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The impact of the railway on the development of Bishkek

Abstract. This study aimed to conduct a detailed analysis of how the railway has influenced the development of the city of Bishkek. The study employed historical-analytical and geographical methods, analysing archival documents, cartographic materials, and academic publications to ascertain the impact of the railway on Bishkek's growth. The findings indicated that the construction of the Turkestan-Siberian railway played a pivotal role in shaping the urban structure of Bishkek. The railway facilitated the city's economic growth, population increase, and industrial development. New residential and industrial areas emerged around railway stations and routes, leading to a significant expansion of the urban territory. Furthermore, the railway enhanced the city's transport accessibility, fostering trade and interregional connections. The influence of the railway was also evident in the city's architecture, characterised by the emergence of buildings and structures typical of the railway era. Over time, the role of the railway in urban life has somewhat diminished, yet its historical influence remains significant. The study revealed that the railway contributed not only

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to economic development but also to cultural changes in Bishkek. The emergence of a railway hub led to increased migration and alterations in the city's demographic structure, attracting new residents and labour resources. The railway also facilitated the development of infrastructure and public services, such as electrification and water supply, which improved the quality of life in the city. Ultimately, the railway became a crucial factor in integrating Bishkek into regional and international transport networks, enhancing its strategic importance in the region. The railway played an essential role in the establishment and development of Bishkek, exerting a multifaceted influence on its economy, social structure, and urban planning. The historical experience of developing the city's railway infrastructure can serve as a foundation for planning its future development

Keywords: railway station architecture; interregional connectivity; urban planning; urban framework; transport network

INTRODUCTION

The relevance of this research lies in the fact that railways have always played a crucial role in the development of cities and regions, fostering economic growth, enhancing transport accessibility, and accelerating urbanisation processes. The primary challenge of this research was to conduct a comprehensive analysis of the numerous factors that influenced the city's development under the impact of railway infrastructure. It was essential not only to identify the immediate effects of the construction of the Turkestan-Siberian railway but also to understand the long-term consequences and interactions of various factors. Moreover, given the city's contemporary development, the study had to consider current trends and future prospects, necessitating the integration of historical analysis with modern data and methods (Attokurova & Adylbekova, 2022).

M. Kozybaeva (2023) highlights the pivotal role of railway construction in developing the transport and communications infrastructure of cities in Northern Kazakhstan, connecting them to major industrial centres within the country. Since 2008, the network of high-speed rail (HSR) lines in China has expanded significantly, a development that, according to many experts, has stimulated economic growth. M. Jin *et al*. (2020) tested this hypothesis by analysing the impact of HSR on economic inequality in China between 2002 and 2016 using a spatial econometric model. Their findings confirmed that HSR indeed contributes to local economic growth, although the spillover effect was found to be insignificant. Conversely, J. Jiao *et al*. (2020) concluded that the economic impact of HSR is more closely linked to improvements in accessibility and connectivity of the railway network rather than simply the presence of HSR infrastructure. Accessibility and connectivity between neighbouring cities exert a mutual influence on their economic growth.

The study by M.B. Bouraima *et al*. (2020) identified that the primary threats to railways are competition from road transport and periodic government intervention. The authors identified outdated and non-functional infrastructure, as well as chronic underfunding, as the main weaknesses of railways. However, they noted that potential market growth and large-scale long-distance rail freight transport are key opportunities and strengths. Meanwhile, Y. Liang *et al*. (2020) discuss the contentious issue of whether HSR can stimulate regional economic growth along its route, particularly when connecting less developed and developed regions, suggesting a need for further research in this area.

A.N.H. Ibrahim *et al*. (2020) argue that while rail-based public transport is a more advanced and preferable mode of transportation, capable of addressing congestion and pollution problems, its adoption rates remain low due to various factors. Among these, they highlight that passengers often opt for more reliable and convenient alternatives or are dissatisfied with the quality of service provided.

While the authors examined various aspects of railway infrastructure and its impact on economic growth and urban development, their research has left certain crucial questions underexplored. The social and cultural impacts of railways have not been examined in detail. Issues such as how railways affect population mobility, access to education and healthcare, and cultural exchange between regions have been overlooked. The environmental consequences of railway development also require deeper analysis. It is essential to consider the impact of railways on the environment, including landscape changes, effects on local flora and fauna, and greenhouse gas emissions. The long-term economic sustainability of railway development is another important aspect that has not been sufficiently addressed. There is a need to understand how railways influence economic diversification and resilience in the face of economic crises.

