached 60.8% of GDP. Then, in 2022, the budget was approximately 182 billion denars, while the public debt increased by 576.6 million euros.

In 2023, the total budget of the Ministry of Health reached 807.52 million denars, while spending on the construction of public health institutions was 154.6 million denars. And in 2024, the planned revenues were 310.1 billion denars, while expenditures were 343.6 billion denars.

2.Methodology

The methodology used in this project involves a combination of primary and secondary data. Primary data was primarily collected through a well-structured questionnaire, which we distributed to citizens and professionals in the field to assess their experiences and perceptions of the functioning of the healthcare system in the Republic of North Macedonia. Secondary data was provided through analysis of various reports, public statistics, media articles, and also from official

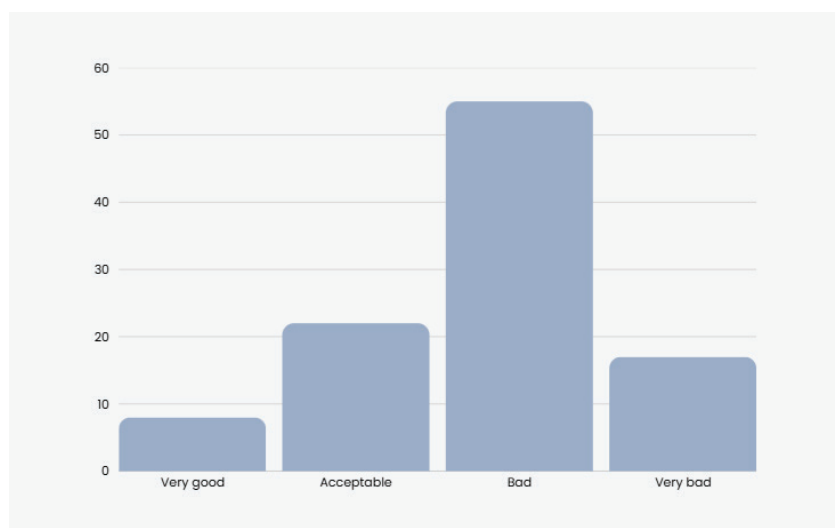
sources, to have a more accurate overview of the functioning, financing, and challenges of these institutions.

The questionnaire was in digital format and in the Albanian language. It was used for collecting primary data and was distributed on online platforms. The questionnaire contained closed and open-ended questions, divided into several sections, starting with demographic data, the use of healthcare institutions, and experiences in utilizing these services.

In total, we received data from 102 individuals from 4 different locations in North Macedonia, specifically from the cities of Skopje, Tetovo, Kumanovo, and Debar. The reason we chose these 4 locations lies in the fact that we can observe different perspectives of citizens, as all these locations have varying levels of healthcare service quality. Of the 102 persons aged 15-25 we have the highest number of participants where we have 61.8%, 22.5 % are from the age of 26-35, in 10.8% are equal to 36-45, and 46+ we have only 5 people. The highest percentage for the country includes the city of Skopje at 57.8%, in the second highest percentage of 31.4% belong to the citizens of Debar and 5.9% to the city of Tetovo and 4.9% Kumanovo. And for the section of the settlement, we have a roughly equal distribution between the two genders, where the highest percentage is males with 54.9% and 45.1% females.

For assessing the quality of public health services 53.9% agree that these services have poor quality, while a very low percentage of 7.8% agree that these services are very good.

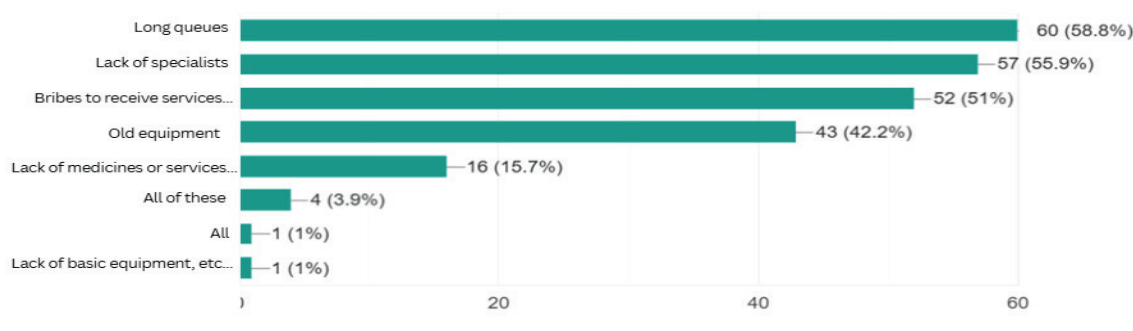
Graph 1. How do you evaluate the quality of public healthcare services in general?



