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A CRITICAL ANALYSIS OF SOME ENERGY POVERTY INDICATORS

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***Abstract:** Current challenges, through wars and conflicts, at global and EU27 level, demonstrate that the energy issue can be used as a weapon against the population. Thus, energy plays a fundamental role in ensuring the well-being of households by affecting health, work, education and financial prosperity. In this context, energy poverty is described as a complex phenomenon, which affects all aspects of life and highlights the inability of the population to secure the necessary energy products and services, whether it is infrastructure or costs. Thus, the article aims to critically analyze a series of energy poverty indicators proposed by the Energy Poverty Advisory Hub (EPAH) at the European Union level and to highlight which could be considered the most valuable indicators to be taken into account in further analyses. The results highlight that the issue of energy poverty encompasses various aspects of life, extremely complex, each of the indicators bringing a new nuance, a new facet to the complete image of this concept.*

***Keywords:** sustainability, energy poverty, housing conditions, inequity.*

***JEL Classifications:** I14, I32, R2.*

1. Introduction

Although the topics of the day focus on regional security issues, resources, energy, trade wars, tariffs, taxes, etc., however, the issue of energy poverty, often not addressed publicly, should also be in the spotlight, being the consequence of uninspired decisions regarding the above, both in public and private policy. Energy poverty represents a complex form of poverty, generally describing the impossibility of households to ensure their basic needs by having the energy needed for cooking, lighting, heating or cooling. The complexity of this form of poverty comes from the countless causes, but also from the multitude of effects and consequences through which it manifests itself. Whether it is the inability to pay bills for the energy consumed, whether it is a self-imposed restriction in order not to end up with non-payment of bills (hidden energy poverty), whether the homes have low energy efficiency, whether there are no elements of local infrastructure that allow access to energy or the cost of this access is prohibitive, all of these represent forms of energy poverty that lead to the impact on the economic well-being of households.

If we refer to the effects, the effects of energy poverty can be multiple: from affecting physical, emotional and mental health, affecting the educational level, accentuating social disparities and inequalities, accentuating regional disparities, but also those between village and city, affecting access to work and a decent life, etc. In general, energy poverty comes to accentuate the financial and social troubles already existing in vulnerable households, worsening all forms of social disparities.

In this context, although it does not seem like a front-page topic, energy poverty is in reality a central element of the social well-being of households that should be approached more seriously within the framework of policies, an element that must be viewed and analyzed more and more thoroughly in its depth. Although energy poverty is treated mainly in the family, household context, nevertheless, special attention must also be paid to energy poverty at the institutional level, but also at the private, company level.

2. Problem description

In addition to economic and social factors, energy poverty mainly speaks about the condition of buildings, which were often built in other periods of time when energy vulnerability was not taken into account (e.g. the 1980s or even earlier, the 1960s). If in developed countries, the inhabitants of homes are often tenants and not their owners, in Central and Eastern Europe the situation is exactly the opposite. However, although owners, the majority of citizens in Central and Eastern Europe do not have the financial means, but also the trust in the authorities and the community to resort to the rehabilitation and renovation of their homes. In Central and Eastern Europe, for decades the focus has been on forced industrialization and urbanization, and the quality of people's lives and especially living and housing conditions has been passed over in silence. These shortcomings really showed their face when the market economy forced the gradual abandonment of forms of state energy subsidies (<https://www.infoclima.ro/> and Sinea et al., 2021), and buildings became increasingly energy-dated, increasingly vulnerable to weather and the passage of time, increasingly energy-consuming.

Also, a relatively paradoxical situation is also occurring in the southern part of Europe, although with a generally warm climate, under the increasing impact of climate change, European Union (EU27) countries such as Spain, Portugal, Italy and Greece are increasingly facing energy poverty problems. The technical condition of old buildings, the superficial way of approaching the problem of heating or cooling the home, the dubious quality of new constructions that do not take into account the need to adjust to climate change, the lack of rehabilitation programs or insufficient rehabilitation of the building stock, insufficient public, private or mixed financing as well as subsidies or other state financial and fiscal instruments granted at an insufficient and/or inefficient level can lead to aggravation of the energy poverty problem.

3. Review of the specialized literature

Energy poverty has been a consistent focus of researchers for several decades. It either starts from tangible, clearly measurable elements, such as cost factors, estimating the phenomenon based on electricity bills adjusted with information on the energy efficiency of buildings and the socio-economic conditions of households (Boardman, 2009; Florio, and Florio, 2013; Li et al., 2014; Antepara et al., 2020) or from subjective aspects, perceptible at the individual level, such as indicators describing the comfort and adequacy of housing, the behaviour of occupants, or issues related to the improper functioning of insulation, cooling or heating systems (Cali et al., 2012; Bouzarovski, 2014; Bakaloglou and Charlier, 2021; Koukoufikis and Uihlein, 2022).

Studies at the global level seem to slightly stir the surface water of the problem (Chan and Delina, 2023; Castro-Cárdenas and Ibarra-Yunez, 2023; Filho et al., 2024), but at the European Union level there is a focus on regional disparities between the centre and the periphery, but also substantial inter-countries disparities in terms of energy poverty (Copus, 2001; Petrakos et al., 2011; Featherstone and Kazamias, 2014; Kerr et al., 2019; Heeman et al., 2022).

From the perspective of systematizing indicators, if some authors treat the issue of energy poverty individually (Rademaekers et al., 2016; Thomson et al., 2017; Castano-Rosa et al., 2020), others consider more appropriate a composite index (Gouveia et al., 2019; Palma et al., 2022). Without proposing to resolve the issue at this stage, the option in this study is to

analyze the EPAH indicators individually, in order to better discern their qualities. Of course, the area covered in this study is at the level of the European Union countries.

4. Methodology and data sources

The analysis is based on a comparative, critical study at the European Union level on the indicators proposed by the Energy Poverty Advisory Hub (EPAH) so that we can discern which may be the most relevant indicators for energy poverty. At the same time, based on the available EPAH data, several indicators considered more relevant are selected and analyzed (including at a graphical level). Table 1 describes the EPAH indicators.

Table 1. Description of variables, systematization and presentation of data sources

Topic	Subtopic	Indicator
Climate		Cooling degree days
		Heating degree days
Facilities / housing	Building Stock	Dwellings with energy label A
		Final consumption expenditure of households
		Population living dwelling with presence of leak dump and rot
		Population living dwelling equipped with heating facilities
		Population living dwelling equipped with air conditioning
		Population considering their dwelling as too dark
	Energy Consumption and Equipment	Final consumption expenditure of households
		Final energy consumption in households by energy use
		Final energy consumption in households by type of fuel
		Final consumption expenditure of households
Mobility		Population who cannot afford a regular use of public transport
		Arrears on utility bills
Socio-economic aspects	Social Economic and Living Conditions	At risk of poverty or social exclusion
		Disposable annual household income
		Final consumption expenditure of households
		Housing cost overburden rate
		Inability to keep home adequately warm
		Population living in dwellings comfortably cool in summer time
		Population living in dwellings comfortably cool in winter time
		Energy expenditure by income quintile
	Energy Expenditure and Energy Markets	Energy prices
		High share of energy expenditure in income (2M)
		Low absolute energy expenditure (M/2)
		Causes of death
	Health	Excess winter mortality/deaths
		Final consumption expenditure of households
		Population reporting a chronic disease

Source: European Commission, EPAH online course.

Based on the description of the variables, a series of factors for and against choosing some of them is highlighted, ultimately selecting only a few for graphical representation, which we can consider the most relevant.

5. Results

Thus, energy poverty is treated with particular care at the level of the European Union institutions, especially the European Commission, one of which is the Energy Poverty Advisory Hub (EPAH). In addition to courses, trainings, studies and practical guides to help local authorities and other bodies interested in managing the problem of energy poverty, EPAH also provides a series of indicators, but also valuable data for them to allow a good assessment of energy poverty at the level of EU countries.

Thus, in the table below, based on the EPAH systematization above, the 25 energy poverty indicators are presented (Final consumption expenditure of households, repeating five times in almost every subsection presented), whether it is climate, facilities/household aspects, mobility or socio-economic aspects, from the perspective of the pros and cons that could convince us to choose them. EPAH proposes its indicators based on data from the Survey on Income and Living Conditions (SILC) and the Household Budget Survey (HBS).

Table 2. Pros and cons of choosing to describe energy poverty

Indicator	Pros	Cons
Cooling degree days	<ul style="list-style-type: none"> -Provides insight into climate variables and the building's energy needs for cooling. -The indicator focuses on average temperatures. -With additional indicators (e.g. "Final Energy Consumption in Households" and "Inability to heat or cool") can help build a more comprehensive picture of energy poverty. 	<ul style="list-style-type: none"> - It does not account for buildings' energy efficiency or affordability. - It does not capture short-timed temperature fluctuations (e.g. heat waves) which can considerably impact residential energy consumption and comfort
Heating degree days	<ul style="list-style-type: none"> -Provides insight into climate variables and the building's energy needs for heating. -The indicator focuses on average temperatures. -With additional indicators (e.g. "Final Energy Consumption in Households" and "Inability to heat or cool") can help build a more comprehensive picture of energy poverty. 	<ul style="list-style-type: none"> - It does not for buildings' energy efficiency or affordability. - It does not capture short-timed temperature fluctuations (e.g. cold waves).
Dwellings with energy label A	<ul style="list-style-type: none"> - Describes the housing situation relatively well, providing a series of valuable information regarding energy poverty. -Its analysis is integral in efforts to understand and assess energy poverty. - It is of significant relevance for national assessments. 	<ul style="list-style-type: none"> -It leaves behind information on the worst performing buildings. - It needs additional indicators on the economic and social dimensions for an adequate energy poverty diagnosis. - It cannot accurately say whether the building's occupants are in energy poverty or not, for example, energy consumption may not cover energy needs or comfort preferences.
Final consumption expenditure of households	<ul style="list-style-type: none"> - It can help to identify potential affordability problems, if it is compared to the household's income. - Indicator disaggregation may show consumption inelasticity, highlighting the types and levels of consumption considered essential for families. - In combination with thermal comfort or energy efficiency indicators may disclose trade-offs in consumption preference that leads to energy poverty. 	<ul style="list-style-type: none"> -Low or high consumption expenditures do not necessarily point to energy poverty.
Population living dwelling with presence of leak dump and rot	<ul style="list-style-type: none"> - Indicator refers foremost to the consequences of poor construction practices of dwellings and humid indoor conditions. - It is a self-reported indicator, it is a consensual based indicator, it has a degree of subjectivity but it is a qualitative indicator. 	<ul style="list-style-type: none"> - May not be directly connected to situations of energy poverty but can also be a consequence of an inability to keep the house adequately warm. -It describes energy efficiency rather than energy poverty. -It requires corroboration with other indicators for an adequate description of energy poverty.
Population living dwelling equipped with heating facilities	<ul style="list-style-type: none"> - It can be an important indicator in diagnosing energy poverty, but it does not speak about the comfort of the residents or energy consumption. 	<ul style="list-style-type: none"> - The fact that a household owns equipment does not necessarily mean that they use it often or at all. - It need additional information such as space heating patterns, duration, schedule, and proportion of space heated, as well as the type of energy carrier, equipment age, and efficiency.
Population living dwelling equipped with air conditioning	<ul style="list-style-type: none"> -It can be an indicator, along with other indicators, to describe the capacity of households to cope with high or low temperatures without having access to electrical equipment intended for this purpose. - It is an informative indicator to assess energy poverty in summer based on access to air conditioners or other electrical equipment (simple fans are not taken into account). 	<ul style="list-style-type: none"> - Owning an air conditioner does not necessarily mean that household use it and not necessarily mean that household is being in energy poverty. A household might live in a region with mild summers where natural ventilation is enough.
Population considering their dwelling as too dark	<ul style="list-style-type: none"> - Indicator depicts self-perception of indoor light conditions, which depends on personal preference and culture. 	<ul style="list-style-type: none"> - It does not consider the underlying causes of the perceived lack of light, including building design, shading, and direction, which may not directly relate

		to energy poverty. - If connected to a lack of artificial light, it can be a symptom of an even deeper vulnerability.
Final energy consumption in households by energy use	-The indicator can be used to understand which type of energy use consumes more energy, helping to identify potential challenges in accessing specific energy services if compared to the national average or median consumption and in the light of income levels.	- The indicator can be in conjunction with others, such as self-reported thermal comfort indicators. Thus, low levels of energy services, especially space heating and cooling, may indicate a problem of energy poverty.
Final energy consumption in households by type of fuel	- The cost and efficiency of transformation vary according to the fuel type, impacting primary and final energy consumption per energy use.	-The dependency of households on expensive and inefficient fuels may create affordability and environmental problems, increasing vulnerability to energy poverty. -It need additional indicators such as regional-specific aspects in fuel access conditions and cultural fuel use.
Population who cannot afford a regular use of public transport	- This indicator addresses the financial barriers to accessing public transportation, a relevant determinant of transport energy poverty.	- It overlooks other transportation-related factors like service quality and availability. - It needs to be combine with indicators reflecting domestic hardship, inability to heat, analysing energy expenditure or housing costs.
Arrears on utility bills	-Is a simple yes/no-question to clear the meaning of this indicator. - The indicator takes into account the total number of households and the total income situation. -The indicator aims to record financial difficulties for which there are arrears.	- The indicator does not clarify the reason why invoices are not paid on time. - It does not cover situations where households need to borrow money to cover their bills on time or catch energy limiting behavior.
At risk of poverty or social exclusion	-The indicator may primarily capture poverty in general.	- It need additional information about the impact assessments of energy-related social policies.
Disposable annual household income	-The indicator is an effective tool for assessing the economic well-being of EU households and identifying locations at risk of energy poverty due to low disposable income levels.	- It cannot fully reflect the complexities of energy poverty and should be complemented with additional variables relating to energy use, efficiency, and specific energy-related expenses.
Housing cost overburden rate	-The indicator is valuable for measuring housing affordability. Increases in housing costs can affect access to energy services.	- It doesn't provide information about housing quality and energy efficiency. -Increases in housing costs can also result from household decisions without sacrificing other essential needs. -It should be supplemented with indicators related to energy consumption, affordability, or thermal comfort.
Inability to keep home adequately warm	-This indicator is subjective, qualitative and refers to an individual's perception of 'adequately', which may differ from one country to another or between age groups, etc.	-The indicator only refers to the warmth and does not cover summer energy poverty. -The indicator does not provide information on the causes for the inability. - It should be considered together with other indicators, such as energy expenditures, to identify potential causes.
Population living in dwellings comfortably cool in summer time	-Summer energy poverty is an increasing concern in the EU. It might be useful for a comprehensive understanding of summer energy poverty vulnerabilities.	- It needs information about the ownership of cooling systems and space cooling energy consumption patterns.
Population living in dwellings comfortably cool in winter time	- It is a subjective indicator, the winter energy poverty is an increasing concern in some EU countries, and it might be useful for a comprehensive understanding of winter energy poverty vulnerabilities.	-The self-reporting of thermal comfort is influenced by a series of factors for consensual-based indicators such as gender, age, socioeconomic situation, culture, and social practices, which justify various possible results both within one- and across countries.
Energy expenditure by income quintile	-Describes the economic dimension of energy poverty, more precisely the financial burden of energy services for households. -Income is important for energy consumption and takes into account the distribution of income across income quintiles.	- The indicator has arguable effectiveness because it does not provide information on the level of energy consumption that determines the expenses or the energy uses.
Energy prices	-It is a clear, quantitative indicator that links energy poverty to the cost of energy.	-The quality of the product and the share of freely or illegally sourced biomass products can significantly impact energy poverty levels, especially in rural regions, and therefore should be considered in diagnosis assessment. - It is important to have information about all types

		of prices (for gas, electricity, oil, biomass, etc.) and the technologies available at regional or local level.
High share of energy expenditure in income (2M)	<ul style="list-style-type: none"> - The indicator describes the percentage of people living in households whose share of expenditure on residential energy in the household's equivalised disposable income is more than two times higher than the national median share of residential energy in equivalised disposable income. -A indicator which identify the proportion of budget spent on the energy bills in a household. 	<ul style="list-style-type: none"> -It is based on national income levels and it is hard to use as a standalone indicator for comparing energy poverty levels in different Member States. -It does not capture underconsumption cases so it can be more informative to read it together with the indicator "Low absolute energy expenditure (M/2).
Low absolute energy expenditure (M/2)	<ul style="list-style-type: none"> -It shows the percentage of persons living in households whose expenditure on residential energy is more than 2 times lower than the national median expenditure on residential energy. -The indicator measures energy expenditure, capturing the economic dimension in each Member State, specifically cases of underspending. 	<ul style="list-style-type: none"> -It leaves out details such as energy efficiency, conditions of households, and climate variability. It can be useful to read it together with the indicator 'High share of energy expenditure in income (2M)' to also capture abnormally high energy expenditures.
Causes of death	<ul style="list-style-type: none"> -It can capture some effect of energy poverty. -Analyzed jointly with the "Population reporting chronic disease", the indicator can identify potential contributing factors and their relationship with energy poverty. 	<ul style="list-style-type: none"> -But the cause of death can be determined by a diversity of factors. By identifying the main cause, this indicator does not reflect all the risk factors contributing to mortality. - Variations in medical diagnosis may result in unequal reporting across regions or countries.
Excess winter mortality/deaths	<ul style="list-style-type: none"> - It may reflect energy poverty if the indicator is analyzed together with others related to building energy efficiency, income levels, energy expenditure, population density, material deprivation, or access to medical services. 	<ul style="list-style-type: none"> - It cannot be taken into account individually, as this could lead to misinterpretations.
Population reporting a chronic disease	<ul style="list-style-type: none"> -Chronic diseases can be either a symptom or a cause of energy poverty. - It needs a wider set of indicators and a robust analysis is needed to investigate this possibility. 	<ul style="list-style-type: none"> - Due to their complexity and multicausality, it is challenging to draw a connection between their occurrence and energy poverty vulnerability. -Relying solely on self-reports may also not fully represent the prevalence of such illnesses within a population.

Source: European Commission (2022), EPAH site, author systematization.

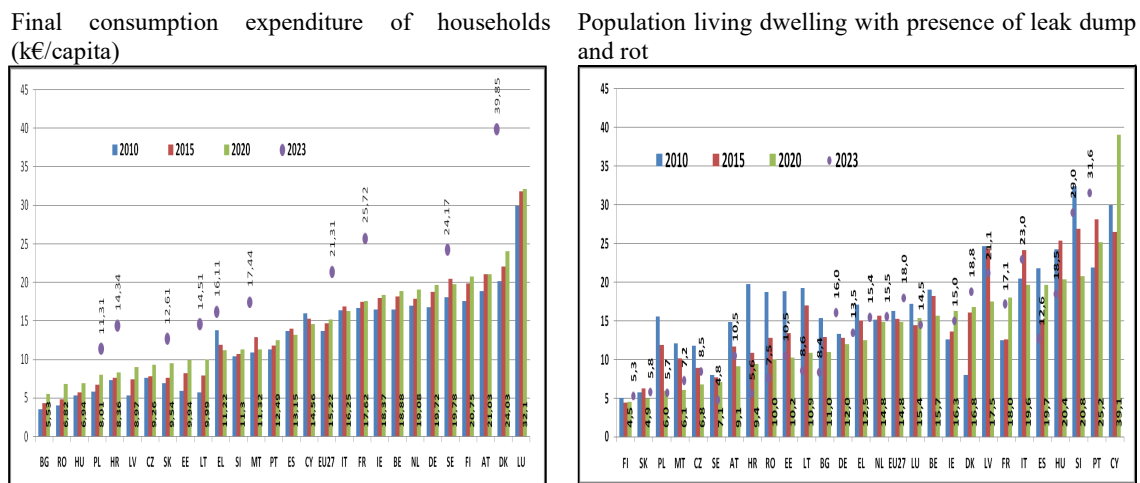
In general, all subsections: Climate, Building stock, Energy consumption and equipment, Mobility, Social, economic and living conditions, Energy expenditure and energy markets, Health, have extremely valuable indicators that describe energy poverty relatively adequately, but choosing just one or a few can prove difficult. From the description above, although there is a recurring indicator (e.g. Final consumption expenditure of households), we can conclude that all the indicators analyzed cannot be viewed individually as the most representative to describe, by themselves, energy poverty. Thus, all EPAH indicators can only constitute an overall picture together. Taken individually, or without even the slightest form of grouping to complete them, the indicators cannot fully describe what energy poverty means.

In addition, it must be said that they require permanent revisions and additional searches to find better, more synthetic ways of rendering energy poverty at the level of EU countries. Among the preferred indicators, some of them also found within the Eurostat indicators. For graphic rendering of energy poverty it has been chosen: Final consumption expenditure of households (Expenditure-based, quantitative indicator), Population living dwelling with presence of leak dump and rot (subjective, qualitative indicator), Arrears on utility bills (subjective, qualitative indicator), Income-based indicator inability to keep home warm (IKHW) (subjective, qualitative indicator), High share of income on energy expenditure (2M) (Expenditure-based, quantitative indicator), Low absolute energy expenditure (M/2) (Expenditure-based, hidden energy poverty, quantitative indicator).

If we look at some of the selected indicators, we observe some worrying trends in recent times. Thus, the final energy consumption of households increased substantially after 2020, with 2023 marking huge increases for some countries compared to 2020, the year of the outbreak of COVID-19. This may indicate in itself that 2020 was an exceptional year, with abnormal values, with probably self-imposed restrictions against the background of uncertainty about the future. At the same time, although we could consider it normal for the countries of the north-west of the continent to have increases in household spending against the background of a more severe climate compared to its south and east, nevertheless, the countries of the Eastern EU27 (e.g. Bulgaria, Romania, Hungary, Poland, Croatia) could still be marked by a restricted consumption possibly self-imposed and against the background of much lower wage and other earnings than the western countries. This indicator can also be corroborated with that of the population living in inappropriate conditions (mold, leaks, etc.).

The indicator Population living in homes with dump, leaks and rot, indicating the southwest of the continent countries, such as Portugal, Cyprus, Slovenia, Hungary, Spain, Italy and France, as being in the top of countries with serious problems with this indicator. At the same time, taking into account the available data, if we analyze the indicator over time, if we compare the year 2020 with 2010 and the year 2023 with the year 2020, we observe a deterioration of the overall situation, the number of countries recording problems increasing to 14 in 2023 compared to 2020 from 5 countries (comparing the year 2020 with the year 2010).

Figure No. 1. Final consumption expenditure of households and Population living dwelling with presence of leak, dump and rot and in EU27 in 2010, 2015, 2020 and 2023



Source: EPAH indicators, author's processing and conception

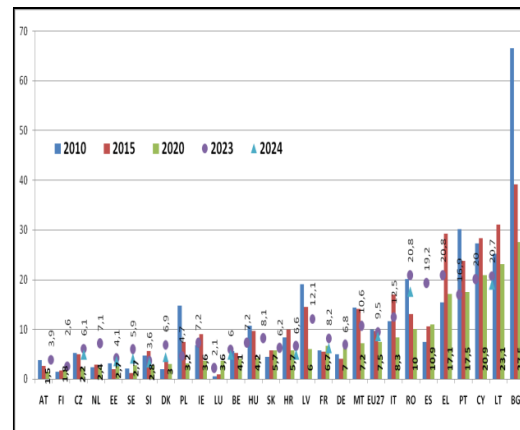
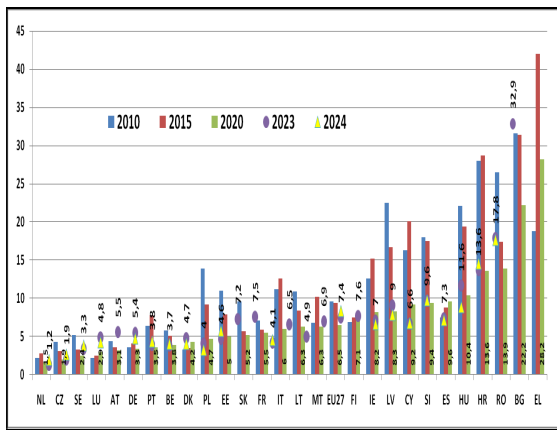
If we analyze the indicator on arrears in payment of bills, we observe that Greece, Bulgaria, Romania, Croatia, Hungary, Spain and Slovenia have the most problems, and for the indicator there is also a deterioration in the values of the indicator over time, the number of countries with higher values of the indicator in 2023 compared to 2020 increasing to 11 compared to 5 (when we look at 2020 in report to 2010). Equally, regarding the indicator Inability to keep the home warm enough - Total (% of households) we observe that countries

such as Bulgaria, Lithuania, Cyprus, Portugal, Greece, Spain and Romania also have very high values compared to the other EU27 states. At the same time, the indicator registered a dramatic increase in 2023 compared to 2020, with over 20 countries registering a dramatic deterioration of the indicator.

Figure No. 2. Arrears on utility bills (subjective, qualitative indicator) and Inability to keep home warm (IKHW) in EU27 in 2010, 2015, 2020, 2023 and 2024

Arrears on utility bills - No disaggregation
(% of households)

Inability to keep home adequately warm - Total (%
of households)



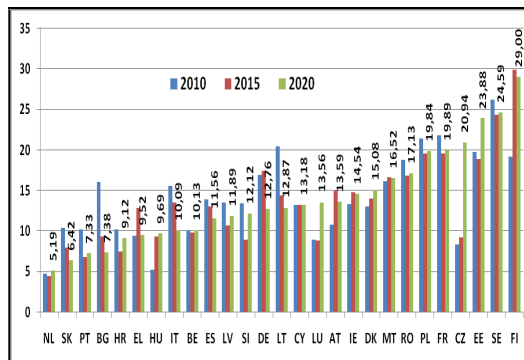
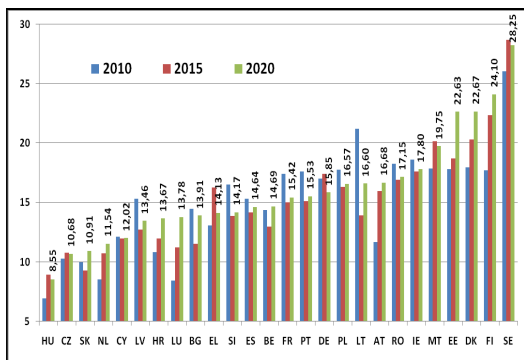
Source: EPAH indicators, author's processing and conception

If we analyze the indicators High share of energy expenditure in income (2M)(% of households) and Low absolute energy expenditure M/2 (% of households), we notice that the top seven for the first indicator are: Sweden, Finland, Denmark, Estonia, Malta, Ireland and Romania, and for the second, the top seven are: Finland, Sweden, Estonia, Czech Republic, France, Poland and Romania.

Figure no. 3. High share of energy expenditure in income (2M) and Low absolute energy expenditure (M/2) in EU27 in 2010, 2015, 2020

High share of energy expenditure in income (2M)(%
of households)

Low absolute energy expenditure M/2 (% of
households)



Source: EPAH indicators, author's processing and conception

These two indicators suggest that not only some Nordic countries have problems with excessive energy costs, but also countries on the eastern and southern flank of the EU27, some of which are also confirmed among countries with extremely low energy expenditure, demonstrating energy self-restraint. Equally, both indicators demonstrate deterioration in energy poverty over time, with over half of the countries recording increases in 2020 compared to 2010.

6. Conclusions

Energy poverty is an issue that is increasingly being considered in academia, but also in the mainstream media. It draws attention to the living conditions and well-being of the population. Thus, the article critically analyzes the energy poverty indicators formulated by the Energy Poverty Advisory Hub (EPAH), noting that most of them cannot be viewed individually but analyzed within a larger group of indicators, so that they corroborate the information accordingly. If we refer to the data of these indicators, in recent years, in general, a deterioration of their situation has been recorded at the level of all Member States, with energy poverty increasing. At the same time, the countries in the East and South of the EU27 seem to be particularly marked by this phenomenon, requiring public, local and governmental authorities to pay special attention to counteracting the causes and finding the best long-term solutions.

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THE ROLE OF DIGITALIZATION AND WAYS TO ACCELERATE THE IMPLEMENTATION OF THE CIRCULAR ECONOMY

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***Abstract:** The study analyzes the impact of implementing digitalization in the circular economy, its ability to integrate and capitalize on digital technologies, and through these tools the circular model is refined and innovated. The fact that the circular economy brings so many benefits: reducing the consumption of natural resources by regenerating and reusing materials, reducing pollution by reducing waste, and extending product use cycles. The integration of emerging digital technologies into the circular economy can improve the efficiency and sustainability of the circular model. By using advanced technologies, such as the Internet of Things (IoT), big data, artificial intelligence, and blockchain, the state of materials and products can be tracked in real time, which allows it to reduce pollution risks and improve recycling and reuse processes. Digitalization also facilitates collaboration between different entities of the economic ecosystem, thus promoting an exchange of information essential for the implementation of a circular model. The study examines digital transformation within the circular economy, which can significantly reduce costs, improve operational efficiency and support innovations that contribute to the development of greener and more economical solutions. Thus, we can say that the integration of these two areas, the circular economy and digitalization, is essential to support the transition to a more sustainable and resource-efficient future.*

***Keywords:** digitalization, circular economy, inclusive economic growth, digital technologies, benefits*

***JEL Classification:** O32, O33.*

1. Introduction

The circular economy (CE) is an economic model that aims to optimize resource consumption, reduce waste and promote a continuous cycle of reuse, repair, reuse and recycling of products and materials (Kirchherr et al., 2017). The circular economy is a regenerative economy, its operation is based on keeping materials in use for as long as possible, thus increasing the lifespan of products and on the other hand reducing waste and pollution (Ellen MacArthur Foundation, 2013). The circular economy has ten 10 R principles also called strategies, which include: reject, rethink, reduce, repair, remanufacture, reuse, reorient, recycle and end-of-life recovery, which are seen as operationalization principles of CE (Reike et al., 2018).

Currently, digital technologies are seen as accelerators of the circular economy, becoming essential factors in social development. These technologies, through the combination of cyber systems, Big Data, artificial intelligence (AI), blockchain and the Internet of Things (IoT) can support circular models in multiple ways: from the use of a large number of data that lead to knowledge of the natural and economic environment, to improving the use of materials and materials used, logistics and the manufacture of smart products, to the sharing of services or, through rental, of products.

The collective and responsible use of circular models facilitated by digital technologies can support environmental protection by optimizing resource use and reducing waste (Radu, 2023).

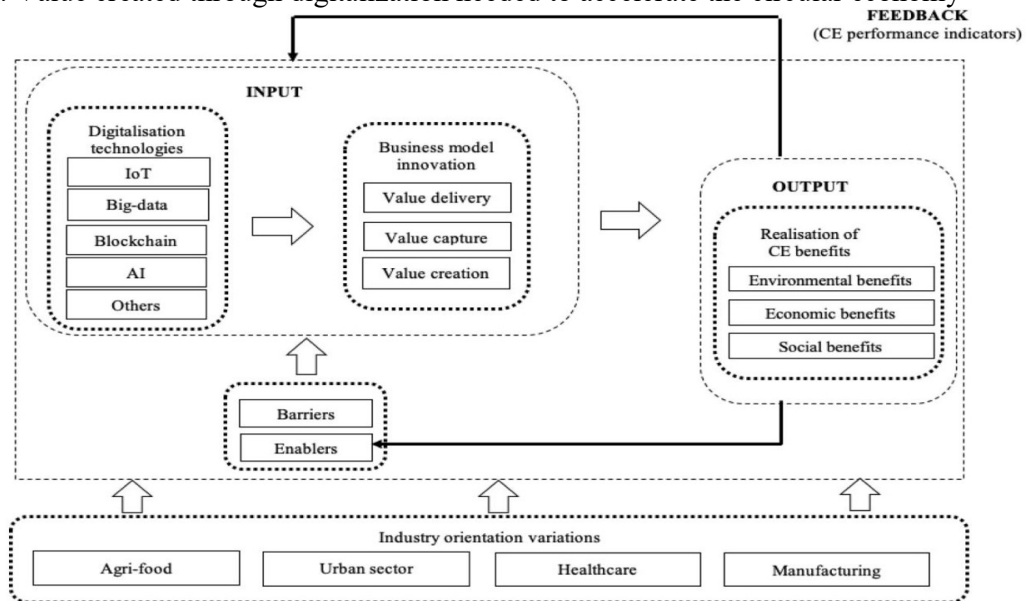
Implementing circular models facilitated by digital technologies can contribute to achieving the United Nations Sustainable Development Goal No. 8, which aims to promote inclusive and sustainable economic growth, full and productive employment and decent work for all. The use of digital technologies also promotes social inclusion by creating economic

opportunities for diverse groups, including through the development of digital skills and access to new forms of work.

Literature review

In the literature, studies on the connection between digital technologies and EC (Chauhan et al., 2019), (Bag et al., 2021) and (Ma et al., 2020), highlight its benefits, due to the possibility of using a very large number of data, at a fast pace and safely (Kristoffersen et al., 2020). Mobile applications dedicated to collaborative consumption, such as Vinted and Too Good To Go, contribute to promoting sustainability, supporting EC strategies by maintaining resources in a closed system (Del Mar Alonso-Almeida et al., 2020). Thus, the integration of advanced digital technologies into organizational processes can also create a competitive advantage (Ellen MacArthur Foundation, 2012), and innovations in business models and circular economies can create not only economic value, but also social and environmental value, by creating, providing and capturing value, significantly contributing to the sustainable development of the company and society (Boons et al., 2013), (Mentink B. 2014) (Figure 1).

Figure 1: Value created through digitalization needed to accelerate the circular economy



Sursa: Chetna et al., 2022)

Thus, we can say that these digital technologies can transform theoretical CE principles into feasible and practical activities (Antikainen et al., 2018; Garcia-Muina et al., 2018a; Kintscher et al., 2020). The application of these technologies can complement the skills and capabilities of those working with circular models and facilitate circularity-based decision-making (Mboli et al., 2020). To support the transition to a more efficient and sustainable circular economy model, it is necessary to focus on reducing carbon emissions and using resources in a responsible way. This not only contributes to a cleaner environment, but also promotes a fairer and more resilient economy.

2. The link between circular economy strategies and digital technologies

Circular economy actions facilitate more efficient use of raw materials and materials used in production, including the following types of C.E. strategies: rejection, rethinking and reduction, and refer to Rejection of redundant product by abandoning its function or offering the same function with a different product, More intensive use of products (for example, by sharing products or by marketing multifunctional products), Increasing efficiency in the manufacture or use of products by reducing consumption of natural and material resources.

Another CE action includes the strategies of reuse, repair, remanufacture, re-use, including the reuse by another consumer of an end-of-life product that is still in good condition and fulfills its original function, the repair and maintenance of the defective product so that it can be used with its original function, the restoration of an old product and its updating, the use of parts of a defective product in a new product with the same function, the use of an end-of-life product or its component parts and their use in a new product with a different function (Table 1).