This study aimed to conduct a comprehensive assessment of the impact of the Turkestan-Siberian railway on the development of the city of Bishkek. The primary objectives of the research included analysing the phases of construction and commissioning of the railway. In particular, the study investigated the transformations of the architecture of the railway station in Bishkek in connection with the development of the railway; the influence of various architectural styles and epochs on the formation of railway structures in Bishkek was also evaluated.

MATERIALS AND METHODS

A variety of sources and methods were employed to investigate the impact of the Turkestan-Siberian railway on the development of Bishkek (formerly known as Frunze, Pishpek), ensuring a comprehensive analysis of the topic. The materials used included historical documents, archival records, maps, and reports. Primary sources comprised

reports on the construction of the Turkestan-Siberian railway, data on the city's urban planning and architectural features, and documents about the industrial and urban development of Bishkek at various points in time. Cartographic materials, such as historical and contemporary maps of the city illustrating changes in its layout, as well as diagrams of railway lines and stations, were also crucial sources (Khitakhunov, 2024). These materials were studied in the library, which provided access to the necessary documents and archival records.

The historical method enabled the analysis of documents and archival materials to identify key stages in the development of railway infrastructure and its impact on urban planning. A comparative analysis of different periods in the city's development helped to understand how its structure changed under the influence of the railway. Cartographic analysis was used to visualise changes in urban planning and railway line routing, as well as for geographical modelling of the railway's impact on the location of industrial and residential areas in the city. The socio-cultural analysis allowed for the study of the railway's influence on the city's socio-economic development, including migration processes, the development of trade and industry, and the cultural and architectural changes caused by the development of railway infrastructure. The theoretical-architectural method was employed to investigate the architectural features of railway stations and adjacent areas, their role in shaping the urban environment, and to analyse urban planning decisions related to the placement of railway facilities in the city's master plan.

A variety of tools and technologies were employed in the study. Geographic Information Systems were used to analyse spatial data and visualise changes in urban planning, as well as to create maps and diagrams illustrating the impact of the railway on Bishkek's development. Statistical methods were applied to analyse demographic and economic data, enabling the identification of correlations between railway development and changes in urban structure. Computer modelling facilitated the simulation of various scenarios for the development of urban infrastructure, considering historical data, and forecasting future changes in the urban environment under the influence of transport infrastructure.

The study was subject to several limitations that must be considered when interpreting the results. Data availability was one such constraint: some archival materials and documents may have been inaccessible or incomplete, limiting the comprehensiveness of the analysis. Modern data on the city's development may have been restricted due to the closure of certain information sources. The accuracy of historical data could also vary, for example, historical documents may have contained inaccuracies or distortions, affecting the reliability of the conclusions; therefore, critical analysis and comparison of various sources were necessary to obtain an objective picture. The complexity of factors further complicated the analysis. Urban development is influenced by a multitude of factors, including economic, political, social, and cultural aspects, making it difficult to isolate the influence of the railway alone. The need to account for the interaction of various factors was crucial for a comprehensive understanding of the development processes.

RESULTS

The construction of the Turkestan-Siberian railway (1926-1931) connected Siberia, Central Asia, and the centre of the country, accelerating transportation (Khitakhunov, 2024). The idea of a Siberia-Turkestan railway emerged in the 19th century. The Crimean War highlighted the importance of railways, and in 1857 a decree was issued to create a railway network. In 1877, the Syzran-Orenburg line was built, but it was decided to extend the route to Tashkent via the Trans-Caspian railway. Although the Altai region could supply grain and coal, the delivery was costly due to the lack of direct communication with Central Asia (Bakytbek *et al.*, 2020)

At the beginning of the 20th century, surveys for the Arys-Verny railway began. In 1906, an interdepartmental committee allocated funds for the construction of the section from Barnaul to Semipalatinsk-Arys (Alotaibi *et al.*, 2022). In 1912, the industrialist A.I. Putilov became involved in the project, completing the line to Burnoe station in 1924. In 1927, a central authority for the construction of the Turkestan-Siberian railway was established in Moscow, and the railway was officially opened on 31 December 1930 (Filatova, 2012).

The route through the Trans-Ili Alatau Mountain range sparked considerable debate. After lengthy discussions, the Chokpar variant was adopted, reducing construction costs by 23 million roubles. Simultaneously, the Semirechensk railway was reconstructed, and the Pishpek-Tokmak line was built (Faísca & Januário, 2024). The Frunze railway division began operations in 1924, serving Bishkek's industrial enterprises. The opening of the railway line facilitated the city's development and led to the merger of Bishkek-1 station with the city. Residential and industrial buildings emerged along the station, many of which have retained their 1920s architectural style (Palin *et al.*, 2021).

