TELEMEDICINE AS A DETERMINANT OF SUSTAINABLE REGIONAL ECONOMIC DEVELOPMENT: SOCIOECONOMIC MECHANISMS AND INSTITUTIONAL CONDITIONS

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Abstract. Abstract. Telemedicine is regarded as a socioeconomic intervention that can modify spatial access to healthcare, household transaction costs, labour time losses, and regional health system resilience. Its relevance is evident in rural, peripheral, and war-affected territories, where transport barriers, staff shortages, infrastructure constraints, and unequal digital connectivity intensify disparities. Telemedicine should be analyzed as both a healthcare delivery technology and an intersectoral instrument for reducing spatial inequality, preserving human capital, and strengthening regional resilience.

Objectives. The objectives are to conceptualize telemedicine as a factor of sustainable regional economic development and to identify mechanisms through which it affects spatial equity, household costs, productive time, human capital, and health system resilience.

Materials and methods. The study applies a qualitative conceptual design based on a narrative review and synthesis of publications, reviews, policy documents, and Ukrainian regulatory sources. The framework covers household and time-related costs, productivity, resource allocation, spatial equity, human capital, digital infrastructure, and institutional conditions.

Results. The study identifies six channels through which telemedicine may affect regional economic development: reducing travel-related and transaction costs, preserving productive time, improving productivity, optimizing resource allocation, mitigating spatial inequality in care access, and strengthening local system resilience. These effects depend on broadband connectivity, stable financing, institutional integration, and workforce digital readiness.

Conclusions. Telemedicine should be interpreted as a conditional determinant of sustainable regional economic development, not an autonomous driver of regional growth. Its contribution is realized through mechanisms linking healthcare access, digital infrastructure, human capital, and territorial resilience.

Keywords: telemedicine; regional economy; sustainable development; digital health; socioeconomic resilience; spatial equity; human capital; labour productivity; rural areas; healthcare infrastructure.

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Digital transformation has become a central direction in the modernization of healthcare systems, but its socioeconomic implications extend beyond the internal organization of medical care. Telemedicine, remote monitoring, digital routing, and other forms of digitally mediated care delivery change the spatial, temporal, and institutional conditions under which healthcare services are accessed and provided. For regional economies, these changes are important because access to medical care is not only a health-system issue but also a determinant of human capital preservation, labour-time use, household expenditure, and the functional resilience of local social infrastructure.

The regional significance of telemedicine becomes more visible in territories characterized by low population density, weak transport connectivity, shortages of healthcare personnel, and limited access to specialized medical services. In such settings, conventional care delivery often requires long-distance travel, additional household expenditure, time away from employment and household responsibilities, and increased dependence on centralized medical infrastructure. Telemedicine can reduce some of these barriers by replacing part of physical mobility with digital interaction, facilitating earlier consultation, and supporting continuity of care. However, its effects are not automatic: they depend on broadband availability, institutional integration, financing models, digital literacy, and workforce readiness.

The Ukrainian context gives this topic particular relevance. Regional inequalities in access to healthcare are intensified by the role of rural and remote communities, the consequences of war, the destruction or disruption of infrastructure, population displacement, and the need to ensure continuity of medical and rehabilitation care. Ukrainian legislation defines the improvement of accessibility and quality of healthcare in rural areas as one of the priorities of state policy and explicitly links medical infrastructure, local self-government, and Internet access for rural healthcare institutions (Verkhovna Rada of Ukraine, 2017). During martial law, a specific regulatory procedure was introduced to govern the provision of medical and rehabilitation care using telemedicine, which demonstrates the transition of telemedicine from an optional service channel to an element of health system resilience (Ministry of Health of Ukraine, 2022).

Despite the expansion of research on telemedicine as a healthcare innovation and as part of digital health transformation, its role as a regional-economic mechanism remains insufficiently conceptualized. Existing studies provide evidence on cost-effectiveness, travel reduction, productivity gains, sustainability conditions, and digital equity, but these findings are often analyzed separately. Less attention has been paid to how these mechanisms jointly influence sustainable regional development, spatial inequality, human capital preservation, and the resilience of local health systems. This research gap is particularly important for Ukraine, where telemedicine development is linked simultaneously to healthcare reform, digital infrastructure, rural development, and wartime resilience.

The objectives of this study are to conceptualize telemedicine as a factor of sustainable regional economic development and to identify the main socioeconomic mechanisms through which it affects spatial equity, household costs, productive time, human capital preservation, and regional health system resilience. The study contributes to the literature by shifting the analytical focus from telemedicine as a healthcare delivery modality to telemedicine as an intersectoral instrument of sustainable regional development.