Table 1: Circular economy strategies

Categories of circular activities	Circular economy strategies	Name of the circular economy strategy	Circular economy activities
Category 1: Efficient use of raw materials and materials used in production	R1	Refuse	Rejection refers to making a product redundant by giving up the function it provides
	R2	Rethink	Repurposing refers to increasing the use of a product, for example, by sharing the product
Category 2: Extending the life of the product and its components	R3	Reduce	Reduction refers to increasing the efficiency in the production or use of the product, consuming fewer natural resources
	R4	Reuse	Reuse by another consumer of a discarded product that is still in good condition and fulfills its original function
	R5	Repair	Repairing and maintaining a defective product so that it can be used with its original function
	R6	Refurbishment	Refurbishing an old product and upgrading it
	R7	Remanufacturing	Using parts of a defective product in a new product with the same function

	R8	Reuse	Using a discontinued product or its component parts and using them in a new product with a different function
Categoria 3: Utilizarea optimă a materialelor considerate deșeuri	R9	Recycling	Processing of materials to obtain the same (high quality) or lower (low quality) quality.
	R10	Recovery	Incineration of material with energy recovery

Source: author's conception

As we have shown above, in practice, the implementation of the circular model is based on 10 strategies (10R), which can be classified according to different categories of circularity actions and objectives. On the vertical axis, there are different actions for a product or system, and on the horizontal axis are the different objectives of implementing the circular economy through its strategies (Figure 2).

Figure 2: Classification of R principles

Product-system	Resell/Reuse Repair Remanufacture	Refurbish Remanufacture	Repurpose Remanufacture
Component	Repair Remanufacture Reuse	Remanufacture	Repurpose
Raw materials	Recycle	Recycle	Recycle Recover
	Original function	Upgraded, original function	Different function

Source: post-processing (Potting et al., 2017)

Digital technologies such as Big Data, Artificial Intelligence (AI), Blockchain and the Internet of Things (IoT) can support the circular economy in several ways.

Big Data or data analytics can help track the flow of materials, identify consumption patterns and detect opportunities to recycle or reuse resources. This can contribute to creating more efficient and sustainable business models. Big data and CE Big data plays an important role in facilitating the acquisition of the desired information for decision-making. Thus, companies take an active role in creating new databases that include them and new ones. Previously overlooked data sets, such as weather conditions, changing economic conditions, are accessed by third-party providers and used to create company-specific decision-making

models. Integrating big data and large-scale group decision-making can promote circularity by addressing various problems of the linear economy, as it integrates different aspects of CE through interactions with stakeholders. For example, Big Data facilitates the application of techniques such as cluster analysis and reduces the weight of the decision-making process.

Artificial Intelligence (AI) can optimize production and recycling processes, providing intelligent solutions for resource management and waste reduction. It can also facilitate the design of products that are easier to repair, reuse or recycle.

Blockchain technology can create a transparent and secure system for tracking materials and products throughout their entire life cycle. Blockchain can help verify the provenance of resources, ensure the integrity of supply chains and facilitate the exchange of recycled products.

Internet of Things (IoT): IoT can connect physical objects to the internet and monitor their conditions in real time. This can support waste management, energy efficiency and resource reuse by collecting and analyzing data on energy consumption, product maintenance conditions, etc.

Blockchain is an information storage and transmission technology that is based on the principle of distribution and security.

The impact of digital technologies on CBM elements can be found in (Table 2).

Table 2: Impact of digital technologies on CBM elements

Adoption of digital technologies	CBM – Value Creation
Adoption of IoT	Sustainable Products
Distributed manufacturing	Satisfying Green Customer Demand
Knowledge generation from Information technology and communication technology	Robust Products and Services
Digital technologies combined with each other	Slowing, Narrowing and Closing Resource Flows
Eco-design tools enabled digitalization	Sustainable and Efficient Products
Blockchain adoption	Improved Product Design
Fintech innovations	Preventive and Predictive Maintenance

Source: adapted from Chauhan, C., Parida, V., & Dhir, A. (2022)

Combined, these technologies can revolutionize circular economy processes, improving their efficiency, transparency and sustainability. Furthermore, they can support the development of new business models that promote innovation in resource management and reduce environmental impact.

3. Barriers to the adoption of digital technologies to accelerate the implementation of the Circular Economy (CE)

The digitalization of the European Union (EU) faces multiple challenges that hinder the uniform progress of the Member States. The barriers identified to date are: Organizational and

technological barriers, Strategic and psychological barriers, Political and regulatory barriers, Cultural and educational barriers. There are various barriers to the implementation of the digitalization of the circular economy, the most significant of which are:

1. Organizational and technological barriers

Lack of structured data management processes and difficulties in developing IoT-compatible products. Among the main barriers identified is the lack of an efficient IT architecture in the public sector. It has been found that many public institutions do not have adequate IT systems to provide efficient electronic public services, which affects the quality and accessibility and performance of digital solutions, such as predictive models for waste management. There is also an insufficient number of qualified personnel in the field of information technologies in the public sector, which makes it difficult to develop and maintain digital services and very high costs associated with the adoption of technologies such as big data.

2. Strategic and psychological barriers

Technological and strategic barriers are considered the most important in terms of adopting a data-driven supply chain in the circular economy.

The lack of predictability that characterizes the impact that emerging technologies, especially those implemented in the circular economy, can create uncertainties for investors and organizations that want to implement digital solutions.

Also, changing the behavior of consumers and those involved in economic processes can be a challenge, especially in the context in which the adoption of new technologies sometimes requires a considerable effort on their part.

Information vulnerability is another barrier in a digitalized system. There are security and privacy risks, and protecting sensitive information is a particularly important aspect.

3. Political and regulatory barriers

Political and regulatory barriers refer to legislative changes and regulations can delay the adoption of innovative technologies. The lack of government impetus blocks the implementation of advanced digital applications, and the absence of a clear and stable legislative framework can be an obstacle to the implementation of new technologies. In addition, the existence of shortcomings in the collection of data related to material flows and other operational phases prevents decision-makers from creating effective policies. For example, Japan has difficulty differentiating between the traditional “3Rs” and modern CE, due to the lack of clarity in public policies. Regulatory complexity and excessive bureaucracy can also be barriers to the implementation of digital technologies in the EC. Complicated regulations and bureaucratic procedures can discourage investment in technology and slow down the digitalization process. To address these challenges, the European Commission launched the “Roadmap to the Digital Decade”, setting clear objectives for 2030 in the areas of digital skills, infrastructure, enterprise digitization and online public services. This program aims to harmonize digital policies at EU and Member State level, reducing market fragmentation and stimulating investment in technology.

As for the European digital market, it is characterised by high barriers to entry and a low number of vertically integrated players, which limits competition and innovation.

4. Cultural and educational barriers

The lack of environmental education and the absence of a strong culture of resource conservation are major barriers to the adoption and implementation of circular economy (CE) principles. These shortcomings, together with low market pressure — whether from consumers or other economic actors — hinder progress towards the digital transition towards a sustainable economic model. These structural obstacles hold back the transformations needed to integrate digital technologies in support of circularity, underlining the need for a systemic approach that includes education, public awareness and policies to stimulate demand for sustainable solutions.

4. Results of implementing digitalisation in the CE

Circular models have a beneficial and important role in transforming technology, the economy and the environment. From the specialized literature, we can say that the impact of digitalization on CE is found in the way it enables and emphasizes the introduction of circular business models (CBM), as well as in the transformation into product service systems (PSS) (Table 3).

Table 3: Value capture due to the impact of digital technologies on CBM elements

CBM- Value Capture
Easy Tracking and Monitoring
Reducing Costs
Reduced Transportation
Reuse and Recycle Attract Additional Customers
Robust Decision Making in the Design Phase
Increased Efficiency
Attract Target Customers
Increased Competitiveness
Increased Control over Products and Systems through End of Life
Decision Support
Avoid Barriers to CBM Adoption
Cost and Cash Flow Savings

Source: adapted from Chauhan, C., Parida, V., & Dhir, A. (2022)

Thus, according to scientific studies, the Internet of Things (IoT) and artificial intelligence (AI) are considered to be key factors in the implementation and acceleration of the circular economy. The article proposes a framework that integrates these emerging technologies and highlights the interconnections between research streams and proposed solutions for achieving a circular economy. This framework provides a unified vision on how digitalization can transform the circular economy, proposing new perspectives on the advantages and implementation of this model.

5. Conclusions

Digitalization plays a key role in driving inclusive economic growth by harnessing technological advances to bridge gaps in accessibility, participation and long-term value creation.

Digital technologies, such as IoT, enable real-time monitoring and management of products, facilitating the tracking of material flows and the optimization of recycling

processes. For example, through connected sensors, IoT can help identify exactly when a product reaches the end of its life cycle, thus allowing it to be recycled or reused efficiently.

AI can improve decision-making in resource management and the optimization of waste streams, through data-driven predictions and recommendations. AI can also support the design of products that are easier to recycle, repair or reuse, creating a more sustainable cycle.

In this regard, the article not only highlights the barriers and challenges, but also provides a clear framework for the digitalization of the circular economy. This can become a guide for future research and practical implementations, bringing benefits not only in terms of sustainability, but also in economic efficiency and business model innovation. Going forward, it will be essential for research to address the political and social challenges related to digitalization and explore new ways to integrate emerging technologies within a circular framework.

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COMPREHENSIVE ASSESSMENT OF THE COMPETITIVENESS OF COMPANIES PROVIDING FREIGHT TRANSPORTATION SERVICES IN THE REPUBLIC OF MOLDOVA

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Abstract: *The article provides a comprehensive assessment of the competitiveness of companies offering freight transportation services in the Republic of Moldova, highlighting the importance of this sector for national economic development. An analysis of existing methodological approaches to competitiveness assessment was conducted, and the most appropriate methodology for the industry was identified, based on the composite index proposed by N. Penishin. This index incorporates key coefficients, including service liquidity, quality, profitability, diversity of transport services, and resource availability. Applying this methodology, the competitiveness of six Moldovan freight transport companies was evaluated for 2022 and 2023. The results revealed considerable variation in the competitive positions of the companies analysed, with liquidity and profitability coefficients exerting the greatest influence on the composite index. However, limitations of the current formula were identified, as some components were deemed insufficiently informative and practical. Consequently, it is recommended that the composition of the composite index be revised to enhance the accuracy and objectivity of competitiveness assessments. The findings may be used to support strategic decision-making aimed at improving efficiency and strengthening competitive advantages within the freight transportation sector.*

Keywords: *competitiveness, freight transportation, composite index, assessment methodology, transport companies.*

Jel Classification: *L91, R41.*

1. Introduction

Given the geographical conditions of the Republic of Moldova, road freight transport constitutes a vital infrastructural component of the national economy. The potential of the national transport sector determines the country's capacity for effective economic development and growth, while the competitiveness of companies within this sector serves as a key indicator of scientific advancement and overall progress (Gheorghita and Sestenco-Diacek, 2025).

Enhancing competitiveness is a primary objective for any company operating within a market economy, as it enables firms to secure a greater market share and increased profitability. In an environment of intensifying competition – driven by both domestic and international factors – effective assessment of competitiveness allows companies to analyze their market position relative to rivals, identify internal weaknesses, and develop strategic measures to improve efficiency and gain a competitive advantage.

To manage competitiveness effectively and implement timely enhancement strategies, managers must have access to appropriate evaluation and analytical tools. As these assessments directly influence the quality and effectiveness of managerial decision-making, identifying robust methodological approaches for evaluating freight transport companies is a highly relevant and timely issue for expanding their future development potential.

2. Materials and methods

2.1. Methodological approaches for assessing the competitiveness of transport companies: a literature review.

Various methodological approaches exist for evaluating company competitiveness. While Klyueva Yu. (Klyueva, 2017) classifies these methods into graphical and analytical groups, others scholars (Abolentseva N., Vinogradova T., Semiletova Ya.) extend this classification to include three categories: graphical, matrix-based, and calculation-analytical (Abolentseva, 2008; Vinogradova and Semiletova, 2016).

A third group of researchers (Zhuran E., Grintsevich L., Mogilya S.) proposes categorising competitiveness assessment methods into four groups: matrix methods; methods based on the evaluation of a company's products or services; methods grounded in the theory of effective competition; and comprehensive methods (Zhuran, 2011; Grintsevich, 2021; Moghildea, 2023). Krivorotov V., Tarasenko A., Tikhanov E., and Chepur P. expand upon these classifications by including graphical methods, such as the competitiveness polygon and various matrix approaches (Krivorotov et al., 2018). Consequently, an analysis of the literature reveals a wide variety of assessment methods; however, ensuring an accurate evaluation requires consideration of the specific characteristics of the industry.

Considering the specific characteristics of transport companies, the methods proposed by N. Penishin merit special attention (Penishin, 2010). The author suggests determining a transport company's competitiveness using a composite index (K_0), calculated as the average of various coefficients according to the following formula:

(1)

where:

- K_{SD} - supply and demand coefficient;
- K_R - service quality coefficient;
- K_P - profitability coefficient (ratio of income to expenses);
- K_D - service diversity coefficient (number of transport service types provided by the company);
- K_R - resources coefficient (availability of the production and technical base and rolling stock);
- n - total number of indicators.

A similar methodology is adopted by Y. Pogorelitseva (Pogorelitseva, 2015). Meanwhile, V. Timiriyanova (Timiriyanova, 2010). It proposes evaluating the competitiveness of service providers, including those in the transportation sector, using the following formula:

$$K = Y_1p_1 + Y_2p_2 + \dots + Y_m p_m \quad (2)$$

where:

- K – competitiveness index;
- Y_i – component of the index K ;
- p_i – weight of the component (its significance in index formation).

Timiriyanova suggests evaluating the competitiveness of freight carriers using a set of parameters, including delivery speed, cargo security, service regularity, accessibility, safety,

environmental impact, and cost-effectiveness. The framework also considers demand fulfillment at both the points of origin and destination, as well as price elasticity. Consequently, the formula primarily emphasizes the customer's perspective on service quality and pricing, while neglecting the internal interests of the transport enterprise. The methodology proposed by A. Mottaeva (Mottaeva, 2017) involves measuring the competitiveness of road transport companies using a total competitiveness index:

$$C_{MTE} = CTS \cdot X_1 + II \cdot X_2 + IMS \cdot X_3 + IOF \cdot X_4 \quad (3)$$

where:

- C_{MTE} - composite competitiveness index of the road transport enterprise, $C_{MTE} \in (0,1]$;
- CTS - competitiveness index of the transport service based on the market model;
- II - enterprise image indicator;
- IMS - market share indicator;
- IOF - indicator of fulfilled obligations;
- X_i - weight of the coefficient corresponding to the i-th evaluation indicator.

According to Belozertseva N. and Yaraikina M. (Belozertseva and Yaraikina, 2013), the aforementioned methodologies employ overly complex criteria and pay insufficient attention to service quality from the consumer's perspective. Consequently, they proposed the following methodology for assessing the competitiveness of freight-forwarding companies and logistics operators:

$$R = \frac{D+L+P+S}{4} \quad (4)$$

where:

- R - competitiveness rating (index);
- D - consumer preference criterion;
- L - logistics service complexity (comprehensiveness) criterion;
- P - company's market position criterion;
- S - customer satisfaction criterion.

The factors influencing an enterprise's competitiveness are reflected in corresponding indicators. However, as Penishin notes, "it is practically impossible to account for the entire range of indicators used to evaluate the competitiveness of motor transport enterprises" (Penishin, 2010).

A key requirement for assessing competitiveness is quantitative definiteness, which enables the comparison of both quantitative and qualitative characteristics. For example, a group of authors suggests that when determining the competitiveness level of a transport enterprise, one should consider not only the price and quality of services provided but also the volume of transportation. In our view, this indicator reflects the level of customer demand for services.

2.2 Selected methodology for assessment of the competitiveness of road freight transport enterprises in the Republic of Moldova.

The diversity of approaches to assessing the competitiveness of a transport enterprise stems from the multifaceted nature of this phenomenon, which encompasses economic, technical, organizational, and social dimensions.

Based on our analysis, a strong set of indicators for measuring a trucking company's competitiveness should follow these key principles:

- **Comprehensiveness** – covers the most important factors that drive competitive success.
- **Data accessibility** – relies on information that is readily available and cost-effective to obtain.
- **Computational practicality** – uses straightforward calculations so that managers can conduct their own assessments.
- **Efficiency** – minimizes the time required to compile and analyse the data.
- **Commensurability** – allows for easy comparison between different indicators without the need for complex conversions.

Considering these principles, the methodology proposed by Penishin N. (Penishin, 2010) for assessing the competitiveness of transport enterprises engaged in freight road transport appears to be the most appropriate. This methodology is particularly relevant for application in the freight transport market of the Republic of Moldova.

This method is based on calculating the integrated competitiveness index for the transport company (K_o).

In the formula for calculating the integrated competitiveness index (K_o), Penishin replaced the coefficients of supply and demand, income, and expenses with the average values of service liquidity and profitability. Thus, the formula for determining the integrated competitiveness index of the transport company (K_o) is expressed as follows:

$$K_o = \frac{K_L + K_R + K_P + K_D + K_R}{n} \quad (5)$$

where:

- K_L - service liquidity coefficient;
- K_R - service quality coefficient;
- K_P - profitability coefficient;
- K_D - service diversity coefficient (number of transport service types provided by the company);
- K_R - resources coefficient (availability of the production-technical base and rolling stock);
- n - total number of indicators.

Below are the formulas for calculating these coefficients.

The **service liquidity coefficient** is calculated using the following formula:

$$K_L = \frac{A_C}{L_C} \cdot 100\% \quad (6)$$

where:

- A_C - current assets, MDL;
- L_C - short-term liabilities, MDL.

The return on assets (ROA) is used as the **profitability coefficient** and is calculated using the following formula:

$$K_P = \frac{P_b}{C_a} \cdot 100\% \quad (7)$$

where:

- P_b - book profit of the enterprise, MDL;
- C_a - value of the enterprise's assets, MDL.

To determine the **service quality coefficient** of road freight operations, it is essential to consider actual transport volumes, the willingness of service users to adhere to schedules, and the capacity of enterprises to organize shipments in the agreed quantities. Consequently, the overall coefficient reflecting transportation quality is calculated using the following formula:

$$K_K = \frac{K_s + K_{ts}}{2} \quad (8)$$

where:

- K_s - level of vehicles specialization;
- K_{ts} - on-time delivery level.

The **level of vehicle specialization** is defined as the proportion of specialised vehicles (dump trucks, refrigerated trucks, container trucks, tankers) to the total number of freight vehicles, calculated using the following formula:

$$K_s = \frac{As}{A} \cdot 100\% \quad (9)$$

where:

- As - number of specialized motor vehicles, units;
- A - total number of freight vehicles, units.

The **on-time delivery level**, a key indicator of service quality, is defined as the ratio of actual shipments completed according to schedule to the total volume agreed upon in contractual obligations. This metric serves as a quality coefficient reflecting customer satisfaction with the enterprise's operations and is calculated using the following formula:

$$K_{ts} = \frac{Q_{gr}}{Q_{agreed}} \cdot 100\% \quad (10)$$

where:

- Q_{gr} – actual volume of transportation performed on schedule, tons;
- Q_{agreed} – agreed and approved volume of transportation, tons.

The **profitability coefficient** (K_p), which reflects the relationship between income and expenses, enables an evaluation of a company's financial efficiency and operational performance. It can be calculated using the following formula:

$$K_p = \frac{I/E}{1.3} \quad (11)$$

where:

- I - enterprise income for a given period, MDL;
- E - enterprise expenses for the same period, MDL;
- 1.3 - threshold income-to-expense ratio corresponding to $K_p = 1$.

To calculate the competitiveness ratio based on the number of transportation types (service diversity coefficient) and services offered by a motor transport enterprise (K_D), the current state of the transport services market is considered. A maximum competitiveness ratio of $K_D=1$ is assigned to enterprises providing three or more types of transportation services. For enterprises offering two types of transportation, the coefficient is reduced to $K_D=0.8$. When only one type of transportation service is offered, the coefficient decreases further to $K_D=0.6$.

The resources competitiveness coefficient of a transport enterprise (K_R) is calculated as the ratio of the active part of fixed production assets (rolling stock) to the total value of fixed production assets (production base). This criterion incorporates a specific weighting for the

production base, set at 40% of the rolling stock value when $K_R=1$. Therefore, the resource competitiveness ratio is determined using the following formula:

$$K_R = \frac{(PB \cdot 100)}{RS} / 40 \quad (12)$$

where:

- PB - value of the production base, MDL;
- RS - value of rolling stock, MDL;
- 40 - the specific weight of the production base within the rolling stock when the competitiveness ratio $K_R=1$.

The **correspondence of the fleet's carrying capacity to its optimal level** is determined using the following formula:

$$Q_{avg} = \frac{Q_f \cdot A_f + Q_d \cdot A_d + Q_v \cdot A_v + Q_t \cdot A_t + Q_o \cdot A_o}{A_f + A_d + A_v + A_t + A_o} \quad (13)$$

where:

- Q_{avg} - average carrying capacity of vehicles corresponding to the rational level, for flatbed trucks, dump trucks, vans, tankers, and other vehicles, respectively;
- A_f, A_d, A_v, A_t, A_o - average number of vehicles by type of specialization.

If the actual carrying capacity of the vehicles corresponds to the optimal level, then the transport enterprise can be considered to meet the transportation requirements, with **resources competitiveness coefficient** K_R equal to 1.

3. Results and discussions

Using the selected methodology, the competitiveness levels of six transportation enterprises in the Republic of Moldova were assessed.

The following criteria were applied in selecting enterprises for the competitiveness analysis:

- Industry and legal form uniformity: ensuring the comparability of operational conditions.
- Ownership of rolling stock: identified as a key resource for a transport enterprise.
- Availability and completeness of data: enabling accurate financial and economic analysis.
- Comparability of operational scale: minimizing distortions in analysis.

According to the classification established by Article 5 of Law No. 179 (dated July 21, 2016) "On Small and Medium-Sized Enterprises", four of the six analysed companies are classified as small enterprises, while two are categorized as medium-sized. This selection ensures that the sample is representative of typical participants in the studied segment. Small and medium-sized enterprises (SMEs) make the most significant contribution to the development of the road freight sector in the Republic of Moldova, confirming the suitability of the chosen sample for further analysis.

The data used for the comprehensive assessment of the selected enterprises' competitiveness include key financial, economic, and operational metrics that reflect their current performance and development trends. Based on this information, a step-by-step calculation of the integrated competitiveness coefficient was performed for each enterprise. The summary results for 2022 and 2023 are presented in tables nr. 1 and nr. 2, allowing for an analysis of changes in their competitive positions over the specified period.

Table nr. 1. Results of the Integrated Competitiveness Index Calculation for Road Freight Transport Enterprises in the Republic of Moldova, 2022

No.	Coefficient	Enterprise nr.					
		1	2	3	4	5	6
1	Average value of liquidity and profitability indicators	1.4	4.05	1.37	2.26	4.98	4.5
2	Quality	0.5	0.5	0.5	0.52	0.5	0.5
3	Income-to-expense ratio	0.98	1.42	0.99	1.06	0.95	1.39
4	Number of transport types and services	0.8	0.6	0.6	0.8	0.6	0.6
5	Resources	3.72	2.5	2.97	2.5	2.5	2.5
6	Integrated competitiveness index	1.48	1.81	1.28	1.42	1.90	1.89

Source: Calculated by the author based on the financial and operational data of the analysed enterprises.

Table 2. Results of the Integrated Competitiveness Index Calculation for Road Freight Transport Enterprises in the Republic of Moldova, 2023

No.	Coefficient	Enterprise nr.					
		1	2	3	4	5	6
1	Average value of liquidity and profitability indicators	2.13	2.27	1.52	2.38	11.07	2.43
2	Quality	0.5	0.5	0.5	0.54	0.5	0.5
3	Income-to-expense ratio	0.90	1.18	0.91	0.95	0.95	1.49
4	Number of transport types and services	0.8	0.6	0.6	0.8	0.6	0.6
5	Resources	2.59	2.5	3.63	2.5	2.5	2.5
6	Integrated competitiveness index	1.38	1.41	1.43	1.43	3.12	1.50

Source: Calculated by the author based on the financial and operational data of the analysed enterprises

The calculation results indicate that in 2022, the analysed enterprises exhibited varying levels of competitiveness. Enterprises No. 5 and No. 6 demonstrated the highest competitiveness indicators. In 2023, Enterprise No. 5 further strengthened its competitive position, driven by a significant increase in the coefficient representing the average value of service liquidity and profitability indicators –from 4.98 in 2022 to 11.07 in 2023.

The integrated competitiveness coefficient for Enterprise No. 6 decreased in 2023, causing the enterprise to fall to second place. The primary factor contributing to this decline was a significant drop in the average service liquidity and profitability coefficient, which fell from 4.5 in 2022 to 2.43 in 2023. Enterprise No. 2, which held the second position in 2022, experienced a decline in 2023. This downturn was driven by reductions in its average liquidity, profitability indicators, and income-to-expense ratio. Conversely, Enterprise No. 3 improved its standing to third place in 2023, following growth in its liquidity and profitability metrics and an increase in available resources. Enterprise No. 1 consistently demonstrated the lowest level of competitiveness throughout the analyzed period (2022–2023).

The study results, based on N. Penishin's methodology, revealed significant disparities in the competitive positions of road freight enterprises in the Republic of Moldova. However, an analysis of the indicators used to calculate the integrated competitiveness index suggests that some metrics may have limited informativeness or relevance within the model. This finding underscores the need to refine the formula's components to improve the accuracy and objectivity of future competitiveness assessments.

4. Concluding remarks

The transport sector plays a crucial role in the national economy of the Republic of Moldova. Although road transport competes with other modes, the majority of freight transportation in the country is conducted by road due to its geographical location. Small and medium-sized enterprises are particularly important in the development of this sector. Their stability and flexibility enable them to quickly adapt to changing market conditions. One of the key tools for achieving and maintaining competitive advantage is the assessment of competitiveness levels.

Currently, numerous methodologies exist for assessing competitiveness levels; however, an accurate evaluation must consider the specific characteristics of the industry. After analysing various approaches, it was concluded that the methodology proposed by N. Penishin for evaluating the competitiveness of freight road transport enterprises is the most suitable. This methodology was applied to assess several road transport enterprises in the Republic of Moldova.

The study confirmed significant differences in the competitiveness levels of freight road transport enterprises in the Republic of Moldova. The analysis revealed that liquidity and profitability ratios have the greatest impact on the integrated competitiveness index, highlighting the importance of financial stability and efficient resource utilization. However, limitations of the applied methodology were identified: some indicators are insufficiently informative and do not always accurately reflect the enterprise's true market position. This indicates the need to revise the composition of the integrated index components to enhance the accuracy and objectivity of competitiveness assessments. It is recommended to include additional criteria that consider service quality, the level of innovation, and customer satisfaction.

The results of this research provide a foundation for transport managers to develop robust competitive strategies and serve as a basis for enhancing methodological approaches to evaluating industry-specific competitiveness.

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GUIDELINES FOR EXPLORATION THE TOURISM POTENTIAL OF THE REPUBLIC OF MOLDOVA

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Abstract: *This paper examines ways to harness the tourism potential in the Republic of Moldova. The overall objective of the research is to highlight the issues and challenges involved in harnessing the tourism potential in the Republic of Moldova. To achieve the general objective of the research, we focused on a comprehensive research methodology, which includes methods such as: analysis, synthesis, induction, deduction, abduction, scientific abstraction, documentation, content analysis, etc. Based on the studies conducted, we highlight that although the Republic of Moldova possesses valuable, authentic, and attractive tourism potential, tourists nevertheless show reluctance to take advantage of the national tourism potential due to multiple issues related to high prices in tourist accommodation facilities, lower-comfort accommodation conditions in some tourist areas, and recreational services that are less adapted to tourists' needs.*

Keywords: *tourism, tourism potential, tourist accommodations, tourism heritage, authenticity of tourism potential.*

JEL Classification: *Q01, Q56, Z32.*

1. Introduction

In the context of globalization and increasing international mobility, tourism has become a dynamic and flexible sector that adapts to the growing demands of tourists, contributing significantly to the economic, social, and cultural development of nations. In this context, the Republic of Moldova is gradually establishing itself as an emerging tourist destination, capitalizing on a diverse and authentic tourism potential characterized by a blend of natural, man-made, and cultural resources.

Tourism is a viable, flexible sector with enormous potential for development in the near future. Our country stands out for its blend of attractive tourist destinations, offering visitors valuable options tailored to different types of tourists. Moreover, we must emphasize that the effective utilization of tourism potential can provide opportunities for increasing national revenue, creating new jobs, and strengthening the country's image as a tourist destination on the international stage.

Moreover, the Republic of Moldova possesses a valuable cultural and historical heritage, embodied in architectural monuments, archaeological sites, and other such landmarks, which shape the country's tourism identity.

The importance of tourism for the Republic of Moldova is evident on various levels. Thus, economically, tourism contributes to the accumulation of national income, on the one hand, and to the development of SMEs in the tourism sector, particularly in rural areas, on the other. The development of tourism infrastructure contributes to job creation, as well as to attracting both domestic and foreign investment.

Therefore, research into the country's tourism potential is a relevant area of study, given its strategic role in economic development as well as in strengthening the country's image on the international stage.

The overall objective of the research is to identify the issues and challenges involved in harnessing the tourism potential of the Republic of Moldova.

Thus, in order to achieve the general objective of the research, we have established the following *related objectives*, among which we highlight:

- O1: Research on conceptual frameworks related to tourism potential;
- O2: Identification of the main forms of tourism potential;
- O3: Identification of the main issues and challenges in harnessing tourism potential in the Republic of Moldova;
- O4: Identification of solutions to improve the effective utilization of tourism potential in the Republic of Moldova.

In line with the research objectives, we have formulated the following research hypotheses:

H1: Tourism potential encompasses all natural, historical-cultural, and socio-economic factors that can generate and sustain the development of tourism activities;

H2: Tourism potential includes both natural and anthropogenic potential;

H3: The main problem in harnessing the tourism potential of the Republic of Moldova is the lack of national tourism development policies;

H4: The main solution for harnessing the tourism potential of the Republic of Moldova is the development of a national tourism development strategy that would include concrete activities to support the development of the national tourism sector.

To achieve the aforementioned objectives, we employed a comprehensive research methodology, focusing on the use of a wide range of research methods, including: analysis, synthesis, induction, deduction, abduction, scientific abstraction, documentation, content analysis, etc.

2. Theoretical and methodological approaches to tourism potential

Taking a theoretical look at the conceptual framework of tourism potential, we can note that Bădăcean, M.G. and Lipan, G.F. (2023) approach tourism potential from the perspective of “...the capabilities and resources of a destination or region to attract and satisfy the needs of tourists” (Bădăcean, Lipan, 2023).

At the same time, Gojaeva, E. and Gutium, T. (2024) note that tourism potential includes “the totality of resources and conditions that support the development of tourism and contribute to economic growth and the development of tourist destinations” (Gajaeva, Gutium, 2024).

Furthermore, we can highlight that, according to Ghiorghilaș (2017), tourism potential “refers to the totality of natural, anthropogenic, economic, social, and cultural elements of a territory that can generate and sustain tourism activities” (Ghiorghilaș, 2017). Interpreting the author’s definition, we note that tourism potential includes a set of natural, economic, social, and anthropogenic elements of a tourist destination that attract tourists to the destination.

On the other hand, Certan, S. and Certan, I. (2014) note that “tourism potential represents the totality of natural, historical-cultural, and socio-economic factors that can generate and sustain the development of tourism activities in a region” (Certan, Certan, 2014).

In the same context, Cocean (2007) notes that “tourism potential represents the totality of natural and anthropogenic elements of a territory which, through appropriate development, can generate tourism activities” (Cocean, 2007). Interpreting the author’s approach, we observe that tourism potential represents a set of elements which, when appropriately combined, contribute to the generation of tourism activities in that territory.

On the other hand, researcher Glăvan (2003) highlights that tourism potential represents “a set of natural, anthropogenic, economic, and cultural resources that can be utilized through tourism activities, with the aim of satisfying the recreational needs of the population”

(Glăvan, 2003). Interpreting the author’s approach, we note that tourism potential comprises a set of interdependent elements designed to meet the recreational needs of the population. It is due to the existence of these elements that tourism develops in the given region.

In the same vein, Minciu (2004) defines tourism potential as “the capacity of an area to attract tourists, determined by the existence and quality of tourism resources, the specific infrastructure, and the degree of accessibility” (Minciu, 2004).

Another approach is found in Stănciulescu (2012), who defines tourism potential as “...the sum of resources and environmental conditions that can be transformed into tourism products and services through investment and appropriate organization” (Stănciulescu, 2013).

Thus, based on the definitions analyzed, we can highlight that tourism potential is the primary prerequisite for strengthening tourism in tourist destinations, since, thanks to the combination of natural and man-made resources and existing facilities at the destination, we can attract tourists and organize various tourism activities that stimulate the flow of tourists wishing to visit the area.

Upon reviewing the specialized literature, we note that tourism potential consists of two distinct elements, as shown in Figure 1.



Figure 1. Components of tourism potential

Source: Prepared by the author

In turn, natural tourism potential consists of numerous components, such as climate, topography, hydrological resources, biodiversity, and geological resources, which are summarized in Figure 2.

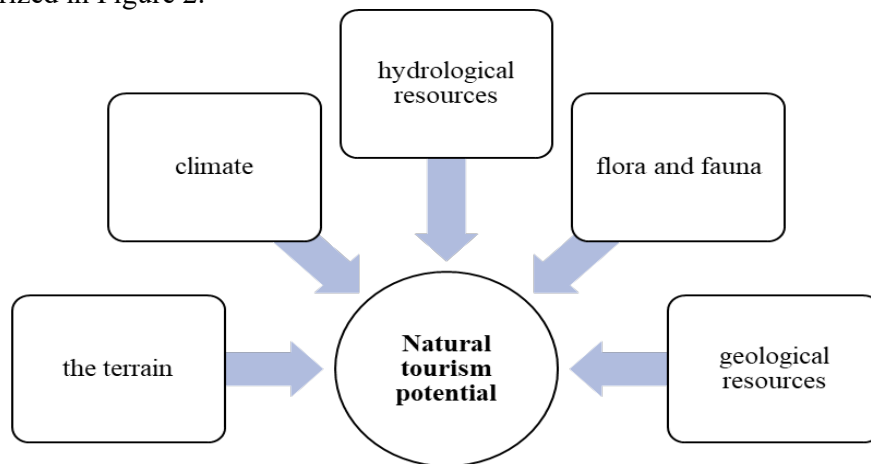


Figure 2. The basic elements of natural tourism potential

Source: adapted from STĂNCIULESCU, G. (2013). *Managementul agenției de turism*. București: Editura ASE.

The terrain—comprising mountains, hills, plains, valleys, and canyons found at the destination—is one of the elements that define the destination’s natural tourism potential. The role of the landscape in the attractiveness of a tourist destination is significant because it enables various forms of tourism at the destination, such as adventure tourism, sports tourism, or recreational tourism.

The climate, based on the overall atmospheric characteristics of an area—including temperature, precipitation, and humidity—determines the periods of peak tourism activity, such as the high season and off-season, and also contributes to increased tourist flows during certain times of the year.

Hydrological resources—including lakes, rivers, waterfalls, hot springs, seas, and so on—help enhance the appeal of tourist destinations, boost their image, and facilitate the development of various types of tourism, such as spa tourism, water-based tourism, and coastal tourism, which in turn leads to an increase in tourist flows to that destination.

Flora and fauna are elements of natural resources that underpin the attractiveness of a tourist destination. Thus, the presence of diverse flora and fauna at the destination constitutes a valuable resource for attracting tourists, fostering the development of various forms of tourism, such as ecotourism, agritourism, educational tourism, etc.

Geological resources—such as caves, cliffs, karst formations, volcanoes, and so on—also have a significant impact on the attractiveness of a tourist destination, as they help increase tourist traffic in those areas. Furthermore, they enable various forms of tourism, such as educational tourism, geological tourism, historical tourism, and so on.