During the 1920s and 1930s, the Kyrgyz railway network developed as part of the unified railway system of the Soviet Union. It consisted of two sections, both single-track, non-electrified, broad-gauge (1,520 mm) lines. In the north, a 323-kilometer section, including stations such as Lugovaya (Kazakhstan), Kara-Balta, Bishkek, and Balykchy, was the southern branch of the Turkestan-Siberian railway, linking Central Asia with Siberia via present-day Kazakhstan. This section was managed from Almaty (Kazakhstan) (Fig. 1). In the south, a 101-kilometer network was constructed, comprising four short branches in Osh, Jalal-Abad, Kyzyl-Kyya, and Tash-Kömür, which connected to the Trans-Aral railway running from Tashkent to Orenburg (Russia), linking Central Asia with European Russia and the Turkestan-Siberian railway at Arys (Kazakhstan). These southern branches were managed from Tashkent

(Uzbekistan). During the 1930s, the area between the city and the station saw the development of industrial and residential buildings for Interhelpo, contributing to the merger of Bishkek-1 station with the city (Niu *et al*., 2021).

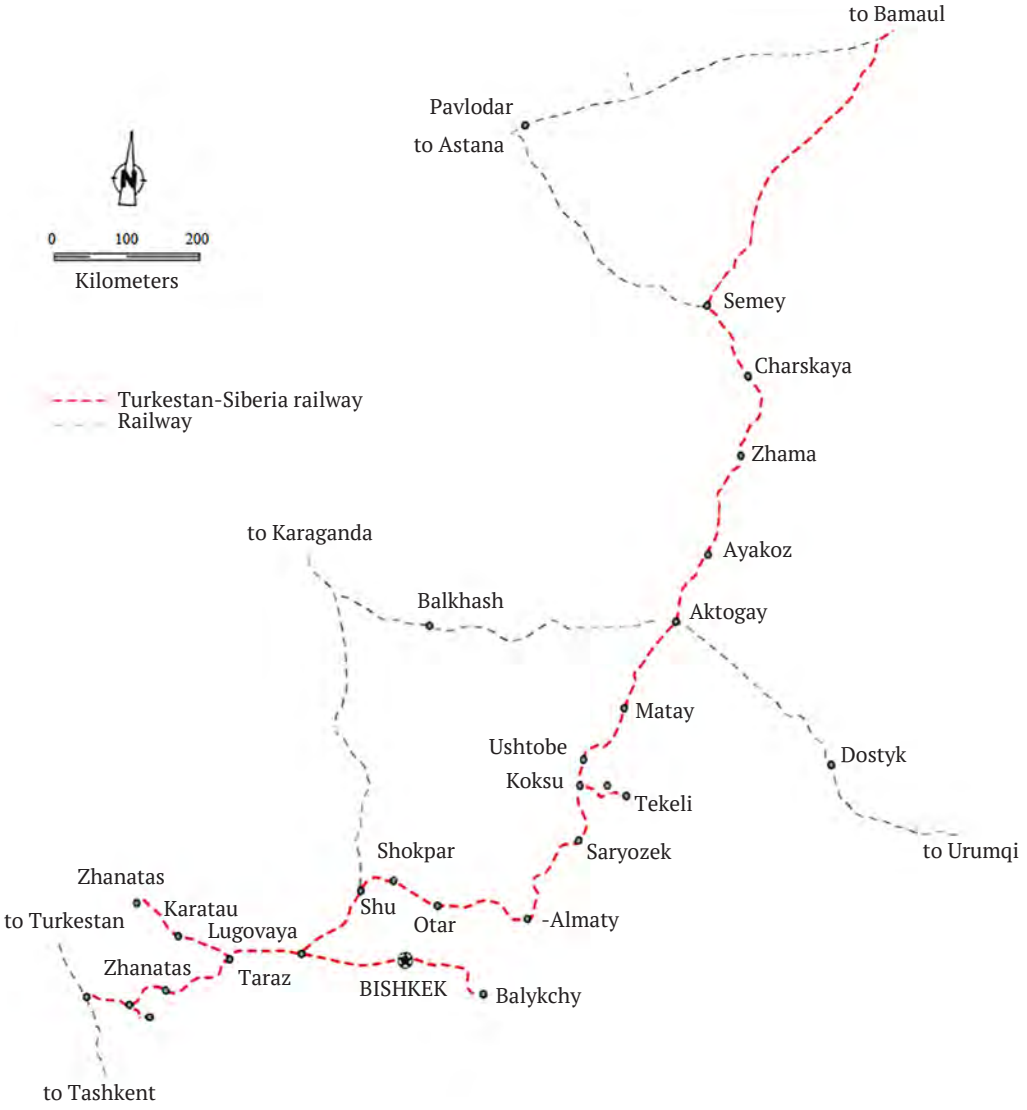

Figure 1. Scheme of Turkestan-Siberian railway

Source: F. Niu *et al*. (2021)

