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HEALTH AND RENEWABLE ENERGY INTEGRATION: A SUSTAINABILITY ASSESSMENT FRAMEWORK FOR COMBATING TERRITORIAL DISPARITIES IN HEALTH ACCESS

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Abstract: *Health is a fundamental pillar of human development and a right guaranteed by the Romanian Constitution. Nonetheless, the Romanian health system is facing chronic issues, emphasized by underfunding, regional inequalities, the migration of the medical personnel, and limited access to services for the vulnerable population.*
Territorial disparities in the access to medical services represent a persistent socio-economical challenge, particularly in the rural and disadvantaged areas. Digital health solutions (e-Health) are essential for bridging this gap, but their long-term impact is conditioned by the resilience and energy sustainability of the infrastructure.
Although e-Health solution, such as telemedicine and remote monitoring, offer a powerful lever for reducing territorial disparities, their long-term success, especially in rural and isolated areas is highly dependent on the resilience and sustainability of the supply infrastructure. The exclusive reliance on the conventional power grid exposes essential services to the risk of power outages and voltage fluctuations, a phenomenon very common in disadvantaged environments. Therefore, the integration of green renewable energy sources, such as photovoltaic panels or small wind systems, becomes a key factor in amplifying the socio-economic impact. This approach not only ensures the energy autonomy and reliability of digital health access points, but also contributes to reducing long-term operational costs and achieving national climate sustainability goals. Therefore, studying the synergy between e-Health and renewable energy is essential for developing truly equitable and resilient healthcare systems.
The paper proposes a conceptual evaluation framework and analyses the theoretical arguments for energy integration, in the absence of aggregated empirical data at the national and especially regional level. The synergistic adoption of e-Health technology and renewable energy sources represents an effective lever for combating socio-economic and territorial inequities in the healthcare sector.

Key words: *e-Health; renewable energy; regional disparities; socio-economic impact; sustainability; health access.*

JEL classification: *I18; O18; Q20; Q56; R11*

1. Introduction

The Romanian healthcare system faces severe territorial disparities and chronic underfunding, which limit its ability to ensure equitable access to medical services. With public health expenditures of only 6.3% of GDP, well below the EU average of 9.8% (Eurostat, 2025) and a life expectancy nearly six years lower than the EU average (75 vs. 81 years) (Eurostat, 2025), the socio-economic and health disparities between regions (e.g., North-East vs. Bucharest-Ilfov) are deeply visible. These imbalances are accentuated by outdated infrastructure and the migration of medical personnel, leaving rural and disadvantaged areas with insufficient medical coverage. Jula and Jula (2013) argue that sustained regional growth depends on the ability of local economies to transition toward sectors with higher added value, which directly influences employment patterns.

E-Health is defined as “an emergent field at the intersection of medical informatics, public health and business, referring to healthcare services and information provided or improved through internet and related technologies’’ (Eysenbach, 2001). Similar to how banking digitalization provides financial services to isolated or underbanked populations (through mobile banking), (Oprea & Nicula, 2026) health digitalization (e-Health) is improving the equity of access to healthcare for rural or disadvantaged communities. Thus, telemedicine and remote monitoring become the main ways of reducing distances and waiting times, contributing to the development of the digital society.

Medical care is limited rural areas because due to the lack of medical infrastructure. Similar patterns appear across other digital public services, where unequal access to digital infrastructure widens territorial gaps and restricts vulnerable communities from benefiting from modern digital solutions (Oprea, 2024). Since most healthcare institutions are located in urban regions, residents of rural communities must travel long distances to urban areas to receive treatment for even minor health issues, a situation that leads to medical tourism. (Currie et al., 2015).

In this context, the large-scale implementation of e-Health solutions (telemedicine, remote monitoring) reduces geographical barriers, improves cost and time efficiency, and expands access to health services for vulnerable groups (Ruhdiat, 2025). Oprea et al. (2025) note that digital innovation generates real benefits only when supported by strong and inclusive infrastructure, as insufficient operational capacity can deepen territorial inequalities. Their argument is directly relevant for e-Health, where inadequate digital and energy infrastructure limits the ability of vulnerable regions to fully benefit from modern medical services.