On the other hand, anthropogenic tourism potential also has a significant impact on the attractiveness of tourist destinations, contributing to increased tourist flows. Thus, anthropogenic tourism potential, as shown in Figure 3, consists of multiple elements, such as cultural and historical potential, events, gastronomy, tourism infrastructure, and tourism services.

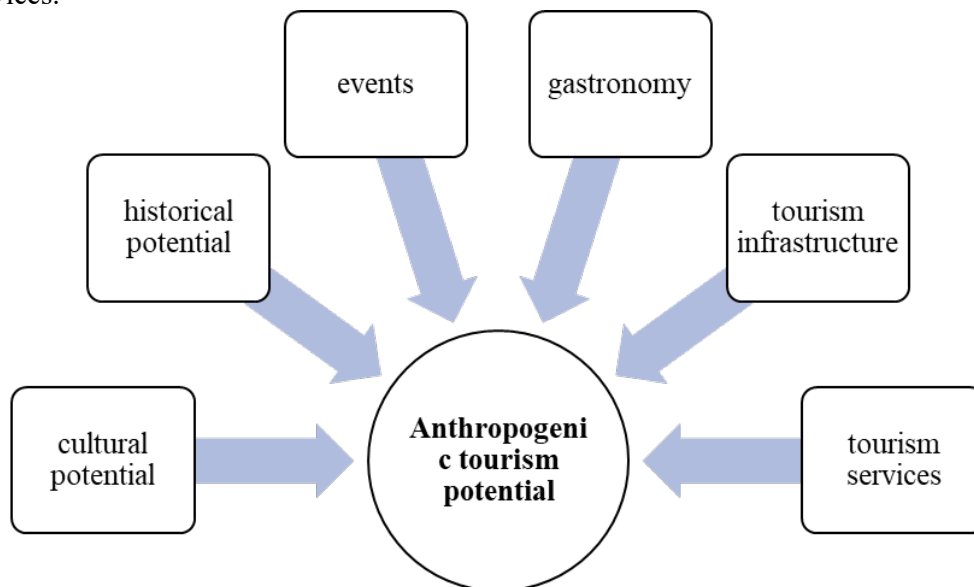


Figure 3. Basic elements of anthropogenic tourism potential

Source: adapted from STĂNCIULESCU, G. (2013). *Managementul agenției de turism*. București: Editura ASE.

The *cultural potential* is underpinned by museums, cultural centers, churches, and archaeological sites, which in turn attract tourists eager to discover the rich cultural heritage of these places. At the same time, cultural potential also consists of the traditions and customs cultivated by locals in tourist areas, which also encourage tourists to discover the culture of the region.

Historical potential consists of historical sites, fortresses, and historic buildings, which attract tourists to visit them and discover the historical significance of these places.

Events organized at the destination, such as concerts, festivals, exhibitions, competitions, and carnivals, help attract tourists to visit the destination during the time these events are held.

Gastronomy is also an important element of the destination's tourism potential, as it allows visitors to discover traditional dishes and local beverages specific to certain tourist areas. Thus, tourists often choose to visit these areas to explore the destination's culinary offerings and enjoy traditional dishes and distinctive beverages.

Tourism infrastructure is of paramount importance, as it supports the development of tourism by enabling tourists to stay in lodging facilities, dine at restaurants and cafes in the tourist area, and so on. Consequently, we can highlight that the presence of a well-established, high-quality tourism infrastructure at the destination encourages visits by various categories of tourists to engage in different forms of tourism.

Tourism services are also defining elements that help attract domestic and international tourists to discover the potential of the tourist destination. Thus, through tourism services such as transportation, accommodation, guided tours, and the organization of excursions, tourists have the opportunity to discover the beauty of the places and create special memories at the destination.

Based on an analysis of the work of researchers in the field, we can reiterate that tourism potential is classified according to various criteria, as summarized in Table 1.

Table 1. Classification of tourism potential according to various criteria

Classification criterion	Types of tourism potential
Based on the nature of the available resources	a. Natural tourism potential b. Man-made tourism potential
Based on how the tourism potential is utilized	a. Exploited tourism potential b. Unexploited tourism potential
Based on the location of the tourism potential	a. Urban tourism potential b. Rural tourism potential c. Coastal or mountain tourism potential
Based on tourism significance	a. Strategic tourism potential b. Local tourism potential

Source: adapted from STĂNCIULESCU, G. (2013). *Managementul agenției de turism*. București: Editura ASE.

Upon analyzing the table, we can see that there are several categories of tourism potential:

- *natural tourism potential* – this consists of all the natural resources used to promote tourism. This category includes resources such as: topography, climate, fauna and flora, hydrological resources, and geological resources, which enable the development and practice of various forms of tourism in the tourist area. At the same time, these resources enhance the image and attractiveness of the tourist destination.

- *anthropogenic tourism potential* – encompasses all anthropogenic resources such as: cultural and historical potential, events, gastronomy, infrastructure, and tourism services, which enable the development of the destination’s natural tourism potential. These resources attract tourists through the quality of the services offered, the uniqueness of the infrastructure, and the elements of the tourist destination’s cultural and historical heritage.

- *developed tourism potential* – encompasses all tourism resources that have already been developed for tourism purposes and are equipped with tourism infrastructure and services that tourists can access when visiting the destination.

- *untapped tourism potential* – encompasses all tourism resources that have not yet been utilized for tourism purposes, for various reasons such as environmental protection, biodiversity conservation, etc., but which could be developed in the future.

- *urban tourism potential* – includes historical and cultural elements, buildings, museums, monasteries, churches, theaters, parks, and urban infrastructure. The presence of this type of potential offers the possibility of developing various forms of tourism, such as cultural, historical, and religious tourism, etc.

- *rural tourism potential* – encompasses the entirety of natural resources, traditions, values, cuisine, and landscapes in rural areas. The presence of this tourism potential offers the opportunity to engage in various forms of tourism, such as: ecotourism, agritourism, etc., which are most often practiced in rural areas.

- *strategic tourism potential* – encompasses the totality of tourism resources within a tourist destination that can be leveraged over a longer period. The presence of these resources offers the opportunity to design and implement various strategic tourism projects that enable development and strengthening the tourist destination.

- *local tourism potential* – encompasses all the tourism resources present in a specific tourist area, within a region, village, municipality, etc., that are utilized by tourists for tourism purposes.

3. Ways to Harness Tourism Potential

Harnessing tourism potential refers to the process by which natural and man-made resources, as well as tourism infrastructure, are utilized for tourism purposes in order to generate various types of benefits: economic, social, and cultural (Ritchie, Crouch, 2003).

The basic principles that must be taken into account in harnessing tourism potential are shown in Figure 4.



Figure 5. Basic principles for harnessing tourism potential

Source: adapted from FERREIRA, D.I., SANCHEZ-MARTIN, J.M. (2021). The Assessment of the Tourism Potential of the Tagus International Nature Reserve Landscapes

Using Methods Based on the Opinion of the Demand. In: *Land*, MDPI, vol.1., 2021, pp. 1-25. ISSN 2073-445X.

Sustainability – this principle boils down to the responsible development of tourism potential in order to provide future generations with opportunities to benefit from that potential and access to tourism resources. In this regard, in recent years there has been an increasing emphasis on harnessing tourism potential alongside protecting biodiversity, ensuring ecosystem balance, etc. Thus, reducing pollution, protecting resources, and conserving resource consumption are key objectives for harnessing tourism potential.

Diversity—this principle encompasses various forms of tourism, such as ecological, cultural, historical, and experiential, with the aim of attracting different categories of tourists to meet their travel expectations. Consequently, tourism organizations design various tourist routes and itineraries that include diverse attractions offering opportunities to engage in these forms of tourism.

Community integration – this principle focuses on involving various stakeholders in the economic, social, cultural, and environmental development of tourist areas. Thus, effective collaboration with stakeholders can ensure the development of tourist areas, as well as strengthen the area’s tourism potential.

Strategic planning – this principle focuses on the effective identification of development priorities for the tourist area and the effective planning of activities to harness tourism potential in order to maximize positive effects and minimize negative effects.

The main changes that have affected the harnessing of tourism potential are shown in Figure 6.

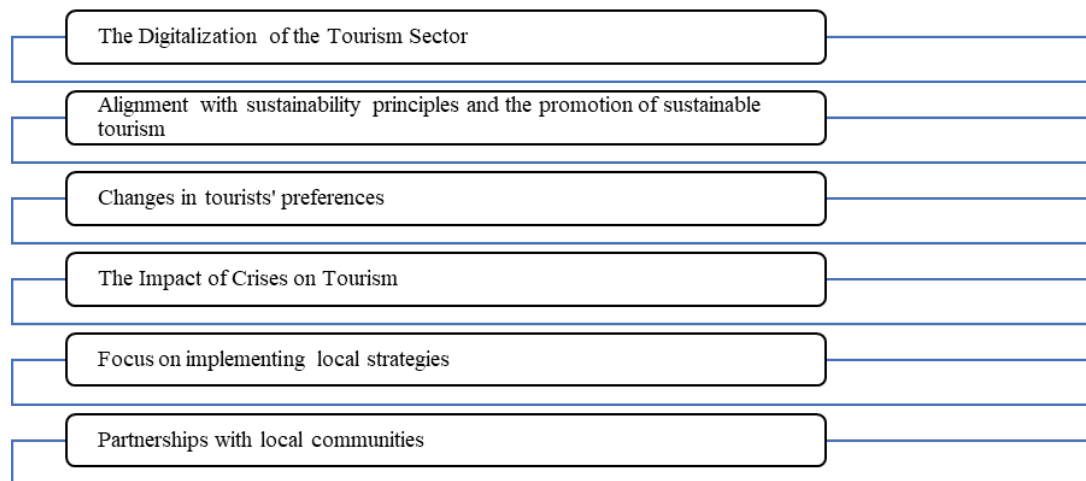


Figure 6. Major changes affecting the realization of tourism potential

Source: adapted from FERREIRA, D.I., SANCHEZ-MARTIN, J.M. (2021). The Assessment of the Tourism Potential of the Tagus International Nature Reserve Landscapes Using Methods Based on the Opinion of the Demand. In: *Land*, MDPI, vol.1., 2021, pp. 1-25. ISSN 2073-445X.

One of the main changes that has impacted the functioning of the tourism industry, on the one hand, and altered the way tourism potential is harnessed, on the other, is the digitization of the tourism sector, which has had a significant impact on the field in recent

years. Thus, as digitization has gained momentum, so too has digital tourism, the use of augmented reality, AI, and IoT in the tourism sector. At the same time, tourism has shifted from the traditional concept of leveraging potential—which involves the need to leave one's place of residence to visit and experience tourism—to "Tourism 4.0," a new way of practicing tourism that does not require leaving one's residence and offers the possibility of capitalizing on tourism potential using digital means such as AR, VR, AI, IoT, etc.

In addition, another change that has impacted the development of tourism potential is the emphasis on sustainability and the promotion of sustainable tourism. As a result, in recent years, the development of tourism potential has placed particular emphasis on natural potential—the unique natural resources available to the tourist destination—as well as cultural resources that must be managed responsibly to ensure that future generations also have the opportunity to benefit from them. As a result of tourism companies aligning with sustainability principles, numerous changes have taken place in the tourism industry, such as: the need for responsible consumption of tourism resources, the need to ensure ecosystem balance, and the reduction of pollution and the carbon footprint, among others, which have a negative impact on tourism potential.

Another factor affecting the realization of destinations' tourism potential is the shift in tourist preferences, which has become increasingly common in recent times. There is a growing demand from tourists for authentic, personalized travel packages, as opposed to the mass tourism that was preferred by tourists several decades ago.

Crises, likewise, have had an impact on the tourism sector, necessitating the reorganization of destinations, a rethinking of how to harness tourism potential, and a reevaluation of how tourism resources are utilized, through the lens of digital technologies and the integration of sustainable business models into the tourism sector.

Another change that has affected the functioning of the tourism sector is the focus on implementing local strategies, which involve strengthening culture, values, and traditions, as well as preserving the authenticity and identity of local communities. De asemenea, putem observa o concentrare pe consolidarea parteneriatelor cu comunitățile locale în vederea valorificării unui management al destinațiilor la nivel local. Totodată, se pune un accent mai mare pe adoptarea politicilor regionale de dezvoltare și valorificare a potențialului turistic la nivelul regiunilor, care dețin un potențial turistic mai slab valorificat.

The Republic of Moldova is a country with valuable, impressive, and extremely attractive tourism potential that draws tourists with the natural beauty, depth, and undeniable value of its tourist destinations. The valuable tourism potential of our country offers tourists the opportunity to engage in various forms of tourism: rural tourism, agritourism, religious tourism, etc.

A revealing analysis in assessing the utilization of tourism potential is the dynamics of tourism organized by travel agencies based on the purpose of visits by tourists participating in outbound tourism. The summary data are presented in Table 2. Thus, during the 2020–2024 period, the majority of tourists participating in tourism did so for the purpose of rest and relaxation.

Table 2. Travel agency activity by purpose of visit, 2020–2024

	2020	2021	2022	2023	2024	24/23	23/22	22/21	21/20
Total number of foreign visitor arrivals in the country	6950	24006	29008	43597	67631	24034	14589	5002	17056
Vacations, recreation, and leisure	6612	22457	26499	41837	65368	223531	15338	4062	1545
Business and professional reasons	238	1467	914	1389	1852	463	475	-553	1229
Other purposes	100	82	1595	371	411	-330	-1224	1513	-18
Total number of departures of Moldovan visitors abroad	74708	217678	324584	362440	396933	34493	37856	106906	142970
Vacations, recreation, and leisure	73725	216498	323473	360161	394531	34370	36688	106975	142773
Business and professional reasons	538	714	677	989	1385	396	312	-34	176
Other purposes	445	466	434	1290	1017	-273	856	-32	21
Number of tourists and day-trippers participating in domestic tourism	42848	79196	123559	97662	91295	-6367	-25897	44363	6348

Source: Compiled based on data from the National Bureau of Statistics, 2025. Available: https://statbank.statistica.md/pxweb/pxweb/ro/40%20Statistica%20economica/40%20Statistic a%20economica_11%20TUR_TUR030/?rxid=af1bdd19-60e4-4712-8f44-bbf70fe6e524

When analyzing the number of foreign visitor arrivals in the country by purpose of visit for the period 2020–2024, we can see that the vast majority of tourists come for recreation and leisure, accounting for 96.6% of the total number of tourists who visited our country. Thus, while 6,612 tourist entries were recorded in 2020, by 2024 this number had risen to 65,368 tourists. Thus, between 2020 and 2024, we observed a roughly tenfold increase in the number of visitors who took advantage of the country's tourism potential.

In addition, analyzing the number of Moldovan visitors traveling abroad, we can note that the vast majority of Moldovans travel to other countries for recreation and leisure, accounting for 99.44% of the total number of tourists leaving the country. At the same time,

we reiterate that during the 2020–2024 period, the number of tourists leaving the country for recreation and vacation purposes recorded a significant increase, approximately 5.31-fold, from 74,708 tourists leaving in 2020 to 396,933 tourists leaving in 2024.

In addition, we note that between 2020 and 2024, the number of domestic tourists is projected to double, from 42,848 tourists recorded in 2020 to 91,295 domestic tourists recorded in 2024.

Another important aspect of Moldova’s tourism potential is the tourism infrastructure that provides tourists with accommodation and enables them to experience the country’s tourism potential. Thus, in Table 3, we have summarized the dynamics and structure of registered tourist accommodation facilities in the Republic of Moldova for the period 2020–2024.

Table 3. Dynamics and structure of registered tourist accommodation facilities in the Republic of Moldova for the period 2020–2024

	2020	2021	2022	2023	2024
Total number of accommodation establishments, of which:	272	280	289	303	300
Hotels and motels	112	115	115	123	120
Tourist and agritourism guesthouses	38	43	47	56	57
Visitor lodges	3	5	6	6	8
Recreational facilities	7	7	7	7	7
Vacation villages and other recreational facilities	59	60	61	58	56
Children’s vacation camps	53	50	53	53	52
Total number of rooms, of which:	8119	8010	8333	8707	8649
Hotels and motels	2832	2853	2845	3137	3096
Tourist and agritourism guesthouses	492	559	645	729	742
Visitor lodges	170	184	186	186	268
Recreational facilities	1089	1094	1094	1094	1094
Vacation villages and other recreational facilities	1404	1426	1453	1418	1382
Children’s vacation camps	2132	1894	2110	2143	2067
Total number of beds, of which:	24666	23881	24709	25386	25418
Hotels and motels	5351	5400	5341	5813	5706
Tourist and agritourism guesthouses	1061	1221	1430	1632	1658
Visitor lodges	545	591	507	507	730
Recreational facilities	1970	1970	1976	1976	1976
Vacation villages and other recreational facilities	3641	3676	3730	3655	3570
Children’s vacation camps	12098	11023	11725	11803	11778

Source: Compiled based on data provided by the National Bureau of Statistics, 2025. Available:

https://statbank.statistica.md/pxweb/pxweb/ro/40%20Statistica%20economica/40%20Statistic%20economica_11%20TUR_TUR030/?rxid=af1bdd19-60e4-4712-8f44-bbf70fe6e524

Analyzing the trends in tourist accommodation establishments in the Republic of Moldova for the period 2020–2024, we can highlight that during this period there is an upward trend in the number of tourist accommodation establishments, from 272 establishments recorded in 2020 to 300 establishments recorded in 2024. Most of these are hotels and motels, which, between 2020 and 2024, showed an upward trend, from 112 establishments in 2020 to 120 establishments in 2024. At the same time, in addition to hotels and motels, our country offers tourists tourist guesthouses for accommodation, which also saw a significant increase between 2020 and 2024, rising from 38 units in 2020 to 57 units in 2024.

On the other hand, the total number of rooms offered by tourist accommodation establishments also showed an upward trend between 2020 and 2024, rising from 8,119 rooms in 2020 to 8,649 rooms in 2024. The largest share, at 35.8%, in 2024, is held by rooms in hotels and motels, followed by children’s vacation camps, which account for 23.9% in 2024, and then by rooms offered by vacation villages, which account for 12.6% of the total number of rooms.

At the same time, the number of beds offered by tourist accommodation establishments in the Republic of Moldova during the 2020–2024 period increased from 24,666 beds in 2020 to 25,418 beds in 2024.

Consequently, Figure 7 provides an overview of the occupancy of tourist accommodation establishments in the Republic of Moldova for the period 2020–2024.

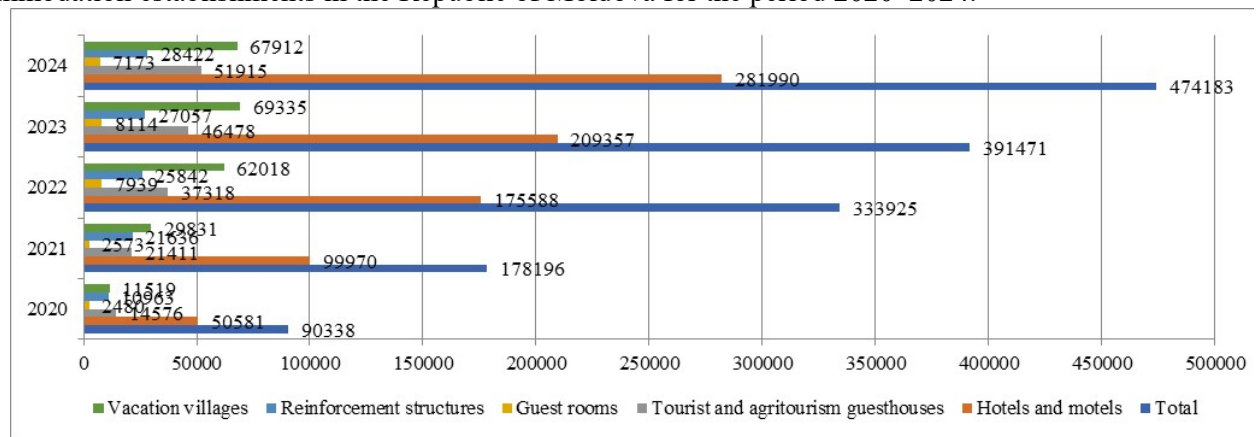


Figure 7. Overnight stays at accommodation establishments in the Republic of Moldova, 2020–2024

Source: Compiled based on data from the National Bureau of Statistics, 2025. Available: https://statbank.statistica.md/pxweb/pxweb/ro/40%20Statistica%20economica/40%20Statistic%20economica_11%20TUR_TUR030/?rxid=af1bdd19-60e4-4712-8f44-bbf70fe6e524

Analyzing the data in Figure 7, we observe that between 2020 and 2024, there was an increase in the number of visitors to tourist accommodation facilities of approximately 5.2 times, from 90,338 overnight guests in 2020 to 474,183 tourists accommodated in 2024.

The most significant increase is observed in hotels and motels, where between 2020 and 2024 there is an increase of approximately 5.6 times, from 50,581 tourists staying in motels and hotels in 2020, to 281,990 tourists staying in these tourist accommodation establishments by 2024.

The trend in overnight stays by non-resident tourists in tourist accommodation establishments is shown in Figure 8. According to the data in the figure, we observe that during the 2020–2024 period there is a positive trend, an increase of approximately 7.1 times, in overnight stays by non-resident tourists, from 70,385 non-resident tourists staying in 2020 to 501,318 non-resident tourists staying in 2024.

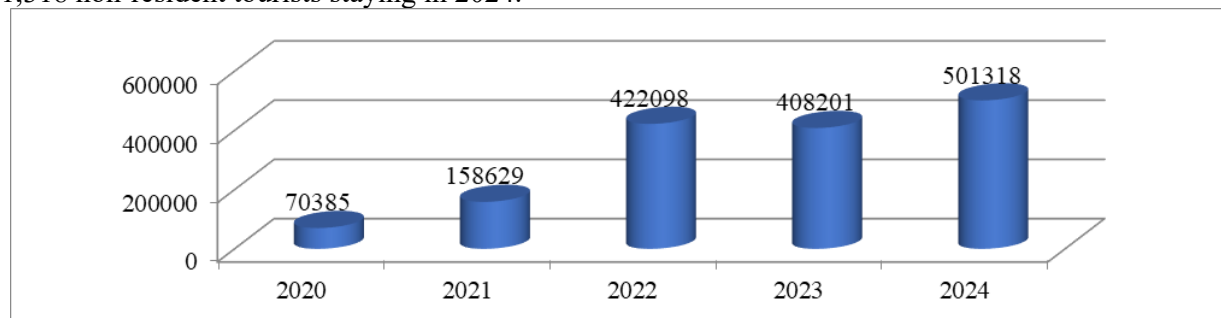


Figure 8. Trends in overnight stays by non-resident tourists staying in tourist accommodation establishments in the Republic of Moldova, 2020–2024

Source: Prepared based on data from the National Bureau of Statistics, 2025. Available: https://statbank.statistica.md/pxweb/pxweb/ro/40%20Statistica%20economica/40%20Statistic%20economica_11%20TUR_TUR030/?rxid=af1bdd19-60e4-4712-8f44-bbf70fe6e524

On the other hand, Table 4 shows the trend in the net occupancy rate of tourist accommodation establishments in the country for the period 2020–2024.

Table 4. Trend in the net occupancy rate of tourist accommodation establishments in the Republic of Moldova, 2020–2024, %

	2020	2021	2022	2023	2024	24/23	23/22	22/21	21/20
Total:	13,0	20,3	29,5	28,8	31,5	2,7	-0,7	9,2	7,3
Hotels and motels	6,9	13,5	25,4	23,8	27,6	3,8	-1,6	11,9	6,6
Tourist and agritourism guesthouses	9,7	12,1	19,5	12,7	16,7	4	-6,8	7,4	2,4
Visitor lodges	62,2	51,3	46,7	42,3	42,1	-0,2	-4,4	-4,6	-10,9
Recreational facilities	30,7	48,6	54,1	57,1	58,4	1,3	3	5,5	17,9
Vacation villages and other recreational facilities	4,1	10,1	19,4	21,9	20,8	-11	2,5	9,3	6
Vacation camps	3,0	13,3	28,1	31,7	34,1	2,4	3,6	14,8	10,3

Source: Compiled by the National Bureau of Statistics, 2025

An analysis of the data in Table 4 reveals that, between 2020 and 2024, there was a significant increase in the net occupancy rate of tourist accommodation establishments in the country, from 13.0% in 2020 to 31.5% in 2024. This is largely due to the sector's recovery following the pandemic crisis, which had previously limited its development opportunities.

3. Conclusions and recommendations

Based on the research conducted, and with a view to strengthening the utilization of the Republic of Moldova's tourism potential, we consider the following recommendations imperative:

- *Developing a national tourism development strategy*—given that the Republic of Moldova possesses valuable tourism potential, we consider it necessary to develop a national tourism development strategy, which would contribute to intensifying the development of tourism in the country.

- *Development of tourism infrastructure* – to promote tourism in the Republic of Moldova, we consider it necessary to develop tourism infrastructure, including: repairing access roads to tourist destinations, installing signage along the entire route, increasing investment in accommodation facilities, and developing tourist trails and rural areas.

- *Promoting entrepreneurship in the tourism sector* – to increase the sector's appeal, we believe it is necessary to provide tax incentives for entrepreneurs in the tourism sector to encourage them to open businesses in rural areas and tourist destinations.

- *Developing an action plan to promote domestic tourism* – to increase the flow of tourists who take advantage of Moldova's tourism potential, we believe it is necessary to develop an action plan that includes concrete activities to help realize the country's tourism potential.

In conclusion, we reiterate that implementing the proposed recommendations would support the process of strengthening the country's tourism potential, on the one hand, and increasing the country's attractiveness as a tourist destination, on the other.

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THE REALITY BEHIND THE STATISTICS

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Abstract: This paper seeks to explore the fact that, in recent years, official statistics show that Romania has been making significant progress in reducing the gaps with European Union standards and aims to verify whether the realities in our country validate the figures. Thus, the gross domestic product per capita, calculated in current prices, but especially at purchasing power parity, shows us a rapid recovery or even surpassing some Eastern European countries, previously better positioned compared to our country. Also, some regions of Romania compete with European regions known for their leading positions in the development rankings. Specifically, the paper investigates the structure of GDP through the lens of income, the distribution of the main incomes by beneficiaries, their size, the number of beneficiaries, the contribution of regions to value creation, etc. The conclusion is that there is great polarization, and the realities in the statistics are valid for a minority, while the majority are far from the averages in European Union.

Keywords: GDP, development, income, pensions, polarization.

JEL Classification: O1, R1.

1. Statistical images

In recent years, the Romanian press has frequently written about the performance of Romania or some regions of our country in terms of economic growth and, in particular, about the dynamics of gross domestic product per capita, and European statistics confirm these aspects.

Table No. 1. GDP per capita – thousand EUR, current prices

Country / Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	index 2024/2003
I	20.4	21.3	22.1	23.3	24.7	25.4	24.2	25.1	25.9	26.0	26.3	26.9	27.8	28.5	29.7	30.6	31.7	30.5	33.3	36.1	38.4	39.9	196
Euro zone	25.0	25.9	26.7	28.0	29.2	29.7	28.4	29.1	29.7	29.8	30.0	30.6	31.4	32.2	33.3	34.4	35.4	33.8	36.8	39.9	42.0	43.4	173
Romania	2.4	2.8	3.7	4.6	6.1	7.1	6.2	6.3	6.9	6.9	7.2	7.6	8.1	8.5	9.5	10.5	11.5	11.4	12.6	14.7	16.9	18.6	783
Bulgaria	2.4	2.7	3.1	3.6	4.2	4.9	4.9	5.1	5.6	5.8	5.9	6.1	6.6	7.1	7.7	8.3	9.3	9.4	11.0	13.3	14.7	16.3	678
Czech	8.7	9.5	10.8	12.1	13.5	15.5	14.2	15.2	15.9	15.6	15.3	15.1	16.2	17.0	18.7	20.3	21.7	21.0	23.4	26.7	29.3	29.4	338
Hungary	7.4	8.3	9.0	9.1	10.2	10.8	9.4	10.0	10.2	10.1	10.4	10.8	11.5	12.0	13.1	14.1	15.2	14.4	16.1	17.6	20.6	21.6	290
Poland	5.1	5.4	6.5	7.2	8.3	9.6	8.3	9.5	10.0	10.2	10.3	10.8	11.4	11.3	12.4	13.3	14.2	14.3	15.8	17.5	20.0	22.6	447
Slovakia	5.6	6.4	7.3	8.5	10.4	12.2	11.8	12.7	13.3	13.6	13.8	14.1	14.8	15.0	15.6	16.6	17.3	17.3	18.7	20.2	22.6	23.9	429
Luxembourg	58.0	61.5	65.0	72.3	78.3	81.8	78.4	83.6	85.3	87.5	90.0	92.8	95.1	96.2	97.4	98.9	100.4	102.2	113.9	117.1	123.0	127.0	219
Ireland	36.4	38.4	40.9	43.3	44.8	41.7	37.4	36.7	37.8	38.4	39.6	43.1	58.0	58.1	64.0	68.5	73.2	75.8	88.1	100.1	99.1	104.5	287
Germany	27.5	28.2	28.6	29.9	31.4	32.1	31.0	32.6	34.2	34.8	35.6	37.0	38.0	39.0	40.6	41.8	43.0	42.0	44.9	48.3	50.7	51.8	189
Spain	19.0	20.1	21.3	22.7	23.8	24.2	23.1	23.1	22.9	22.2	22.0	22.4	23.4	24.2	25.2	26.0	26.6	23.9	26.1	28.8	31.0	32.6	172
French	26.1	27.1	28.0	29.1	30.4	31.0	30.0	30.8	31.7	32.0	32.3	32.6	33.2	33.5	34.3	35.1	36.1	34.3	36.9	38.9	41.3	42.6	163
Italy	24.4	25.2	25.8	26.7	27.6	27.8	26.6	27.1	27.6	27.1	26.9	27.1	27.6	28.4	29.1	29.7	30.2	28.1	31.2	33.9	36.3	37.3	153

Source: Eurostat (Gross domestic product (GDP) and main components per capita, nama_10_pc, DOI:10.2908/nama_10_pc, 28/10/2025)

In table no. 1, we can see the dynamics of gross domestic product per capita in Romania, then in the entire European Union, but also in several member states: from Eastern Europe, from Western Europe, but in the states where the indicator has the highest value. We can observe several aspects:

- first of all, there is a significant distance between the GDP per capita in Romania, but also, in general, between the EU countries in Eastern Europe and the averages at the EU and

euro zone level, the member states in Western Europe and even greater compared to the maximum values of the indicator, recorded in Luxembourg and Ireland;

- secondly, the differences in GDP per capita of the EU member states in Eastern Europe tend to fade. If in 2003, the GDP per capita of the Czech Republic, Hungary, Poland was 2-3.5 times higher, in 2024, these states have a GDP per capita higher by 15-50% compared to our country;

- thirdly, the speed with which our country has eliminated the gap is very high. Thus, if GDP per capita, for the entire European Union, but also for Western member states where the indicator has the highest value, doubles (or comes close to doubling), in Romania it increases eight times, twice as high as the values recorded by sister states in the former socialist camp (except Bulgaria).

If we change the reporting basis to gross domestic product per capita, calculated at purchasing power parity (table no. 2), the progress of the Eastern European member states is even faster. Thus, these states, including Romania, in 2003 were quite far from the value of GDP per capita for the EU as a whole (with the exception of the Czech Republic and, partially, Hungary), in 2024 they are very close to the value of GDP per capita for the EU as a whole, but also to the same indicator in Western European member states, but they are still far from the maximum of the indicator, recorded in Luxembourg and Ireland. Also, with the exception of the Czech Republic, there is no longer a visible discrepancy between the GDP per capita calculated at purchasing power parity, the differences being very small. And in the case of this indicator, Romania has the fastest speed, recovering 48% and surpassing Hungary, Slovakia and being one percent behind Poland.

Table no. 2. GDP per capita (at PPP) - % of the EU average

Country / Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Δ2024/2003
I	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Euro zone	116	115	115	114	113	112	111	110	109	109	109	108	108	108	107	107	106	105	105	105	105	104	
Romania	30	35	36	39	44	51	52	52	54	56	54	55	56	58	62	65	69	72	72	73	77	78	48
Bulgaria	34	35	38	38	40	43	43	44	45	47	46	48	49	51	52	53	55	57	59	62	63	66	33
Czech	79	81	82	81	84	85	86	85	84	84	85	88	89	89	92	93	95	96	92	89	90	91	12
Hungary	62	63	63	63	61	63	65	65	66	66	68	69	70	69	69	71	73	75	75	76	76	76	14
Poland	50	52	52	52	54	56	60	63	66	68	67	68	70	69	70	72	74	78	79	78	77	79	29
Slovakia	57	58	61	64	68	72	72	76	76	77	77	78	78	73	70	70	70	74	74	71	74	75	18
Luxembourg	242	249	255	269	272	278	271	272	272	274	277	280	279	275	266	258	248	255	262	248	244	241	-1
Ireland	146	149	150	151	150	135	129	130	131	133	134	141	185	178	187	191	189	205	225	237	218	221	75
Germany	124	124	121	120	120	119	119	122	125	126	126	128	126	126	126	126	123	124	122	120	118	116	-7
Spain	101	101	102	105	104	102	100	96	92	91	90	90	91	92	92	91	90	82	85	88	90	91	-10
French	113	112	113	111	109	108	109	109	109	108	109	108	106	105	103	103	105	104	101	97	99	98	-15
Italy	118	114	112	111	109	108	108	106	105	103	100	98	97	99	98	96	96	93	96	98	98	98	-20

Source: Eurostat (Gross domestic product (GDP) and tomorrow components per capita , nama_10_pc, DOI:10.2908/nama_10_pc, 28/10/2025)

Romania's progress is visible not only at the national level, but also at the regional level, although it must be said that there is still a considerable gap between Romania's development regions and the most developed such areas in the EU, but also outside the Union.