Following the dissolution of the Soviet Union in 1991, the Kyrgyz Republic inherited a railway infrastructure comprising 2,500 freight wagons, 450 passenger carriages, and 50 locomotives. To manage and operate the railway network within the country, a new state-owned enterprise, "Kyrgyz Temir Zholu", was established, taking over the functions of the former Soviet railway centres in Almaty and Tashkent. Trains operating on Kyrgyz railways now had to cross international borders to connect to the main lines in Kazakhstan and Uzbekistan. All transportation between the northern and southern parts of the Kyrgyz railway network was carried out via the railway networks of these two neighbouring states.

In 2024, warehouse facilities, various wholesale bases of organisations, and industrial enterprises extend along the railway station. The residential buildings are predominantly single-storey, and the surrounding courtyards feature characteristic railway workers' houses designed in a pre-revolutionary style that persisted into the 1920s, as can be seen in Taraz, where the railway also arrived in the 1920s (CAREC, 2021). Elsewhere in the city, this district was generally not perceived as being connected to the railway station, despite it being an interesting landmark with pre-revolutionary architectural features. The surrounding area is still known as Bishpek, which remained the name of the station until 1991, while the current Bishkek-2 was previously known as Frunze station (Fig. 2). Within the station grounds, there was a garden. The waiting room floor was adorned with colourful tiles featuring various patterns and ornaments.

Figure 2. Pishpek station

Notes: photo taken in 1924
Source: S. Horák (2022)

Along the railway routes crossing the city, passenger, freight, and sorting stations have developed, alongside numerous engineering, technical, and civil structures. Bishkek's railway junction developed into a complex structural and planning scheme, occupying vast urban areas. Advances in railway technology, such as increased speeds and load capacities, coupled with a lack of territorial reserves, led to the irrational placement of certain parts of Bishkek. As a result, the railway and its associated infrastructure, along with the nearby urban development, found themselves in extremely constrained and congested conditions (Acker & Triggianese, 2021).

Bishkek's railway junction, a complex and multifaceted system, played a pivotal role in shaping and developing the city's infrastructure. The passenger station served numerous routes, connecting Bishkek with other regions and countries, thereby fostering increased population mobility and tourism. The freight and sorting stations ensured efficient logistics and goods transportation, stimulating industrial and commercial growth. The railway junction's engineering and technical infrastructure, encompassing depots, repair workshops, warehouses, and administrative buildings, guaranteed the seamless operation of the entire system (Wang *et al.*, 2020a).

Advances in railway technology, manifested in increased speeds and load capacities, necessitated the expansion and modernisation of railway infrastructure. However, a lack of available land and dense urban development constrained these expansion possibilities. Consequently, some sections of the railway infrastructure were ineffectively situated, creating challenges for urban planning and transport logistics. Nevertheless, the development of railway transport had a significant impact on the formation of the urban environment, facilitating the integration of different districts and improving transport accessibility (Musayev *et al.*, 2022).

The shaping of the city's urban structure under the influence of railway transportation enabled more precise planning and implementation of urban development policies. The utilisation of scientific data and historical urban analysis facilitated informed decision-making in the creation of new projects and the reconstruction of existing facilities. This allowed for the creation of a balanced and harmonious urban environment, fostering the sustainable development of Bishkek and its integration into regional and international transport networks.

The emergence of Bishkek as an industrial centre of the Kirghiz Soviet Socialist Republic (SSR) was influenced by the evacuation of industrial enterprises and labour resources during the Second World War, as well as the presence of a railway transport infrastructure of union significance within the city. The need for the rapid restoration of evacuated large industrial enterprises and the construction of new facilities resulted in the haphazard formation of industrial zones in Bishkek along the railway corridor, which subsequently shaped the development of residential and public areas of the city beyond the primary provisions of the master plan (Jelen *et al.*, 2021). The incessant expansion of urban areas has led to a lack of comprehensive architecture and planning in urban development. The unplanned allocation of land for residential housing to serve the labour needs of industrial enterprises resulted in the persistence of a spatial arrangement where industrial zones were situated between residential areas, separated by railways. Consequently, as Frunze continued to develop, its urban structure became even more fragmented.