Literature Review. Digital health and telemedicine as health system interventions. Telemedicine is increasingly interpreted not as an isolated technology of remote consultation but as part of a broader system of digital health interventions aimed at strengthening healthcare systems. International recommendations emphasize that digital interventions should be assessed in terms of their contribution to accessibility, acceptability, resource use, equity, sustainability, and the overall functioning of the healthcare system rather than as

technical tools alone (World Health Organization, 2019; World Health Organization, Regional Office for Europe, 2022). This approach is important for economic research because it allows telemedicine to be analyzed as a mechanism for redistributing time, resources, and access across territories. The WHO global and regional digital health frameworks underline that digital health technologies should support health system resilience, continuity of care, and equitable access to services (World Health Organization, 2021; World Health Organization, Regional Office for Europe, 2025). These priorities are directly relevant to regional development, since healthcare accessibility influences labour-force participation, household expenditure, demographic stability, and the attractiveness of territories for residence and economic activity.

Spatial inequality and digital health equity. A significant shift in contemporary literature is the transition from a narrow focus on technological availability to the broader category of digital health equity. Telemedicine can expand access to care, but under adverse conditions it may also reproduce or intensify territorial and social inequalities. Differences in broadband availability, digital literacy, user trust, device access, and institutional capacity determine whether remote care becomes an inclusive instrument or an additional barrier for vulnerable populations (Petretto et al., 2024; World Health Organization, 2019). For sustainable regional development, this conclusion is fundamental. Telemedicine can reduce spatial inequality only when it is embedded in reliable digital infrastructure and supported by institutions capable of ensuring inclusive access. Therefore, the socioeconomic effect of telemedicine depends not merely on the availability of remote consultation technologies but on the broader conditions of territorial connectivity, workforce capacity, and public policy coordination.

Economic evaluation and sustainability of telemedicine. Economic evaluations of digital health interventions show that telemedicine can generate cost savings, improve cost-effectiveness, and reduce the economic burden associated with healthcare access. Systematic reviews have demonstrated that digital interventions in cardiovascular diseases and heart failure may be cost-effective, although the magnitude of economic benefits differs across clinical areas, healthcare systems, and evaluation perspectives (Jiang et al., 2019; Zakiyah et al., 2024). Methodological literature emphasizes that economic evaluation of digital health should account not only for clinical outcomes but also for resource use, implementation context, distributional effects, sustainability, and the perspective of patients and society (Gomes et al., 2022). Sustainability is a key condition for transforming telemedicine from a pilot intervention into an element of regional infrastructure. A systematic review of barriers and facilitators in low- and middle-income countries shows that long-term viability depends on organizational, financial, workforce-related, and infrastructural factors. Key barriers include insufficient equipment, Internet access, electricity supply, and limited institutional support, whereas sustainability is facilitated by government support, intersectoral cooperation, staff motivation, user trust, and effective scaling mechanisms (Kaboré et al., 2022). Evidence from the Greek National Telemedicine Network also shows that the sustainability of telemedicine services depends on governance, stakeholder alignment, interdisciplinary coordination, scalability, and service quality (Rizos et al., 2025).

Telemedicine in Ukraine: institutional and infrastructural context. Ukrainian scientific literature is more strongly focused on the applied, organizational, and infrastructural dimensions of telemedicine. Telemedicine is described as a form of high-quality medical service provision that accelerates the transmission of diagnostic information, expands access to consultations with specialized physicians, and is particularly significant for geographically remote institutions and emergency conditions (Oksak, 2019). Studies on electronic healthcare in Ukraine emphasize that digitalization is not merely a technological trend but also an instrument for improving managerial decisions, restructuring care delivery processes, and integrating information and communication technologies into the healthcare

system (Soroka, 2023). Analytical and regulatory documents also demonstrate that Ukraine has already developed an institutional foundation for telemedicine. The Strategy for the Development of Telemedicine in Ukraine defines telemedicine as an important direction of healthcare modernization and service accessibility (Cabinet of Ministers of Ukraine, 2023). At the same time, situation analysis of telemedicine in Ukraine points to uneven implementation conditions, including infrastructural, organizational, and human-resource constraints (Local Health System Sustainability Project [LHSS], 2023).

Research gap and analytical premise. Existing research provides fragmented evidence on the regional-economic implications of telemedicine, while its role in sustainable regional development remains insufficiently conceptualized. The available literature largely focuses on clinical access, digital health implementation, cost-effectiveness, or organizational issues. Less attention is paid to the integrated mechanisms through which telemedicine affects household costs, labour-time losses, spatial inequality, healthcare resource allocation, and human capital preservation at the regional level.