E-Health must be sustainable and resilient for a long-term and it is imperative to address its source of power supply. Dependence on traditional energy grids can generate vulnerabilities in rural areas and runs counter to environmental objectives. Oprea (2025) argues that digital transformation cannot function reliably without a robust technological and operational infrastructure, as insufficient system resilience amplifies existing disparities and limits the benefits of innovation.

The integration of solar energy solutions into rural healthcare is an impact multiplier that brings operational resilience and quality improvements (Soto et al., 2022). The reliable power supply provided by these systems extends operating hours and enhances lighting for procedures, enabling more accurate diagnoses and superior medical services. A benefit is to ensure the safety and potency of vaccines through solar refrigeration (Kapuria et al., 2024). From a sustainability perspective, solar solutions strengthen the financial independence of facilities by reducing long-term operational costs and contribute to environmental sustainability by lowering the carbon footprint (Al-Rawi, 2023).

Therefore, the present study adopts a conceptual approach and analyses the synergy between e-Health and Renewable Energy and how these two concepts optimize energy performance and social sustainability for service reliability and the reduction of disparities. Based on these gaps, the objective of this article is to examine how renewable energy enhances the sustainability of digital healthcare systems and to construct a PCA-based Green Resilience Index that quantifies the link between digital healthcare, energy autonomy and regional disparities.

2. Literature review

The integration of e-health and renewable energy is recognized as a new approach that reduces territorial disparities in health access, particularly in rural and underserved regions. The literature highlights the role of reliable, sustainable energy, especially solar and hybrid systems, which makes possible continuous healthcare delivery, and supports digital health infrastructure, and advances sustainability goals.
Rural and remote communities globally face persistent health access inequalities, often due to unreliable or absent energy infrastructure, which impedes the operation of healthcare facilities and digital health services (Franco et al., 2017; Izuka et al., 2023; Teklemariam et al., 2025). According to Jula and Jula (2000), structural disparities in productivity and sectoral specialization are determinants of the long-term competitiveness gap between Romanian regions. These disparities are accentuated by geographic isolation, limited resources, and underdeveloped transportation and energy networks (Izuka et al., 2023; Tu et al., 2025).
Solar and hybrid renewable energy systems are widely documented as effective solutions for powering healthcare facilities in off-grid or energy-insecure areas. These systems ensure the operation of medical equipment, vaccine refrigeration, lighting, and digital health platforms, leading to improved healthcare quality and accessibility (Olatomiwa et al., 2022; Alsaad et al., 2024; Teklemariam et al., 2025).
Hybrid systems, which combine solar, wind, and storage, are particularly effective in providing reliable, cost-efficient energy (Ayodele et al. 2021).
The adoption of renewable energy also reduces operational costs, carbon emissions, and enhances community resilience (Izuka et al., 2023; Alsaad et al., 2024; Teklemariam et al., 2025).
E-health initiatives, such as telemedicine, remote patient monitoring, and digital health records, depend on stable energy supplies and robust ICT infrastructure. The literature identifies indicators for smart rural healthcare, including the number of patients monitored remotely, access to mobile health clinics powered by renewables, and the availability of digital health data through reliable, renewable-powered servers (Maja et al., 2022).
Comprehensive sustainability assessment frameworks for renewable energy integration in healthcare emphasize multi-dimensional evaluation: environmental, economic, social, and technological (Campos-Guzman et al., 2019; Tian et al., 2024).
Life Cycle Analysis (LCA) combined with Multi-Criteria Decision Making (MCDM) is identified as the most robust methodology for evaluating the sustainability of energy-health projects, allowing for the selection of context-appropriate indicators and the balancing of trade-offs (Campos-Guzman et al., 2019; Abdolmaleki & Bugallo, 2025).