The development of new industrial and residential districts with low-rise housing of undistinguished aesthetic quality perpetuated the "flat" character of urban development. This contributed to problems related to the cost-effectiveness of the city's engineering services (Wang *et al.*, 2020b). The connection of central districts to the main

railway line facilitated a significant expansion of residential development, resulting in the construction of large hotel complexes, such as the Ala-Too and Pishpek hotels, near the railway. Additionally, substantial public, commercial, and cultural buildings, as well as shopping centres, were erected along Mira and Lev Tolstoy Avenues. This development also prompted the reconstruction of the planning structure in nearby districts, including the construction of overpasses on Sovetskaya and Alma-Atinskaya Streets, Mira Avenue, and the widening of Timur Frunze Street.

The current and prospective development of the agglomeration has been driven by the railway remaining one of the primary modes of mass transport, facilitating both long-distance travel and commuter flows of the workforce. As a result of the ongoing development of the track and warehousing facilities at the railway hub, alongside the construction of access routes to new enterprises, there has been an increased demand for the organisation of the city's transport infrastructure. This has necessitated a significant rise in capital investment for its reconstruction.

The escalating freight traffic on the railway and the impossibility of physically relocating the railway line within the city have had a profound impact on the overall functioning of the city's transport hub. As a result, the construction of bypass roads, complete with additional infrastructure, has become necessary. The emergence of Pishpek and the formation and development of its planning structure were directly linked to the construction of the Turkestan-Siberian railway. The city's growth was driven by a confluence of geographical, economic, geological, and strategic factors that facilitated the transformation of a small district town into the large, multi-industrial transport hub of Frunze.

The chosen research topic facilitated clarification of the city's typology at various stages of its development and elucidated the trajectory of its changing urban specialisation, influenced by the railway complex as a stable foundation for the city's urban-typological development. The first typological characteristic of Pishpek was the fortress built at the intersection of caravan routes. The next stage of its development can be identified as a commercial and fair crossroads, featuring spontaneous constructions. By the end of the 19th century, the status of the settlement was changed to that of a county town. The political changes in the country in 1917 led to an influx of migrants and the establishment of the "Interhelpo" commune, which proposed the creation of a new sun city in the steppe (Uralbayev & Yermekbayev, 2021).

The station was established during the construction of the railway branch from Lugovaya to Pishpek, which led to the creation of a settlement adjacent to the station. On the eve of the 1940 war, Pishpek had evolved into a significant railway station on the Turkestan-Siberian railway. The increase in freight traffic necessitated the urgent establishment of new enterprises in the area. In the development of the master plan for Pishpek, the "Hippodamian" planning system was selected, which was more progressive compared to the medieval layouts characteristic of Central Asian cities (Fig. 3). This rectangular quarter structure was devised by the ancient Greek architect and urban planner, Hippodamus of Miletus (485-405 BC). In the 5th century BC, he designed cities such as Rhodes (Turkey), Thurii (Italy), and Alexandria (Egypt) in Greek-colonised territories, as well as the Athenian port of Piraeus. In these projects, Hippodamus embodied his philosophical idea of a strictly geometric organisation of urban space, a principle that remains relevant even today (Khitakhunov, 2024).

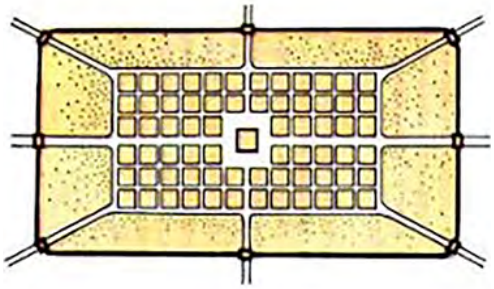

Figure 3. The chessboard Hippodamian street system, 1917
Source: Ya. Mazmanov (2020)

During the 1920s and 1930s, significant industrial enterprises were established in Frunze, laying the foundation for the modern western industrial zone. One notable example of urban planning from this period is the "Workers Township", a project realised by Czechoslovakian communist workers who had founded the "Interhelpo" cooperative in Frunze. The name "Interhelpo" translates from Ido (Esperanto) as "mutual aid". This cooperative, operating in the city from 1923 to 1943, was involved in constructing power stations and foundries, becoming the progenitor of Kyrgyz industry and a leading force in the republic's industrialisation during the pre-war period (Alymbaev, 2024). The "Workers Township" project embodied the dream of realising the utopia envisioned by the Italian Renaissance scholar Tommaso Campanella in his work "City of the Sun" (Figs. 4, 5).