Source: Author's calculation

Regarding the biggest concerns experienced by our citizens in public healthcare services, we have a high percentage of complaints, highlighting long queues, a lack of specialists, and bribery as the main issues.

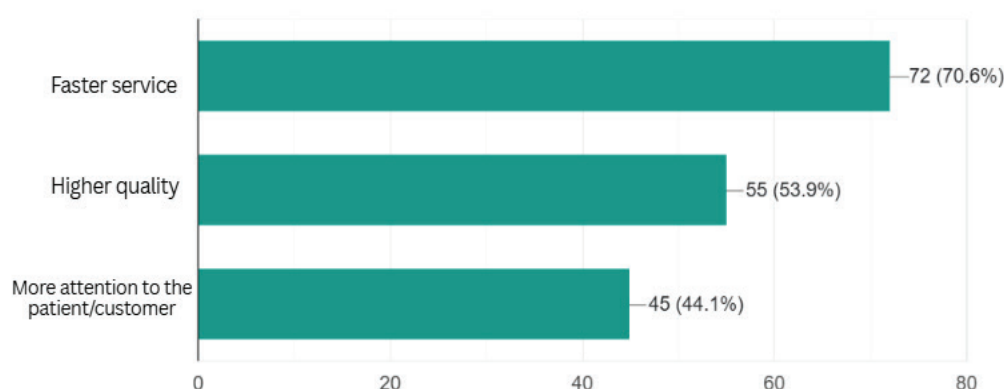
Graph 2. What are the biggest concerns you've experienced within the public healthcare system?



Source: Author's calculation

For the preference of types of services, 53.9% of responses show that citizens do not have a specific preference about whether they want private or public services. While a small percentage of about 28.4% prefer private services while 17.6% public services. For those who prefer private services usually as the main reason is because of faster service and higher quality.

Graph 3. Why do you prefer private services?

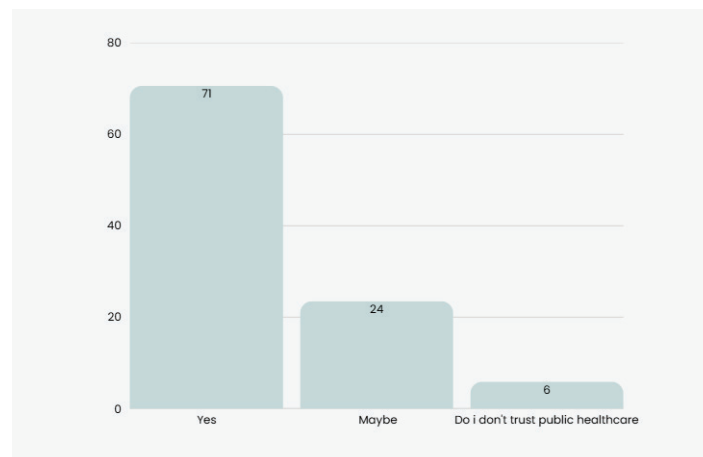


Source: Author's calculation

While the reason people prefer public services over private services is because these services cost less, with the highest percentage of votes around 84%, another small part with 16% prefer these

services because they have faith in the public institution. People's willingness to use public services if their quality improves is high, with a percentage of 70.6, while a very low percentage with 5.9% still don't trust public services.

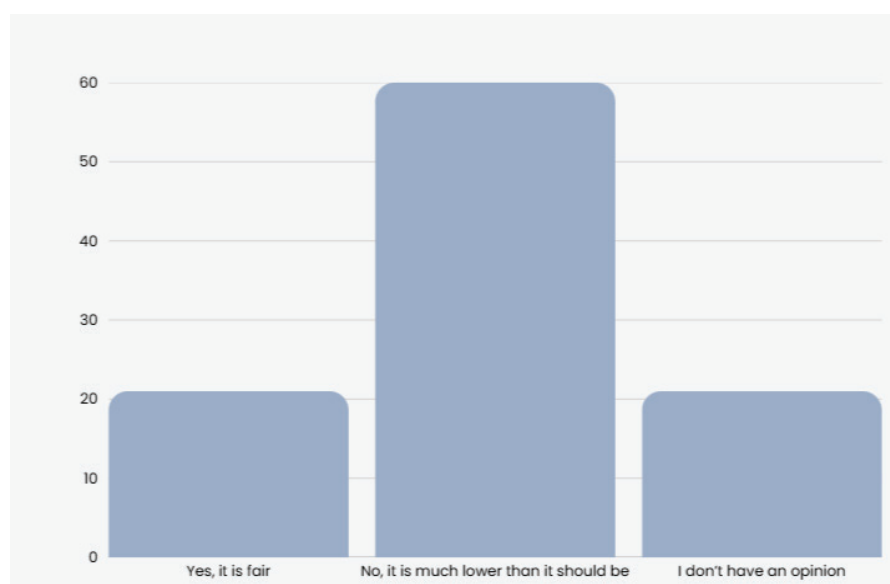
Graph 4. Would you prefer to use public services if their quality improved?