Frameworks should consider policy, financing, and stakeholder engagement to ensure long-term viability (Alsaad et al., 2024; Mohamed & Elsayed, 2025).
Challenges include high initial investment costs, maintenance, technological constraints, and the need for specialized expertise (Olatomiwa et al., 2022, Izuka et al., 2023). Policy frameworks, government support, and innovative financing models are very important to overcome these barriers and scale up renewable-powered e-health solutions (Mohamed & Elsayed, 2025). Community engagement and capacity building are also important for sustainability and local ownership (Teklemariam et al., 2025).

3. Methodology

To argue and quantify the necessity and complexity of the interactions between ecological sustainability, technological development, and e-health, we chose to construct a composite index, the Green Resilience Index (GRI). The objective is to determine whether the GRI combines these factors in a manner that supports the idea that digitization (e-health) becomes sustainable through the use of renewable energy. Principal Component Analysis (PCA) was utilized to add methodological rigor to the conceptual framework built upon the dimensions of digitization, energy autonomy, and health. Firstly, PCA reduces the redundancy among proxy variables, synthesizing information from strongly correlated indicators into a reduced number of latent components. Secondly, the method allows for obtaining robust scores that are comparable across countries and years, avoiding the arbitrariness of simple aggregation. The PCA method, provides a solid statistical foundation for constructing composite indices, confirming that the conceptual dimensions are empirically supported by the data structure. Thus, PCA is not an end in itself, but a tool that ensures the consistency and validity of the variables subsequently introduced into the econometric model, thereby strengthening the link between theory and empirical analysis.
For the construction of the index, there were utilized the following proxy variables: Households - type of connection to the internet (2003-2021)%; Internet use: interaction with public authorities; Individuals' level of computer skills [PC_IND]; Share of renewable energy-overall(%);Energy import dependency by products(%);Population unable to keep home adequately warm by poverty status(%);Energy productivity (KGOE); Health care expenditure all provider(million euro); Generalist medical practitioner(nr); Total health care expenditure(million euro).
During the database construction phase, it was found that for several relevant variables within the conceptual framework (e.g., digital skills [PC_IND], energy productivity, health expenditure), the data available in Eurostat were either discontinuous or entirely absent for the 2015–2023 period. To maintain temporal coherence and comparability across countries, alternative proxy variables with complete or extended coverage were selected, such as the internet connection rate, online interaction with public authorities, the share of renewable energy, and the density of general practitioners. Where data were missing for the years 2018–2023, a calibrated extrapolation method was applied: an annual increase of +1.0 percentage point for Sweden and Denmark (countries with high levels and stable trends), and +1.2 percentage points for Estonia, Greece, Portugal, and Romania (countries undergoing recovery). This adjustment allows for the coherent completion of the time series and their integration into the PCA analysis without distorting structural trends.

4. Results and Discussion

The selection of the variables used is based on economic and social theories that explain the role of infrastructure, digital capital, and territorial equity in regional development. The share of renewable energy in gross final consumption reflects the structural capacity of an economy to sustain digital medical infrastructure with green sources, reducing vulnerability to interruptions and operational costs, consistent with critical infrastructure theory. Energy import dependency serves as an inverse proxy for energy autonomy; economies with high dependency are more exposed to external shocks that affect the continuity of digital medical services, especially in rural areas. Energy productivity captures systemic efficiency and the capacity to generate economic value with limited resources, correlating with the sustainability of e-Health infrastructure. Energy poverty expresses infrastructural and social vulnerability and is associated, within the theory of territorial equity, with limited access to public services, including telemedicine. Fixed internet penetration and basic digital skills are fundamental in digital capital theory, directly influencing the population's capacity to access and utilize e-Health services, while the lack of these resources perpetuates the "digital divide." The use of e-government services is a proxy for the digital maturity of public administration and the degree of integration of medical services into the national digital ecosystem. Finally, public health expenditure per capita reflects the system's capacity to sustain modern medical services, including teleconsultations, and is correlated with the availability of medical infrastructure in disadvantaged areas.
The Green Resilience Index (GRI) was conceived to measure a multidimensional construct, demonstrating that resilience is an intersection of the dimensions of Health, Digitization (e-Health), and Energy. PCA was performed on the correlation matrix to extract the components. By using PCA, the index empirically confirms the interdependence between these factors. For example, it was demonstrated that Digitization is sustainable only if coupled with Renewable Energy, an essential aspect of modern resilience. By including variables such as Energy Imports (with a negative loading), the Index evaluates a region's capacity to ensure its autonomy. Green resilience implies reducing strategic vulnerability to global energy market shocks and geopolitical dependence. Digitalized health (e-health) is a critical infrastructure, and the GRI index assesses not only the existence of this technology but also its energy sustainability, ensuring that vital services are not interrupted by supply crises.

