



## DYNAMICS OF MEDICAL INFRASTRUCTURE DEVELOPMENT IN THE FERGANA VALLEY REGIONS. (1991-2025)

Khazirov Bobirjon Burkhaniddinovich

Andijan branch of Kokand university

Lecturer at the Department of History and Social

Sciences, Independent Researcher.

bobirjon\_burxaniddinovich@mail.ru. +998 90.385 02 22

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**Abstract.** This article analyzes the stages and regional differences in the development of medical infrastructure in the regions of the Fergana Valley in 1991-2025. The study utilized a historical-comparative and institutional approach, comparing regulatory documents and open statistical sources. The results show the cycles of modernization, the reorganization of the primary link, and the territorial unevenness of investment flows. The work offers a dynamic model for the historiography of regional healthcare. The article examines the problem of changes in medical infrastructure in the regions of the Fergana Valley during 1991-2025. As a methodology, source analysis, statistical comparison, and periodization methods were combined. The main results highlight the imbalances associated with the transition of the sector from centralization to functional diversification, optimization of the hospital fund, and staff shortages. The study identifies regional criteria for assessing infrastructure. The study explains the dynamics of the formation of medical infrastructure in Andijan, Namangan, and Fergana regions from 1991 to 2025. The methodological basis was chosen as a historical-systemic approach, analysis of the content of reforms and comparative reconstruction by indicators. The results identify infrastructure constraints for the institutional reconstruction of primary healthcare, the growth of specialized centers, and the quality of services. The work provides conceptual conclusions explaining the development of regional healthcare.

**Keywords:** Fergana Valley, medical infrastructure, health system reforms, primary health care, hospital network, regional disparities.

**Introduction.** The Fergana Valley is a region with high demographic density in Uzbekistan, a mix of urban and rural lifestyles, and active migration flows; therefore, medical infrastructure in this region serves not only as part of the social services system but also as a factor determining the quality of labor resources, the stability of human capital, and the institutional foundation of regional development. In the period after 1991, the healthcare system gradually transitioned from the centralized management, priority of inpatient care, and planned resource allocation of the former Soviet Union to new financing mechanisms, centralization of primary care, and functional diversification of medical services. These changes were particularly complex in the conditions of the Fergana Valley: high population density, inter-district commuting, morbidity profiles related to environmental and industrial factors, and competition in the human resources market required infrastructure planning and territorial adaptation.

In the scientific literature, general characteristics of Uzbekistan's healthcare reforms, updates to the regulatory framework, and the implementation of the primary healthcare model are extensively covered [1; 2]. However, there is a lack of historical and analytical works

explaining the real dynamics of infrastructure through stages, institutional mechanisms, and interregional differences, taking 1991-2025 as a continuous period across the regions of the Fergana Valley. Some existing studies are limited to specific areas, such as rural medicine or human resources, while others draw regional conclusions from national indicators; such an approach does not sufficiently reveal the internal differences of the valley, city-district ratios, the location of specialized centers, and transport and logistics factors [3; 4]. Therefore, the research problem is the question of what stages, based on which institutional logic, and with what regional differences the medical infrastructure in the regions of the Fergana Valley developed in 1991-2025.

The purpose of this article is to periodically analyze the dynamics of medical infrastructure development in the Andijan, Namangan, and Fergana regions, identify its driving factors through institutional and resource approaches, and propose an analytical model that explains interregional differences. According to the goal, the tasks are interpreted as follows: first, to reconstruct the content of the main reforms in the healthcare sector from an infrastructure perspective during 1991-2025; second, to conduct a comparative analysis of changes in the ratio between primary care, the stationary network, and specialized services by region; third, to explain the constraints and opportunities associated with resource allocation, human resources, and the material and technical base in connection with factors in the regional context; fourth, to show how new infrastructure requirements are forming in the 2020s against the backdrop of digitalization, logistics, and the integration of medical care. The scientific novelty of the research is an attempt to explain infrastructural changes not only through the number of facilities, but also through the functional role, management mechanism and service architecture, considering the three regions of the valley as a single space.

**Methods.** The research methodology relied on a combination of historical-systemic and institutional approaches. The historical-systemic approach made it possible to view medical infrastructure simultaneously as a complex of material objects, a product of management decisions, and an architecture of services linked to the needs of the population; through this approach, the period of 1991-2025 was divided into stages with internal logic, and the points of continuity and disconnection between the stages were clarified. Institutional analysis served to explain changes in healthcare management, financing, forms of ownership, and the distribution of responsibilities as the primary determinants of infrastructure dynamics; it was this approach that proved effective in explaining "reorganization-functional redistribution" processes within the sector rather than "construction-multiplication" [5; 6].