Table No. 3. Regional GDP - billion EUR (calculated at purchasing power parity)

	Region / Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Index 2023 / 2012
1	Ile de France	631	646	655	672	685	704	727	758	701	744	785	860	136
2	Lombardia	351	348	355	362	373	383	394	398	373	424	457	490	139
3	Upper Bavaria	216	225	234	245	256	269	274	293	284	306	329	350	162
4	Istanbul	205	220	217	240	243	236	203	208	189	210	262	313	153
5	Community of Madrid	196	193	196	206	214	224	234	244	221	240	268	293	149
6	Eastern and Midland	107	114	126	143	152	169	189	206	215	249	287	291	272
7	Rhone Alps	203	206	209	214	220	226	235	242	233	250	261	285	140
8	Catalonia	195	193	197	206	215	223	231	240	215	235	259	282	145
9	Dusseldorf	183	186	193	197	202	210	218	224	220	234	250	263	144
10	Stuttgart	176	180	187	199	202	213	222	225	217	230	247	262	149
58	Bucharest -Ilfov	37	38	40	44	45	51	55	62	61	68	82	96	258
75	Budapest	38	37	39	41	42	46	50	55	52	57	62	75	199
78	Wielkopolski	37	38	40	42	42	47	50	53	53	58	65	73	199
101	Lesser Poland	30	30	32	34	34	38	41	44	43	48	53	60	203
136	Mazowiecki regional	21	20	22	23	23	25	26	28	28	31	37	41	198
141	Northwest	16	16	17	18	20	23	25	27	27	30	34	39	250
150	South-Muntenia	17	18	20	20	21	22	24	26	25	27	32	37	221
156	Center	16	16	17	18	19	21	24	25	25	27	30	35	220
159	Bratislava Region	21	22	22	23	24	25	26	27	27	29	31	33	162
162	Northeast	14	15	15	16	17	19	22	24	24	25	28	33	230
163	Belgrade region	15	16	15	15	16	17	19	21	21	23	26	33	225
167	Southeast	15	16	17	17	17	19	21	22	21	24	27	31	208
173	Central Moravia	15	15	15	16	17	18	20	21	20	22	26	29	190
174	West	14	14	14	15	16	18	19	21	20	22	25	28	207
177	Moravian-Silesian Region	16	15	15	16	17	18	20	20	19	21	25	27	170
188	City of Zagreb	15	15	15	15	16	17	18	19	18	20	22	26	167
191	Southwest Oltenia	11	11	11	12	12	14	16	17	17	18	22	25	232
221	Podlaskie	9	9	9	10	9	10	11	12	12	13	15	17	193

Source: Eurostat (Regional gross domestic product by NUTS 2 region , tgs00003, DOI:10.2908/tgs00003, 19/03/2025)

Thus, analyzing the total GDP of the region, in 2023 the Bucharest-Ilfov Region placed 58th out of over 300 regions in Europe, with a GDP of almost 100 billion EUR. In fact, the other development regions of Romania are also in the first half of the ranking or in the immediate vicinity of the median area. It should also be noted that all the development regions of our country have recorded doublings of the GDP value and that the Bucharest-Ilfov region is three, respectively four times more value-creating compared to the other Romanian regions.

**Table no. 4. Regional GDP per capita
(calculated at purchasing power parity, as % of the EU average)**

	Region	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Variation 2023 / 2012
1	Eastern and Midland	168	175	185	203	206	213	226	220	237	255	265	245	77
2	Luxembourg	276	278	282	281	277	268	259	249	256	260	252	237	-39
3	Southern	115	109	113	218	195	209	206	205	221	250	269	225	110
4	Prague	184	189	193	196	198	202	207	210	212	207	199	193	9
5	Brussels-Capital Region	220	218	217	215	210	206	202	200	202	197	194	191	-29
6	Bucharest -Ilfov	132	128	127	134	137	146	149	159	165	169	179	190	58
11	Budapest	144	141	145	142	140	142	147	155	157	158	163	168	24
39	City of Zagreb	113	111	109	112	114	116	119	120	116	121	119	125	12
105	Schleswig-Holstein	102	102	103	100	99	101	100	100	103	99	99	96	-6
154	střední Czech Republic	78	78	81	82	84	87	86	89	87	83	80	81	3
155	Wielkopolski	72	72	73	76	76	77	78	80	84	83	82	81	9

159	West	61	57	56	59	63	65	68	71	72	73	74	78	17
172	Central Moravia	66	68	71	71	72	75	75	76	78	74	71	73	7
187	Northwest	49	47	49	49	53	59	61	64	68	67	67	71	22
190	Mazowiecki regional	58	57	58	60	60	60	61	64	69	70	74	70	12
191	Center	55	51	52	53	56	60	63	65	68	68	66	70	15
218	Southwest Oltenia	43	40	40	41	42	47	51	54	55	55	59	62	19
221	Southeast	49	49	50	48	49	52	55	55	56	59	58	61	12
225	South Muntenia	44	43	47	45	47	49	52	52	54	55	57	60	16
255	Northeast	35	34	34	34	36	39	42	44	47	46	44	47	12

Source: Eurostat (Regional gross domestic product (PPS per inhabitant in % of the EU27 (from 2020) average) by NUTS 2 region , tgs00006, DOI: 10.2908/tgs00006, 19/03/2025)

If we change the reporting indicator to GDP per capita, calculated at purchasing power parity, and we report to GDP per capita in the EU, we have the surprise that the Bucharest-Ifov Region is the sixth region in Europe, with a GDP value almost double the European value of the indicator. Only one region, West, is still in the first half, but at a great distance from Bucharest-Ifov, the others being in the third third of the ranking or very close to it, but even in their case, the progress in 12 years (2012-2023) is considerable, recovering over 10 percent and in some cases even 20%. However, it should be noted that during the analyzed period, about 160 of the regions of Europe (about half) recorded decreases in GDP per capita or stagnation, another 70 recorded increases of up to 10%, another 40, increases of over 10%, and for another 40 there was no data. But the main observation remains, they have a GDP per capita of approximately one third (60-70%) compared to the Bucharest-Ifov area, and Moldova (Northeast), only one quarter (less than 50%).

2. Views on European gaps

Konya, (2023) studied convergence and economic growth in 11 European Union member states in Central and Eastern Europe between 2000 and 2019 and concluded that the main objectives of economic policy should be to identify new sources of productivity growth, including higher spending on research and development, public sector reform, infrastructure expansion, and investment in human capital.

Dăianu (2002), before the countries of Eastern Europe began their European path, considered that a more realistic objective for governments could be to promote sustainable growth, which would allow convergence and not policies that strictly follow nominal criteria for EU accession, and that although both options are difficult to put into practice, the key to development remains the first policy.

Delhey and Guericke (2001) considered that “*although partial convergence can be achieved, full recovery of the gap, i.e. reaching the ‘first league’ of rich, post-industrial European societies, is difficult*”, [...] “*we can hardly imagine that countries like Bulgaria or Romania could immediately become as modernized and prosperous as Germany or the Netherlands*”, [...] “*the acceding countries will benefit from EU membership, but nevertheless should be prepared to belong to the semi-periphery for at least another generation or two*” and that [...] “*an EU regional policy with a stronger emphasis on restructuring, similar to post-industrial, knowledge-based societies, could accelerate the process – but, nevertheless, the road will remain long*”.

In the same note, Baltă (2013) considered that “*the catching-up processes in the euro zone were not hindered by insufficient capital*” [...] but by “*the misallocation of capital, the accumulation process gradually becoming less economically efficient*”, statistical data showing that “*in most economies in the catching-up process, investments were high in all*

sectors of non-tradable industries/services than in the manufacturing sector” and that the allocation of:

“large capital flows to low-productivity industries in the non-tradable/service sectors could suggest an accumulation process driven more by the search for returns than by efficiency considerations. The weakness in productivity in catching-up countries has been widespread, affecting all economic sectors. This cannot be explained by differences in human capital, as the skill structure has improved over the past decade in the countries concerned. While further analytical work is needed to better understand the determinants of total factor productivity (TFP), insufficient investment in ICT and imperfect framework conditions in terms of competition and entry barriers could be important explanations for the disappointing performance.”

Dunford and Smith (2000) consider that there are “significant variations in the speed and direction of change in per capita income and in productivity and employment rates across countries and a sample of European regions”, that “falling behind (divergence) occurs both at the level of economic development and at the level of catching up (convergence)” and that “understanding spatial development requires attention to processes of differentiation and, in particular, the deterioration of the less developed areas of Central Europe and the overcoming of the gaps with the more developed ones, as well as to processes of catching up”. The same authors note that:

“[...] Eastern Europe and Austria-Hungary were consistently at the lower end of the economic development rankings in Europe, [...] the path to modernization taken by Western Europe was not open to the countries on the periphery in the second half of the 19th century; [...] the continued peripheralization of Eastern Europe resulted from the “refeudalization” of the region through a “second serfdom”, which developed in several ways. The most important of these was the “pull” of industrial development in Western Europe, which had the consequence that Eastern Europe was forced to play a role in the European division of labor as a producer of agricultural products and raw materials for Western European markets. Concurrent with this was the re-inscription of serfdom and tithes to feudal lords, especially in Russia and Romania”

Finally, Lackenbauer (2004) considered that Central and Eastern European (CEEC) countries, such as Hungary, are not only relatively backward compared to the “old” EU member states (EU-15), but are also witnessing a worrying increase in regional inequalities within their borders and that EU cohesion policy must take into account both catching up with the national gap and limiting regional disparities.

3. Romanian realities

Although true, the previous information seems quite far from the daily reality in our country. Undoubtedly, the economic situation of the average citizen is considerably better compared to December 1989 or January 1, 2007, when we entered the European Union. But these are averages. At the level of the majority of ordinary citizens, there is a significant discrepancy if we compare it to the average values. Specifically:

I. Wages are only a part of the gross domestic product, the latter including, in addition to employee remuneration (and these assessed at gross values, therefore including income tax and social and health contributions), corporate profits (gross operating surplus) and a series of taxes and duties on product or production. From the taxes collected by the various budgets of Romania from the gross domestic product and its components, public employee remuneration and various social benefits (pensions, benefits, etc.) are paid. So, to begin with, we should look at how much these represent in total GDP (table 5). From table no. 5 we note that employee remuneration (from the private sector, where GDP is created) represented shares in

GDP between 30 and 40% between 2006 (the year preceding EU accession) and 2024. But these are gross values, because if we deduct taxes and contributions on salaries, they are reduced to about 25%. In recent years, the salaries of public sector employees have represented about 9% of GDP, and social assistance expenses another 12-13%, which leads to a cumulative value of employee remuneration, payroll expenses of public sector employees and those with social assistance of only 43-47% of GDP. In other words, as a conclusion, the average values regarding GDP per capita represent incomes only one percent lower than 50% (in fact, 43-47%).

Table No. 5. GDP, wages, social assistance

Year		<i>billion lei current prices</i>																		
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
GDP		343	426	540	531	540	587	621	632	669	713	752	852	953	1,060	1,064	1,186	1,385	1,591	1,759
Employee remuneration (gross value)	abs wave .	132	144	196	182	181	185	193	202	218	229	269	318	365	411	421	449	519	618	735
	% in GDP	38.5	33.8	36.3	34.3	33.5	31.5	31.1	32.0	32.6	32.1	35.8	37.3	38.3	38.8	39.6	37.9	37.5	38.8	41.8
Employee remuneration (net value)	abs wave .	93	102	138	128	128	130	136	142	154	161	190	224	213	240	246	263	303	362	430
	% in GDP	27.1	23.9	25.6	24.1	23.7	22.1	21.9	22.5	23.0	22.6	25.3	26.3	22.4	22.6	23.1	22.2	21.9	22.8	24.4
Personal expense budget	abs wave .	27.6	33.7	45.6	46.8	42.8	38.4	40.8	46.2	50.4	52.1	57	69.6	86.1	102.3	110	111.9	117.7	132.7	164.6
	% in GDP	8.0	7.9	8.4	8.8	7.9	6.5	6.6	7.3	7.5	7.3	7.6	8.2	9.0	9.7	10.3	9.4	8.5	8.3	9.4
Cost of social assistance budget	abs wave .	30.9	38.9	54.2	64	68.6	68	67	68.4	71.2	76	81.8	92.6	101.4	114.7	138.6	147.2	174.3	191	224
	% in GDP	9.0	9.1	10.0	12.1	12.7	11.6	10.8	10.8	10.6	10.7	10.9	10.9	10.6	10.8	13.0	12.4	12.6	12.0	12.7
Total check . with salaries and assistance sociale	abs wave .	152	174	238	239	239	237	244	257	275	289	329	386	401	457	495	522	595	685	819
	% in GDP	44	41	44	45	44	40	39	41	41	41	44	45	42	43	47	44	43	43	47

Source: INS (www.insse.ro), Ministry of Finance (www.mfinante.gov.ro) and author's calculations

II. Secondly, salaries and social security benefits, i.e. the incomes analyzed previously, are not obtained by all citizens. There is a significant number who do not register incomes, at least not in the official statistics of the Romanian state. For example, from the resident population reported by the National Institute of Statistics, of about 21.7 million inhabitants, we have approximately 6 million employees, and others, 5.1 million people receive social benefits, such as pensions (and other assimilated benefits), from the Social Insurance Budget or special budgets, approximately 3.4 million children receive allowances and others approximately 1 million people receive disability benefits. So, approximately 75% of the resident population receives various incomes, resulting in 25%, i.e. one person in four having no income.

Table No. 6. Population categories and average incomes of the category

Population category / population income	THOUSAN D People	Average value (gross) - lei	% of total resident population
employee	5,955	9,201	27.4
state pensions for farmers	4,693	2,777	21.6
pensioner social benefits	885	526	4.1
veterans	12	914	0.1
pensions and allowances special laws	405	1,059	1.9
service pensions	12	16,790	0.1
child allowances	3,442	336	15.8
child-rearing allowance	147	3,698	0.7

Population category / population income	THOUSAND D People	Average value (gross) - lei	% of total resident population
child growth insertion stimulant	75	755	0.3
child placement allowance	28	1,303	0.1
minimum inclusion income	353	664	1.6
home heating aid (2024)	38	265	0.2
compensation and personal budget for severe disability	363	728	1.7
allowance and personal budget for severe disability	405	496	1.9
personal budget medium handicap	85	80	0.4
family budget with a severely disabled child	53	463	0.2
family budget with a severely disabled child	11	232	0.1
family budget with a child with a medium disability	17	80	0.1
allowance for accompanying person with severe visual disability	34	2,574	0.2
child food allowance	0.1	1,000	0.0
food allowance	14	990	0.1
food allowances for people with tuberculosis	4	890	0.0
total	17,031.1		78.34%
resident population	21,739		100%

Source: compiled by the author based on data collected from the National Pension House (www.cnpp.ro, statistics section), from the National Agency for Payments and Social Inspection (www.mmanpis.ro, Public Interest Information section, subsection Payments made by ANPIS) and calculations by the author

III. Thirdly, although salaries are the most important income of Romanians and are obtained by most of the population (27%), several characteristics can still be observed regarding them:

- in July 2025, 74% of employees had a gross monthly salary below the national average of 9,200 lei. That is, for 3 out of 4 employees, the average was not relevant;
- more than 36% of employees, i.e. one in three people, had a gross monthly salary at or close to the national minimum wage, which is currently 4,050 lei;
- income polarization, the second tranche of average gross salary, with an average of 2,530 lei, is almost 30 times lower than the average salary of the last tranche, which is 71,783 lei.
- if we take as a benchmark the GDP per capita of 18,600 EUR, we notice that this value is representative of less than 10% of Romanian employees.

Table no. 7. Salaries in Romania and their grouping by intervals

Gross income tranche	Number of incomes (salaries, allowances, unemployment benefits, etc.)	Average monthly income related to the tranche (lei)	Number of cumulative incomes, including the respective installment	Share of cumulative income in total income	Average annualized gross monthly income (lei)	Average annualized gross monthly income (euro; cv 5076 lei)	Average annualized net monthly income (euro; current 5076 lei)
0	49,128	0	49,128	0.82	0	0	0
1-4049	1,257,139	2,530	1,306,267	21.93	30,355	5,980	3,498
4050	38,325	4,050	1,344,592	22.58	48,600	9,574	5,601
4051-4581	842,882	4,223	2,187,474	36.73	50,678	9,984	5,840
4582	102,740	4,582	2,290,214	38.46	54,984	10,832	6,337
4583-5000	343,016	4,766	2,633,230	44.22	57,192	11,267	6,591
5001-6000	586,235	5,475	3,219,465	54.06	65,702	12,944	7,572
6001-7000	450,712	6,504	3,670,177	61.63	78,054	15,377	8,996

Gross income tranche	Number of incomes (salaries, allowances, unemployment benefits, etc.)	Average monthly income related to the tranche (lei)	Number of cumulative incomes, including the respective installment	Share of cumulative income in total income	Average annualized gross monthly income (lei)	Average annualized gross monthly income (euro; cv 5076 lei)	Average annualized net monthly income (euro; current 5076 lei)
7001-8000	390,992	7,494	4,061,169	68.20	89,932	17,717	10,365
8001-8619	218,055	8,322	4,279,224	71.86	99,867	19,674	11,510
8620	315	8,620	4,279,539	71.86	103,440	20,378	11,921
8621-9000	118,266	8,808	4,397,805	73.85	105,697	20,823	12,181
9001-10000	265,718	9,494	4,663,523	78.31	113,930	22,445	13,130
10001-12000	425,093	10,960	5,088,616	85.45	131,524	25,911	15,158
12001-13000	144,233	12,473	5,232,849	87.87	149,677	29,487	17,250
13001-15000	230,979	13,911	5,463,828	91.75	166,928	32,886	19,238
15001-16000	65,776	15,468	5,529,604	92.85	185,613	36,567	21,392
16001-18000	99,493	16,964	5,629,097	94.52	203,572	40,105	23,461
18001-20000	67,256	18,973	5,696,353	95.65	227,671	44,852	26,239
20001-22000	51,901	20,972	5,748,254	96.53	251,669	49,580	29,004
22001-25000	53,460	23,412	5,801,714	97.42	280,938	55,346	32,378
25001-30000	61,204	27,231	5,862,918	98.45	326,776	64,377	37,660
30001-40000	56,110	34,075	5,919,028	99.39	408,903	80,556	47,125
40001-43099	7,722	41,552	5,926,750	99.52	498,626	98,232	57,466
43100	7	43,100	5,926,757	99.52	517,200	101,891	59,606
Over 43100	28,439	71,783	5,955,196	100.00	861,392	169,699	99,274
Total	5,955,196	-	-	-	-	-	-

Source: author's calculations according to CNPP - Centralizing situation regarding the types of insured persons and the average gross income by income tranches for July 2025, <https://www.cnpp.ro/ro/indicatori-statistici-pilon-i> (accessed 27 Oct. 2025)

IV. Fourthly, pensions are the second most notable income of Romanians, being obtained by 24% of the population, so approximately one in four people obtains this type of income, and related to it we can observe the following aspects:

- in July 2025, the majority (approximately 90%) were state pensions for farmers and only 10% were paid by other pension funds or were paid under special laws or were considered special pensions;
- approximately 90% of state pensions and those for farmers (i.e. the majority) are very small, the average value being only 2,777 lei, many of them being under 1,200 lei, so that about 20% of beneficiaries also receive a social allowance to ensure a minimum level of subsistence;
- there is a certain polarization in the case of pensions (the state category and for farmers, i.e. the majority), but less pronounced than in salaries. Thus, between the average of the first interval and the average of the last interval there is a ratio of 1 to approximately 20;
- if we take as a benchmark the GDP per capita of 18,600 EUR, we notice that this value is found in very few cases in the case of state pensions. In fact, less than half a million state pensioners have monthly pensions of over 5,000 lei gross per month (so 12,000 EUR annually);
- the only large pensions in Romania are the special ones, with an average value of about 16,800 lei per month (therefore, about 40 thousand EUR gross annually), for which the GDP per capita of 18.6 thousand EUR is representative.

**Table no. 8. Pensions in Romania (and other similar benefits)
and their grouping by intervals**

Pension levels	Social security benefits - total	average of the interval (gross monthly compensation) - lei	Monthly value relative to the interval - lei	Net monthly value relative to the interval - lei	net annual value – lei	net annual value in EUR (5,076 lei)
up to 700	354,973	350	124,240,550	350	4,200	827
701-1000	298,092	850	253,378,200	850	10,200	2,009
1001-1200	243,325	1,100	267,657,500	1,100	13,200	2,600
1201-1400	244,688	1,300	318,094,400	1,300	15,600	3,073
1401-1500	127,929	1,450	185,497,050	1,450	17,400	3,428
1501-1600	136,139	1,550	211,015,450	1,550	18,600	3,664
1601-1700	124,039	1,650	204,664,350	1,650	19,800	3,901
1701-1800	124,613	1,750	218,072,750	1,750	21,000	4,137
1801-1900	121,751	1,850	225,239,350	1,850	22,200	4,374
1901-2000	118,517	1,950	231,108,150	1,950	23,400	4,610
2001-2100	113,631	2,050	232,943,550	2,050	24,600	4,846
2101-2200	110,560	2,150	237,704,000	2,150	25,800	5,083
2201-2300	106,650	2,250	239,962,500	2,250	27,000	5,319
2301-2500	205,024	2,400	492,057,600	2,400	28,800	5,674
2501-2700	195,053	2,600	507,137,800	2,600	31,200	6,147
2701-2900	188,288	2,800	527,206,400	2,800	33,600	6,619
2901-3000	92,025	2,950	271,473,750	2,950	35,400	6,974
3001-3500	428,959	3,250	1,394,116,750	3,225	38,700	7,624
3501-4000	361,672	3,750	1,356,270,000	3,675	44,100	8,688
4001-4500	287,837	4,250	1,223,307,250	4,100	49,200	9,693
4501-5000	213,459	4,750	1,013,930,250	4,500	54,000	10,638
over 5000	495,586	6,650	3,295,646,900	6,020	72,240	14,232
TOTAL	4,692,810		13,030,724,500			

Source: author's calculations according to CNPP - Grouping the number of pensioners by pension levels according to pension rights due in September 2025, <https://www.cnpp.ro/indicatori-statistici-pilon-i> (accessed 27 Oct. 2025)

V. Fifth, economic growth has not been equal throughout the country. In principle, the developed regions have prospered a lot, and though less developed ones have caught up to an extent, their progress is much smaller. Thus:

- if we compare the regional GDP of Bucharest with that achieved in the other regions, respectively, the GDP per capita of the Bucharest-Ilfov Region with that of the other regions, we find that that of Bucharest is 2.5-4 times higher than that of the other regions;

- The Bucharest-Ilfov Region has consolidated its position in terms of contribution to the national GDP, from about a quarter in 2012 to almost 30%. We still have negligible increases in the contribution to the national GDP in the Northwest and Northeast Regions, while the other five regions (South-Muntenia, Center, Southeast, West, Southwest) are recording decreases;

Table no. 9. Share of regional GDP – in national GDP %

	Region	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	Bucharest-Ilfov	26.4	26.4	26.5	27.5	26.9	27.3	26.7	27.7	27.7	28.2	29.3	29.6
2	Northwest	11.4	11.1	11.3	11.3	12.0	12.3	12.1	12.1	12.3	12.4	12.1	12.0
3	South-Muntenia	12.1	12.5	13.2	12.5	12.6	11.8	11.7	11.6	11.4	11.2	11.4	11.4
4	Center	11.4	11.1	11.3	11.3	11.4	11.2	11.7	11.2	11.4	11.2	10.7	10.8
5	Northeast	10.0	10.4	9.9	10.0	10.2	10.2	10.7	10.7	10.9	10.4	10.0	10.2

6	Southeast	10.7	11.1	11.3	10.6	10.2	10.2	10.2	9.8	9.5	10.0	9.6	9.6
7	West	10.0	9.7	9.3	9.4	9.6	9.6	9.2	9.4	9.1	9.1	8.9	8.6
8	Southwest Oltenia	7.9	7.6	7.3	7.5	7.2	7.5	7.8	7.6	7.7	7.5	7.9	7.7

Eurostat data (Regional gross domestic product by NUTS 2 region , tgs00003, DOI:10.2908/tgs00003, 19/03/2025)

- GDP per capita is in all regions far from GDP per capita in the Bucharest-Ilfov Region. In all regions, except the Northwest region (but here too with a negligible increase), the share of GDP per capita in the GDP of the Bucharest-Ilfov Region decreases (in some cases, by more than 5%). Interestingly, this regression occurs in almost all cases starting with 2018 with the establishment of permanent tax offices for large taxpayers in Bucharest, thus taking place a transfer of economic power to the Bucharest-Ilfov Region.

Table no. 10. Ratio between regional GDP per capita and GDP per capita in the Bucharest-Ilfov region (%)

	Region	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	Bucharest -Ilfov	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2	West	46.2	44.5	44.1	44.0	46.0	44.5	45.6	44.7	43.6	43.2	41.3	41.1
3	Northwest	37.1	36.7	38.6	36.6	38.7	40.4	40.9	40.3	41.2	39.6	37.4	37.4
4	Center	41.7	39.8	40.9	39.6	40.9	41.1	42.3	40.9	41.2	40.2	36.9	36.8
5	Southwest Oltenia	32.6	31.3	31.5	30.6	30.7	32.2	34.2	34.0	33.3	32.5	33.0	32.6
6	Southeast	37.1	38.3	39.4	35.8	35.8	35.6	36.9	34.6	33.9	34.9	32.4	32.1
7	South Muntenia	33.3	33.6	37.0	33.6	34.3	33.6	34.9	32.7	32.7	32.5	31.8	31.6
8	Northeast	26.5	26.6	26.8	25.4	26.3	26.7	28.2	27.7	28.5	27.2	24.6	24.7

Eurostat data (Regional gross domestic product by NUTS 2 region , tgs00003, DOI:10.2908/tgs00003, 19/03/2025)

From the previous data we can see that we are witnessing a significant polarization, as in the entire Romanian economy. As Neagu, Dragu, and Costeiu (2016) observed, the average statistical indicators calculated for the entire Romanian economy practically become irrelevant, being impossible to generalize the averages at the national level, the trends as well as the consistency of some average values are given by a minority, for whom the economic and public policies are actually created and applied and with whom the bulk of the population does not identify.

4. Conclusions

After joining the European Union, Romania has made significant progress in terms of economic growth and the derived indicator of gross domestic product per capita. Thus, the speed with which our country has closed the gap that separated it from the founding states of the EU is very high. Also, the differences in GDP per capita of the EU member countries in Eastern Europe tend to fade. If we change the reporting basis to gross domestic product per capita, calculated at purchasing power parity (table no. 2), the progress of the member countries in Eastern Europe is even faster, and in the case of this indicator, Romania has the highest speed, recovering 48% and surpassing Hungary, Slovakia and being one percent behind Poland.

Romania's progress is not only visible at the national level, but also at the regional level (although it must be said that there is still a considerable gap between the development regions of Romania), in 2023 the Bucharest-Ilfov Region placed 58th out of over 300 regions in Europe, with a GDP of almost 100 billion EUR. In fact, the other development regions of Romania are also in the first half of the ranking or in close proximity to the median area.

While the Bucharest-Ilfov Region was the sixth region in Europe, with a GDP value almost double the European value of the indicator, the others were in the third third of the ranking.

But, unfortunately, in the conditions of a heightened polarization of Romanian society, the average statistical indicators calculated for our country practically become irrelevant, being impossible to generalize the averages at the national level, the trend, as well as the consistency of the average values, are given by a minority, for whom economic and public policies are actually created and applied and with whom the bulk of the population does not identify. Thus:

- there is a long way between GDP per capita and the income of the population, employee remuneration represents only about 30-40% of GDP, and if we add the salaries of state employees and the amounts redistributed through public budgets, we reach 43-47% of the national GDP;

- salaries and social security benefits, i.e. the incomes analyzed previously, are not obtained by all citizens, but only approximately 75% of the resident population receives various incomes, resulting in 25%, i.e. one person in four, having no income at all;

- although salaries are the most important income of Romanians and are obtained by most of the population (27%), about 74% of employees had a gross monthly salary below the national average of 9,200 lei, more than 36% of employees, that is, one in three people, had a gross monthly salary at or near the national minimum, which is currently 4,050 lei, and the range of salaries indicates their polarization (the second tranche of average gross salary, with an average of 2,530 lei, is almost 30 times lower than the average salary of the last tranche, which is 71,783 lei). Additionally, if we take as a benchmark the GDP per capita of 18,600 EUR, we note that this value is representative of less than 10% of Romanian employees;

- pensions are the second income of Romanians, being obtained by 24% of the inhabitants, but the majority (90%) are very small, the average value being only 2,777 lei, many of them being under 1,200 lei (which is why beneficiaries also receive a social allowance to ensure a minimum level of subsistence). If we take as a benchmark the GDP per capita of 18,600 EUR, we notice that this value is found in the case of special pensions, with an average value of about 16,800 thousand lei per month (therefore, about 40 thousand EUR gross annually).

- economic growth has not been distributed equally throughout the country. In principle, the developed regions have prospered a lot, and though less developed ones have caught up to an extent, their progress is much smaller. Thus, the regional GDP of Bucharest has consolidated its position, and the other regions achieve about a third of the economic power of the Capital and the surrounding geographical area.

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WATER AS A CIRCULAR RESOURCE IN REGENERATIVE AGRICULTURE: RISK GOVERNANCE AND CIRCULAR ECONOMY PRINCIPLES IN MOLDOVAN ECO-ENTERPRISES

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Abstract: *This study investigates the interplay between regenerative agriculture and circular economy principles through the lens of water resource governance in the Republic of Moldova. Water occupies a structurally central position in both paradigms: regenerative agriculture depends on the restoration and stewardship of water cycles, while the circular economy demands that water be treated not as a linear throughput input but as a continuously recirculated, quality-preserved resource. Drawing on a score-based risk assessment applied to each technological stage of the Chisinau municipal water supply system, from Dniester River intake through treatment, pumping, distribution, and operational management, the paper demonstrates that current water governance failures represent a systemic barrier to the uptake of regenerative and circular agricultural models in Moldova. The analysis identifies maximum-score risks (25/25) concentrated at the water intake stage, attributable to fluvial mismanagement, aging Soviet-era infrastructure, and the absence of a transboundary Dniester River Administration. The study integrates financial vulnerability assessment (Conan-Holder model) to quantify how water disruptions affect the balance-sheet resilience of eco-SMEs. Recommendations are grounded in circular economy design principles: closed water loops through aquaponics, constructed wetlands, and greywater reuse; regenerative soil-water management practices reducing irrigation demand; and institutional governance reforms enabling integrated water resource management consistent with the EU Water Framework Directive. The paper concludes that advancing the regenerative agriculture and circular economy nexus in Moldova is inseparable from resolving the country's water governance crisis.*

Keywords: *regenerative agriculture, circular economy, water risk management, Republic of Moldova, circular water loops, score-based risk assessment.*

JEL Classification: *Q25, M21, O13.*

1. Introduction

The twin paradigms of regenerative agriculture and the circular economy have emerged as central frameworks for rethinking sustainable development in the twenty-first century. Regenerative agriculture goes beyond mere sustainability: rather than simply maintaining existing natural capital, it seeks actively to restore degraded soils, revive biodiversity, rebuild hydrological cycles, and sequester carbon through land-use practices grounded in ecological systems thinking. The circular economy, meanwhile, challenges the linear extract-produce-discard model by advocating for closed resource loops, waste elimination, and the continuous recirculation of materials, energy, and water across economic systems.

Water sits at the intersection of both paradigms in a constitutive rather than merely instrumental sense. For regenerative agriculture, water cycle restoration through cover cropping, reduced tillage, soil organic matter enhancement, riparian buffering, and constructed wetlands is both a means and an end. For the circular economy, water is a prime example of a resource whose value is destroyed by one-way flows and whose utility is compounded by intelligent recirculation. Despite this conceptual convergence, the academic literature has rarely examined regenerative agriculture and circular economy principles together, and even more rarely through the concrete lens of water risk governance in transition economies.

The Republic of Moldova offers a revealing empirical context for this inquiry. As a small, agrarian, climate-vulnerable economy at the EU's eastern frontier, Moldova faces acute water governance challenges: a structurally fragile dependence on the Dniester River, a nascent but strategically significant eco-agricultural sector, pervasive informal agricultural employment, and an institutional framework for water risk management that falls well short of EU standards. At the same time, the country's National Development Strategy Moldova 2030, the Green Economy Package of 2018, and the National Strategy for Agriculture and Rural Development 2014-2020 all recognise the imperative to transition toward greener, more circular agricultural models.

This paper investigates the interplay between regenerative agriculture and circular economy principles specifically through the prism of water risk governance for eco-enterprises in Chisinau municipality. It applies a score-based risk assessment methodology, drawn from the WHO Water Safety Plan framework, to each stage of the municipal water supply chain operated by Apa-Canal Chisinau, and interprets the findings through regenerative and circular economy frameworks. The central argument is that the successful development of regenerative agriculture enterprises in Moldova requires not only circular water-use practices at the farm and firm level, but also systemic governance reforms that treat water as a shared circular resource at basin and national scale.

2. Litterature review

Gattinger et al. (2012) demonstrated through meta-analysis that organic and regenerative farming systems achieve significantly higher soil organic carbon stocks than conventional systems, with direct implications for water retention and drought resilience. Poeplau and Don (2015) quantified the carbon and water co-benefits of cover cropping, establishing that soil organic matter improvements translate directly into enhanced water infiltration and storage capacity. These soil-water relationships constitute the biophysical foundation of regenerative agriculture's contribution to circular water resource management.

On the circular economy side, Geissdoerfer et al. (2017) provide a comprehensive review of the circular economy concept, confirming that water is consistently identified as a priority circular resource across all major frameworks, with wastewater reuse, industrial symbiosis around water, and watershed-scale governance emerging as key implementation domains. The Ellen MacArthur Foundation (2015, 2021) reports emphasise the economic case for circular water management in the food system, estimating that transitioning global food production toward circular water practices could generate substantial economic value through input cost reductions, supply chain resilience improvements, and ecosystem service conservation. For Moldova, where agricultural water costs are near the lowest in the region, the economic argument is particularly powerful.

Rogers and Hall (2003) articulated the foundational framework for Integrated Water Resources Management, presupposing that water must be managed as an economic good with social and environmental dimensions simultaneously, a conception directly aligned with circular economy principles. Their work underpins the Water Safety Plan methodology deployed in this study. Boin et al. (2005) and the Romanian administrative risk management methodology documents provide the procedural grounding for the multi-stage risk matrix approach. The application of these methodologies to eco-agricultural enterprise water security represents a methodological contribution of this paper: score-based assessment had previously

been applied primarily to public utility systems rather than to the enterprise risk landscape of eco-businesses.

Cano Rodriguez and Nunez Nickel (2006) confirmed that financial vulnerability to external shocks, including resource supply disruptions, is a systematic moderator of SME performance. For regenerative agriculture enterprises, which operate with longer time horizons and lower short-term returns due to transition costs and the multi-year nature of soil regeneration, this financial vulnerability is heightened and demands explicit risk management integration from business plan inception.

In this context, Moldova's National Development Strategy 2030, the Green Economy Package of 2018, and the National Strategy for Agriculture and Rural Development 2014-2020 collectively chart ambitions toward greener, more circular agricultural development. Oprea, Mutaf, and David (2014) document substantial gaps between policy ambitions and institutional implementation, particularly in disaster and climate risk management for agriculture. Santos (2019) confirms that adaptive responses remain fragmented and technology-focused rather than systemic, a pattern that circular economy and regenerative agriculture frameworks are specifically designed to transcend through their emphasis on systemic design over incremental improvement.

The scientific, economic, and governance foundations for integrating regenerative agriculture and circular water management are well established, yet their translation into enterprise-level risk practice, particularly for SMEs operating in institutionally fragile, climate-exposed transition economies such as Moldova, remains an unaddressed gap that this study directly seeks to fill.

3. Research Methodology

This study employs a mixed-methods research design integrating: (1) qualitative analysis of institutional and regulatory frameworks governing water management and eco-agricultural development in Moldova; (2) quantitative score-based risk assessment applied to the Chisinau municipal water supply chain; and (3) financial vulnerability analysis using the Conan-Holder (1978) model. All three analytical components are interpreted through the dual theoretical lens of regenerative agriculture and circular economy principles.

The risk assessment follows the WHO Water Safety Plan framework adapted in Moldova's National Guide for Water Safety Plans. For each technological stage of the water supply cycle, including intake, transmission aqueducts, water treatment, pumping stations, distribution networks, and operational management, each identified hazard is evaluated on probability of occurrence (scale 1-5) and severity of consequences (scale 1-5), yielding a composite initial risk score with a maximum of 25. After mapping existing control measures and monitoring protocols, a treated risk score is calculated. Hazards with treated scores above 10 are classified as residual high-priority risks requiring additional interventions framed within circular economy or regenerative agriculture logic.