4.1 Principal Component Selection

According to the Kaiser-Guttman criterion (Eigenvalue > 1), only components with an eigenvalue greater than 1 are retained. The three retained components cumulatively explain 82.74 of the total variance. This indicates that the majority of the information within the initial dataset is conserved.

Tabel 4.1. Eigenvalue

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	4.714576	2.289873	0.4715	4.714576	0.4715
2	2.424703	1.289095	0.2425	7.139279	0.7139
3	1.135609	0.337098	0.1136	8.274888	0.8275
4	0.798511	0.308433	0.0799	9.073399	0.9073
5	0.490078	0.180869	0.0490	9.563478	0.9563
6	0.309209	0.240083	0.0309	9.872687	0.9873
7	0.069126	0.025085	0.0069	9.941813	0.9942
8	0.044041	0.029894	0.0044	9.985854	0.9986
9	0.014146	0.014146	0.0014	10.00000	1.0000

Source: Eviews output generated by authors

PC 1: 4.714576 > 1 ; PC 2: 2.424703 > 1 ; PC 3: 1.135609 > 1

Principal Component 1, or the "General Resilience Factor," explains 47.15% of the variance. All variables show a large positive loading, suggesting that PC1 represents a common factor or a general dimension of resilience, where a higher value on this component signifies a better overall state. PC1 appears to be dominated by variables related to Health care expenditure, share of renewable energy-overall, and housing infrastructure, Population unable to keep home adequately warm by poverty status. The Energy Import variable acts in the inverse direction, which is logical for green resilience (resilience is higher when import dependency is lower).
The fact that health and renewable energy are the most strongly associated and share the same sign within the most important component (PC) suggests that they are fundamental and interdependent dimensions of "green resilience." A high score on this component simultaneously signifies a robust health system and reduced energy dependence on polluting sources.

Tabel 4.2. –Principal Component eigenvectors

Variable	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9
TOTAL_HEALTH...	0.321408	0.428190	-0.011314	0.143202	-0.308612	0.036191	-0.188191	0.223893	0.103054
SHARE_OF_REN...	0.374073	0.209685	-0.409639	0.078562	-0.038740	0.078218	0.611164	-0.449902	-0.242021
POPULATION_U...	-0.382542	0.270329	0.227542	-0.132048	-0.101950	0.246666	0.591553	0.516064	-0.154522
INTERNET_USE_...	0.364466	-0.014798	-0.035551	-0.649472	0.232709	-0.030615	0.191993	0.140509	0.576344
INDIVIDUALS__L...	0.217088	-0.301732	0.561872	0.462039	-0.140114	0.165695	0.309529	-0.149741	0.409064
HOUSEHOLDS_...	0.385128	-0.133870	0.033498	0.101758	0.513052	0.603264	-0.156458	0.264124	-0.317629
HEALTH_CARE_...	0.321408	0.428190	-0.011314	0.143202	-0.308612	0.036191	-0.188191	0.223893	0.103054
GENERALIST_M...	-0.231899	0.370928	-0.200010	0.470264	0.606169	-0.162214	0.077063	0.064730	0.378947
ENERGY_PROD...	0.258970	0.257667	0.579371	-0.094578	0.298871	-0.534723	0.042224	-0.068547	-0.374424
ENERGY_IMPOR...	-0.240823	0.450665	0.293945	-0.244203	0.062058	0.475244	-0.202094	-0.556952	0.110096