The analytical premise of this study is that telemedicine affects sustainable regional economic development through several interrelated channels: reducing spatial barriers to care, lowering direct and indirect household costs, preserving productive time, improving health system resource allocation, maintaining the labour and demographic potential of territories, and strengthening functional connectivity between the centre and the periphery. This framework enables the transition from a description of digital innovation to an analysis of its systemic socioeconomic effect.

Materials and Methods. The study uses a qualitative conceptual design based on a narrative review and analytical synthesis of scientific, analytical, and regulatory sources. This design is appropriate because the aim of the study is not to estimate a single effect size but to conceptualize the socioeconomic mechanisms through which telemedicine may influence sustainable regional economic development. The methodological approach combines bibliographic analysis, comparative analysis, and logical-structural generalization. The source base includes peer-reviewed articles, systematic reviews, methodological publications on economic evaluation of digital health interventions, documents of international organizations, Ukrainian regulatory acts, and Ukrainian scientific publications on telemedicine and electronic healthcare. Priority was given to sources directly related to telemedicine, digital health interventions, economic evaluation, rural and remote healthcare, spatial inequality, health system resilience, and institutional conditions of implementation. The analytical synthesis was structured around eight categories: direct household costs, indirect time-related costs, labour productivity effects, healthcare resource allocation, spatial equity, human capital preservation, digital infrastructure, and institutional conditions for telemedicine implementation. These categories were used to identify the principal channels through which telemedicine may influence regional economic resilience and sustainable territorial development.

The study does not apply a formal PRISMA-based systematic review procedure. Instead, it uses a conceptually oriented narrative synthesis intended to integrate evidence from heterogeneous sources and to build an analytical framework for subsequent empirical research. This approach is consistent with the objective of identifying mechanisms, conditions, and policy-relevant implications rather than conducting a meta-analysis.

Results. Reduction of direct and indirect access-related costs. The first and most consistently documented economic channel of telemedicine is the reduction of direct and indirect costs associated with access to healthcare. For patients in rural, remote, and peripheral territories, in-person care often involves transport expenditure, accommodation or accompanying-person costs, and time away from economically significant activities. Evidence from a systematic review of the economic impact of telehealth on maternal and child health in

regional, rural, and remote areas of Australia included 20 studies with 2,713,990 participants and found that telehealth was classified as a cost-saving option in 18 studies, while two studies reported comparable costs and outcomes (Adella et al., 2026).

The same review indicates that the principal source of savings was the reduction or complete avoidance of travel costs for patients and healthcare professionals. This finding is highly relevant for regional economics because travel-related costs function as transaction costs of healthcare access. Their reduction may improve affordability of care, decrease the financial burden on households, and support more regular interaction between patients and the healthcare system.

Labour productivity and time-use effects. The second channel concerns the preservation of productive time. Telemedicine does not directly increase labour productivity in the technological sense; rather, it reduces the amount of time withdrawn from employment, self-employment, household care, and other forms of economically significant activity. A study based on 30,149 outpatient telemedicine consultations in Queensland estimated that 9,644,569 km of travel and 27,068 days away from usual activities were avoided. The total societal productivity gain amounted to AUD 9,176,052, or AUD 304 per consultation (Snoswell et al., 2022). At the regional level, these effects are particularly important for territories where access to specialized care requires long travel distances and where the loss of working time has a greater relative impact on household income and local economic activity. Telemedicine can therefore be understood as an instrument for preserving the stock of productive time available within a territory. Additional evidence confirms the importance of service volume, patient flow, and waiting time. In a randomized study of remote orthopedic consultations in Northern Norway, video consultations became less costly than standard face-to-face consultations after 151 consultations per year; at 300 consultations per year, annual savings reached EUR 18,616 (Buvik et al., 2019). In the UAMS Health system in Arkansas, the average indirect wait time for telemedicine visits in 2022 decreased by 20.8 days compared with 2020, while the average visit duration decreased by 53.65 minutes (Cengil et al., 2024). These results indicate that telemedicine can influence both the patient-side and system-side efficiency of time use.