Primary data are drawn from Apa-Canal Chisinau operational documentation, water quality laboratory records, and feasibility study reports. Secondary data include BNS statistical series, environmental monitoring reports from the Agency Apele Moldovei, and FAO agri-food price data for Eastern Europe. Geographical focus on Chisinau municipality is justified by its concentration of approximately 56% of national GDP, its dominant position in the eco-product retail market at 73% of national retail turnover, and its role as the primary node in Moldova's prospective regenerative agriculture supply chain.

4. Regenerative Agriculture as a Systemic Hydro-Ecological Approach

Regenerative agriculture is defined by its commitment to continuously improving the health of agricultural ecosystems rather than merely maintaining them. Its core practices, including no-till or reduced-till cultivation, diverse crop rotations, cover cropping, agroforestry, composting, and livestock integration, share a common mechanism: they rebuild soil organic matter, which in turn enhances the soil's capacity to absorb, hold, and slowly release water. Soils with high organic matter content can retain significantly more water per unit mass than depleted soils, dramatically reducing both irrigation demand and erosion-driven water quality degradation downstream.

This hydro-ecological function of regenerative soils directly addresses the water scarcity and water quality risks documented throughout this study. Farms that transition to regenerative practices reduce their exposure to municipal water supply interruptions because their reduced irrigation demand provides a buffer that conventional farms lack. They also generate positive externalities for downstream water users, including urban eco-enterprises, by reducing sedimentation, nitrate leaching, and pesticide contamination of river systems, which are precisely the contamination risks that currently inflate risk scores at the Dniester intake stage.

4.1. Circular Economy Principles Applied to Water

The circular economy, as systematised by the Ellen MacArthur Foundation and operationalised through the EU Circular Economy Action Plans, rests on three principles: eliminate waste and pollution; keep products and materials in use; and regenerate natural systems. All three principles apply directly to water management in the agricultural context. Water pollution elimination maps onto the contamination-risk reduction challenge throughout the supply chain. Keeping water in use translates into recirculation technologies including greywater reuse, rainwater harvesting, aquaponic closed loops, and constructed wetland effluent treatment. Regenerating natural systems corresponds precisely to the hydro-ecological functions of regenerative agriculture itself.

In circular economy terms, the current Moldovan water system is almost entirely linear: water is extracted from the Dniester, treated, used once, and discharged as wastewater with minimal recirculation. The municipal water consumption data for Chisinau, currently representing approximately 25% of historical Soviet-era peak volumes, reveals massive overcapacity in infrastructure built for a linear, high-throughput system. Transitioning to circular water flows would simultaneously reduce infrastructure stress, lower per-unit treatment costs, and increase enterprise resilience to supply disruptions.

The nexus between regenerative agriculture and the circular economy is most visible in three interaction zones. First, nutrient cycling: regenerative practices return organic matter to soils, creating biological nutrient loops that reduce dependence on synthetic fertilisers whose production is highly water-intensive and whose run-off drives water quality degradation. Second, water cycling: regenerative soils and agroforestry systems regulate the water cycle locally, reducing flash-flood peaks and maintaining base flows during low-water periods, outcomes directly relevant to the Dniester River's documented flow regulation challenges. Third, closed-system production: aquaponic and hydroponic systems represent the circular economy's inner loop applied to agriculture: virtually zero-waste, near-zero net-water-discharge production units whose economic viability has been demonstrated by Moldovan enterprises such as Salamer-Com LLC.

This theoretical convergence provides the analytical frame for interpreting the empirical findings that follow. Each risk identified in the water supply assessment can be reinterpreted as a failure point of the linear water system that circular economy and regenerative agriculture transitions are designed to overcome. Conversely, each circular or regenerative intervention generates co-benefits across multiple risk dimensions simultaneously, embodying the systemic logic that distinguishes these paradigms from incremental technical fixes.

4.2. The Chisinau Eco-Agricultural Economy: Position and Circular Potential

Moldova's ecological agriculture sector has undergone significant institutional and quantitative growth since 2020, repositioning itself as a credible component of the country's circular economy development trajectory. The number of ECO-certified agricultural producers has grown from 38 enterprises in 2020 to 151 producers holding ECO certificates covering approximately 50 agricultural crops (UN Development Programme), with the area cultivated under organic certification estimated at approximately 26,000 hectares. Despite this expansion, organic farmland still represents only around 1% of Moldova's total arable land, well below the government's stated ambition of achieving 25% organic conversion by 2030. The product mix remains skewed toward tree crops and perennials, with 12 honey-producing enterprises certified in the animal production category as of early 2024 (Seerural), a marginal improvement that nonetheless leaves certified vegetable, fruit, and broader animal production severely under-represented. On the legislative side, a landmark reform occurred with the adoption of Law No. 237/2023 on organic production and labelling, which entered into force on 1 July 2024 (Seerural), aligning Moldova's regulatory framework with EU Regulation 2018/848, a prerequisite for the mutual recognition of Moldovan organic certificates on European markets. Government Decision No. 433/2024 on the organic production control and certification system (STC) further operationalised these reforms. International market positioning has advanced: Moldova participated in BIOFACH 2025 with a record national stand double the size of previous editions, with eight companies presenting certified organic honey, wines, cold-pressed oils, plums, nuts, bio flour, and cereals and the country now exports over 40,000 tonnes of organic products to the EU annually Gov. On the retail side, the Chisinau food market has expanded substantially: the turnover of the ten largest retail chain operators in Moldova reached €1.55 billion in 2024, representing a 23.4% increase over 2023, and 521 of the country's 940 chain retail outlets are concentrated in the capital, confirming Chisinau's enduring dominance as the primary commercial market for eco-products. This market concentration makes Chisinau simultaneously the most viable location for eco-product commercialisation and the site where regenerative agriculture's circular economy potential can most readily be demonstrated, validated, and scaled.

The informal agricultural sector remains a structural feature of Moldova's rural economy, though its composition and policy context have shifted materially since 2017. The share of employment in the informal economy has reached 56% in 2022, one of the highest rates in the Central and Eastern European region, while informal employment in agriculture specifically stands at 44%, with over 56% of agricultural workers lacking formal contracts and thus excluded from pension, sickness, and unemployment protections Moldpres. Moldova's agricultural workforce has contracted sharply, from approximately 770,000 workers in 2000 to an estimated 179,000 in 2023, a decline of roughly 78%, reflecting persistent rural poverty, low wages, seasonal precarity, and emigration. According to the NBS Labour Force Survey 2024, 18.1% of Moldova's total workforce remains employed in

agriculture, underscoring the sector's continued centrality despite its structural fragility. Smallholder and family farms account for 98.8% of all agricultural producers and cultivate 36.4% of agricultural land, generating over 62% of total agricultural produce, a production base whose low-external-input character makes it intrinsically aligned with regenerative agriculture principles, even if not yet formally certified. This reservoir of potential regenerative practitioners is, however, increasingly constrained by demographics: Moldova's ageing rural population, with over 50% of rural inhabitants aged above working-age norms, and high emigration continue to shrink the agricultural workforce, making collective organisational structures an economic necessity rather than merely a policy preference.

The legal environment for collective formalisation has strengthened considerably. Building on the Agricultural Producer Groups Law of 2020, 54 Local Action Groups are now active across the country, covering over 61% of Moldova's territory and more than 1.14 million citizens. The National Agricultural and Rural Environment Development Fund has recorded a 70% increase over four years, reaching a record 1.9 billion lei in 2025, with over 8,200 unique farmers, including approximately 2,900 women and young people benefiting from subsidies, and micro-farmers now representing 61% of fund beneficiaries. Crucially, allocations for young farmers, women farmers, producer groups, and entrepreneurial cooperatives were explicitly increased in the most recent legislative reform cycle, reinforcing the policy architecture for collective transitions to ecological and regenerative production. The overarching strategic framework has also been renewed: the National Strategy on Agriculture and Rural Development 2023–2030 is now the governing policy document, partially aligned with the EU Common Agricultural Policy FiBL, and the Agrifood Partnership Platform, launched in October 2023 by the Ministry of Agriculture together with the EU Delegation and FAO, formalised a Joint Declaration supporting Moldova's agri-food sector on its path toward EU membership. Moldova's October 2024 constitutional referendum, which anchored EU membership as a strategic goal in the constitution, further institutionalises the trajectory toward EU-aligned ecological production standards, including the organic regulation framework introduced by Law No. 237/2023, as the definitive long-term direction for the sector.

4.3. Climate Change as a Driver of Circular Water Imperatives

Moldova's climate trajectory makes the transition from linear to circular water management a matter of economic survival rather than merely good practice. Historical temperature records show that 7 of the 10 hottest years on record in Moldova occurred in the last two decades. Agricultural droughts now regularly span entire growing seasons. The Dniester River, which supplies approximately 80% of Moldova's total water needs and 98% of the water received by the capital Chisinau, is under compounding anthropogenic, climatic, and now direct war-related pressures. The Novodnistrovsk hydroelectric complex has chronically reduced natural flow regimes to 120–130 cubic metres per second in critical sections, versus the natural norm of 220–260 cubic metres per second, and the river's self-purification capacity has declined by an estimated 80% over three years.

The latent contamination risk from Ukraine's Dniester basin, previously attributed to 25 Soviet-era toxic waste deposits storing 165 million tonnes of industrial hazardous material, escalated into an acute crisis in March 2026. On March 2026, Russia carried out its first large-scale missile and drone attack on the Dniester Hydroelectric Power Plant in Chernivtsi Oblast, Ukraine. Slicks of technical transformer oil were discovered in the Dniester near the village of

Liadova in Ukraine's Vinnytsia Oblast, with the pollution confirmed to have originated from infrastructure damaged by the Russian strike. The oil slicks drifted downstream and were confirmed within Moldova's territory near Naslavcea, prompting Moldova's Environment Minister to warn that the actual volume of oil in the river significantly exceeded the initially reported 1.5 tonnes, and that pollutants were still actively entering the river. As a result, Moldova's government activated the EU Civil Protection Mechanism, deployed absorbent booms and containment barriers at critical intake points including near the Vadul-lui-Voda water intake station that supplies Chisinau, and water supply was restricted in northern regions as a precautionary public health measure. It is to be mentioned that since early October 2025, Russian forces have deliberately attacked 11 hydroelectric power plants and 45 major combined heat and power plants across Ukraine (UNCTAD), making the Dniester contamination not an isolated incident but the latest manifestation of a systematic strategy of environmental destruction with transboundary consequences.

This March 2026 crisis transforms what was previously a latent risk scenario into a documented, recurring threat category for Chisinau's water supply and, by extension, for every eco-enterprise in its downstream agricultural value chain. In circular economy terms, the river remains the ultimate upstream node of the regional water loop: its acute contamination by war-related petroleum products, layered upon chronic flow mismanagement and Soviet-era industrial waste legacies, constitutes a compounding systemic value destruction that no individual water utility or farm operator can absorb or offset. Restoring the Dniester's ecological integrity, through transboundary governance, military conflict resolution, and the regenerative upstream agricultural practices described throughout this study is therefore not merely an environmental goal but an existential economic prerequisite for the entire downstream regenerative agriculture and circular economy transition in Moldova.

4.4. Score-Based Risk Assessment and Circular Economy Reinterpretation

The Chisinau water supply system is a linear throughput system in its current configuration: water is extracted from the Dniester, treated through coagulation-flocculation-sedimentation-filtration-chlorination, distributed to users, and discharged as wastewater with minimal recirculation. The system was designed for Soviet-era consumption volumes; current use represents approximately 25% of historical peak demand, creating structural overcapacity that nonetheless masks significant vulnerability due to aging equipment and single-source dependence. Water quality monitoring at the intake section reveals average *E. coli* counts of 245 UFC per 100ml and total coliform counts of 334 UFC per 100ml, requiring full multi-stage treatment before distribution.

From a circular economy perspective, each risk identified in the assessment below corresponds to a failure point of this linear model. The risk assessment simultaneously serves as a diagnostic of where circular economy interventions, at the governance, infrastructure, and enterprise levels, would generate the greatest resilience returns. The reinterpretation of each risk through a circular economy and regenerative agriculture lens is an analytical contribution of this paper, connecting technical risk management to the broader paradigm shift.

The intake stage from the Dniester River carries the highest concentration of maximum composite risk scores. Seven principal hazards at this stage register initial scores between 20 and 25 out of 25. Table 1 presents the assessment including circular economy and regenerative agriculture intervention pathways, demonstrating how each risk corresponds to a

design failure of the linear system and how circular or regenerative interventions address it at source.

Table 1. Risk Assessment at Water Intake Stage: Circular Economy and Regenerative Agriculture Intervention Pathways

Hazard (Initial Score)	Init.	Current Controls	Treat.	CE / Regenerative Agriculture Intervention Pathway
Dniester level below minimum intake (Prob-5, Sev-5)	25	Reservoir discharge management; minimum flow 190 m3/s	20	Establish Dniester River Administration (governance circularity); upstream regenerative agriculture to restore hydrological base flows; riparian reforestation for evapotranspiration regulation
Atypical toxic substances with unknown treatability (Prob-4, Sev-5)	20	Pump shutdown protocol; visual intake screening	15	Bio-indicator organisms (freshwater mussels) as circular biosensors; constructed wetland pre-treatment as natural circular filter; upstream toxic waste remediation programme
Dniester level above maximum intake - flooding (Prob-5, Sev-5)	25	Stop intake pumps; drainage pumps; existing emergency protocol	10	Fluvial administration with real-time discharge scheduling; upstream reforestation to attenuate flood peaks (regenerative hydrology)
Excessive turbidity - siltation (Prob-5, Sev-5)	25	Pump shutdown to prevent siltation; sludge washing protocol	10	Upstream regenerative agriculture (cover crops, no-till) to reduce soil erosion and sedimentation, directly reducing turbidity at source; settling pond as circular recirculation node
Power supply interruption (Prob-5, Sev-5)	25	Transfer to own power source; emergency protocol	10	Renewable energy integration (solar/wind) for circular energy self-sufficiency at pumping stations; gravity-fed circular distribution design alternatives
Nitrates and nitrites above norm - rising probability with climate change (Prob-2, Sev-4)	8	Pump shutdown; water quality monitoring	8	Upstream regenerative agriculture (precision nutrient management, legume cover crops, riparian buffer strips) eliminates the risk at source rather than managing it at end of pipe; eliminates need for costly anionite filtration stage
Qualified personnel shortage (Prob-5, Sev-5)	25	Detailed step-by-step operational procedures; motivating salary for suburban location	5	Circular digital infrastructure: remote IoT monitoring, SCADA with biosensor integration; reduces human labour dependency at remote locations

Source: Own elaboration based on Apa-Canal Chisinau operational data; CE/RA intervention pathways represent the authors' analytical contribution.

Two risk items merit particular attention through the regenerative agriculture lens. The turbidity risk (scored 25/25 initially, treated to 10/25) and the nitrate risk (scored 8/25 and

unchanged by current controls) are primarily driven by upstream agricultural practices: conventional tillage, synthetic fertiliser over-application, and the absence of riparian buffer zones. A regional transition to regenerative agriculture practices upstream of the Chisinau intake would reduce these risks at source, dramatically outperforming end-of-pipe treatment solutions in both cost effectiveness and ecological benefit. This is the circular economy principle of regenerating natural systems applied concretely: soil health restoration generates measurable downstream water quality benefits that reduce infrastructure risk scores throughout the entire supply chain, while simultaneously building the productive capacity and climate resilience of the agricultural sector itself.

At the transmission stage covering aqueducts of 1,400 to 2,000 mm diameter, key risks including pipeline rupture (initial 25/25, treated 20/25) and pathogen contamination through structural cracks (initial 25/25, treated 5/25 under current chlorination) point toward the circular infrastructure principle of designing for durability, reparability, and minimum material throughput. Leakage losses, which in many post-Soviet water systems represent 30 to 50% of treated water volumes, constitute a critical value leak in circular economy terms: treated water embodying significant energy and chemical inputs is lost before reaching end users. Digital leak detection technologies and pipe rehabilitation investments represent circular infrastructure upgrades with positive returns across energy, water, and financial dimensions simultaneously.

At the treatment stage, the nitrate risk (initial 8/25, treated 8/25, unchanged by current controls) reflects the fundamental limitation of end-of-pipe treatment for diffuse agricultural pollution. A standard anionite filtration stage could reduce this risk but would require significant capital investment and ongoing chemical inputs. The circular economy alternative, reducing fertiliser run-off through upstream regenerative practices, achieves equivalent risk reduction while simultaneously building soil carbon, reducing farmer input costs, and preserving natural nutrient cycles. This cost comparison, between adding a treatment stage downstream and investing in regenerative practices upstream, exemplifies the economic logic of moving from linear risk management to circular systems design.

In the distribution network, the highest residual risk is water supply insufficiency during peak demand or drought periods (initial 20/25, treated 16/25). This risk has no purely technical solution within the current linear system, as it reflects a structural imbalance between fixed infrastructure capacity and variable seasonal demand. A circular demand-management approach combining enterprise-level closed water loops, distributed rainwater harvesting at building and farm level, and legislative restriction mechanisms for peak periods could reduce effective demand sufficiently to relieve system pressure. This aligns with the circular economy principle of keeping resources in use at highest value, applied here to water volume management rather than material flows.

The Conan-Holder model provides a framework for assessing how water supply disruptions affect the financial health of Moldovan SMEs in the eco-agriculture sector. The composite score $Z = 0.24R1 + 0.22R2 + 0.16R3 - 0.87R4 - 0.10R5$ evaluates enterprise viability, where R1 measures own financing capacity as gross operating surplus over total debt, R2 measures patrimonial solvency as permanent capital over total assets, R3 measures working asset efficiency as current assets minus stocks over total assets, R4 measures financial cost burden as financial charges over turnover, and R5 measures labour remuneration intensity as personnel costs over value added.

Table 2. Conan-Holder Failure Risk Grid: Circular Economy Resilience Levers for Moldovan Eco-SMEs

Z Score	Enterprise Situation	Failure Risk	Circular Economy Resilience Lever
$Z > 0.16$	Very good	< 10%	Reinvest surplus in closed-loop water infrastructure
$0.10 < Z < 0.16$	Good	10-30%	Adopt aquaponic or hydroponic systems to reduce water cost exposure
$0.04 < Z < 0.10$	Alert	30-65%	Emergency water storage; diversify sources through rainwater harvesting
$-0.05 < Z < 0.04$	Danger	65-90%	Transition to regenerative practices reducing irrigation dependence
$Z < -0.05$	Failure	> 90%	Co-operative pooling via Agricultural Producer Group

Source: Conan and Holder (1978), adapted with circular economy resilience pathways by the author.

Water supply disruptions affect Moldovan eco-SMEs primarily through R3 (inventory and current asset losses from production stoppages), R1 (reduced operating surplus from lost revenue), and potentially R4 (emergency water procurement raising financial charges). The circular economy adaptation visible in Table 2 is that each Z-score zone has a corresponding circular economy resilience lever: rather than merely absorbing shocks, circular economy-aligned enterprises structurally reduce their exposure to water-driven financial volatility by closing water loops, reducing net consumption, and diversifying water sources. This transforms water risk management from a cost centre into an investment in resilience that simultaneously lowers both the probability and severity of financial distress.

Additionally, aquaponic systems represent the most complete circular economy application available in the agri-food context. Fish provide organic fertilisation for plant growth, eliminating synthetic fertiliser costs. Plant roots biologically purify fish water, eliminating water discharge treatment costs. The net water consumption of the closed loop is near zero, eliminating irrigation water costs and supply disruption exposure simultaneously. The Salamer-Com LLC case in Moldova demonstrates commercial viability at small scale: lettuce and other crops are grown in an aquaponic system, with fish providing organic nutrient cycling and plant roots performing biological water purification. The economic logic aligns precisely with circular economy value creation theory: internalising previously externalised resource flows (nutrient management, water treatment) generates cost savings that exceed the investment required to close the loop.

Constructed wetlands represent a regenerative agriculture-compatible circular infrastructure investment with multiple co-benefits. They treat greywater and lightly contaminated agricultural runoff through natural biological processes, producing treated water suitable for irrigation, thereby creating a second-loop circular water supply that reduces dependence on the linear municipal system. Constructed wetland treatment costs are typically 50 to 80% lower than conventional wastewater treatment per unit volume, and the systems

simultaneously provide biodiversity habitat, carbon storage, educational value, and landscape aesthetic quality consistent with regenerative enterprise positioning and eco-tourism development.

The Orhei-Vit canning company's documented achievement of a 20% water consumption reduction through automatic valve installation, generating USD 345,000 in annual savings, illustrates the circular economy principle of doing more with less through intelligent design rather than resource substitution. Scaling this logic to circular water system design that integrates rainwater harvesting with greywater recirculation and closed-loop production processes would generate savings proportional to water intensity while reducing supply chain vulnerability. Romania's national irrigation infrastructure rehabilitation programme confirms the macroeconomic scale of these returns: investments generate net benefits of approximately 19,580 thousand euros per 100,000 hectares through productivity improvements and crop optimisation.

5. Conclusions

This study has demonstrated that the interplay between regenerative agriculture and circular economy principles is most tangibly expressed, in the Moldovan context, through the governance and management of water as a shared circular resource. The score-based risk assessment reveals that critical barriers to water security for eco-enterprises in Chisinau operate at multiple scales simultaneously: at the basin scale through Dniester flow mismanagement and transboundary toxic waste risks, at the infrastructure scale through aging linear throughput systems and single-source dependence, and at the enterprise scale through insufficient adoption of closed water loop technologies.

The regenerative agriculture and circular economy frameworks provide not merely a theoretical overlay but an actionable solution architecture for each identified risk category. Regenerative upstream agricultural practices reduce turbidity and nitrate risk at source, outperforming end-of-pipe treatment investments in cost-effectiveness and ecological co-benefit generation. Circular water technologies at the enterprise level transform water from a single-use linear input into a continuously recirculated resource, dramatically reducing both supply disruption exposure and operating costs. Governance circularity, the creation of feedback loops between enterprise practices, local water management, and basin-scale institutional coordination, is the systemic precondition for both.

The following policy recommendations are advanced. First, the establishment of a Dniester River Administration with legal authority to monitor, schedule, and coordinate extractions, reservoir discharges, and emergency responses is the highest-priority governance reform. This body should operate on principles of integrated adaptive water resource management consistent with the EU Water Framework Directive, and should publish real-time hydrological data modelled on Romania's INHGA diagnostic and prognostic system.

Second, national agri-environmental support schemes should explicitly incentivise regenerative agriculture practices including cover cropping, no-till cultivation, and riparian buffer establishment as upstream water quality and flow management interventions, recognising their ecosystem service value for downstream water users throughout the Chisinau eco-enterprise ecosystem.

Third, circular water infrastructure including aquaponic systems, rainwater harvesting, greywater loops, and constructed wetland treatment should be classified as eligible investments in FDD Moldova infrastructure financing rounds and in the BNM credit risk

mitigation framework under Regulation No. 112/2018, with risk-adjusted return calculations that incorporate the monetised value of water disruption risk avoidance.

Fourth, Water Safety Plans mandated by Law No. 182/2019 on Drinking Water Quality should be extended to include enterprise-level circular water plans for eco-certified producers, creating a standardised framework for water circularity assessment and continuous improvement integrated within the ecological certification system.

Fifth, legislative frameworks enabling demand management during drought or peak periods should be enacted, recognising that circular demand reduction at the consumer and enterprise level is as important as supply-side management for systemic water resilience.

Moldova's geographic position, its EU Association Agreement obligations, and the growing global premium for traceable, regeneratively produced food create a genuine strategic opportunity. The country's transition toward the regenerative agriculture and circular economy nexus requires above all a secure water governance foundation: without it, the most sophisticated circular water technologies and the most committed regenerative farmers remain exposed to systemic risks that no individual enterprise can manage alone. Resolving Moldova's water governance crisis is, therefore, the indispensable first step toward realising the full economic and ecological potential of the regenerative agriculture and circular economy transition.

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INCREASING INTERNAL CONTROL AND MANAGING RISKS IN THE PUBLIC CULTURAL SECTOR - EUROPEAN-LEVEL SOLUTIONS FOR SUSTAINABLE GOVERNANCE

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Abstract: *This paper explores the intricacies of risk management and the enhancement of internal control within public cultural institutions, aiming primarily to uncover solutions that promote sustainable governance within the European framework. This research employs a mixed methodology, incorporating an analysis of risks unique to the cultural sector, a review of pertinent European policies and instruments, and the presentation of exemplary models of best practices. This paper conducts a comparative analysis of various institutions and assesses risk management tools, emphasizing the critical role of strong internal control in preventing malfunctions, enhancing transparency, and optimizing operations. The findings emphasize that establishing robust internal control mechanisms, tailored to the unique characteristics of each institution, is crucial for maintaining the sustainability and competitiveness of the European public cultural sector amidst the challenges presented by an ever-changing global landscape.*

Keywords: *risk management, sustainable governance, public cultural institutions, internal control, Accounting.*

JEL Classification: *H83, Z18, M41.*

1. Introduction

Recognizing culture as an interdisciplinary topic with social, economic, and educational implications, public cultural sectors across Europe and the world use an integrated and participatory approach (Sabatini, 2019). Most EU development projects involve cultural activities, and the EU funds a number of programs that promote cultural collaboration on a global scale and the sector's long-term viability (Gustafsson and Lazzaro, 2021). Promoting cultural variety and social inclusion on a global scale, culture therefore becomes an integral aspect of international discussion and development policies (Zapata-Barrero and Mansouri, 2022).

Management of resources and procedures must be efficient, transparent, and integrated to promote the development of cultural infrastructure and the correct operation of public institutions, this is why governance in the public cultural sector is important (Mendoza & Talavera, 2025). A predictable and stable administrative and legal structure enhanced organizational performance, and the prevention of corruption are all outcomes of strong governance (Agu et. al.,2024). Given the cultural sector's susceptibility to a wide range of risks-including financial ones, risks associated with heritage, and threats to the continuation of cultural activities-risk management is an integral part of this governance (Mutua and Ibembe, 2020).

Public authorities may safeguard cultural assets, maximize the use of public monies, and encourage community and cultural actor participation in decision-making through the implementation of laws rooted on participatory governance and rigorous risk management (Grcheva and Oktay Vehbi, 2021). It makes it easier to address regional, national, and European issues with unified plans that are tailored to each location. Within a larger

framework of internal control and audit, risk management in the cultural sector include the preservation of cultural objects and the environment.

Strategic frameworks that encourage multilateral collaboration and long-term sustainability are therefore providing more and more assistance to the public cultural sector in both the European and worldwide contexts (Vila and al., 2021). A contemporary cultural administration rests on the tenets of good governance and risk management; they safeguard not just the continued existence of cultural institutions but also the growth of a culture that is both adaptable to new circumstances and able to make the most of its global cultural potential (David, 2025).

2. Methodologies

Starting from the main research question: How do internal control systems and risk management influence the governance and performance of public cultural institutions? the study aims at the following two objectives:

1. *Analysis of the contribution of internal control systems to increasing transparency, accountability and efficiency in resource management in public cultural institutions.*
2. *Examining the influence of organizational culture on fostering sustainable governance through the enhancement of internal control and the adaptation to modern challenges.*

The objectives outlined establish a clear and focused framework for evaluating managerial and administrative processes within public cultural institutions, emphasizing the direct connection between internal control, organizational culture, and performance governance (Figure no. 1).



Figure no. 1 - synergy between internal control, organizational culture and performance governance

Source: Own research

This study employs a clear and rigorous methodology, utilizing a mixed approach that incorporates critical analysis of pertinent documents and case studies within the realm of public culture. Through a careful review of existing guidelines, reports and policies, it seeks to highlight how internal control systems and risk management contribute to effective and accountable governance.

The chosen case studies allow a deepening of the practical applications of this theoretical framework in cultural institutions that represent models of good practice in Europe, analysing the results of transparent management of resources and compliance with the rules. This method provides an integrated perspective, which combines the theoretical with the concrete example, to provide pertinent recommendations for optimizing administrative and managerial processes.

The methodological approach emphasizes the qualitative interpretation of sources and the contextual understanding of cultural governance, providing a humanized academic framework that reflects the complexity and dynamics of the public cultural sector. Thus, research is promoted that capitalizes on existing documentation and institutional experiences to generate conclusions relevant to future practice and strategies.

2. Current challenges of public cultural institutions - Risk management in the public cultural sector

There are many and complicated problems that public cultural institutions are facing right now. Changes in the environment mean that people and businesses must quickly adjust to new social and technical realities. At the same time, financial demands mean that people must handle limited resources in a smart and innovative way (Rudkouskaya and Malik, 2024). Digitalization necessitates the amalgamation of contemporary technology to enhance cultural accessibility and to invent methods of displaying and protecting history (Poddar, 2024). But the need for openness and accountability is growing, and institutions must keep lines of communication open and honest with the public and their donors to create confidence and achieve the standards of good governance (Modise and Modise, 2023).

In the public cultural sector, risk management means figuring out what kinds of risks there are. These include financial risks, which have to do with not having enough money or using it wrong; operational risks, which have to do with how things work on a daily basis and the infrastructure; reputational risks, which hurt the institution's image and credibility; and legislative risks, which make sure that the rules and laws are followed.

Risk management in the public cultural sector may be seamlessly included into internal control systems. Internal control makes ensuring that people follow the law and keep their finances in order, which are both important for controlling financial and legal risks (Abiodun, 2020). Internal control also helps reduce operational risks that come from everyday operations and infrastructure by making sure that operations run smoothly.

Regular audits, stakeholder engagements, and monitoring of the outside world are all ways to find and evaluate risks that work well with the internal control architecture. These approaches help you think ahead about difficulties and how to stop them from happening. Also, internal control improves long-term governance by being open and responsible (Manginte, 2024). These are essential components of controlling reputational risk, which can affect the image and credibility of cultural organizations. In the public cultural sector, risk management is based on an integrated system where internal control is the basis for constant monitoring, compliance, and flexibility (Kuola and Obasan, 2025). This is done to protect the organization's cultural mission and long-term success.

Internal control, concepts and roles - Relevant European legislative framework and policies

Internal control in cultural institutions involves a straightforward set of processes and procedures aimed at helping the organization meet its goals (Abiodun, 2020). This means following the law, managing money wisely, and making things work better. This framework is key for effective governance. It offers cultural institutions a clear and dependable system that can adapt to handle both internal and external risks, while keeping their main cultural mission in sight.

The rules and guidelines in Europe play a key role in supporting public cultural institutions to function effectively (Bekpayeva and Nikiforova, 2023). European regulations give forth norms for public financing, conserving cultural assets, and copyright (Vučković et. al., 2021). They try to find a balance between protecting culture and the need for new ideas. European policies help people feel included and make it easier for everyone to take part in cultural activities.

The European Union's Cultural Agenda is an example of a commitment to making public policy more integrated, encouraging cultures to work together, supporting digitalization, and promoting sustainable development (Vries, 2020). These programs provide participants a clear framework that makes them want to discuss their best practices, come up with new ideas, and join cultural groups from other countries. By doing this, they make culture more important as a key role in bringing people together and helping the economy grow (Aririguzoh, 2022). Thus, internal control in cultural institutions, in close correlation with the legislative framework and European policies, becomes a strategic tool for ensuring an efficient, accountable and adaptable administration, which protects cultural heritage, optimizes the use of resources and promotes an organizational culture oriented towards excellence and sustainability (Puchkov and Kholodkov, 2025).

3. Instruments and techniques to improve internal control

Enhancing internal control within public cultural institutions relies heavily on the tools and methods employed, which serve as crucial foundations for achieving effective and sustainable governance (Boufounou et. al. , 2024). In this context, internal audit functions as an independent and objective process, offering regular evaluations of adherence to legal standards and the operational efficiency of processes (Ogunsola, et. al., 2021). This practice not only identifies vulnerabilities but also suggests corrective actions to address them. The periodic risk assessment strengthens this approach by conducting a comprehensive evaluation of potential threats, regardless of whether they originate from within the institution or from external sources (Landoll,2021). This enables the organization to actively identify and address these risks before they arise.

Monitoring and feedback mechanisms (Figure no. 2) serve as essential tools that enable ongoing oversight of organizational processes, allowing for swift modifications and sustained enhancement of activities (Carreno,2024). These mechanisms promote transparency and accountability among managers, establishing a framework that can adjust to changes in context and address new challenges as they arise (Mason, 2020).



Figure no. 2- CSR Integration and Control Mechanism

The integration of risk management with internal control determines an integrative and preventive approach, which not only reacts to the identified problems, but also builds the institution's resilience. Through this functional synergy, cultural institutions protect their tangible and intangible assets, ensure the continuity of their cultural mission and strengthen their position in the face of contemporary challenges, such as legislative changes, financial pressures or reputational risks (Ma and Guo, 2024). Thus, strengthening internal control through these tools and methods contributes to managerial performance and sustainability in the cultural public sector (Boufounou et. al., 2024), establishing a strong framework for responsible and efficient management of resources and for promoting an organizational culture oriented towards performance and adaptability.

Examples of good practice and case studies from Europe

In Europe, public cultural institutions have successfully implemented internal control and risk management in different contexts. Initiatives such as the CoGov project in Central and Eastern Europe, inspired in part by Nordic practices, promote collaborative governance and the integration of cultural spaces into sustainable urban strategies (Mickov, 2025). These models combine urban revitalisation with the multiple involvement of cultural actors, communities and the private sector, ensuring an efficient and transparent use of funds and resources, within a clear and enforceable legal framework (Burnham, 2022).

The advanced participatory governance models implemented in museums and cultural centres in the Nordic countries are characterised by the active involvement of local communities, cultural operators and the administration in a continuous and transparent dialogue (Pierroux et. al., 2020). These institutions use internal audit as a fundamental tool for the ongoing assessment of financial and operational risks, which ensures rigorous monitoring of the use of funds (Ogunsola et. al., 2021).

By implementing clear and transparent procedures, institutions promote managerial accountability and mitigate the risks associated with resource diversion or inefficiency. cultural groups in Finland were some of the first to employ tight internal control systems in the 2000s. They also encouraged people in the community to help make decisions and keep an

eye on museum resources, which helped create a culture of openness and responsibility throughout the institution (Murawski,2021). This plan makes money more open and gives cultural institutions a bigger social impact, which makes them even more vital as places for people to learn and socialize. Managers are vital for setting up and keeping up internal controls that help the organization follow the rules and save money (Hamed,2023). They do this by keeping a tight eye on how the government spends its money, this internal control is decentralized and based on managerial responsibility at the organizational level (Babalola, 2020).

Also, in Germany, some cultural institutions have developed robust risk management systems, which include periodic assessments that allow anticipating crises and quickly adapting to legislative or social changes (Cvetković and Andrić,2023), having an open organizational culture that encourages the involvement of employees in the process of reporting risks and problems. Internal control is closely linked to the organizational culture by promoting an open and responsible work environment (Nunticha et. al., 2024), in which employees are involved in the decision-making process and in the reporting of emerging risks.

In France, public cultural institutions have adopted integrated risk management methodologies, combining operational (Gourbier et. al., 2025), financial and reputational aspects with European governance standards, the internal control system is highly decentralised and includes both operational, financial and reputation control. Cultural institutions integrate European standards and use independent internal audit to verify compliance with policies and resource efficiency (Batko,2021). Regular evaluations help find hazards and make sure that internal processes are always changing.