Source: Eviews output generated by authors

Principal Component 2 (PC2) – the "technological/digital factor" explains 24.25% of the variance. This component is most strongly correlated with internet use Internet use: interaction with public authorities) and Individuals using the internet Individuals' level of computer skills). PC2 can be interpreted as the "digitization and information access" dimension or "technological resilience."
The positive association between digitization/internet and renewable energy in PC2 suggests that digitization processes (and, consequently, e-Health potential) are more

advanced in areas that also have a higher share of renewable energy. This correlation indicates an incipient sustainability—the necessary infrastructure for digitization can be supported, at least partially, by a green energy source. To further support this argument, we look at the direct correlation between the key variables: the correlation between Share of renewable energy and Individuals using the internet Individuals' level of computer skills (digitization) is 0.6092 (positive and strong); the correlation between Share of renewable energy and Health care expenditure is 0.792778 (positive and very strong).

Tabel 4.3. Ordinary correlation

	TOTAL HEALTH CARE EXPE...	SHARE O...	POPULATI...	INTERNET...	INDIVIDUAL...	HOUSEHO...	HEALTH C...	GENERALI...	ENERGY ...	ENERGY I...
TOTAL_HEALTH...	1.000000									
SHARE_OF_REN...	0.792778	1.000000								
POPULATION_U...	-0.301678	-0.628144	1.000000							
INTERNET_USE_...	0.427294	0.609237	-0.611906	1.000000						
INDIVIDUALS__L...	0.079439	0.018365	-0.464832	0.110515	1.000000					
HOUSEHOLDS_...	0.389135	0.596042	-0.763732	0.662215	0.539777	1.000000				
HEALTH_CARE_...	1.000000	0.792778	-0.301678	0.427294	0.079439	0.389135	1.000000			
GENERALIST_M...	-0.003250	-0.112599	0.521234	-0.572412	-0.509356	-0.390490	-0.003250	1.000000		
ENERGY_PROD...	0.588720	0.298088	-0.193214	0.497632	0.362591	0.376763	0.588720	-0.104871	1.000000	
ENERGY_IMPOR...	0.064505	-0.335208	0.843414	-0.317851	-0.458654	-0.492745	0.064505	0.502674	0.130393	1.000000

Source: Eviews output generated by authors

In conclusion, the correlations demonstrate a strong and direct correlation. If e-health is represented by Digitization and Health, both are strongly correlated with Share of renewable energy.
The generated PCA model strongly supports the hypothesis that health digitization (e-health) is intrinsically linked and potentially sustained by the use of renewable energy (energy sustainability), collectively forming a coherent "Green Resilience Index". Factor 1 (PC1) shows that successful general resilience combines health with renewable energy. Factor 2 (PC2) indicates that digitization is a separate dimension, but it is also positively associated with renewable energy. In practical terms, the generated Green Resilience Index favors those regions/entities where digitalized health systems (e-health) are accompanied by a smaller energy footprint and a higher share of renewable sources.
The negative sign of the loading for the Energy import dependency by products variable on PC1 is an essential element and highly coherent with the idea of Green Resilience and Autonomy. The Energy import dependency by products variable has a loading of 0.240823 on Principal Component 1, which is the foundation of the Green Resilience Index (explaining 47.15% of the variance).
PC1 being the main resilience factor, is a measure that we want to be as high as possible (a high score = high resilience). The negative loading indicates an inverse relationship. For the score on the Green Resilience Index to increase, the level of Energy imports must decrease. This negative relationship validates how the Green Resilience Index was constructed from the perspective of energy security. An energy system is considered resilient when it is autonomous and isolated from external shocks (volatile prices, geopolitical crises). Energy import is precisely the source of this vulnerability.
In the specific context of health digitization (e-health) and sustainability, e-health systems (servers, networks, digital medical equipment) are critical infrastructures that