Healthcare resource allocation and system efficiency. The third channel is related to the more efficient allocation of healthcare resources. Systematic evidence on digital health interventions for cardiovascular diseases shows that all 14 studies included in one review classified such interventions as cost-effective, with heart failure and stroke being the most frequently analyzed conditions (Jiang et al., 2019). Although cost-effectiveness varies by clinical field, patient group, and implementation model, the evidence supports the conclusion that digital interventions can reduce inefficient use of healthcare resources when they are integrated into care pathways. Telemedicine can support resource allocation by enabling remote triage, monitoring, follow-up, and selective referral to in-person care. For regions with shortages of healthcare personnel and limited specialized infrastructure, this mechanism is particularly important because it can increase the functional capacity of the regional healthcare system without proportional growth in capital expenditure. In this respect, telemedicine should not be interpreted as a substitute for conventional care but as a modality for optimizing its structure.

Spatial equity and regional resilience. The fourth channel concerns spatial equity and territorial resilience. Studies that situate telemedicine within spatial development demonstrate that its effects extend beyond healthcare accessibility. The case study of Agrafa, Greece, conceptualizes telehealth as a catalyst for smart rural development and sustainable tourism by improving access to care, supporting digital equity, and strengthening the resilience of local communities (Koumpouros & Kavoura, 2026). OECD materials on rural innovation similarly underline that access to public services, including physical and digital

infrastructure, remains a major barrier to rural innovation, while shortages of qualified skills further constrain development. The same policy perspective links rural innovation to digital connectivity, service accessibility, and the modernization of territorial infrastructure (OECD, 2025). These findings suggest that telemedicine produces regional-economic effects only when it is part of a broader infrastructure system that includes broadband access, workforce capacity, public service provision, and governance coordination.

Institutional constraints in the Ukrainian context. Ukrainian data indicate the existence of an institutional foundation for telemedicine development, while also demonstrating the unevenness of conditions for its economic realization. The Strategy for the Development of Telemedicine in Ukraine notes that in 2018-2020 primary healthcare institutions received approximately 4,000 mobile telemedicine hardware and diagnostic complexes, and the first regional telemedicine centres were established in several regions (Cabinet of Ministers of Ukraine, 2023). At the same time, evidence from the primary care level indicates that 65% of villages lack broadband Internet, 45% of rural healthcare institutions remain disconnected from the network, and the share of teleconsultations increased from 4.3% in 2021 to 5.2% in 2022, corresponding to 5.7-6.9 million cases (Riabkov, 2025). These indicators show that telemedicine in Ukraine is already forming an organizational basis for reducing territorial inequality in healthcare access, but its regional-economic potential is constrained by digital infrastructure, financing, and workforce readiness.

Conceptual model of telemedicine's regional-economic effects. The identified mechanisms can be summarized as a conceptual model linking telemedicine functions with intermediate socioeconomic effects and regional economic outcomes in Table 1. This model clarifies that the contribution of telemedicine to sustainable regional development is mediated by cost, time, access, infrastructure, and resilience mechanisms rather than by the mere availability of digital technologies.

Table 1. Conceptual model of telemedicine's regional-economic effects

Telemedicine mechanism	Intermediate socioeconomic effect	Regional economic outcome
Remote consultations	Fewer patient trips and lower travel-related expenditure	Reduced household transaction costs and improved affordability of care
Remote monitoring and follow-up	Earlier detection of deterioration and fewer unnecessary in-person visits	Lower burden on local healthcare infrastructure and more efficient resource use
Digital triage and patient routing	More selective referral to specialized services	Improved throughput capacity and better allocation of scarce medical personnel
Reduced travel and waiting time	Lower working-time losses for patients and accompanying persons	Preservation of productive time and support for labour productivity
Digital access for rural and peripheral areas	Lower spatial barriers to basic and specialized care	Reduced territorial inequality and stronger service accessibility

Continuity of care during disruptions	More stable access under wartime, infrastructural, or mobility constraints	Higher functional resilience of regional health systems and local social infrastructure
Integration with broadband and digital infrastructure	Inclusion of healthcare in territorial digital modernization	Strengthened foundation for smart rural development and regional innovation

Source: Authors' elaboration based on Adella et al. (2025), Buvik et al. (2019), Jiang et al. (2019), Koumpouros and Kavoura (2026), Riabkov (2025), Snoswell et al. (2022), and Cengil et al. (2024).

Discussion. The results confirm that the regional-economic potential of telemedicine is determined not only by its ability to expand access to medical care but also by its influence on the cost structure of healthcare access, the use of productive time, and the resilience of local social infrastructure. These findings are consistent with systematic evidence showing that telehealth can reduce costs and improve cost-effectiveness, especially where travel and access barriers are substantial (Adella et al., 2026; Jiang et al., 2019).