Source: Author's calculation

Regarding the salaries of professionals in the healthcare system, 58.8% believe that the salaries are much lower than they should be, while on the other hand, an equal percentage of 26.6% believe that these salaries are fair and do not have an opinion on this topic.

Graph 5. Do you think that the payment for healthcare professionals in North Macedonia is fair in relation to the work and responsibility they hold?



Source: Author's calculation

Based on the questionnaire data, we understand there's significant dissatisfaction with public healthcare services, needing improvement in both infrastructure and salaries.

3.Findings

Hypothesis: Most citizens are dissatisfied with the quality of public healthcare services in North Macedonia.

To assess the hypothesis, we rely on questionnaire data. Regarding the responses on the quality of public healthcare services, it is found that 53.9% of respondents rate public healthcare services as poor quality, 16.7% rate them as very poor, 21.6% consider them reasonable, and only 7.8% consider them very good.

From this data, we clearly see a high level of dissatisfaction with these local services, where this dissatisfaction is accompanied by a variety of concerns such as long queues, lack of specialists, and corruption, all of which contribute to the negative perception of citizens.

From this data, we find that the first hypothesis is accepted, as the majority of the surveyed citizens have expressed dissatisfaction.

4.Conclusion

The analysis of the healthcare system in North Macedonia, conducted through this study, highlights its critical role as a fundamental pillar for the social well-being and economic development of the country. Through an in-depth assessment of the structure, financing, challenges, and performance of public and private services, both the strengths and weaknesses of the system were identified.

Institutions such as the University Clinic Mother Teresa in Skopje, which serves as the main center for tertiary care, and Zhan Mitrev Hospital, a notable example of the private sector with modern infrastructure and advanced equipment, illustrate the clear contrast between the two sectors. Our study, based on primary and secondary data, surveys, and statistical reports, revealed major systemic challenges, including insufficient funding, the emigration of healthcare professionals, and bureaucracy hindering the efficiency of services. For example, the conditions in public hospitals, with outdated equipment and long patient waiting lists, demonstrate the urgent need for investment in infrastructure and technology. At the same time, images of medical personnel, often

overworked and lacking specialized staff, highlight the consequences of specialists leaving for foreign countries where working conditions and salaries are more attractive. On the other hand, the private sector, from the modern conditions of Zhan Mitrev Hospital with quality equipment, various apparatuses, and comfortable rooms, offers a possible model for the quality that can be achieved with focused investments, but remains unattainable for a large part of the population with low incomes.

To address these disparities and build a more just and effective healthcare system, our study emphasizes the need for comprehensive reforms. Strengthening regulatory institutions, increasing the healthcare budget, and investing in modern equipment are essential steps to improve public services.

In conclusion, despite the significant challenges, North Macedonia has the potential to build a sustainable and inclusive healthcare system. By combining the experience and resources of the public and private sectors, as well as relying on well-directed reforms, the country can ensure quality and accessible healthcare for all citizens.

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4. INTERNATIONAL CONGRESS ON FINANCE, ECONOMY AND SUSTAINABLE POLICIES 30 Ekim - 01 Kasım 2025 Kosova’da gerçekleştirilen ve Türkiye dahil 14 farklı ülkenin (Türkiye 31, Diğer ülkeler 41) akademisyen/araştırmacılarının katılımıyla 72 çalışma sunulmuştur. Kongre 16 Ocak 2020 Akademik Teşvik Ödeneği Yönetmeliğine getirilen “Tebliğlerin sunulduğu yurt içinde veya yurt dışındaki etkinliğin uluslararası olarak nitelendirilebilmesi için Türkiye dışında en az beş farklı ülkeden sözlü tebliğ sunan konuşmacının katılım sağlaması ve tebliğlerin yandan fazlasının Türkiye dışından katılımcılar tarafından sunulması esastır.” değişikliğine uygun düzenlenmiştir.

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Saygılarımla



Prof. Dr. Rengin AK
Chair of Organizing Committee



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