Figure 4. The City of the Sun, 1920
Source: Ya. Mazmanov (2020)

Figure 5. Bishkek. Workers Township, 2024
Source: Ya. Mazmanov (2020)

In 1926, a railway line connecting Lugovaya station to the city of Frunze was constructed. That same year, the city's streets were classified into three types: central, intermediate, and peripheral. The 1930s saw a surge in construction activity, although the city remained provincial in character. Following the establishment of the Kirghiz Soviet Socialist Republic (SSR) in 1936, Frunze became its capital, necessitating significant changes in the city's architecture. In 1938, a series of large-scale state initiatives in architecture and urban planning were implemented, laying the foundation for a new phase in the development of the capital of the Kirghiz SSR. The first general plan for Frunze was developed, prepared by the workshop of the architect I.V. Zholtovsky and oriented towards the city's economic development within a planned economy. Among the authors of the plan were architect N.I. Smirnov, engineering economist G.D. Babad, and consulting academician I.V. Zholtovsky. Additionally, state regulatory documents governing urban planning were introduced, and an architectural and planning department was established, headed by the city's chief architect, responsible for shaping urban policy and overseeing the implementation of the general plan. Furthermore, the Union of Architects of Kyrgyzstan was founded, a public organisation coordinating architectural activity in the region (Alymbaev, 2024).

These measures, alongside the strengthening of the construction sector and the establishment of the first enterprises in the building industry, led to significant changes in urban development. Construction based on the first master plan commenced in 1940 and continued after the Second World War. The city retained a rectangular quarter layout, expanding to the east, west, and south, with the construction of buildings rising to two or three stories. Architectural ensembles began to emerge in Frunze. Between 1946 and 1950, several notable structures were built, including the opera and ballet theatre designed by architects A.I. Laburenko and P.P. Ivanov, residential buildings and a hospital complex on Moskovskaya Street designed by P.P. Ivanov, the ensemble of Soviet Square featuring the building of Kyrgyz State University, which was conceived by architects E.G. Pisarskaya, P.P. Ivanov, and V.E. Nusov, as well as a complex of buildings for the Academy of Sciences designed by Y.V. Bilinsky and A.D. Bocharov, among other projects.

The second general plan for the city of Frunze, developed in the post-war years and approved by the Council of Ministers of the Kirghiz SSR in 1956, differed little from the first. It incorporated provisions that had not been implemented due to the war and represented an adjustment of these. However, the population estimate in the new plan was lower than the actual figure, which diminished the value of the analytical component. This necessitated the development of a new general plan for the city of Frunze, although the overall layout of the city remained virtually unchanged. Table 1 provides a systematic overview of the key changes in the city's architecture and infrastructure associated with the development of the railway network.

Table 1. Impact of the railway on the architecture and infrastructure of Pishpek

Aspect	Description
Changes in the architecture of railway stations	Stations became more functional and spacious, featuring elements of industrial style.
Use of new materials	The adoption of modern building materials to enhance strength and durability.
Planning of new districts	The development of new districts and industrial zones in proximity to railway lines.
Development of transport logistics	The integration of railway transport into the urban environment to improve logistical connections.
Impact on urban panelling	The master plans of the city were oriented around the location of the railway infrastructure.

Source: compiled by the authors

The development of the railway in Bishkek during the mid-20th century played a pivotal role in transforming the city from an administrative and cultural centre into a major industrial hub. The railway not only provided transport links to other regions but also stimulated the creation of a powerful industrial base, which became the foundation for the city's economic growth and development. Along the railway lines, factories and plants began to be constructed at a rapid pace, fundamentally altering Bishkek's architectural landscape.

The industrial zone that emerged around the railway station quickly became one of the city's key districts. The proximity of the railway provided convenient transportation links, making this area ideal for the location of large industrial facilities. Among the first and most significant establishments in this zone was the machine engineering plant, which became a symbol of Bishkek's industrialisation.

Constructed between the 1950s and 1960s, the plant was designed to meet the contemporary standards for industrial buildings. Key design criteria included scale, functionality, and durability, reflecting the need for production facilities capable of operating at full capacity for extended periods. Occupying a substantial area, the plant was equipped with all necessary utilities and infrastructure to ensure uninterrupted production.