Open statistical collections, regional socio-economic reviews, the content of regulatory legal acts on healthcare, and the evidence presented in scientific literature on the field were comparatively reconstructed as an empirical basis [1; 7]. The comparative method allowed for a comparison of the three regions based on identical periodization criteria: coverage and geography of primary care, repurposing of the inpatient fund, the formation of a network of diagnostic and specialized centers, and factors affecting staffing levels. Through source analysis, the discrepancies between the goals set in the documents and the practical structure were clarified, i.e., the differences between the planned model and the actual territorial adaptation. The analytical generalization method was aimed at combining individual facts and observations along conceptual axes such as "access, continuity, specialization, and resource



sustainability" of the medical infrastructure; as a result, a consistent statement explaining the dynamics was created.

The choice of these methods was driven by the two-layered nature of the topic: historical (since 1991) and practical (the actual functioning of the infrastructure). Relying solely on regulatory documents may not sufficiently reveal the actual state of the infrastructure, and a statistical approach alone may not be able to explain the institutional logic of reforms. Therefore, the use of a combined methodology—that is, the combined use of analysis, comparison, and periodization of document content—was deemed appropriate for the purpose of the study.

**Results.** The analysis conducted for 1991-2025 allowed for the interpretation of the development of medical infrastructure in the regions of the Fergana Valley within four main stages. The first stage is the period from 1991 to 1999, which is characterized by the preservation of the legacy fixed-route network, ensuring minimal functionality in conditions of resource scarcity, and the readaptation of management and financing mechanisms. In all three provinces of the valley, the existing hospital fund and polyclinic network continued to operate, but disruptions in supply chains, equipment wear and tear, and the migration of skilled personnel to central cities increased the pressure on infrastructure. An important result of this period is that, while the "quantitative" indicators of the infrastructure appeared relatively stable, there was a latent degradation in its "quality" parameters, especially in terms of diagnostic capabilities and service continuity; this situation became one of the main arguments for institutional restructuring in subsequent stages.

The second stage covers 2000-2010 and is characterized by the strengthening of primary health care and the reorganization of regional services. During this period, medical infrastructure underwent a transition from the "hospital-centered" model to the "primary care-centered" model; in rural areas, medical centers and services based on a model close to family practice expanded, and referral and consultation links at the district level were restored [1; 2]. The results showed that although the primary link increased geographical proximity in the regions of the valley with high internal demographic density, the quality of services was not at the same level due to high workload and staff shortages. Due to the relatively high share of industry and cities in Andijan and Fergana, specialized service centers were formed faster, while in Namangan, inter-district transport and the structure of settlements complicated the issue of primary care coverage. Another result of this stage is related to the optimization of the stationary network: some small-capacity departments were re-specialized or consolidated, which allowed for the concentration of resources, but for some remote areas, the distance factor was increased.

The third stage was observed in 2011-2019, characterized by the functional diversification of medical infrastructure and the expansion of specialized centers and diagnostic services. In all three regions of the valley, the network of institutions in areas such as cardiology, endocrinology, perinatal care, and emergency medical care has been strengthened, laboratory and diagnostic capabilities have been expanded, and the functional division between the state and non-state segments in certain services has been strengthened [6; 7]. The results particularly highlighted the phenomenon of "network deepening": that is, the internal functional structure of existing institutions has become more complex than the number of institutions, clinical protocols and referral routes have increased, resulting in increased



management complexity of the infrastructure. Interregional differences were mainly manifested in two directions: first, the faster concentration of high-tech services in regional centers; second, the weakening of the "bridge" function between the primary and specialized levels in areas where personnel stability was not ensured at the district level. Another important result of this stage is the intensification of the interdependence between medical infrastructure and transport and logistics infrastructure: the efficiency of the ambulance and referral system has become directly linked to the road network, intercity travel, and seasonal migration.

The fourth stage, forming in 2020-2025, is characterized by the integration of healthcare management and services, the expansion of digitalization elements, and the transformation of epidemiological risk preparedness criteria into infrastructure requirements. During this period, medical infrastructure began to be viewed not merely as a collection of buildings and beds, but as an integrated ecosystem with data flows, logistics, consumables reserves, and laboratory networks [8; 9]. The results showed that in the Fergana Valley, regional centers and large cities implemented elements such as digital registration, queue management, and laboratory result transfer faster, while in the districts, digital infrastructure was implemented unevenly due to communication quality, maintenance, and staff qualifications. At the same time, in the 2020s, the territorial distribution of specialized assistance was revised, and certain services were re-standardized along the "district-region-republic" referral chain; this process accelerated the development of infrastructure as "vertical integration," but at the "horizontal" level, i.e., where mechanisms for inter-district cooperation and access to shared resources were insufficiently institutionalized, efficiency constraints persisted.

The main result, summarized by stages, is that the development of medical infrastructure in the regions of the Fergana Valley occurred not through linear growth, but through successive cycles of functional redistribution, optimization, and specialization. While institutional strengthening of primary care has expanded access to health care, "intra-regional differences" in service quality persist due to disparities in staffing and diagnostic provision. The consolidation of the stationary network helped concentrate resources, but in some remote areas, the distance factor and the complexity of the routing chain increased. The growth of specialized centers has contributed to improving the quality of disease detection and treatment, but due to the fact that the majority of them are concentrated in cities and centers, "dependence on the center" has increased where there is insufficient logistical and information infrastructure connecting districts.