require constant and stable power supply. The model suggests that the sustainability of this digital infrastructure is best ensured when it is powered by local renewable energy, or does not depend on an energy source vulnerable to interruptions or external decisions (i.e., Energy import dependency by products The negative loading of energy imports is not only logical but consolidates the quality of the Green Resilience Index. It ensures that the index rewards those entities that not only implement e-health (PC2) and use renewable energy (PC1) but which have also reduced their strategic vulnerability by diminishing their dependence on external energy sources.
The final Index is calculated as a weighted sum of the scores of the three principal components, using the proportions of explained variance as weights to reflect the relative importance of each factor.

$$\textbf{Green Resilience Index} = \lambda_1/\Sigma\,\lambda * PC_1 + \lambda_2/\Sigma\,\lambda * PC_2 + \lambda_3/\Sigma\,\lambda * PC_3$$

$$\textbf{Green Resilience Index} = 0.5698 * PC_1 + 0.2931 * PC_2 + 0.1372 * PC_3$$

This aggregate index offers a synthetic and robust measure that captures 82.74% of the variance of green resilience, where higher scores indicate superior performance across the three key dimensions.
The Green Resilience Index developed through Principal Component Analysis (PCA) is not merely an aggregate measure; rather, it unveils a factorial structure that confirms the interdependence between energy sustainability and the digitalization of the healthcare system (e-health).
The results highlight that investments in e-Health cannot be dissociated from the green transition and energy policies. Reducing FI (Factor Importer – *presumably F2/Energy Vulnerability*) and increasing IAE (Energy Autonomy Index – *likely F1/Renewable Energy Share*) transforms telemedicine from an intermittent service into a reliable one, with a disproportionate impact on rural areas. Simultaneously, strengthening digital skills and connectivity infrastructure remains essential for equity. Therefore, public policies must be coherent and interconnected, simultaneously targeting health digitization and energy autonomy to ensure not only increased access but also continuity and sustainability. The paper thus provides a methodological and empirical framework that can guide the prioritization of investments and the foundation of integrated green e-Health policies, capable of reducing regional disparities and strengthening social resilience.

The complete table of the calculated Resilience Index is presented as follows:

Tabel 4.4. Green Resilience Index

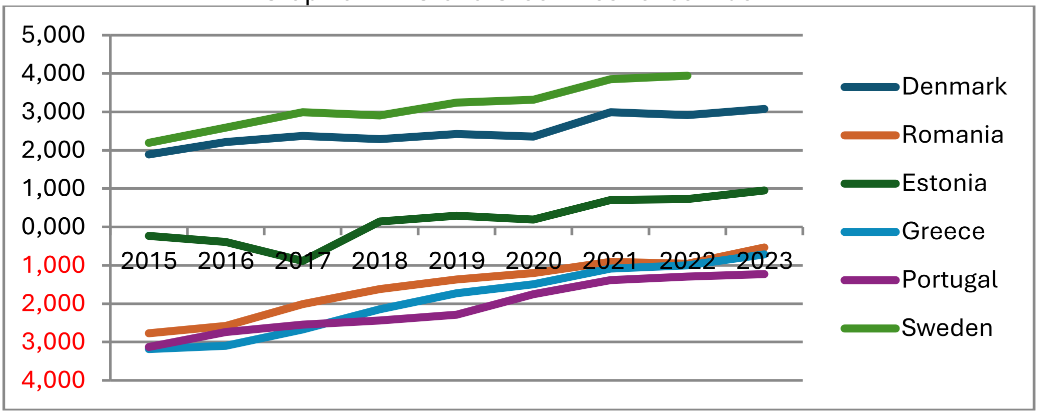
	Denmark	**Romania**	**Estonia**	**Greece**	**Portugal**	**Sweden**
2015	1.891	2.771	0.230	3.183	3.129	2.194
2016	2.214	2.584	0.393	3.101	2.740	2.592
2017	2.370	2.015	0.886	2.669	2.550	2.992
2018	2.292	1.618	0.142	2.143	2.438	2.910
2019	2.423	1.370	0.295	1.727	2.288	3.244