In Slovenia and Croatia, internal control is preventative, meaning it tries to stop things from happening that could get in the way of reaching institutional goals (Lobnikar and Ropoša,2020; Veledar and Letica, 2020).). In both countries, the managers and staff of the institutions are mostly responsible for this system, which means they must be actively involved in keeping the environment under control (Afsar and Umrani,2020), this has facilitated not only regulatory compliance, but also the development of human and technological resource strategies adapted to new digital and societal challenges.

Through these good practices, these institutions have been able to optimize their operation, maintain stability and improve cultural and managerial performance. Thus, case studies in Europe confirm that the success of the implementation of internal control and risk management depends on the ability of institutions to integrate transparent, but also adaptive and participatory mechanisms, closely linked to organizational culture and European governance models (Manginte, 2024).

4. Recommendations for strengthening sustainable governance

For public cultural organizations to enhance their viability, it is essential to adopt practical approaches such as participatory governance (Sokka et. al., 2021). It is essential to emphasize the importance of transparent management and to foster collaboration among the public sector, cultural operators, communities, and the business sector (Swasthaisong et. al., 2025). Updating cultural infrastructure and enhancing financial management are crucial steps that require the identification of practical and sustainable economic solutions (Yang et. al., 2021).

When professionals engage in ongoing education in cultural governance and management, institutions become more cohesive and adaptable, fostering the development of

communities of practice (Devis-Rozental and Clarke,2024). Ongoing monitoring and transparent reporting foster trust and ensure accountability among individuals. To address the distinct needs of each country and Europe as a whole, it is advisable to connect local plans with European initiatives, such as the EU Cultural Agenda and the principles of the New European Bauhaus, which promote sustainability, inclusivity, and aesthetics (Rosado-García et. al., 2021). It is essential for institutions to integrate these guidelines into their daily practices and leverage the local opportunities for cultural and economic innovation (Gurgu et. al., 2024).

Legal and financial instruments must support the revitalisation of cultural spaces and cross-sectoral collaboration. In addition, adaptation requires sensitivity to national cultural diversity, but also openness to transnational cooperation for the exchange of good practices and joint projects, creating sustainable urban cultural ecosystems (Dameri and Demartini,2020). This supports sustainable governance, which maintains the vitality of the cultural sector, ensuring both heritage preservation and adapted and inclusive innovation, in the current European context and national specificities.

Strengthening sustainable governance in public cultural institutions is a complex process, which requires an integrated approach adapted to both local specificities and European requirements and values (Petti et. al., 2020). The implementation of participatory governance becomes an essential pillar in this approach, promoting a transparent and accountable administration, in which decisions are made through active collaboration between the administration, cultural operators, local communities and the private sector. This multifaceted involvement helps people get along with each other better, but it also makes sure that cultural policies, are better suited to the real requirements of the people and groups engaged (Kale, et. al., 2023).

The modernization of cultural infrastructure is a pressing need to respond to contemporary challenges, ensuring functional, accessible spaces adapted to new technologies and models of cultural consumption. In parallel, optimising financial management through the adoption of viable and sustainable economic models contributes to the stability and autonomy of institutions, reducing over-dependence on traditional sources of financing and allowing for greater flexibility in the allocation of resources (Zheng et. al., 2024).

Ongoing education in cultural governance and management, alongside the establishment of professional communities of practice, are crucial mechanisms for enhancing institutional capacity and fostering an organizational culture focused on performance and innovation. These programs facilitate the exchange of best practices, adaptation to shifts in the social and cultural landscape, and the enhancement of professional networks. Continuous supervision of decision-makers and stakeholders, along with transparent and explicit reporting, are essential methods to ensure accountability and foster public trust.

Through the implementation of open evaluation and communication strategies, cultural institutions can effectively demonstrate the importance and results of their projects, thereby strengthening support from both communities and legislators. The synchronization of local initiatives with European policies, such as the Cultural Agenda of the European Union and the tenets of the New European Bauhaus, establishes a unified and progressive framework for the sustainable development of the cultural sector. These strategies promote the values of inclusion, sustainability and aesthetics or "beauty", inviting institutions to integrate directives that stimulate cultural and economic innovation, but also social responsibility, into their operational policies (Acevedo et. al., 2022).

To effectively tackle contemporary challenges and harness local creative potential, sustainable urban cultural ecosystems require financial and legal backing for the revitalization of cultural spaces and the promotion of interdisciplinary collaboration. Exhibiting cultural sensitivity and embracing international collaboration is crucial for exchanging effective practices and jointly undertaking initiatives that enhance the role of culture in fostering social cohesion and driving economic development. In this way, public cultural institutions can build a sustainable governance framework that maintains the vitality of the cultural sector, ensures the preservation of heritage and stimulates adapted but also inclusive innovation, thus responding to both national specificities and current European requirements.

5. Conclusions

The concept of sustainable governance in public cultural institutions highlights the necessity of a cohesive framework that utilizes cultural diversity to foster social cohesion and enhance community welfare. These measures bring the cultural sector in line with European principles, emphasizing the necessity of transparency, accountability, and adaptability in sustainable governance. Transparency and managerial accountability promote public trust and the legitimacy of cultural institutions, while adaptability enables effective responses to the complex and evolving challenges of the modern context, including enhanced access to culture within an advanced digital environment. Therefore, sustainable governance constitutes not merely a collection of regulations but an organizational culture that fosters performance, innovation, and social inclusion.

The prospects highlight the significance of digitalization and transnational collaboration as essential catalysts for fostering innovation and expanding the diversity of cultural offerings. Promoting public-private partnerships, combined with the active engagement of local communities in decision-making processes, enhances the participatory aspect of cultural governance, thereby amplifying its significance and effectiveness. Simultaneously, responding to social and energy transitions necessitates adaptable and sustainable policies that safeguard cultural heritage while also fostering social inclusion as a core principle.

The establishment of contemporary, effective legislative frameworks aligned with European standards constitutes a fundamental pillar in promoting cultural investments and ensuring accountable long-term governance. These frameworks will empower institutions to oversee resources in a transparent and strategic manner, ensuring a balance between heritage conservation and the innovation required to adapt to emerging socio-economic and technological developments.

In conclusion, a comprehensive approach that incorporates effective management techniques, ongoing professional development, modern infrastructure, and a suitable legal framework is necessary for sustainable governance in public cultural organizations. Together, these elements form a strong, diverse, and creative cultural industry that can meet the needs of both local communities and modern-day Europe.

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SUSTAINABILITY OF PUBLIC FINANCES IN THE REPUBLIC OF MOLDOVA IN THE CONTEXT OF ECONOMIC RESILIENCE

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***Abstract:** This study investigates the sustainability of public finances in the Republic of Moldova through the lens of economic resilience, with a focus on the interplay between fiscal policy, institutional capacity, and macroeconomic stability. Drawing on theories of fiscal sustainability and resilience economics, the paper employs a mixed-methods approach, combining quantitative analysis of fiscal indicators (e.g., debt-to-GDP ratio, primary balance, and tax effort) with a qualitative assessment of institutional reforms and policy responses. The analysis is based on national budgetary data, IMF and World Bank reports, and recent academic literature. Findings reveal that while Moldova has achieved relative fiscal consolidation in recent years, its public finances remain vulnerable to external shocks and domestic structural weaknesses, including limited revenue diversification and high dependence on external financing. The paper argues that enhancing fiscal resilience requires a coherent framework that integrates counter-cyclical fiscal policies, institutional strengthening, and long-term investment in economic diversification. The research contributes to the broader discourse on fiscal sustainability in small, open, and transition economies. The article was developed within the framework of Subprogram 030101 „Strengthening the resilience, competitiveness, and sustainability of the economy of the Republic of Moldova in the context of the accession process to the European Union”, institutional funding.*

***Keywords:** fiscal sustainability, economic resilience, public finance, fiscal policy, macroeconomic stability.*

***JEL Classification:** E62, H62, H63.*

1. Introduction

In recent years, the Republic of Moldova has faced significant challenges in ensuring the sustainability of public finances amid regional and global economic crises. Nevertheless, the authorities have implemented measures to balance the budget and control public debt.

The sustainability of public finances is not merely a situational concern. It affects intergenerational equity and reflects principles that apply at all times to all governments, regardless of their current level of indebtedness. Keeping public debt under control and maintaining the capacity to issue debt securities when necessary are essential for the proper functioning of the economy.

The sustainability of public finances has become an increasingly critical issue for developing and transition economies, particularly in the face of recurrent global and regional shocks. For the Republic of Moldova, a small open economy in Eastern Europe undergoing a prolonged transition toward market-oriented structures, fiscal sustainability is not only a matter of budgetary discipline but also a key determinant of long-term economic resilience. The country's economic landscape is shaped by limited natural resources, a narrow tax base, significant migration-driven remittance inflows, and high exposure to external economic and geopolitical pressures. These factors place Moldova in a vulnerable position, amplifying the importance of robust fiscal frameworks capable of absorbing shocks and supporting sustainable growth.

Over the past two decades, Moldova has undertaken a series of fiscal and structural reforms aimed at consolidating public finances, improving revenue collection, and enhancing expenditure efficiency. Despite these efforts, challenges persist. Public debt, while relatively moderate by international standards, remains sensitive to external borrowing conditions and

currency fluctuations. The budgetary system continues to experience cyclical deficits, compounded by limited capacity for domestic revenue mobilization and persistent dependence on donor support. Furthermore, institutional weaknesses and governance challenges have, at times, undermined the credibility and effectiveness of fiscal policy.

The research contributes to the academic discourse by combining empirical analysis with a theoretical framework rooted in fiscal sustainability and resilience economics. In doing so, it offers a comprehensive assessment of Moldova's fiscal position and outlines pathways toward a more stable and resilient public finance system.

2. Literature Review

The sustainability of public finances has been a central theme in macroeconomic literature, particularly in the context of fiscal policy's role in ensuring long-term economic stability and resilience. According to Perotti, Roberto & Strauch, Rolf & von Hagen, Jürgen, 1997, fiscal sustainability implies the government's ability to maintain current fiscal policies without resorting to excessive borrowing or default over the long term.

In the context of emerging and transition economies, sustainability is often constrained by institutional capacity, external vulnerability, and structural inefficiencies. Baldacci, Gupta, and Mulas-Granados (2009) highlight that in low-income and developing countries, fiscal sustainability is closely linked to governance, the quality of public expenditure, and debt management practices. Similarly, Cottarelli (2011) emphasizes the need for fiscal frameworks that combine counter-cyclical flexibility with credible long-term consolidation strategies.

The concept of economic resilience—defined as the ability of an economy to absorb, recover from, and adapt to shocks—has gained prominence following the 2008 global financial crisis and, more recently, the COVID-19 pandemic. Briguglio et al. (2009) distinguish between intrinsic resilience (related to economic structure and diversification) and policy-induced resilience (based on governance, fiscal prudence, and social protection mechanisms). For countries like Moldova, which face structural vulnerabilities such as a heavy reliance on remittances and external aid, economic resilience is deeply tied to the sustainability and flexibility of fiscal policy.

Several studies have examined fiscal sustainability in the post-Soviet and Central and Eastern European (CEE) contexts. For example, Tapsoba (2012) and Ghosh et al. (2013) analyze fiscal rules and sustainability metrics in transitional economies, pointing to the importance of expenditure control and revenue mobilization. In Moldova's case, studies by the IMF (2019) and World Bank (2021) underline persistent vulnerabilities including limited tax capacity, inefficient public investment, and dependence on concessional financing.

However, there remains a gap in the literature regarding the integration of fiscal sustainability with economic resilience in Moldova specifically. Most existing analyses treat these issues separately, often emphasizing short-term fiscal indicators over systemic vulnerabilities and long-term adaptive capacity. This paper seeks to fill this gap by offering a comprehensive assessment that connects fiscal discipline, institutional effectiveness, and macroeconomic resilience in the Moldovan context.

3. Research methodology

This study adopts a mixed-methods approach, combining quantitative analysis of fiscal and macroeconomic indicators with qualitative assessment of institutional and policy frameworks. The methodology is structured around three core components: empirical

evaluation of fiscal sustainability, assessment of economic resilience indicators, and contextual analysis of policy and governance structures in the Republic of Moldova.

To estimate fiscal sustainability thresholds, the study draws on the fiscal reaction function approach (Bohn, 1998), which tests whether the government adjusts its primary balance in response to changes in debt levels. Stationarity tests and regression models are applied to evaluate the long-term relationship between public debt and fiscal effort.

The combined methodological approach provides a comprehensive view of Moldova's fiscal sustainability, considering not only numerical thresholds but also the institutional, political, and structural context that underpins economic resilience.

4. Research results

In the last five years, the public debt balance has doubled. By the end of 2023, it amounted to 107.9 billion lei, which represents approximately 36% of GDP (+2.1 percentage points compared to the previous year). Therefore, as of December 31, 2023, the share of the state debt service relative to state budget revenues (excluding grants) remains within sustainable limits, accounting for 8.9%, below the 10.0% threshold established in the Program. This currently does not pose additional risks to the country's macroeconomic stability. However, attention must be paid to the current and potential level of public debt, as a high level of public debt may jeopardize fiscal and budgetary sustainability, regardless of long-term expenditures related to population aging. For the current year, the Republic of Moldova is within the risk and sustainability parameters (the maximum being 43% for state debt). In the first quarter of 2024, the debt-to-GDP ratio stands at 32%.

As stated above, ensuring the sustainability of public finances in recent years illustrates the principles of governance, regardless of the current level of indebtedness. Therefore, it is essential to keep public debt under control for the proper functioning of the economy.

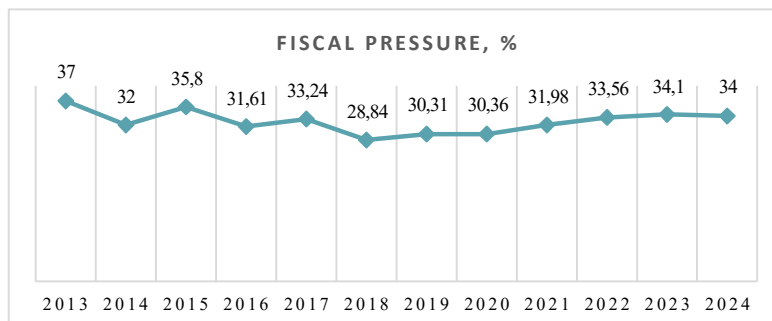


Figure 1. Dynamic fiscal pressures, %

Source: Prepared by the author based on data from the Ministry of Finance.

Fiscal pressure in the Republic of Moldova represents the ratio between total tax revenues collected by the state and Gross Domestic Product (GDP), expressed as a percentage. This is an important indicator reflecting how much citizens and businesses contribute to the public budget through taxes and levies. Fiscal pressure in Moldova has ranged between 28% and 34% of GDP in recent years. Compared to the European average (which can exceed 40% in some countries), fiscal pressure in Moldova is moderate. The

economy of the Republic of Moldova faces high informality, with many taxpayers failing to declare their actual income. The low efficiency of tax collection results in fiscal losses and tax evasion. Disproportionate tax burden – small and medium-sized enterprises (SMEs) may be more affected than large companies.

The analysis of the dynamics of fiscal pressure is essential to understand how a state finances its activities and to assess the impact on economic growth and citizens' well-being. A moderate and equitable level of fiscal pressure can contribute to sustainable development, while an excessively high level can have negative effects on the economy.

In many European Union (EU) countries, fiscal pressure tends to be higher compared to other regions, reflecting the robust public sector, social benefits, and extensive public services available to citizens.

Nordic countries (Sweden, Denmark, Finland, Norway): These countries exhibit some of the highest fiscal pressures in the world, often exceeding 40% of GDP. This high level is primarily due to comprehensive welfare systems, universal healthcare, and generous pension schemes. The Nordic model is characterized by high taxes in exchange for extensive public goods and services.

Germany, France, and the Netherlands: These economies typically have fiscal pressures ranging from 40% to 45% of GDP. High fiscal pressure is linked to strong social security systems, subsidies, public health, and educational services. These countries also have relatively high tax rates for individuals and corporations.

The fiscal pressure in these countries - Southern Europe (Italy, Spain, Greece), tends to be lower compared to the Nordic region, but still significant. It generally ranges from 30% to 40%. Economic challenges, including high public debt and unemployment rates, have put pressure on tax systems to generate sufficient revenue while managing austerity measures.

In 2024, revenues of the national public budget registered an increase of 7.9% compared to the revenues accumulated in the same period of 2023. By the end of 2024, the public debt balance amounted to 125,567 million MDL, representing approximately 38.8% of GDP (+3.1 percentage points compared to the previous year).

Therefore, as of December 31, 2024, the share of state debt service relative to state budget revenues (excluding grants) remains within sustainable limits, accounting for 6.7%, below the 10% ceiling established in the Program. This currently does not pose additional risks to the country's macroeconomic stability. However, attention must be paid to the current and potential level of public debt, as a high level of public debt may jeopardize fiscal and budgetary sustainability, regardless of long-term expenditures related to population aging.

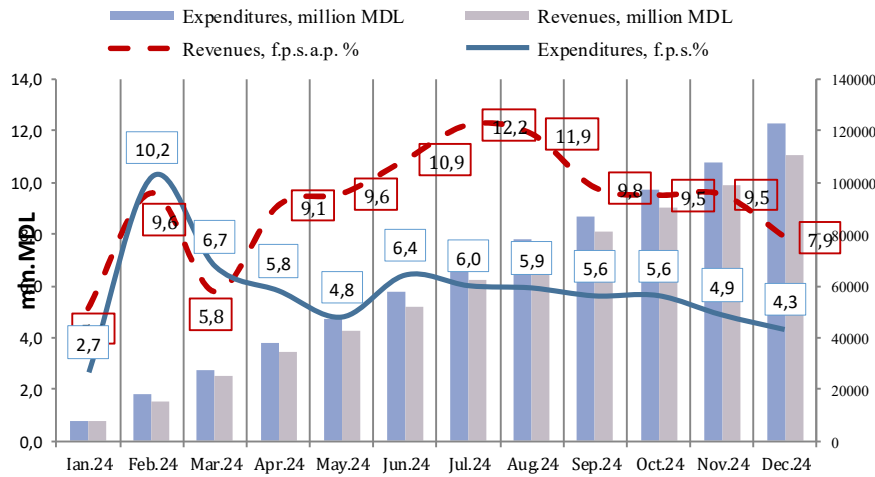


Figure 2.

Growth Rate of Monthly Revenues and Expenditures of the National Public Budget, million MDL, %

Source: Prepared by the author based on data from the Ministry of Finance.

In 2024, the revenues of the National Public Budget (NPB) amounted to 110,338.5 million MDL, an increase of 8,039.3 million MDL or 7.9% in nominal terms compared to the same period in 2023. The increase in public budget revenues in 2024 was driven by taxes and fees, which totaled 68,481.3 million MDL, reflecting an increase of 8.7%. Received grants amounted to 2,592.3 million MDL, a decrease of 51.5% or 2,754.7 million MDL compared to the previous year.

Therefore, contributions and insurance premiums saw an increase of 16%, totaling 33,561.2 million MDL, while other revenue categories also registered a 16% increase, amounting to 5,700.7 million MDL compared to the same period in 2023.

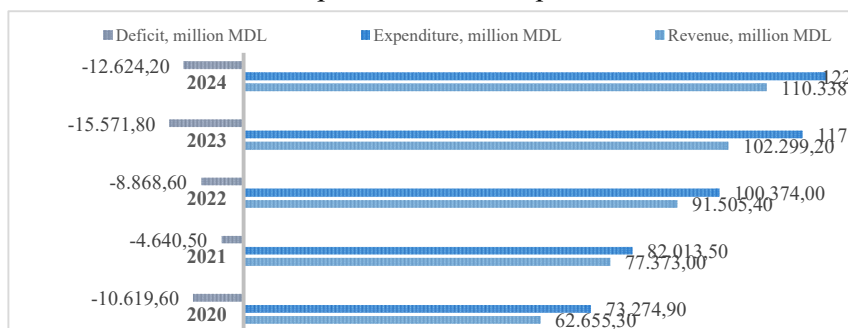


Figure 3. Growth rate of annual revenues and expenditures of the national public budget, million MDL, %

Source: Prepared by the author based on data from the Ministry of Finance.

Therefore, in 2024, out of the total revenues of the National Public Budget, state budget revenues accounted for 43%, revenues from the state social insurance budget accounted for 43%, revenues from the mandatory health insurance funds accounted for 10%, and revenues from local budgets accounted for 19%. The total revenues of the state budget amounted to 66,632 million MDL, including: general and collected revenues – 61,098.9

million MDL, grants – 2,395.1 million MDL, transfers received within the NPB – 18.8 million MDL, and other revenues – 3,119.2 million MDL. Compared to the same period in 2023, total revenues of the state budget increased by 3.7%, as a result of an 8% increase in general and collected revenues.

In 2024, expenditures from the National Public Budget (NPB) were primarily driven by the dynamics of social spending, which recorded an increase of 7% compared to the previous year. The share of total expenditures in the National Public Budget during the first half of 2024 amounted to 57,706.9 million MDL, representing an increase of 6.4% compared to the same period in 2023. In the first semester of 2024, the largest share of financing was allocated to the social sector:

- Social protection with a share of 38.2% – 47,007.8 million MDL;
- Education with a share of 16% – 19,630.7 million MDL;
- Healthcare with a share of 14.7% – 18,077.2 million MDL;
- General government services with a share of 9% – 11,114 million MDL;
- Economic sector services with a share of 9.2% – 11,300.9 million MDL.

Overall, social public expenditures amounted to approximately 68,327.9 million MDL by December 31, 2024, representing about 53% (an increase of 1.2 percentage points compared to the previous year) of the total public expenditures executed during this period. The budget deficit decreased by 19% in 2024 compared to the previous year. As of December 31, 2024, the execution of the National Public Budget showed a deficit of 12,627.2 million MDL, a decrease of 2,944.6 million MDL compared to the same period in the previous year. The budget deficit as a percentage of GDP was 3.90% in 2024, 1.28 percentage points lower than in 2023.

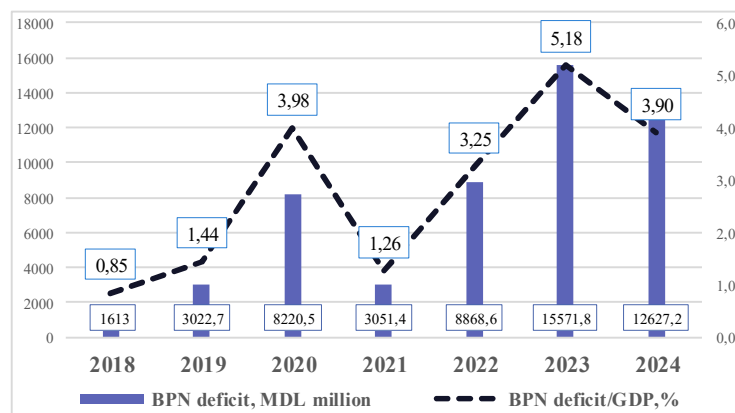


Figure 4. Public Finance Deficit, million MDL

Source: Prepared by the author based on data from the Ministry of Finance.

In 2024, there was an increase in the share of public sector debt in GDP (38.8%), with a 3.1 percentage point rise compared to the end of 2023. As of December 31, 2024, the public sector debt balance amounted to 125,567 million MDL, representing a 15.9% increase compared to the end of 2023. This increase led to a rise in the balance of domestic public debt to 45,926.4 million MDL and external debt to 79,640.6 million MDL. According to the forecasted GDP data for 2024, the share of public sector debt in GDP as of December 31, 2024, was 38.8%, marking an increase of 3.1 percentage points compared to the end of 2023.

However, the increase in the public sector debt balance at the end of 2024 compared to the end of 2023 is driven by the increase in the state debt balance by a nominal value of 17,390.9 million MDL and the balance of direct local government debt by 44.9 million MDL. Therefore, the balance of the National Bank of Moldova's debt decreased to 157.6 million MDL, and the balance of direct debt of public sector enterprises recorded a decrease to 67.1 million MDL.

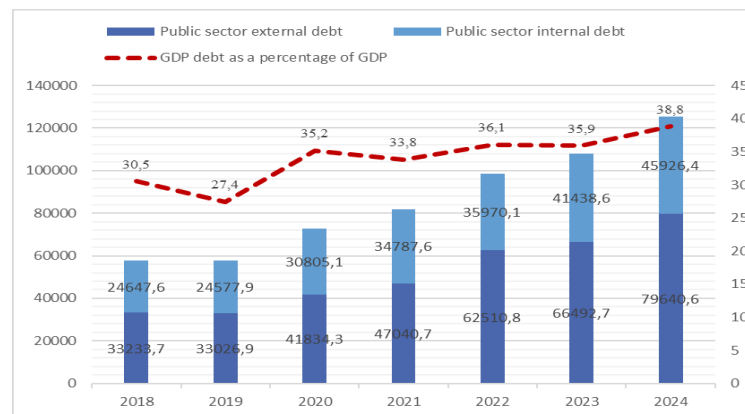


Figure 5. Public Sector Debt, billion MDL, %

Source: Prepared by the author based on data from the Ministry of Finance.

As of December 31, 2024, the share of state debt at nominal value in GDP was 37.5%, reflecting an increase of 3.2 percentage points compared to 2023. The change in the balance of external state debt is due to positive net external financing amounting to 674 million USD and the negative fluctuation in the exchange rate of the US dollar against other currencies, amounting to 179.9 million USD. At the same time, the increase in the balance of domestic state debt was primarily driven by positive net domestic financing of government securities issued in the primary market during the reference period. As a share of GDP, as of December 31, 2024, external state debt accounted for 23.9%, increasing by 2.7 percentage points compared to December 31, 2023.

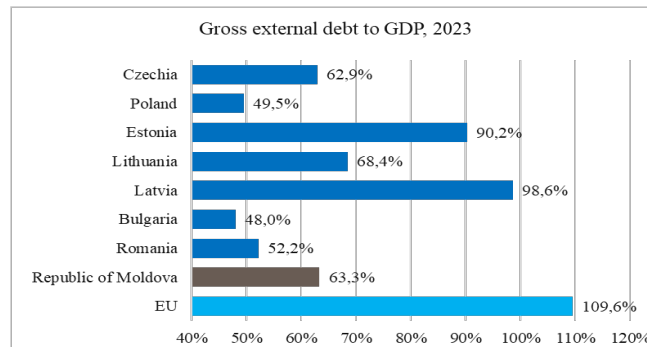


Figure 6. Gross external debt to GDP 2023, %

Source: Prepared by the author based on data from the Ministry of Finance.

As a result of the aforementioned, it can be stated that ensuring the sustainability of public finances in recent years illustrates the principles of governance, regardless of the current level of indebtedness. Therefore, it is essential to keep public debt under control for the smooth functioning of the economy. Thus, throughout 2024, the Ministry of Finance focused on securing funding for the budget deficit, utilizing both internal and external sources. This approach influenced the increase in public sector debt; however, it remained within economically sustainable limits. This process reflects the strategy adopted to maintain fiscal balance, considering the need to respond to economic pressures and support public investment development, without exceeding thresholds that could compromise long-term macroeconomic stability.

5. Conclusions

In conclusion, the sustainability of public finances in the Republic of Moldova in recent years has been largely shaped by the economic resilience efforts amid both regional and global crises. Despite the rising public debt, the government has managed to implement measures that ensure fiscal stability and control over public expenditure, maintaining the balance between the growing debt and the economy's capacity to support it.

The increase in public sector debt in 2024, although significant, has remained within economically sustainable limits. The government's ability to secure both internal and external financing for the budget deficit, along with the prudent management of public debt, has been crucial for maintaining macroeconomic stability. The government's focus on social spending, particularly in sectors such as social protection, education, and healthcare, has contributed to the economic and social resilience of the country.

Nevertheless, it is essential to closely monitor the dynamics of public debt, as continued growth in debt levels, especially if not accompanied by corresponding economic growth, may pose risks to fiscal sustainability in the long run. The government must continue to balance fiscal expansion with prudent debt management to avoid compromising future economic stability.

Ultimately, ensuring the sustainability of public finances is not only a matter of managing the budget deficit and debt levels but also of implementing sound governance principles that support long-term economic growth and stability. The challenges ahead will require a continued commitment to fiscal discipline, careful planning, and responsive policies to mitigate risks and promote sustainable economic development.

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THE ROLE OF REGIONAL INNOVATION SYSTEMS IN PROMOTING SUSTAINABLE ECONOMIC DEVELOPMENT: THE CASE OF THE REPUBLIC OF MOLDOVA

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Abstract: This article examines the role of regional innovation systems in stimulating sustainable economic development in the Republic of Moldova, highlighting the importance of interactions among local actors—the business community, research institutions, universities, and public administration—in generating a functional innovation ecosystem. Based on a systemic approach, the study highlights that economic innovation manifests itself predominantly at the regional level, where the capacity for adaptation, learning, and knowledge transfer directly influences territorial performance. A statistical analysis of innovative enterprises for the 2019–2024 period reveals a downward trend in innovative activity, particularly pronounced in regions with limited infrastructure and resources. At the same time, the predominance of small enterprises in innovation processes and the low level of collaboration between academia and industry point to the existence of systemic constraints. The article links these realities to national strategic directions, such as the National Regional Development Strategy 2022–2028 and the “SMART Moldova” Program, which promote smart specialization and investments focused on sectors with high innovation potential. The paper confirms that the success of sustainable economic development depends directly on the regions’ ability to generate, absorb, and capitalize on knowledge and innovation, and that a coherent policy in this direction can become the driving force behind a new model of national development.

Keywords: regional innovation system, innovative enterprises, economic development, innovations, strategic directions.

JEL Classification: O31, R11, R58, O38.

1. Introduction

In the context of the contemporary global economy, the ability of states to generate and capitalize on innovation is a fundamental determinant of both competitiveness and sustainable economic growth. In recent decades, economic development models have evolved significantly, highlighting the shift from resource- and production-based economies to knowledge-based economies, in which innovation, digitalization, and technology transfer become essential elements of progress. In this context, regional innovation systems take on particular importance, as they are recognized as structures capable of stimulating economic growth by connecting local actors—the business community, research institutions, universities, public administration, and civil society—into a functional and performance-oriented ecosystem.

For the Republic of Moldova, strengthening the regional innovation system represents a strategic priority, given the need to modernize the economy, reduce territorial disparities, and integrate into international value chains. Regions thus become key spaces for generating innovative initiatives, testing new solutions, and attracting technology- and knowledge-oriented investments. Furthermore, in the context of a small economy, regional innovation potential can significantly contribute to increasing productivity, diversifying the economic structure, and enhancing national competitiveness.

Although the state’s role in the direct management of research and innovation activities has diminished in the context of globalization, the role of the regional level is intensifying, as it is considered an optimal space for implementing policies tailored to local specificities. Consequently, analyzing how the regional innovation system influences economic performance becomes particularly relevant, especially for small, open economies such as that of the Republic of Moldova.

2. Materials and methods

This research was based on the analysis and utilization of a diverse corpus of scientific sources, including works by leading authors, materials presented at various scientific conferences, as well as other publications relevant to the subject under investigation. Furthermore, the study utilizes data selected, processed, and interpreted by the author based on information provided by the National Bureau of Statistics and other documentary sources relevant to the research field.

In conducting the investigation, several methods specific to scientific research were applied, such as analysis and synthesis, comparison, generalization, the formulation of logical reasoning, and the drawing of conclusions. These methods enabled a systematic and coherent approach to the analyzed phenomena, contributing to the attainment of results relevant to the proposed objectives.

2.1. The systemic approach to innovation—the foundation for economic development.

The systemic approach to innovation applied in developed countries assumes that the existence of links between actors and organizations within a favorable social and institutional context gives rise to a positive dynamic of learning, creating, and exploiting new knowledge. The nature of these dynamics is systemic, in the sense that the innovation process is far from being a linear phenomenon; rather, it is the result of complex patterns of interaction among a series of components that act together in accordance with shared norms, practices, and historical legacies.

The transition to the innovation-driven model of economic development—which represents a complex system of goal-setting involving many actors, levels, aspects, and different directions—cannot be effectively achieved by examining and addressing tasks related to a single direction (e.g., focusing on the development of the innovation sector). In regional development theory, as well as in economic theory as a whole, there is no generally accepted and sufficiently universal model of how the innovative economy functions as a complex, multidimensional, multi-level system (Klein, 2019).

Based on the above, it can be concluded that a National Innovation System (NIS) should be understood and analyzed as a complex of subsystems that can be classified by region and sector (Chung, 2001). Therefore, the NIS can be described as a matrix of regional and sectoral innovation systems (Table 1).

Table 1. National Innovation System

	Region A	Region B	Region C	
Sector 1	○ □ ▼ ◇	○ □ ▼ ◇	○ □ ▼ ◇	...	SSI – 1
Sector 2	○ □ ▼ ◇	○ □ ▼ ◇	○ □ ▼ ◇	...	SSI – 2
Sector 3	○ □ ▼ ◇	○ □ ▼ ◇	○ □ ▼ ◇	...	SSI – 3
Sector 4	○ □ ▼ ◇	○ □ ▼ ◇	○ □ ▼ ◇	...	SSI – 4
⋮	⋮	⋮	⋮		⋮
	SRI – A	SRI – B	SRI – C	...	SNI

Note: ○ - universities; □ - public institutions; ▼ - regional authorities; ◇ - industry

Source: Adapted by the author based on [2]

The ability of regions to adapt and adopt innovations is essential for their economic progress (MacKinnon, Chapman and Cumbers, 2002), as regional economic development depends on their capacity to shift resources from old to new activities (Molle and Cappellin, 1988). Regions are, by necessity, often much more open and have a much greater potential for innovation than nations (McCann and Ortega-Argiles, 2015). Furthermore, innovative regions are more resilient to crisis. And to develop an open innovation ecosystem, it is important for the region to be open and supported by intense economic interactions.

Under current conditions, the innovation component of regions is becoming increasingly important. Innovations are becoming the main driver of the country's and region's socio-economic development (Toffler and Toffler, 2006), as well as the factor driving the territory's competitiveness (Sukhovoy and Golova, 2019), or the so-called "power" of regions (Asheim, Grillitsch and Trippl, 2000).

Innovative economic development takes place, for the most part, at the regional level, where systematic and repeated interactions among relevant local actors, encouraged by a favorable institutional framework, shape the innovation capacity of specific regional contexts and enable the absorption and use of knowledge in an economically productive manner.

Innovation systems can be analyzed at different levels: regional, national, and international (OECD, 1999). The study of the regional innovation system makes it possible to take into account the particularities of each individual territory and thus creates the conditions for more effective management of the innovation system at the national level.

In recent years, the concept of the regional innovation system has evolved and become a widely used analytical framework, providing an empirical basis for the development of innovation policies. The concept itself is a popular theory applied to understand the nuances of regional economic interactions and to inform policies and strategies aimed at fostering regional economic competitiveness. The importance of regions within this system lies in the continuous improvement of innovation performance (Simmie, 2003), which supports both the regional and national economies.

The concept of regional innovation is based on an interactive set of public and private interests, formal institutions, and other entities that operate in accordance with organizational and institutional agreements and establish relationships that lead to the generation and dissemination of knowledge. The concept involves analyzing the existence of various actors (institutions, groups, universities, industries, etc.) and regional competencies, as well as

ongoing inter-network interactions engaged in innovation-related purposes within the overall objective of providing local and state authorities with tools to define policies capable of stimulating competitiveness (Huahai, Xuping and Feng, 2011). Innovation is considered one of the main ways through which both regions and the country as a whole can achieve and maintain competitiveness.