The contribution of this study is in conceptualizing telemedicine as a regional-economic mechanism rather than only as a healthcare delivery modality. Unlike studies focused primarily on clinical outcomes or cost-effectiveness within a healthcare system, the present analysis emphasizes socioeconomic transmission mechanisms: reduction of transaction costs, preservation of productive time, mitigation of spatial inequality, optimization of local healthcare resources, and strengthening of the adaptive capacity of regional health systems.

The effect on productive time is particularly important for regional economies. The evidence on avoided travel and avoided days away from usual activities indicates that telemedicine can preserve time that would otherwise be withdrawn from employment, self-employment, household care, education, and other economically meaningful activities (Snoswell et al., 2022). For peripheral regions, where distance to specialized care is often greater and transport options are more limited, this effect can be more consequential than in large urban centres. Telemedicine also changes the relationship between healthcare infrastructure and territorial development. When remote consultation, monitoring, and digital routing are integrated into care pathways, regional health systems may use scarce specialized resources more selectively and efficiently. This does not eliminate the need for in-person care, hospitals, or specialized facilities. Rather, it creates a more differentiated model of care delivery in which digital and physical infrastructure complement one another.

The Ukrainian context demonstrates both the relevance and the limitations of this model. On the one hand, telemedicine is supported by a national strategy, regulatory mechanisms, mobile diagnostic complexes, and regional telemedicine centres (Cabinet of Ministers of Ukraine, 2023). On the other hand, the persistence of broadband gaps and uneven institutional capacity limits the possibility of transforming telemedicine into a fully functional instrument of regional economic resilience (Riabkov, 2025). Therefore, the Ukrainian case confirms that telemedicine is a conditional, not autonomous, factor of sustainable regional development. From a policy perspective, telemedicine should be included not only in healthcare digitalization strategies but also in regional development, rural infrastructure, broadband connectivity, and human capital policies. Its economic value should be assessed from a broader societal and regional perspective, including travel-related costs, working-time losses, patient and caregiver time, infrastructure constraints, and the resilience of local service systems. This is especially important for rural, remote, peripheral, and war-affected territories, where the economic cost of limited healthcare access is structurally higher.

The findings also indicate that isolated pilot projects are insufficient for achieving sustainable regional effects. The transition from episodic telemedicine use to regional economic impact requires institutional integration, financing continuity, interoperable digital platforms, health workforce digital readiness, patient trust, and reliable broadband connectivity. Without these conditions, telemedicine may remain a fragmented technological solution with limited capacity to reduce territorial inequality.

Study Limitations. This study is based on a conceptual and narrative design rather than a formal systematic review or meta-analysis; therefore, the findings should be interpreted as an analytical synthesis of mechanisms and institutional conditions rather than as a quantitative estimate of telemedicine's regional-economic effect. The evidence analyzed originates from heterogeneous healthcare systems, clinical areas, countries, and economic evaluation frameworks, which limits the direct comparability of cost indicators, productivity gains, and implementation outcomes. The study also does not include region-level empirical modelling for Ukraine, which restricts the possibility of directly estimating the impact of telemedicine on gross regional product, employment, budgetary indicators, household expenditure, or labour productivity. **Future research** should use Ukrainian statistical and administrative data to quantify the regional-economic effects of telemedicine. Particular attention should be paid to differences by type of territory, including rural, peripheral, urban, and war-affected regions. Economic-mathematical models should assess how the effect of telemedicine depends on population density, transport accessibility, broadband availability, workforce capacity, clinical profile, and institutional integration.

Conclusions. Telemedicine should be regarded as a conditional determinant of sustainable regional economic development. Its socioeconomic contribution is realized through the reduction of direct and indirect access-related costs, preservation of productive time, more efficient allocation of healthcare resources, mitigation of spatial inequality, and strengthening of the functional resilience of local health systems. These mechanisms link healthcare accessibility with human capital preservation, household expenditure, labour productivity, and the adaptive capacity of regional infrastructure.

For rural, peripheral, remote, and war-affected territories, telemedicine has not only medical but also regional-economic significance. It can reduce the economic burden of distance, support continuity of care, improve access to specialized consultations, and strengthen local social infrastructure. However, these effects are not automatic. They depend on broadband connectivity, stable financing, institutional integration, interoperable digital systems, patient trust, and health workforce digital readiness.

For Ukraine, the development of telemedicine should be considered within an integrated policy framework that combines healthcare modernization, digital infrastructure development, rural policy, human capital preservation, and regional economic resilience. Further empirical research is required to quantify the contribution of telemedicine to regional productivity, household cost reduction, healthcare resource allocation, and the sustainable development of territorial communities.

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