The architecture of the machine engineering plant, like other industrial buildings of that era, was characterised by strict and laconic forms. Functionality was paramount: buildings had to be robust, practical, and conducive to the production process. As a result, the plant buildings had simple rectangular or square forms, allowing for efficient use of the internal space. Concrete and steel were the primary materials used in construction (Babachenko *et al.*, 2022). These materials provided the necessary structural strength, resistance to external elements, and durability. Industrial buildings were characterised by high ceilings and large window openings, ensuring sufficient natural light and ventilation for optimal production processes.

The façades of these buildings typically lacked intricate decorative elements. The primary focus was on simplicity and practicality. The only decorative features might be relief patterns on concrete panels or the use of colour accents to highlight specific structural elements. This simplicity and minimalism became a hallmark of industrial architecture of that period, reflecting broader trends in Soviet architecture which emphasised functional and durable buildings. The construction of the machine engineering plant and other industrial facilities near the railway station significantly altered Bishkek's urban infrastructure. The emergence of such large industrial enterprises led to the creation of new jobs, which in turn attracted a population influx to the city. This necessitated the construction of new residential areas, schools, hospitals, and other social infrastructure.

Industrial zones that developed around the railway line became pivotal elements of the city's economy. They employed a significant portion of the population and contributed to the growth of related sectors such as transport, logistics, and services. Furthermore, the expansion of industry in the city led to the establishment of new educational institutions, and training specialists for work in factories. The rapid industrialisation also had a significant impact on the city's environment. The proliferation of factories led to increased air and water pollution, becoming a major concern for city authorities. In response, measures were subsequently taken to improve the ecological conditions, including the modernisation of production processes and the implementation of wastewater treatment facilities.

Bishkek's industrial heritage, forged in the mid-20th century, remains a significant part of the city's history. Many factories continue to operate, contributing to the city and regional economies. Concurrently, these industrial zones are undergoing modernisation, leading to improved environmental conditions and the creation of new jobs. The railway, as a catalyst for industrial development, continues to be reflected in Bishkek's architectural landscape and social fabric, underscoring the importance of this infrastructure project in the city's history.

In the second half of the 20th century, as Bishkek's population grew due to the expansion of the railway, there was a pressing need for new residential areas to accommodate the increasing number of inhabitants. One significant project of that era was a residential complex built in the vicinity of the railway station. This complex, which became an integral part of the urban landscape, was conceived as a model of contemporary urban planning and a realisation of innovative architectural ideas.

The residential complex near the railway station was designed according to the principles of late Modernism, a style widely adopted in Soviet architecture of that period. The core concept of the project was to create a comfortable and functional environment where housing and public facilities were integrated into a unified architectural and urban space. The complex comprised several apartment buildings, constructed according to standard designs typical of Soviet architecture in the 1960s and 1970s. These buildings were made of reinforced concrete and brick, ensuring their durability and longevity. The high-rise buildings, typically five to nine storeys tall, were designed to maximise the use of urban space, allowing for a large number of apartments to be accommodated within a relatively small area.

The architecture of the residential complex was typical of late Modernism: the buildings had simple, geometrically clean lines, minimalist façades, and functional layouts. The primary focus was on comfort and practicality. Each building featured large windows to maximise natural light, and balconies, which served as both an architectural feature and an additional space for residents. The building façades, primarily constructed from brick and reinforced concrete, were finished with plaster and facing panels. A restrained colour palette, such as light shades of grey and beige, was employed, giving the complex a sober and contemporary appearance. The façades were also characterised by the horizontal lines and rhythmic repetition of window openings typical of the period, emphasising the laconic and functional nature of the architectural solution.

The residential complex constructed near the railway station, in the style of late Modernism, successfully embodies the principles of Soviet architecture from the 1960s and 1970s. Through the use of standardised designs, reinforced concrete, and brick, the complex ensures durability and functionality, which were key aspects of that era. Its architecture, with its simple geometric forms and minimalist facades, reflects the core ideas of convenience and practicality, aligning with the tenets of late Modernism.

However, considering modern comfort standards and urban planning regulations, this residential complex may not fully meet contemporary expectations. Although spacious windows and balconies provide ample natural light and extra living space for residents, the limitations of standardised designs and restrained architectural solutions may fall short of more innovative and adaptable approaches in modern construction. Nevertheless, the use of a restrained colour palette and the underlying emphasis on functionality remain relevant, making the complex suitable for comfortable living but not ideal in terms of contemporary demands for residential spaces.

The development of Frunze's urban transport infrastructure was largely influenced by the presence of the railway, which limited the number of level crossings and overpasses. Key structures such as the Frunze-2 station, Dzerzhinsky Boulevard, the eastern industrial zone, and the combined heat and power plant became central elements around which large-scale construction took place. These facilities contributed to the creation of unique architectural and spatial solutions, such as the Vokzalnaya Square complex, the railway workers' park in Pishpek, and the panoramic view of Sovetskaya Street visible from the pedestrian bridge of the overpass.