**Discussion.** The results obtained demonstrate the dynamics of medical infrastructure in the regions of the Fergana Valley in accordance with general trends in the history of reforms, but as a specific process formed under the influence of regional characteristics. The concept of primary care centrality is emphasized in international health literature as an important condition for efficiency and equity; The World Health Organization notes that a strong primary healthcare system increases system resilience and cost efficiency [9]. The expansion of the primary link in all three regions of the Valley has improved access, but our analysis shows that in regions with high demographic density, the burden on the primary link increases rapidly, and if not supported by diagnostics and personnel, this model will not be able to provide "real quality" evenly while increasing "formal coverage." Therefore, the condition of "strengthening

the primary link" in the international concept should be considered in conjunction with factors of personnel migration and inter-district mobility in the conditions of the valley.

In research on healthcare reforms in Russia and the post-Soviet space, the optimization of the stationary network is often justified by the need to concentrate resources and increase efficiency, but a cautious approach to territorial equality is required [5]. Results in the Fergana Valley are similar: consolidation in some cases helped consolidate medical technologies, strengthen specialized departments, and simplify management, but this process, along with roads, emergency logistics, and referral protocols, increased patient time costs in unmodernized settings. Therefore, evaluating optimization based solely on the number of inpatient beds is scientifically insufficient; it must be analyzed in connection with "distance-time" indicators, inter-district routing stability, and the diagnostic potential of the primary care unit.

Researchers in Uzbekistan often cover reforms in the healthcare system from the perspective of management and financing mechanisms, emphasizing the priority of primary care and prevention [1; 3]. Our analysis complements this approach: although the development of prevention and primary care in the three regions of the valley has expanded infrastructurally, the level of integration with specialized services and the laboratory network varies by region. These differences cannot be explained solely by the volume of funding, as resource efficiency largely depends on staff stability, interagency cooperation, and information exchange systems. In this sense, it is necessary to measure the dynamics of infrastructure not as "construction of facilities," but also as "density of institutional links."

In international scientific literature, digital healthcare and data-driven management are interpreted as an important part of infrastructure modernization; here, digitalization is not just technology, but an institutional change related to standards, personnel competence, and data quality [8]. Results for 2020-2025 showed that digital solutions were implemented faster in the central cities of the valley, while in the districts, "uneven digitalization" occurred due to maintenance and competence. This situation scientifically means that digital infrastructure does not automatically ensure territorial equality; on the contrary, it can exacerbate existing disparities if there are no support mechanisms. Consequently, in the conditions of the Fergana Valley, it is scientifically and practically justified to view digitalization policy as a single package with district-level technical services, training, and internet infrastructure.

Another important conceptual conclusion within the framework of the discussion is that the medical infrastructure in the Fergana Valley functions as a "system of intra-regional centers": regional centers consolidate specialized services, districts bear the main burden of the primary link, and between them, logistics and referral mechanisms become the quality-determining link. In explaining this model, classical approaches to healthcare systems—namely, views on the balance between the input, process, and outcome components of the system—will be useful [10]. Our results show that if the process component, i.e. the mechanisms of orientation, diagnostics and information exchange, are not strong, a disconnection occurs between the input component (proximity to the institution) and the result component (quality). Thus, when assessing the dynamics of medical infrastructure, institutional processes, along with the network of institutions, must be the object of historical analysis.



**Conclusion.** An analysis of 1991-2025 showed that the development of medical infrastructure in the regions of the Fergana Valley proceeded through gradual reorganization and functional complexity rather than linear growth. While maintaining the existing fixed network was a priority in the initial period, in subsequent stages, the primary link expanded and access to the service increased, but quality gaps persisted due to uneven human and diagnostic resources. The expansion of specialized centers and diagnostic services in the 2010s deepened the network, but increased dependence on centers and the complexity of the referral chain. In the 2020s, the concept of infrastructure began to be reinterpreted as an integrated ecosystem with digital management, logistics, and laboratory networks; it was at this stage that the issue of territorial equality became more clearly visible as being directly linked to technical and institutional support.

The scientific contribution of the article is to substantiate a conceptual model that explains the dynamics of medical infrastructure in the regions of the Fergana Valley in the context of stages, institutional mechanisms, and regional differences. In practical terms, the results demonstrate the need for joint modernization of personnel stability, diagnostic capabilities, and the referral and logistics system to reduce qualitative differences between districts and cities. As a promising direction for future research, it is proposed to reconstruct "distance-time" input indicators in historical dynamics by district, assess the impact of digital infrastructure on service quality and management costs, and study functional integration mechanisms with the non-state sector using regional examples.

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