2.2 Regional Innovation Systems in the Republic of Moldova.

National economic performance is closely linked to a nation's regional economic performance. Thus, it becomes clear that an NIS will be easily formed and implemented in terms of effective Regional Innovation Systems (RIS). The concept of RIS is a good tool for generating effective Sectoral Innovation Systems. By generating different but competent sectoral innovation systems in various regions, RISs can build an effective NIS.

Figure 1 illustrates the direct linkage between sectoral, regional, and national innovation systems in the Republic of Moldova.

The regional innovation systems of the Republic of Moldova are based on four development regions and one functional region:

1. Northern Development Region – with an area of approximately 10,014 km², constituting about 30% of the territory of the Republic of Moldova. It comprises three municipalities and 11 districts with a population of 644,574 inhabitants. It is the most industrialized region after Chişinău (the capital of the republic), with a diversified infrastructure and a strategic role in trade and transportation.

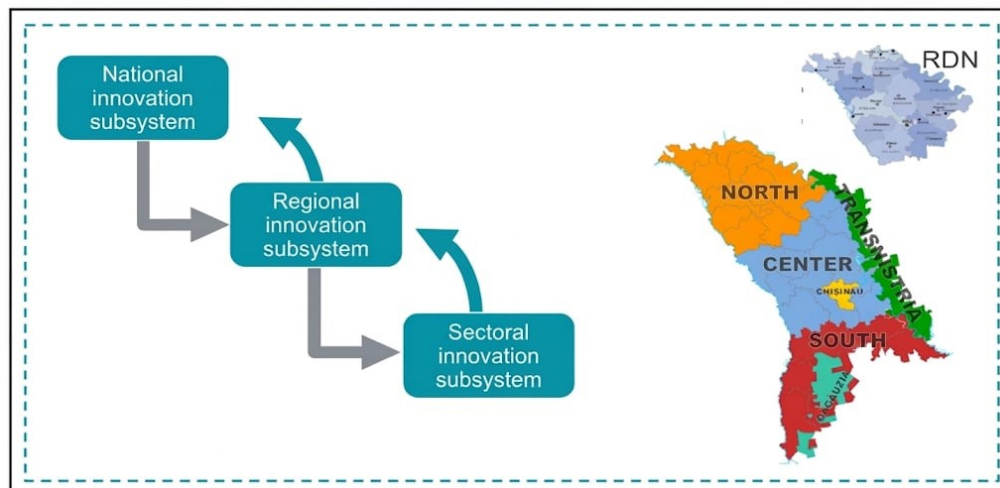


Figure 1. Classification of Innovation Subsystems in the Republic of Moldova

Source: Pripa, S., 2021

2. The Central Development Region comprises 13 districts and includes 14 cities and numerous rural localities, accounting for 31.5% of the country's total area. It has a population of approximately 850,000 people, or nearly one-third (29.8%) of the total population of the Republic of Moldova. It is a mixed-use area with high agricultural potential, food industry, viticulture, and agricultural product processing.

3. The Southern Development Region—comprising 8 districts—covers 24% of the territory of the Republic of Moldova and is home to approximately 15% of the country's total

population. It is a predominantly agricultural region, specializing in cereal crops, viticulture, animal husbandry, and agri-food processing. It is highly vulnerable to drought and climate change.

4. The Gagauzia Territorial Administrative Unit – is a territorial autonomy with its own administrative powers. It includes three cities and the associated rural localities, covering 5.5% of the Republic’s territory. The region’s population is 161,900 inhabitants, or 4.6% of the total population of the Republic of Moldova. It specializes in the food industry, winemaking, clothing manufacturing, and cross-border trade.

5. Chişinău Municipality (Functional Region) – is the capital and the main socio-economic center of the republic. It accounts for over half of the national GDP, most large companies, the IT sector, financial services, education, and research. It attracts the largest share of investments and the workforce with higher education. It is the engine of national innovation and the most important logistical and economic hub.

Regional innovation systems in the Republic of Moldova are in the process of formation and consolidation, reflecting both the potential and the structural constraints of the national economy. The literature emphasizes that the development of innovation at the regional level is influenced by the interdependencies between public policies, the capacity of economic actors, and research infrastructure, as well as limited resources.

3. Results and discussions

3.1 Context and performance of regional innovation in the Republic of Moldova

Technological science and innovation have become recognized as fundamental pillars of sustainable economic development at the national level. Innovative firms are distinguished by the systematic and consistent adoption of innovative practices aimed at achieving a sustainable competitive advantage. Thus, innovation becomes not only a strategic element but also a catalyst for economic performance and long-term competitiveness (Anghel, Grigorescu and Radu, 2020).

To highlight the innovation potential of each region, the number of innovative enterprises was analyzed, given that they form the foundation of both regional development and the national economy.

Table 2 presents the dynamics of innovative enterprises by development region for the years 2019–2024.

Table 2. Trends in innovative enterprises by development regions for the years 2019–2024

Years	2019–2020		2021–2022		2022–2024	
	No. of enterprises	%	No. of enterprises	%	No. of enterprises	%
Chişinău Municipality	272	60.7	230	54.8	248	63.9
Northern Region	69	15.4	69	15.4	53	13.7
Central Region	66	14.7	79	18.8	51	13.1
Southern	25	5.6	28	6.7	28	7.2

Region						
Gagauzia	16	3.6	14	3.3	8	2.1
TOTAL	448	100	420	100	388	100

Source: Author’s calculations based on NBS data NBS, 2024.

Following the COVID-19 pandemic, the total number of innovative enterprises nationwide showed a downward trend, falling from 448 enterprises in 2019–2020 to 388 enterprises in 2022–2024, a decrease of over 13%. The data presented in Table 2 show that during the analyzed period, only one region—the southern region—recorded an insignificant increase in the number of innovative enterprises, from 25 to 28 enterprises. The most unfavorable situation is observed in the Autonomous Territorial Unit of Gagauzia, where the number of innovative enterprises has halved (from 16 to just 8 enterprises). Data on the share of innovative enterprises in innovative regions for the period 2019–2024 indicate that the highest share of innovative enterprises is in the municipality of Chişinău (over 60%), followed by the Northern Region and the Central Region with approximately the same share (just over 13% in 2024).

The main causes of the decline in the number of innovative enterprises are cited as weaknesses of the Republic of Moldova’s research and innovation system and include: a decline in the number of personnel in the research and innovation system, particularly among young people; low wages, below the national average; outdated infrastructure; very low public funding for research and innovation, at 0.23% of GDP; low levels of collaboration between academia and industry; insufficient investment in technology transfer (ANCD, 2023).

The distribution of innovative enterprises by size class reveals that the majority of innovations occur in small enterprises, both at the national level and across regions (Table 3).

Of the total number of innovative enterprises, small enterprises accounted for the largest share in 2022–2024, over 63% nationwide, and in the South Region, their share exceeded 71%. The share of large innovative enterprises is quite small. Between 2022 and 2024, the share of large innovative enterprises ranged from 3.6% in the Central Region to 15.1% in the Northern Region. In Chişinău, there were 26 large innovative enterprises, accounting for 10.5%. In the Southern Region and the Gagauzian Autonomous Territorial Unit, there was only one large innovative enterprise each.

Table 3. Number of innovative enterprises by size class and development region, 2022–2024

Enterprise size	Total	of which by development region				
		Chişinău Municipality	Northern Region	Central Region	Southern Region	Gagauzia
Small enterprises (10–49 employees)	245	162	27	31	20	5
Share, %	63.2	65.3	50.9	60.8	71.4	62.5
Medium-sized enterprises	104	60	18	17	7	2

(50–249 employees)						
Share, %	26.8	24.2	34.0	33.3	25	25
Large enterprises (250 or more employees)	39	26	8	3	1	1
Share, %	10.0	10.5	15.1	5.9	3.6	12.5
Total enterprises	388	248	53	51	28	8
Share, %	100	100	100	100	100	100

Source: Calculated by the author based on NBS data NBS, 2024.

Enterprises engaged in research specialize in different types of innovations, such as product innovations, business process innovations, or a combination of product and process innovations. The structure of innovative enterprises by type of innovation is presented in Table 4.

Table 4. Structure of innovative enterprises by type of innovation, %

Type of innovation	2019–2020	2021–2022	2022–2024
Total enterprises included in the study	100	100	100
Innovative enterprises, total	12.6	11.4	10.6
of which:			
- product-based innovative enterprises	0.9	0.5	0.6
- enterprises innovative only in business processes	4.9	5.5	6
- enterprises innovating in both products and business processes	4.7	4.9	4
Non-innovative enterprises	87.4	88.6	89.4

Source: Calculated by the author based on NBS data NBS, 2024.

The data presented in Table 4 show that during the period following the Covid-19 pandemic-19, the share of innovative enterprises in the total number of enterprises included in the survey showed a steady downward trend, falling from 12.6% in 2019–2020 to 10.6% in 2022–2024, a decrease of 2 percentage points. Although the share of innovative enterprises specializing in products and business processes is quite small, it is encouraging that during the period analyzed, there is a steady upward trend in the share of these enterprises, rising from 4.9% to 6%, or by 1.1 percentage points.

According to the results of the assessment conducted by the United Nations Economic Commission for Europe—“Innovation for Sustainable Development”—17% of Moldovan enterprises that innovate in products, services, and processes collaborate in the innovation process with equipment suppliers, 24% collaborate with customers and buyers, and only 6% with research institutions and universities (UNECE, 2021).

The main economic sectors where innovation occurs in the Republic of Moldova are industry and services (Figure 2)

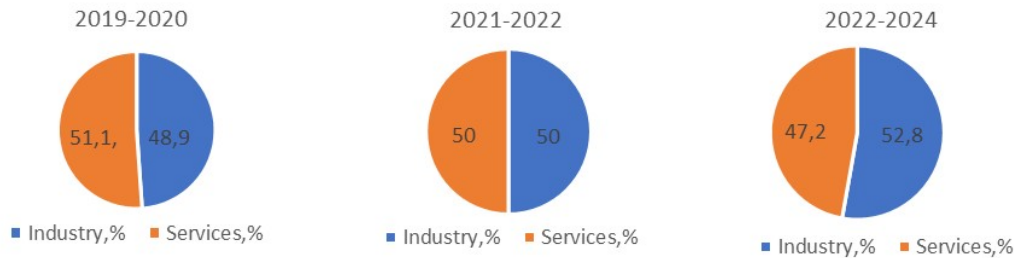


Figure 2. Main economic sectors where innovation takes place in the Republic of Moldova

Source: Calculated by the author based on NBS data NBS, 2024.

Over the past 5 years (2019–2024), the share of innovative enterprises in industry has shown an upward trend, rising from 48.9% to 52.8%, or by 3.9 percentage points. At the same time, the share of innovative service-providing enterprises decreased from 51.1% to 47.2%. Among innovative enterprises in industry, those in the manufacturing sector predominate, accounting for 46.6% during the 2022–2024 period, while among innovative enterprises in the service sector, 16.2% were in wholesale trade, 12.9% in information and communications, and 10.1% in transportation and storage) (UNECE, 2021).

An analysis of innovation activity among enterprises in the Republic of Moldova, both at the national and regional levels, shows that innovation activity is quite insignificant. The share of innovative enterprises in the country is quite low compared to the situation in EU member states (53%) (Eurostat, 2022).

The low level of innovation in the Republic of Moldova is caused by the limited collaboration among representatives of different sectors across the entire innovation value chain. Scientific collaboration between universities and the business community is also quite limited. According to the Global Innovation Index (GII) 2023, which is one of the most important benchmark studies for measuring countries' innovation performance, the Republic of Moldova ranked 60th out of 132 countries and economies, marking a drop of 4 positions compared to the previous year (State Agency For Intellectual Property, 2023).

3.2 Strategic directions for strengthening innovation in the regions.

Innovation in regions is a key factor in stimulating economic growth. The success of a region's innovative development directly influences the territory's competitiveness and the well-being of its residents.

The main strategic directions for strengthening innovation activity at both the national and regional levels are reflected in policy documents that provide for:

- more coherent integration of innovation into regional development strategies;
- intensified cross-sectoral collaboration within the Triple Helix model;
- modernizing research infrastructure and increasing investment in technology transfer;
- stimulating regional cooperation to create innovative clusters and platforms;
- facilitating SME participation in innovation processes;
- strengthening institutional and governance capacity at the regional level.

These recommendations reflect the need for a coordinated and integrated approach to transform the Regional Development System into a functional mechanism for economic and technological development.

The new paradigm of regional development, outlined in the main strategic document dedicated to this field— National Regional Development Strategy (NRDS) 2022–2028 — emphasizes the need for greater involvement of local and central public authorities in local economic development processes. In this context, economic policies prioritize optimizing economic performance and improving the quality of life for the population in the regions. The strategic concept reflects both the conclusions and experiences gained over the past decade of implementing regional development policies and current European guidelines on transforming the approach to regional development (MIDR, 2026).

The document promotes intensified efforts to ensure balanced territorial development by integrating the principles of regional competitiveness and economic cohesion. At the same time, the SNDR 2022–2028 is fully aligned with European regional development policy, complying with the provisions of the Association Agreement between the Republic of Moldova and the European Union, as well as the guidelines established by the 2030 Agenda for Sustainable Development.

Priority directions regarding innovation at the national level are set out in the Republic of Moldova’s National Smart Specialization Program for 2024–2027, titled “SMART Moldova.” It is the first national strategic document aimed at harnessing economic potential through innovation and smart specialization. Its role is to direct public and private investments toward strategic sectors identified as having high potential for knowledge-based development (ANCD, 2023).

The document establishes four priority areas of specialization: agriculture and agricultural product processing, information and communications technology, energy, as well as biomedicine and biopharmaceuticals. The selection of these areas was based on a comprehensive study of research potential, the business environment’s readiness to adopt innovations, and opportunities for collaboration between researchers and the private sector.

The program’s main objectives aim to strengthen the country’s innovation ecosystem by fostering innovative entrepreneurship, increasing the application of research results, stimulating cooperation between academia and the business sector, and promoting smart, sustainable, and inclusive economic growth. The program also emphasizes the training and development of human resources involved in research, innovation, and technology transfer.

Overall, “SMART Moldova” constitutes a central pillar of the modernization of the national economy by strategically directing resources toward sectors with high innovation potential, stimulating collaboration between research and industry, and integrating the Republic of Moldova into European development trends based on smart specialization.

4. Concluding remarks

An analysis of regional innovation systems in the Republic of Moldova highlights the fact that modern economic development cannot be conceived outside of innovative processes, and regions represent the key spaces where these processes manifest, consolidate, and spread at the national level. Although the Republic of Moldova has potential in certain sectors, the performance of regional innovation systems remains modest, being affected by both structural and institutional factors. Interactions between the business community, research institutions, universities, and public administrations are still fragmented, and the level of collaboration

along the innovation value chain is low. This situation limits knowledge transfer, the adoption of new technologies, and the emergence of new economic sectors.

Statistical data on the dynamics of innovative enterprises (2019–2024) indicate a significant decline in innovative activity, both at the national and regional levels. Regional performance is closely dependent on economic infrastructure and the concentration of skilled human resources. The municipality of Chişinău remains the main driver of innovation, accounting for over 60% of all innovative enterprises, which confirms the structural polarization of the national economy. The South, Center, North, and Gagauzia regions face challenges associated with resource constraints, depopulation, weak economic diversification, and climate vulnerabilities. The predominance of small enterprises in the innovation sector suggests untapped potential among medium and large companies, which could typically generate innovation on a larger scale and with a stronger economic impact. Compared to EU member states, where over 50% of companies are innovative, Moldova's share of just 10.6% confirms the significant gaps compared to developed European economies.

For the Republic of Moldova to strengthen its economic performance and move closer to European standards, a profound transformation of regional innovation systems is necessary. Recently adopted strategic documents create a favorable framework for restructuring the national and regional innovation system. These documents emphasize priority areas such as innovative agriculture, information technologies, energy, and biomedicine, thereby aligning national priorities with European knowledge-based development models. Regional transformation and innovation are not merely strategic objectives, but essential conditions for increasing competitiveness, economic resilience, and the quality of life for the population of the Republic of Moldova.

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ECONOMIC RESILIENCE: CONCEPTS AND CHALLENGES

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***Abstract.** This study aims to outline a conceptual framework for national and international economic resilience, supporting economic development and improved living standards. It examines the case of the Republic of Moldova within the context of regional and global transformations, emphasizing the importance of governance, innovation, and institutional adaptability in fostering resilience. The research employs systemic, documentary, and both qualitative and quantitative analysis methods to investigate the dimensions of economic resilience and its macroeconomic indicators. The findings propose a systemic model highlighting the interaction between key decision-making factors and their impact on economic and social performance. The study underscores that resilience is essential for economic security, enabling timely adaptation to shocks and sustaining long-term development. The originality lies in the integrated analysis of socioeconomic, political, and geopolitical factors influencing Moldova's growth potential. The originality of the work is reflected by the comprehensive or system analysis of the interdependence between the multitude of socioeconomic, political and geo-political factors and their impact on the growth potential of the national economy in general and the business environment in particular. Economic resilience are fundamental factors that determine the strengthening of the security of the national economy. A competitive and well-developed business environment can help the Republic of Moldova to register high and sustainable economic growth. Thus, resilience is a factor that favors the entrepreneurial environment to resist economic fluctuations, crises and other negative events that affect the national economy. The article was developed within the framework of Subprogram 030101 „Strengthening the resilience, competitiveness, and sustainability of the economy of the Republic of Moldova in the context of the accession process to the European Union”, institutional funding.*

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JEL Classification: G11, G18, E44.

1. Introduction

In a global environment characterized by economic interconnectedness, and under conditions of increasing disruption, resilience has unquestionably become a priority in response to the impact of recent crises. The global financial crisis, the COVID-19 pandemic, the growing climate crisis, regional conflicts, are the latest examples of unprecedented external shocks capable of disrupting economies and societies, have highlighted the need for economic resilience in ensuring stability, prosperity, sustainable and inclusive growth. As crises have become a persistent aspect of daily life, they have compelled governments and businesses to recognize the vital importance of economic resilience in responding to disruptions.

The financial crisis of recent years has highlighted the importance of economic resilience. It is worth noting that flexible economies are more resistant to negative shocks than rigid economies. For example, in Ireland the adjustment of wages and relative prices took place immediately after the recession of 2008-2009. As a result, an export-led recovery began in 2011 and the unemployment rate began to decline in 2012. The situation was different in other countries, such as Greece, Portugal and Spain, where nominal adjustment began many years after the recession (Sondermann, 2018). Thus, well-functioning national economic structures are important for ensuring economic resilience.

According to the World Economic Forum, resilience or the lack thereof can influence global annual GDP growth by 1% to 5%. Concurrently, effective efforts in reskilling and upskilling the workforce for a digital economy have the potential to boost economic growth by up to 4.5% annually by 2030 (WEF, 2022).

International experience demonstrates that economic resilience is a dynamic, evolving process rather than a fixed state, necessitating ongoing adaptation to emerging challenges and opportunities. In the scientific literature, a common approach to economic resilience is lacking.

In recent years, the manifestation of shocks in the economy is inevitable, then the study of the economy's ability to respond appropriately to them has become a topic of interest for decision-makers, a phenomenon also revealed by the objectives of the European Union's policies. The concept of economic resilience is a priority to understand the response of economies to shocks and to succeed in reducing the economic costs generated by these shocks. Low economic resilience is associated with poor economic structures, such as: weak economic competition, entry/exit difficulties, labor market rigidities, low governance quality and corruption. All this significantly reduces the ability to absorb shocks and the transformation needed to resume the trend of sustainable economic growth.

A resilient economy is one that either avoids or minimizes an economic downturn at best, and after the shock passes, quickly returns to the long-term trend of growth and high employment. Thus, an economy's ability to resist and recover from shocks depends on its flexibility, that is, the ability of capital and labor to adapt to ever-changing economic conditions.

The importance of having a resilient economy is given by the fact that it is subject to either smaller or shorter downturns. The longer or longer the period of economic decline, the more the confidence and optimism of companies and employees is affected in the long term, which can lead to repetitive effects (crisis leads to distrust, distrust leads to crisis).

2. Methodology

This research examines the theoretical and methodological foundations of resilience from economic, sectoral, and social perspectives, in relation to key objectives such as enhancing sustainability and aligning macroeconomic indicators. The study also develops a systemic framework to analyze the mechanisms of interaction between various decision-making actors and their influence on the economic and social environment through the lens of resilience and performance. It further investigates the nature and specific features of economic resilience tools that can contribute to sectoral development, as well as the strategic relevance of their implementation.

The research is primarily theoretical, focusing on the evolution of the concept of resilience and the foundational elements that have shifted the analytical focus toward the economic dimension. The structure of the study includes: a review of the relevant body of knowledge, identification of emerging trends, and the formulation of appropriate solutions.

The aim of the article is to synthesize current research on economic resilience and to identify contextual trends that mediate and moderate this relationship within varying national economic conditions. The study employs several analytical approaches, including the interpretation of findings from the specialized literature, the theory of resource depletion, systems analysis, and comparative analysis. The selected factors are examined from legislative, financial, and social perspectives.

3. Literature review

The term "resilience" is defined in the Larousse Dictionary as the mechanical characteristic of materials to resist various external shocks and to return to the initial state, being used at first only with this meaning. Etymologically, the word derives from the Latin verb *salio*, -ire, which means "to jump", "to jump", accompanied by the prefix *re-*, also of Latin origin, which means "against", "back". Only since the 70s, this concept has been used with a metaphorical meaning to describe systems that face different disturbing factors and that go through varied periods of imbalance, having the ability to resist and return to the initial state (Martin & Sunley, 2015).

The concept of resilience has progressively expanded in scope and has been integrated into a wide range of disciplines, including engineering, ecology, environmental studies, psychology, sociology, and economics. In fields such as philosophy and logic, resilience is often understood as an indicator of stability.

Therefore, resilience has been defined by the speed with which a certain ecosystem returns to its initial state after a period of imbalance, or by referring to the magnitude of a disruptive event, which a certain system can cope with, without changing its structure or functionality. The concept is very often considered a key element in the sustainable management of ecosystems, while biodiversity contributes to increasing the resilience, stability and functionality of ecosystems. Resilience has a special significance in periods of transition, of stress accumulation, periods that may also include unexpected events external to the individual (natural disasters, job loss, poverty). These events require increasing the ability to face them, in order to maintain a positive approach (psychological, attitudinal or behavioral).

The importance of the concept of resilience in sustainable development studies explains the establishment of the Resilience Alliance in 1999, an organization of scientists and practitioners from different fields and which aims to research the dynamics of socioecological systems. In this organizational and research framework, special importance is given to adaptive capacity, as an element of resilience. Other authors consider the adaptive capacity as actually being influenced by resilience and denoting the ability to make intervention plans and implement technical measures before, during and after the manifestation of extreme events; adaptive capacity is thus considered to be influenced by resilience (Puțuntică, 2013).

Economic resilience is "the ability to recover or adapt to the negative impacts of external economic shocks" (Briguglio et al., 2009). It foresees the following reactions in the face of a crisis: self-organization, adaptation, transformation and survival (Humbert and Joseph, 2019). Resilience characteristics are distinct for each actor in the economy and depend on both skills and capabilities: absorption, recovery, adaptation (Hafele et al., 2023; Martin and Sunley, 2015).

According to the OECD Report, it is necessary to learn the lessons to guide the policy actions necessary to strengthen economic resilience, understood as the following "tritych" policy:

- prevention of potential vulnerabilities;
- preparing to absorb shocks when they occur;

- the ability to recover quickly from those shocks through well-governed economic markets, as well as effective reforms of structural policies and institutional frameworks (OECD 2021).

The specialized literature offers multiple definitions of resilience, alongside various dimensions, characteristics, and principles that shape this multifaceted concept. Several authors (Zobel, 2011) categorize resilience into four key dimensions: technical resilience, referring to the capacity of an organization's physical systems to function appropriately during a crisis; organizational resilience, reflecting the ability of decision-makers to implement actions that prevent or mitigate crisis impacts; economic resilience, indicating the capacity to absorb and manage the financial costs associated with a disruption; and social resilience, which involves society's ability to adapt and respond effectively, often through the support of first responders or volunteer efforts.

4. Results and discussion

Resilience can be examined across multiple scales, including individual, collective, local, national, regional, ecological (or green), digital, and economic levels. Thus, individual resilience represents a stable trajectory of the individual's healthy functioning after an extremely turbulent event (trauma caused by factors, usually external) or the individual's ability to adapt to new internal or external environmental conditions, and can be one of the best predictors to deal with the threats of COVID-19. National resilience is a hybrid threat response tool, based on the promotion of security culture, and involves both the specific response measures designed at the institutional level and an overarching process that includes all the constituent elements of a nation, including social solidarity and patriotism.

Regional resilience is a highly complex process, significantly shaped by the nature, duration, and magnitude of shocks, as well as by additional influencing factors such as past experiences, regional economic structures, and multi-level public policies. A resilient region is characterized by the continuous adaptation of local markets and governance structures to evolving environmental conditions. Structural transformations typically occur only when these adaptive processes are hindered often as a result of inappropriate interventions by higher-level authorities that constrain local innovation and flexibility.

Green resilience refers to the capacity to adapt to climate change by enhancing the resilience of infrastructure, promoting the circular economy, minimizing environmental impacts on natural resources, preserving biodiversity, eliminating toxic substances, and transforming production and consumption patterns. It also encompasses the development of eco-friendly industries and employment, as well as the restoration of ecological systems to ensure that human activities remain within the planet's environmental limits.

Digital resilience ensures that the way we live, work, study and interact in the digital age respects/strengthens human dignity, democracy, equality, freedom, security and other fundamental European values. Resilient digital transformation can foster the shaping and appropriation of human-centered digital technologies, as well as their effective contribution to global sustainability. Digital transformation is a way to modernize the economy and address critical social challenges.

Economic resilience is generally the ability of an economy to withstand and recover from the disruptive effects of an economic shock and to achieve long-term structural change in an equitable and inclusive way. Given the cyclical and structural nature of changes, economies need not always return to their pre-shock status or the same growth trajectory.

The Strategic Foresight Report 2020, titled "Charting the Course Towards a More Resilient Europe", underscores the growing importance of strategic foresight in EU policy-making and introduces the overarching concept of EU resilience (European Commission, 2021). The report conceptualizes resilience through four interrelated dimensions: social and economic, geopolitical, ecological, and digital. For each dimension, it identifies key capacities, vulnerabilities, and opportunities revealed by recent crises, emphasizing the areas that require targeted policy action and investment in both the medium and long term to enhance the European Union's strategic autonomy and preparedness.

Social and economic resilience refers to the capacity to withstand economic shocks while pursuing long-term structural transformation in a manner that is both equitable and inclusive. Ecological resilience, on the other hand, involves achieving climate neutrality by 2050, alongside efforts to mitigate and adapt to climate change, reduce pollution, and restore the functionality of ecological systems, all while ensuring that human development remains within the planet's environmental limits.

Digital resilience means ensuring that the way we live, work, study and interact in this digital age respects and strengthens human dignity, freedom, equality, security, democracy and other fundamental European rights and values. Escalating US-China tech clashes disrupting global supply chains will heighten debate at European level on the need for the EU to pursue its agenda on technological and digital sovereignty.

Geopolitical resilience refers to the European Union's efforts to reinforce its 'open strategic autonomy' and assert its role as a global leader in an increasingly interdependent and competitive international landscape. The COVID-19 pandemic has accelerated existing geopolitical shifts and altered global power dynamics, emphasizing the EU's position as a reliable partner and responsible actor on the world stage. In the face of a potentially fragmented and destabilized global order, the EU aims to serve as a stabilizing force and a guarantor of peace. Open strategic autonomy' reflects the EU's commitment to open and fair trade, the preservation of an open economy, and the promotion of a revitalized multilateralism by supporting international partners in embracing shared global values (Stoica et al., 2021).

At the same time, the EU is aware of the need to reduce its dependence and strengthen its security of supply in key technologies and value chains (European Commission, 2020).

Lessons learned from previous epidemics have limited relevance for addressing the impact of COVID-19 on the global economy. The Spanish flu of 1918, one of the most devastating pandemics in history, caused major economic destruction worldwide, but in the wake of a four-year war (World War I) and in much less connected and much smaller economies than today. More recent epidemics have not caused such large economic collapses. The SARS crisis caused by SARS-CoV-1 in 2002–2003, one of the most significant health crises of the early 21st century, had notable economic repercussions on both the demand and supply sides. However, the overall economic impact proved to be less severe than initially anticipated, as most affected economies recovered relatively quickly, with economic activity and global trade connections largely restored.

As a result, embedded, inclusive, and often informal economies grounded in mutualism and solidarity have experienced notable growth. For example, the food supply sector has witnessed a significant expansion of solidarity-based initiatives, ranging from large-scale food donations to vulnerable populations to the provision of mobile food services for disadvantaged groups in certain countries. Communities have mobilized to address

systemic gaps and support those in need, with civil society organizations at times collaborating with state institutions to enhance the effectiveness of these efforts.

Effective economic governance is characterized by the decentralization of authority within enterprises, the active engagement and mobilization of workers and stakeholders to facilitate transformative change, and the centrality of networks and coalitions in economic coordination. It further entails deliberative decision-making processes and the democratization of knowledge to enable collective agency. These dimensions were particularly accentuated in the economic responses to the COVID-19 crisis, revealing the potential for more resilient and inclusive economic models.

The concept of resilience was also used before the publication of EUGS 2016, but in the context currently the EU proposes a so-called strategic approach to resilience, which leads on the one hand to increasing the impact that the EU's external action has and, on the other hand, to supporting the Union's objectives in terms of development, humanitarian assistance, foreign policy and security.

Thus, in the EU, the Recovery and Resilience Mechanism (RMR) is a temporary tool and a central element of NextGenerationEU - the plan that will help the Union emerge stronger and more resilient from the current crisis. Through the mechanism, the EU raises funds by borrowing on the capital markets (it issues bonds on behalf of the EU). These funds are then made available to its member states to implement ambitious reforms and investments through which:

- their economies and societies become more sustainable, more resilient and more prepared for the green and digital transition, according to the Union's priorities;
- to propose solutions to the challenges identified in the specific recommendations for each country formulated within the European Semester for the coordination of economic and social policies.

In order to access support under the Recovery and Resilience Facility, EU Member States were required to submit national recovery and resilience plans detailing the reforms and investments to be implemented by the end of 2026, structured around specific milestones and targets. Each plan was mandated to allocate a minimum of 37% of its budget to climate-related (green) measures and at least 20% to digital transformation initiatives.

Economic resilience measurement indicators. Measuring the economic resilience of EU regions and Member States to economic and financial crises can be achieved through the use of composite indicators, which integrate four core sub-indicators either composite or individual in nature:

- Macroeconomic resilience sub-indicator, constructed from three components: GDP per capita, gross fixed capital formation per capita, and real gross value added in the construction sector per capita;
- Firm-level economic resilience sub-indicator, based on a single metric: the survival rate of firms;
- Labor market resilience sub-indicator, measured using real GDP per capita divided by the total number of hours worked;

Financial-banking resilience sub-indicator, composed of two metrics: the Bank Z-score (which captures the likelihood of default in a country's commercial banking sector, inversely scaled post-normalization), and the ratio of credit extended by state-owned banks to state-owned enterprises relative to GDP (also inversely scaled).

Based on these indicators, two key temporal dimensions of resilience - commonly referenced in the literature can be identified:

a) Resistance (Impact phase) – defined as the interval between the peak value preceding the shock and the trough, or lowest value, observed during the shock. Notably, the trough may occur following brief periods of partial recovery.

b) Recovery (Bounce-back phase) – defined as the period from the trough to the year when the indicator returns to or surpasses its pre-shock value. If full recovery is achieved, the end of the recovery period is marked by the first year in which the pre-crisis level is equaled or exceeded. In cases where the indicator does not return to its pre-shock value, the latest available year is considered the endpoint (Lupu & Pavel, 2013).

The European Commission currently employs resilience dashboards as a key instrument in guiding resilience-building efforts. While these dashboards are valuable tools, their practical application in policymaking and international comparisons could be enhanced by supplementing them with a unified measure of economic resilience. This need arises for two main reasons: first, the dashboards lack a theoretical foundation specific to economic resilience; and second, they encompass over 100 indicators, which can limit their accessibility and utility for decision-makers. In response to these limitations, the Economic Resilience Index (ERI) has been developed. Grounded in a coherent theoretical framework, the ERI consolidates relevant indicators into a single composite measure, offering a more streamlined and theoretically consistent approach to assessing economic resilience.

Economic resilience has become a key focus in both public discourse and the European Union's policy agenda. Notable policy initiatives reflecting this priority include the Recovery and Resilience Facility (RRF), designed to mitigate the economic and social consequences of the COVID-19 pandemic while strengthening the resilience of EU economies. Furthermore, the European Commission has introduced the Single Market Emergency Instrument, aimed at reinforcing the resilience of the Single Market through enhanced crisis preparedness and management measures.

Building resilient economies requires a clear understanding of their defining characteristics. In recent decades, it has become evident that an exclusive reliance on GDP growth has left economies vulnerable to shocks and crises. Challenges such as climate change, ecological degradation, and growing social and territorial inequalities have intensified. In response, the EU has increasingly emphasized the need to move beyond GDP as the sole measure of progress. These debates support a broader vision of economies that ensure a good quality of life for all, within planetary boundaries. Crucially, such economies must not only achieve this in stable conditions, but also maintain or restore it in the face of multiple and overlapping disruptions.

The resilience dashboards were incorporated into the 2022 European Semester Country Reports for nine member states, including Denmark, Finland, and Estonia, to assess various dimensions of national resilience⁵. These dashboards serve as a comprehensive and detailed tool for policymakers to evaluate a country's capacity to withstand and adapt to shocks. However, their overall impact remains limited due to inconsistent integration across national Semester reports. To enhance their effectiveness and policy relevance, two key gaps hindering their successful use by policymakers must be addressed.

Furthermore, considering the economy's deep interconnection with society and the environment, its higher-level objective is defined as "ensuring wellbeing for present and future generations while remaining within planetary boundaries." Consequently, the role of

the economy is viewed as a means to contribute to this overarching goal. From this perspective, two key constraints emerge for the economic system: (1) to minimize adverse social impacts that undermine wellbeing, and (2) to operate within the environmental limits set by planetary boundaries. Figure 1 illustrates this interconnectedness, highlighting the economy’s embedded role within societal and environmental systems.