2020	2.357	1.201	0.195	1.493	1.750	3.316
2021	2.994	0.911	0.699	1.083	1.383	3.855
2022	2.919	0.958	0.732	1.002	1.296	3.943
2023	3.076	0.535	0.952	0.715	1.229	

Source: Generated by the authors from index output by Eviews

Based on the generated Green Resilience Index we calculated using Principal Component Analysis, the differences between countries are clearly structured into three categories: Leaders, Middle Ground, and Rear Guard. Denmark and Sweden are positioned as Leaders, showing the highest scores (consistently above +2.0), a fact demonstrated by their excellence in PC1 (Sustainability and Infrastructure), which holds a dominant weighting of 57% in the Index. Estonia represents the Middle Ground, demonstrating rising resilience, with scores that have shifted from negative to positive, reaching nearly +1.0 in 2023, due to rapid progress in digitization and reduced energy vulnerability.

Graphic 4.1. Grafic Green Resilience Index



Source: Generated by the authors from index output by Eviews

Conversely, Romania, Greece, and Portugal form the Rear Guard, maintaining scores below zero, due to a double penalty: poor performance in PC1 and a massive negative contribution from PC2 (Energy Vulnerability), which explains 29.31% of the index and is dominated by energy import dependency. This visual divergence necessitates accelerated investment policies in the vulnerable states to reduce resilience disparities.

5. Conclusion

The analysis shows that e-Health solutions have a substantial potential to reduce regional disparities in healthcare, particularly in vulnerable rural areas in Romania, by eliminating physical distance. However, the paper confirms that theoretically, telemedicine alone is not enough because energy vulnerability and lack of operational

resilience caused by unstable power grids undermine the benefits of equity. The integration of renewable energy is a strategical pre-requisite for long-term success.
The paper introduces a new and relevant concept, Green Resilience Index based on a rigorous methodology that surpasses a simple aggregation of indicators.
The key hypothesis was empirically demonstrated: health digitization (e-Health) is intrinsically linked to energy sustainability (renewable energy). This interdependence is a highly current theme at the intersection of Information and Communication Technology and sustainable development goals.
The analysis has a few limitations. The lack of data obliged us to apply a calibrated extrapolation method (annual increases of (+1.0) or (1.2) percentage points to maintain temporal coherence for the years 2018–2023.
PCA identified a three-factor structure that explains 82.74% of the variance. The residual variance (over 17% remains unexplained), suggesting that there are other resilience factors that are not captured by the current set of variables.
The Index is based exclusively on quantitative variables. It does not include essential qualitative factors for resilience, such as institutional trust, quality of governance, or political stability, which directly influence the implementation of green and digital policies.
To counteract these limitations, we propose that future research should utilize panel regression models to isolate temporal effects (Fixed Effects) and attempt to include data at the sub-national or regional level (NUTS-2) to capture internal disparities.
Based on resilience and the double dividend principle (social and operational), we bring some suggestions to decision-makers: the Government and the financial authorities should allocate funds for e-Health infrastructure only if minimum mandatory Energy Autonomy Index (EAI) is achieved (i.e.: 70%) in areas with a high level of energy risk. This ensures that the investment is resilient to failures (low FI). The performance evaluation of e-Health projects must go beyond adoption indicators (such as the number of users) to include resilience indicators, such as the Frequency of Incidents (FI), in order to measure the real impact on service reliability. Policies ought to acknowledge that, although the initial cost of green infrastructure may be higher, it is justified by a Life Cycle Cost (LCC) analysis, demonstrating a reduced Average Operational Cost (AOC) in the long term, thus supporting the financial sustainability of the healthcare system.

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