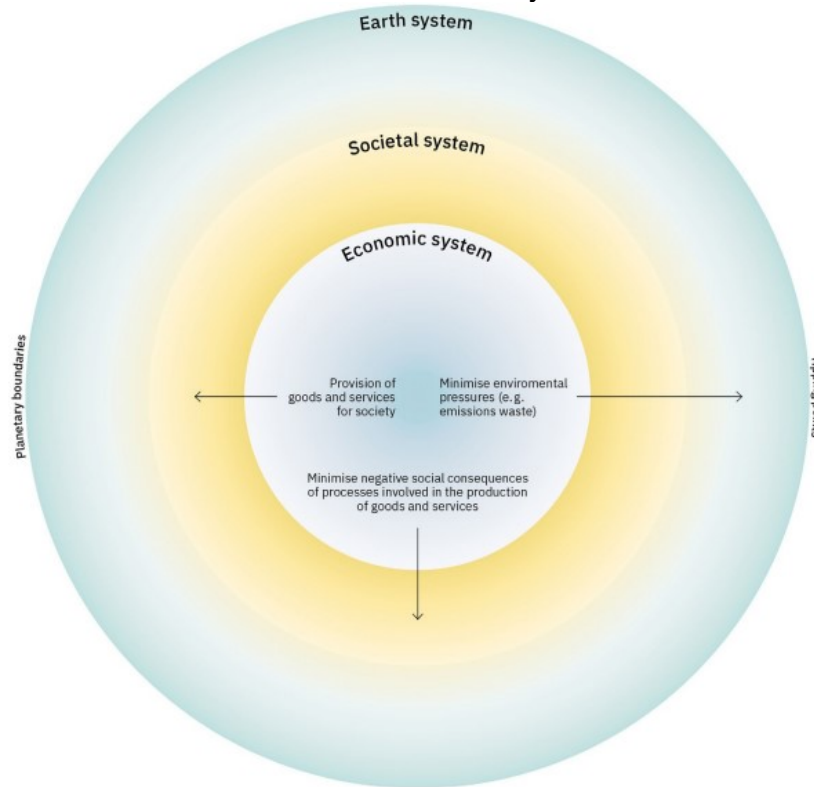


Figure 1. Purpose of the economy in relation to society and the environment, setting the reference value to assess economic resilience

Source: (Hafele et al., 2023).

Moreover, different components of the economy carry out activities aimed at fulfilling its overarching purpose. Four key actors involved in the provision of goods and services are identified: households, communities, businesses, and the state. These are collectively referred to as provisioning actors (Hafele et al., 2023). Provisioning is based on both monetary and non-monetary interrelations within and among these actors, conceptualized as flows (Phelan, 1999). Building upon this framework, provisioning actors require a specific set of eight core abilities that enable them to effectively perform their interlinked functions. For example, these actors must be able to access natural resources and to generate, disseminate, and apply knowledge (Hafele et al., 2023).

5. Conclusions and recommendations

Strategic resilience primarily entails the existence of a balanced, well-structured, and adaptable socio-economic system, in which daily processes and activities unfold without major disruptions, thereby facilitating the attainment of national development objectives. It

also enables individuals to contribute meaningfully to broader systems of cooperation and collaboration in which the state in this case, Romania - actively participates.

Beyond the domestic advantages, such as a high standard of living, mitigation of crisis impacts, and the general prosperity of citizens, a resilient and robust state, one that upholds universally recognized principles and norms, including human rights, the rule of law, a consolidated market economy, and a high level of security is consistently regarded as a reliable, valued, and respected international partner.

Attaining such a level of strategic resilience requires, above all, effective national governance, a well-functioning educational system capable of producing a skilled and educated workforce, and the rational allocation of resources aligned with long-term development strategies. These foundations are essential for building systemic capacities to prevent, absorb, and recover from external or internal shocks.

As previously emphasized, it is crucial to distinguish between stable and responsive initiatives in the broader resilience framework.

- Stable initiatives involve sustained, long-term efforts to enhance a community's or region's capacity to resist or avoid shocks altogether.
- Responsive initiatives, on the other hand, focus on the ability to respond swiftly and effectively to recovery needs following an adverse event.

Together, these two categories form the pillars of a comprehensive and proactive approach to resilience, integrating both preventive and reactive dimensions of strategic planning.

The complexity of the factors that have an impact on the prospects of economic growth for the Republic of Moldova, such as the context of war in a neighboring country, hybrid attack, an election year and climate change, increase uncertainties regarding the short-term dynamics. Such events can significantly influence the economic dynamics of countries. The military conflict and hybrid attacks generate instability in the security of the Republic of Moldova. Cyber security is also becoming essential to ensure sustainable economic growth by protecting economic activities, infrastructure and critical information. A secure digital infrastructure and online trust are fundamental to economic sustainability.

The risk of political instability, catalyzed by this year's presidential and 2025 parliamentary elections, may negatively affect domestic and foreign investor confidence by creating an unfavorable climate for business and investment. Government decisions taken in the context of elections can influence economic policy and reforms, consequences for the business and investment environment.

The Republic of Moldova remains a country where agriculture continues to play a significant role in the economy. Addressing the development challenges facing this strategic priority area sector. It is necessary to dynamize the process of reform and implementation of climate change adaptation strategies, reorientation of producers towards products and activities with high added value, and capacities to market products on the domestic and foreign markets. Given the austere nature of the national public budget, it is important to ensure a prioritization of the sector in the context of capitalizing on or attracting external support.

Vulnerability to international developments is growing. Among the risk factors can be mentioned, the continuation of the moderation of the pace of economic activity in the European Union, the uncertainty regarding the political configuration in several key states

where there are elections in 2024, the escalation of tensions and conflicts at the international level.

The themes addressed in this paper, economic resilience, as well as resilience indicators for the financial and other key sectors are of critical importance for the Republic of Moldova, particularly in light of anticipated future developments. They provide a valuable foundation for generating insights that can inform the design and implementation of strategic development plans aimed at strengthening the country's economic framework and ensuring sustainable growth.

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THE IMPACT OF ESG ON ECONOMIC RESILIENCE AND COMPETITIVENESS IN A CANDIDATE ECONOMY FOR EUROPEAN INTEGRATION

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Abstract: *The transition to sustainable finance has placed ESG (Environmental, Social and Governance) criteria at the center of assessing long-term economic performance, going beyond the limits of traditional indicators such as gross domestic product, inflation, unemployment, etc. In the current context, marked by energy shocks, geopolitical instability and climate pressures, the capacity of an economy to generate sustainable resilience and competitiveness is becoming a strategic priority for public policy makers and international financiers. Through a time-series regression model, the study examines to what extent the quality of institutional governance, investments in human capital and energy transition determine the competitiveness and resilience of the economy of the Republic of Moldova as a candidate state for European integration. The results of the study contribute to the literature on the sustainability of finance in small open economies and formulate public policy recommendations aimed at strengthening national resilience in the perspective of European integration.*

Keywords: *ESG factors, economic resilience, competitiveness, human capital, governance, sustainable finance, Republic of Moldova, economies in transition.*

JEL Classification: *Q56, O43, O15, P27.*

1. Introduction

The global sustainable finance agenda, which includes the set of international initiatives, policies, regulations and practices that aim to redirect capital flows towards sustainable economic, social and environmental projects and activities, has profoundly changed the way they are directed, analyzed and managed, now taking into account not only profit, but also the impact on the environment, society and governance.

Environmental, Social and Governance (ESG) factors and criteria have evolved from marginal ethical exclusion instruments, which entailed the elimination of certain companies or sectors considered unethical, to a central infrastructure of international financial markets, used by institutional investors, banks and regulatory bodies to direct capital flows towards more resilient and competitive economies (Fichtner et al., 2023; OECD, 2022). In 2024, assets managed according to ESG criteria in the European Union exceeded 6.6 trillion euros, representing 38% of total assets under management — an increase that reflects not just a market trend, but a profound structural change in the way investments are made globally (Heflich & Saulnier, 2024).

The literature and research in the field highlight the existence of gaps between the promises of ESG as a tool for real impact and the reality structured by market dynamics and dominant private standards. Economists Jaspert et al. (2024) warn of the risk of "infrastructural lock-in", a process by which private definitions of sustainability, based in particular on the single materiality approach and promoted by the socio-technical infrastructure of ESG ratings, data and indices, become a dominant norm in sustainable investments, without producing real measurable effects in the real economy, such as additional capital allocation to green projects or significant changes in companies' business

practices. And Fichtner et al. (2023) identify an "ESG capital allocation gap" noting that most ESG funds, although promoted as "green", are not directed towards projects that actually help the environment. This distance between rhetoric and reality is all the more acute in small and open economies, where the institutional capacity to absorb and capitalize on sustainable finance remains limited.

This reality is also very relevant for small transition economies that are candidates for European integration, which simultaneously face high energy dependence, institutional fragility and acute demographic pressures, such as the Republic of Moldova. Access to European sustainable financing mechanisms represents for such countries both a strategic opportunity and a structural challenge. In this context, the central objective of the research is to identify and quantify the impact of ESG factors (human capital, institutional governance and energy transition) on long-term economic resilience and competitiveness. To answer this question, the study operationalizes ESG factors at the macroeconomic level through the World Bank's Sovereign ESG Data Portal indicators and empirically tests, based on available data, the relationships between pillars E, S and G and national economic performance, thus providing an empirical perspective anchored in contemporary debates on the real effectiveness of ESG factors in economies vulnerable to external shocks (Fichtner et al., 2023; Gubareva et al., 2023; OECD, 2022).

2. Literature review

The relationship between ESG factors and a country's macroeconomic performance has become one of the most dynamic areas of research in recent years, moving beyond the initial framework of corporate analysis to address the sovereign and national dimension. Recent studies argue that ESG factors operationalized at the country level, through environmental, human capital and institutional quality indicators, constitute structural determinants of long-term resilience, not simple reporting indicators (Keenan et al., 2021; Billio et al., 2024). This perspective is also theoretically grounded in the World Bank's "Changing Wealth of Nations" framework, which argues that sustainable national wealth must incorporate human and natural capital alongside produced capital, thus reconfiguring the traditional metric of economic competitiveness (World Bank, 2021).

Table 1. Summary of the main empirical findings on ESG factors and economic performance

<i>Pillar</i>	<i>Factor</i>	<i>Effect</i>	<i>Context</i>	<i>Source</i>
<i>E</i>	CO ₂ emissions	↓ long-term competitiveness	Developed economies	Billio et al. (2024); Keenan et al. (2021)
<i>E</i>	Energie regenerabilă	↑ energy resilience	EU, economies in transition	Kwiliński et al. (2024); Akadiri & Özkan (2025)
<i>E</i>	Energy intensity	↓ productivity	Fossil-dependent economies	Solangi et al. (2025)
<i>S</i>	Human capital	↑↑ long-term growth	Universal	Poveda (2023); World Bank (2021)
<i>S</i>	Life expectancy / mortality	↑ productivity	Developing economies	Ghazali et al. (2023); Işık et al. (2024)
<i>S</i>	Education expenditure	↑ innovation, competitiveness	Eastern Europe	Shkolnykova et al. (2024)
<i>G</i>	Rule of law	↑↑ investment, stability	Economies in transition	Ortas et al. (2018); Shkolnykova et al. (2024)
<i>G</i>	Corruption control	↑ capital efficiency	EU candidates	Reyad et al. (2024)
<i>G</i>	Governance effectiveness	↑ FDI attraction	Eastern Europe	Shkolnykova et al. (2024)

Source: elaborated by authors based on reviewed literature.

Recent research on a large sample of European countries confirms a positive relationship between country-level ESG performance and GDP per capita in the long run, although short-term effects remain inconsistent across economies, reflecting institutional and developmental heterogeneity (Iwanicz-Drozdowska et al., 2025). In turn, Wang et al. (2023) demonstrate, on a panel of international data, that country-level ESG performance is positively associated with economic growth, with effects being stronger in economies with more mature institutions and deeper financial markets, a finding particularly relevant for transition economies seeking EU accession.

Although the general direction of ESG effects on economic performance is positive, their intensity and consistency vary significantly by pillar, institutional context and time horizon, as reflected in the asymmetries identified in Table 1 and further detailed for each dimension.

The literature on the **environmental dimension of ESG** at the macroeconomic level reveals an important paradox: while environmental factors are considered crucial for long-term resilience, their short-term effects on competitiveness are often ambiguous or even negative, especially in economies with fossil fuel-based energy structures. Billio et al. (2024) argue that sustainable climate finance can shift capital towards low-emission activities, strengthening macro-financial resilience, but only when credible carbon pricing mechanisms and coherent energy transition policies are in place.

For small economies in transition, energy dependence represents a critical structural vulnerability. Kwiliński et al. (2024) demonstrate that energy poverty and energy import dependence are associated with institutional and economic fragility in Europe, amplifying exposure to geopolitical shocks. This conclusion is directly applicable to Eastern European economies with a high degree of energy dependence. In the same context, Akadiri and Özkan (2025) confirm that environmental ESG factors significantly influence the dynamics of clean energy markets, although the effect depends on the development and maturity of the regulatory framework. Solangi et al. (2025) identify, using data from emerging economies,

that social investments and green finance are mutually reinforcing in achieving sustainable development goals, suggesting the complementarity of the E and S pillars in sustainable growth trajectories.

Human capital is identified by economists as the strongest determinant of sustainable national wealth and long-term competitiveness. This conclusion is supported by the World Bank's theoretical framework (World Bank, 2021), which shows that in most economies in the world, human capital represents the dominant component of total national wealth, significantly exceeding produced and natural capital. Poveda (2023) in turn demonstrates that investment in human capital is perceived by experts as the most critical factor for achieving sustainable development goals, ahead of physical capital or environmental policies. This prioritization is also confirmed by research by Işık et al. (2024), which shows that economic growth in East Asian economies is predominantly aligned with the performance of pillars S and G, not with pillar E. At the European level, Shkolnykova et al. (2024) find that innovation systems and human capital accumulation explain significant differences in transition and competitiveness trajectories between Central and Eastern European countries. Asffel offers an interesting perspective for understanding the gaps between EU member and candidate economies.

At the same time, pillar S has the most robust positive impact on economic growth among the three ESG factors, while the effects of pillar E are less consistent in developing economies (Ghazali et al., 2023).

These studies show that the existing asymmetry between different countries can have direct methodological implications. For small transition economies, empirical models should give greater weight to human capital and public health indicators compared to strictly environmental indicators.

If the literature attributes the role of pillar S as the dominant determinant of wealth, **institutional governance** plays the role of *structural catalyst, the necessary condition without which the impact of other ESG factors cannot materialize*. Ortas et al. (2018) demonstrate, using cross-country data, that national institutions significantly moderate the ability of firms and economies to transform ESG criteria into real performance, while countries with weak institutions obtain limited benefits from ESG integration, regardless of the quality of pillars E and S.

This perspective is also confirmed by the research of economists Shkolnykova et al. (2024) in the context of Central and Eastern Europe, showing that economies with institutions closer to EU standards show faster convergence and greater resilience to external shocks.

Reyad et al. (2024), in an explicit study dedicated to Eastern Europe, demonstrate that ESG performance improves firms' resilience to geopolitical risks and the effect is decisively mediated by the quality of governance at the national level. This suggests that investments in institutional reform, on the one hand, directly improve competitiveness and, on the other, indirectly amplify the benefits of the other ESG pillars.

The complexity of the relationships between ESG factors and economic resilience in small EU candidate economies cannot be captured by a linear analysis of each pillar in isolation, it requires understanding a system of interactions in which environmental factors, human capital and governance condition each other, and their effects are amplified or attenuated by specific contextual moderators. Figure 1 summarizes the transmission mechanisms through which ESG factors influence economic resilience and competitiveness,

highlighting the moderating role of institutional quality and convergence with European standards.

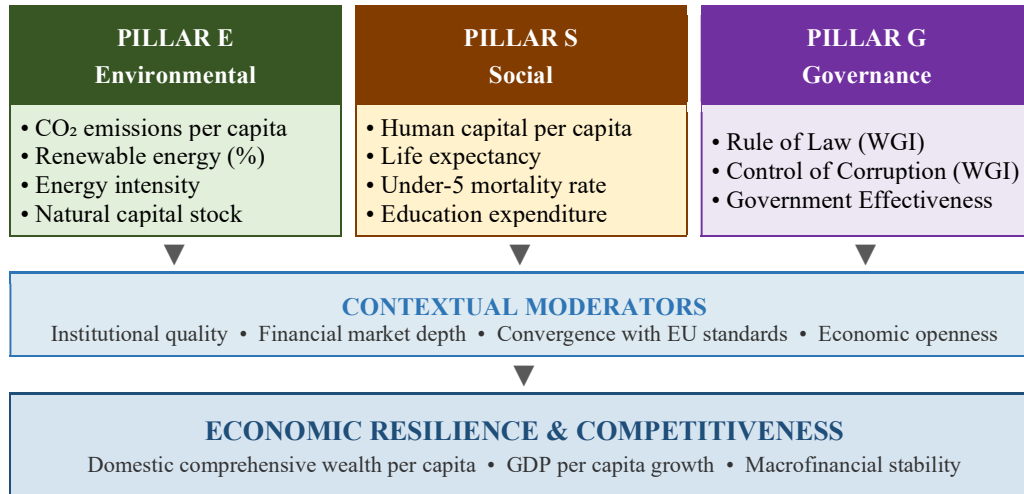


Figure 1. ESG factors and economic resilience in small transition economies

Source: elaborated by authors based on reviewed literature.

Small economies that are candidates for European integration face a specific configuration of constraints and opportunities in relation to the ESG agenda. On the one hand, the EU accession process constitutes a powerful driver of institutional reform and alignment with sustainability standards, generating positive effects on the quality of governance and investment attractiveness (Campos et al., 2014). On the other hand, these economies start from a lower level of development, with limited institutional capacity to absorb green financing instruments and with economic structures that are more vulnerable to external shocks (Bucevska, 2019).

ESG performance and economic growth mutually influence each other in achieving sustainable development goals, with stronger effects in economies with stronger governance. An example in this regard would be Latvia, a small Eastern European economy recently integrated into the EU that demonstrates that ESG investments can improve the financial well-being of the population and that increasing financial literacy amplifies the benefits of integrating ESG criteria, providing a relevant model for candidate economies (Mavlutova et al. (2021). Fichtner et al. (2023) warn that the access of small economies to ESG financing instruments is limited by the "ESG capital allocation gap" which represents the gap between the capital managed according to ESG criteria and the capital actually directed to projects with real impact.

Research shows that ESG factors influence economic resilience and competitiveness, but the effects are strongly conditioned by institutional quality, the maturity of financial markets and the specifics of the development context.

3. Methodology

In order to empirically test the relationship between ESG factors and economic resilience in a small economy in transition candidate for European integration, the research focuses on the Republic of Moldova, considered a sufficiently representative case by combining institutional fragility, high energy dependence and the active process of alignment

with European standards, formally initiated by granting EU candidate status in 2022 (European Council, 2022). For this, data available in the Sovereign ESG Data Portal of the World Bank (World Bank, n.d.) were used, covering the period 1996–2021, operationalizing ESG factors through 18 macroeconomic indicators grouped into the three pillars: Environmental, Social and Governance, along with relevant macroeconomic control variables. The dependent variable is comprehensive household wealth per capita, a composite indicator that goes beyond the limits of traditional GDP by incorporating human, natural and manufactured capital (World Bank, 2021; Arrow et al., 2012). Given the nature of the time series and the specific structure of the available data, the econometric estimation was performed using a fixed-effects model with robust standard errors, which controls for unobservable heterogeneity and ensures the robustness of statistical inference under the specific conditions of a panel with a small number of units (Baltagi, 2008).

4. Results and discussion

The econometric model created based on existing studies and research adapted to the specifics of a small economy in transition, proved to be an adequate analytical framework. The results obtained present an explanatory capacity and provide relevant empirical evidence on the differentiated way in which the three ESG pillars shaped the trajectory of economic resilience and competitiveness over the 26 years analyzed (Table 2).

Table 2. OLS Regression Results: ESG Determinants of Sustainable National Wealth (1996–2021)

Variable	Description	Coefficient	Std. Error	
Pillar S — Social				
<i>ln NW HCA</i>	Human capital per capita (log)	+0.2593	(0.0319)	***
<i>ln MORT</i>	Mortality rate under-5 (log)	+0.1855	(0.0236)	***
Pillar E — Environmental				
<i>ln CO2</i>	CO ₂ emissions per capita (log)	+0.1235	(0.0103)	***
<i>REN ENERGY</i>	Renewable energy consumption (%)	-0.0010	(0.0005)	*
<i>ln NW NCA</i>	Natural capital per capita (log)	-0.2728	(0.1372)	*
Pillar G — Governance				
<i>RULE LAW</i>	Rule of Law (WGI)	-0.1192	(0.0234)	***
<i>CORR CTRL</i>	Control of Corruption (WGI)	-0.0142	(0.0099)	
<i>GOV EFF</i>	Government Effectiveness (WGI)	+0.0280	(0.0197)	
Control Variables				
<i>ln GDP</i>	GDP per capita (log)	+0.1167	(0.0138)	***
<i>UNEMPL</i>	Unemployment rate (%)	+0.0114	(0.0024)	***
<i>INFLATION</i>	Inflation (%)	+0.0009	(0.0001)	***
<i>const</i>	Constant	+8.0507	(1.1419)	***
R²	0.9801	Observations	26	
Adjusted R²	0.9644	F-statistic	1539.075	
Durbin-Watson	2.341	p-value (F)	1.36e-19	

Notes: Dependent variable: $\ln(\text{Domestic comprehensive wealth per capita})$. HAC standard errors (Bartlett kernel, bandwidth 2) in parentheses.

Significance: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.10$, n.s. not significant. Period: 1996–2021 ($T=26$).

Source: Authors' estimates based on World Bank Sovereign ESG Data Portal.

To understand the significance of these results, it is necessary to place them in the economic context of the analyzed period. The following figures illustrate the trajectory of economic resilience and competitiveness, human capital, institutional governance indicators and renewable energy consumption in the period 1996–2021, which allows us to reconstruct the economic profile of the analyzed period. The profile of a small economy marked by the legacy of the post-Soviet transition and a series of external shocks that have repeatedly tested its capacity for resistance and adaptation.

GDP per capita, the most direct indicator of economic competitiveness, increased from a minimum of 399 USD in 1999 to 5,274 USD in 2021, a recovery visible in Figure 2, but which places the analyzed economy among the most vulnerable in the European space in terms of development level. This upward trajectory has not been linear, disrupted by the 2009 global financial crisis that generated a 6% contraction, the 2014–2015 domestic banking crisis that wiped out the equivalent of about 12% of GDP through systemic fraud, and the 2020 pandemic that produced the most severe contraction in the last two decades, of 8.3%. Each of these episodes highlighted the very structural vulnerabilities that ESG factors are supposed to address, namely fragile human capital eroded by massive emigration, institutions with limited capacity to prevent systemic crises, and an energy dependence of almost 85% on imports, which amplifies any external turbulence and reduces the room for maneuver of economic policy.

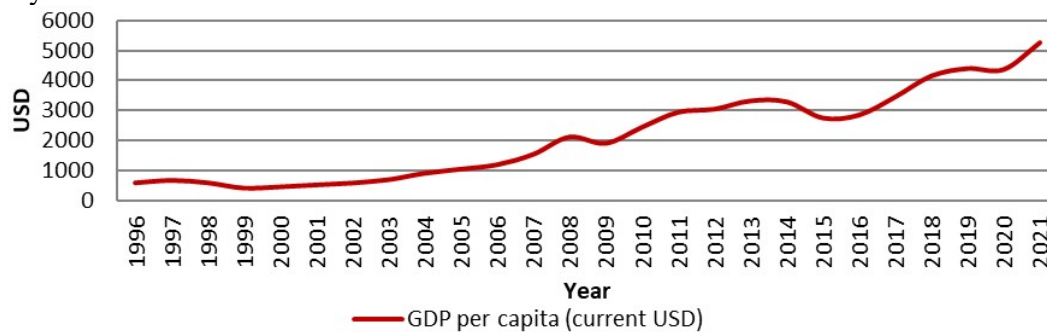


Figure 2. GDP per capita Republic of Moldova, 1996–2021

Source: World Bank Sovereign ESG Data Portal. Author’s own calculations.

Of the three structural vulnerabilities identified, human capital represents the factor with the strongest impact on long-term economic resilience, both in economic theory and in the results of the empirical model constructed.

Figure 3 illustrates the simultaneous evolution of all S-pillar indicators during the analyzed period, highlighting divergent trends that reflect the structural tensions of an economy in transition: life expectancy gradually increased from 66.2 to 71.5 years, under-5 mortality decreased significantly from 38.4 to 14.8 deaths per 1,000 live births, and education spending fluctuated between 12% and 22% of the government budget, all positive signals of social progress.

Human capital per capita, represented on the secondary axis, followed a more complex trajectory directly reflecting the impact of massive emigration, before partially recovering in 2021. The most important result of the study is the confirmation of the dominant role of human capital in determining long-term economic resilience and competitiveness. The estimated coefficient is positive and statistically significant ($\beta = +0.259$, $p < 0.001$), which means that a 1% increase in human capital per capita is associated with an improvement of approximately 0.26% in the economy's capacity to generate sustainable economic performance.

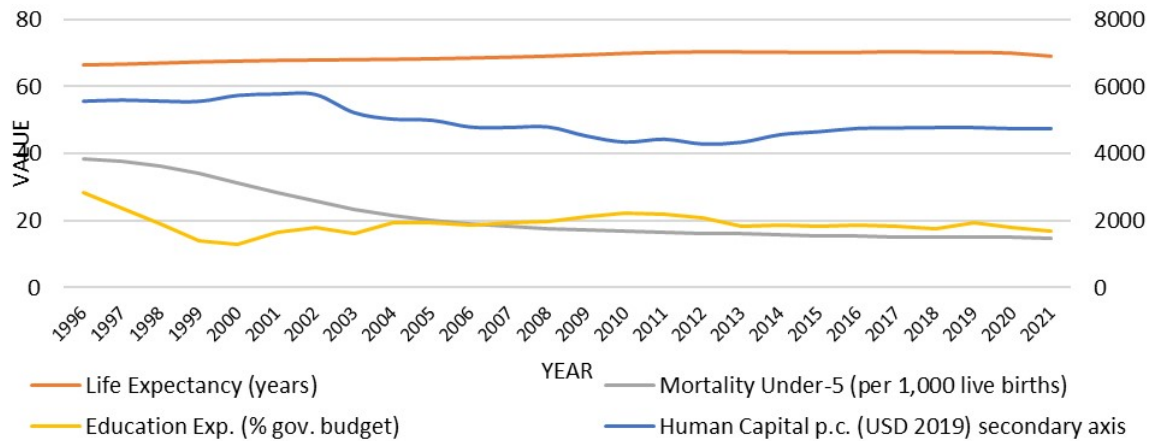


Figure 3. Social Indicators: Human Capital, Life Expectancy, Under-5 Mortality and Education Expenditure, 1996–2021

Note: Human Capital per capita (USD 2019) plotted on secondary axis (right).

Source: World Bank Sovereign ESG Data Portal. Author’s own calculations.

This conclusion is not surprising from the perspective of economic theory, but it acquires particular relevance in the specific context analyzed. The analyzed economy lost, according to estimates, between 25% and 30% of its skilled human capital through emigration during this period. Our model suggests that this loss was the most costly factor in the erosion of competitiveness in the long term, superior in impact to any specific political or financial crisis. Poveda (2023) and Wang et al. (2023) confirm this perspective at the international level, identifying human capital as the ESG factor with the most robust positive impact on long-term economic performance, especially in transition economies where the accumulation of knowledge and public health represents the main source of competitive advantage in the absence of abundant natural resources or physical capital.

Another S-pillar indicator, the under-5 mortality rate, also shows a significant positive effect ($\beta = +0.185$, $p < 0.001$). This does not mean that high mortality generates economic growth, but a historical legacy relationship specific to the transition period: in the first years of the analyzed interval, 1996–2005, infant mortality was high, but the economy still benefited from the physical capital and infrastructure accumulated during the Soviet period, generating an apparent positive correlation that gradually reversed as the infrastructure deteriorated and emigration intensified.

The energy transition represents the second structural vulnerability identified in the economic context of the analyzed period. Figure 4 illustrates the evolution of the three indicators of pillar E.

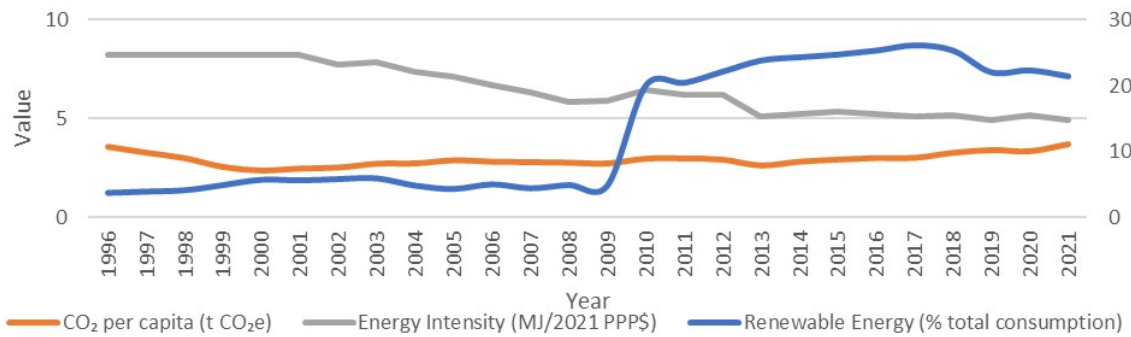


Figure 4. Environmental Indicators: CO₂ Emissions per capita, Energy Intensity and Renewable Energy Consumption, Republic of Moldova, 1996–2021

Note: Renewable Energy (% of total final energy consumption) plotted on secondary axis (right).

Source: World Bank Sovereign ESG Data Portal. Authors' own illustration.

The most visible phenomenon observed is the increase in renewable energy consumption from 3.7% in 1996 to 26.1% in 2021, the most dynamic evolution of all the monitored indicators, accelerated especially after 2010, with the entry into force of the association agreements with the European Union that imposed stricter standards in the field of energy and climate. At the same time, the energy intensity of the economy decreased from 8.2 to 4.9 MJ per unit of GDP, a signal of increasing energy efficiency, while CO₂ emissions per capita remained relatively stable at around 3 tons.

The results of the econometric model for pillar E show effects at the limit of statistical significance. Renewable energy registers a marginal negative effect ($\beta = -0.001$, $p = 0.069$), and natural capital per capita an effect that is also negative and marginally significant ($\beta = -0.273$, $p = 0.067$). These results should not be interpreted as a failure of environmental policy, but as confirmation of the long horizon for the materialization of the economic benefits of the energy transition. Investments in renewable energy imply high capital costs and restructuring of the energy system, whose benefits, energy independence, reduced operational costs, resilience to external shocks, materialize with a delay. Fichtner et al. (2023) estimate that this materialization horizon is 7–15 years, especially in economies with poorly developed financial markets and limited institutional capacity to absorb green financing. A strong argument in favor of continuing and accelerating investments in clean energy, the effects of which will become measurable in the coming decades. Governance indicators remained in negative territory throughout the analyzed period, confirming the persistent institutional fragility of the economy (figure 5). A gradual improvement trend becomes visible after 2016, especially for the rule of law and the control of corruption, reflecting the impact of accelerated institutional reforms in the context of the European association process.

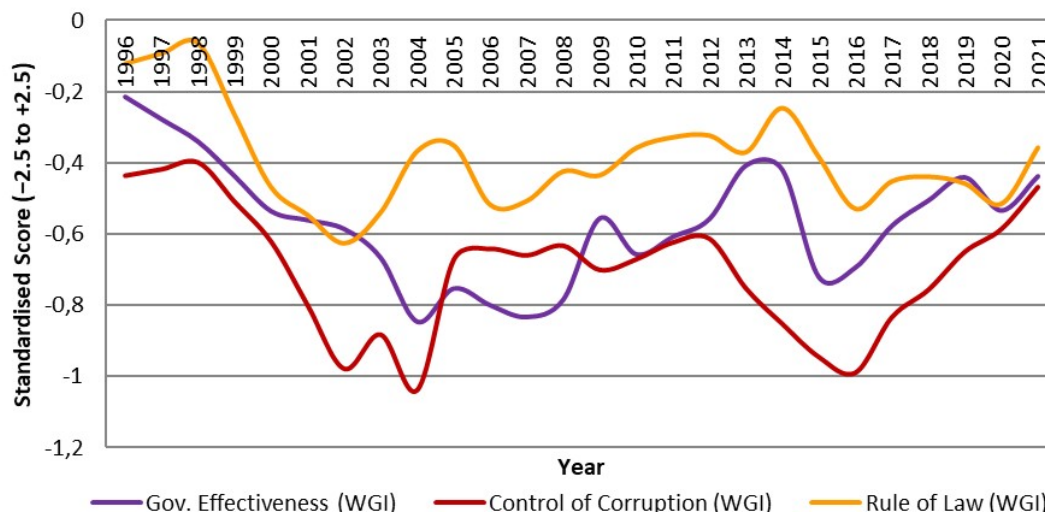


Figure 5. Governance Quality: Government Effectiveness, Control of Corruption and Rule of Law (WGI), Republic of Moldova, 1996–2021

Source: World Bank Worldwide Governance Indicators. Authors' own illustration.

Among the institutional governance indicators included in the model, the rule of law is the only one that presents a statistically significant, negative and strong effect ($\beta = -0.119$, $p < 0.001$). This result is, at first glance, surprising, but the explanation lies in the specific dynamics of institutional reform in post-Soviet economies. The major legal reforms in the analyzed period, the adoption of new civil and criminal codes, the establishment of anti-corruption institutions, the alignment of legislation with the community acquis, coincided chronologically with the most difficult economic periods: the political crisis of 2009–2010, the banking crisis of 2014–2016 and the governmental instability of 2019. In other words, the country chose to reform institutions precisely at the moments of maximum economic vulnerability, generating in the short term a negative correlation that does not reflect the real impact of the reform in the long term. Confirming that in economies with weak institutions, legal reforms generate significant transition costs, uncertainty, compliance costs, administrative restructuring, which temporarily erode competitiveness before producing structural benefits (Ortas et al. (2018). Shkolnykova et al. (2024) confirm the same pattern in Central and Eastern Europe, showing that countries that implemented accelerated institutional reforms in the context of EU accession went through periods of temporary decline in competitiveness, followed by sustained convergence.

5. Conclusions and recommendations

This study aimed to identify and quantify the impact of ESG factors on the resilience and economic competitiveness of the Republic of Moldova in the period 1996–2021. The results of the econometric model confirm that the three ESG pillars exert differentiated and asymmetric effects, with clear implications for the public policies of a small economy candidate for European integration.

Human capital has proven to be the dominant determinant of long-term economic resilience — a robust conclusion, consistent with the international literature and with the specifics of an economy that has lost between 25–30% of its skilled workforce through emigration. Institutional governance, through the rule of law dimension, produces negative

effects in the short term but structurally necessary in the long term, legal reforms coincide with periods of economic vulnerability, generating inevitable transition costs. The energy transition is underway, but the economic benefits are not yet measurable in the analyzed horizon, confirming that the effects of environmental investments materialize in the long term.

These conclusions lead to three priority public policy recommendations for the analyzed economy:

First, investments in human capital must be treated as a national strategic priority, not as a secondary social policy. Second, institutional reform, especially the consolidation of the rule of law, must be accompanied by explicit mechanisms to compensate for the short-term transition costs. The timing of reforms should be linked to the economic cycle, and the international and European financing available through the accession process should be used to cushion institutional shocks, not just for infrastructure investments. Third, continuing the energy transition remains essential despite the absence of immediate economic effects. The 85% dependence on energy imports represents the structural vulnerability with the greatest potential for destabilization in the current geopolitical context. Investments in renewable energy, even if they do not generate immediate competitiveness gains, reduce exposure to external shocks and are a necessary condition for access to European green financing instruments.

The study presents limitations inherent to the time series analysis for a single country, in particular regarding the generalizability of the conclusions. Future research could extend the analysis to a panel of candidate and post-candidate economies, to test the robustness of the identified effects and to quantify more precisely the long-term benefits of institutional reforms and energy transition.

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