The Turkestan-Siberian railway had a profound impact on the development of Bishkek, acting as a catalyst for its economic growth and urbanisation. The construction of railway infrastructure stimulated trade and industry, facilitated migration and altered the city's demographic makeup. The railway also influenced architectural and urban changes, including the expansion of the city's boundaries and the formation of new districts. In the future, railway infrastructure will continue to play a pivotal role in the city's further modernisation and development.

The architecture of Bishkek's railway stations has been significantly modernised since the advent of the railway. The buildings have become more functional and expansive, exhibiting elements of industrial style through the use of new building materials and technologies, which ensure the strength and durability of the structures. The railway has facilitated the expansion of urban territory and the formation of new districts. Urban development has actively progressed in the eastern, western, and southern directions, made possible by the advancement of railway infrastructure. The establishment of new industrial zones in close proximity to the railway lines has improved transport logistics and promoted the integration of rail transport into the urban environment. The study has indicated that the modernisation of the existing railway infrastructure is essential for enhancing its functionality and integrating it into the overall city transport system. Railway facilities, possessing architectural and historical significance, require a careful approach to their preservation and adaptation to contemporary conditions.

The findings of this research should prove beneficial in addressing urban planning and architectural challenges facing the city. In the future, when undertaking reconstruction projects, the research materials can provide valuable insights for creating a comprehensive transport hub, supported by terminal and warehousing infrastructure. Given Bishkek's advantageous geographic location and its administrative significance within the region, understanding how the city's urban structure has been shaped by railway transport will allow for more precise adjustments to the city's urban planning policies.

DISCUSSION

The construction of the Turkestan-Siberian railway played a crucial role in the economic development of Bishkek, transforming the city and significantly influencing its growth. The railway acted as a catalyst, initiating processes that ultimately led to an increase in population and an expansion of the industrial sector. These changes inevitably affected the city's architecture, which began to undergo substantial transformations. This was particularly evident in the station buildings, which became a vital component of the new urban infrastructure. Their architecture evolved to be more expansive and functional, reflecting the city's need for an efficient transport system. New building materials and technologies, such as iron and steel, were actively incorporated into the designs of the stations, ensuring their durability and strength. This development allowed the stations to become symbols of the industrial progress that accompanied Bishkek's growth during that period. Such changes mirrored broader processes of modernisation that encompassed the city as a whole.

Analysis of existing research has shown that a similar impact of railway transport on urban architecture can be observed in other regions. For instance, in the study by A. Cardoso de Matos *et al*. (2020) focusing on the Iberian Peninsula, the significant role of railway stations in transforming the urban environment is also highlighted. In major cities such as Lisbon and Seville, railway stations have become key elements of industrial architecture, mirroring the processes occurring in Bishkek. Here, as in the capital of Kyrgyzstan, new materials and technologies, such as iron, steel, and glass, were introduced, leading to considerable changes in urban morphology and landscape. However, despite the similarities in the processes of change, there are also notable differences. In Bishkek, the emphasis was placed on integrating the railway into the urban environment and developing industrial zones, whereas on the Iberian Peninsula, the focus was on architectural changes that reflected the cultural and historical characteristics of the region. This contrast underscores the diversity of approaches to urban modernisation, which is contingent upon local conditions and traditions.

The development of the railway in Bishkek also had a significant impact on the demographic processes within the city. Improved transport accessibility attracted a large number of migrants, contributing to population growth. This influx of new residents necessitated the expansion of residential and industrial zones, which, in turn, stimulated further urban development (Danchuk *et al*., 2019). New districts began to emerge around the railway lines, forming

the basis for Bishkek's urban growth. These changes were driven by the need to adapt the urban infrastructure to new economic realities. The railway not only enhanced transport connections but also facilitated the creation of new jobs, attracting many individuals seeking economic opportunities (Gavkalova & Kyrychenko, 2023). This laid the groundwork for a new urban structure focused on industrial development and the integration of various city districts.

Similar urban transformations can be observed in other regions where railway development has played a pivotal role in urban growth. For instance, a study by A. Rjoub & R.K. Al-Shawabkeh (2018) on the impact of the Hejaz railway on the development of Mafraq in Jordan, also demonstrates how railways facilitated urban growth. However, despite similarities with Bishkek, Mafraq placed a greater emphasis on preserving architectural heritage, while Bishkek focused more on industrial growth and modernisation. This difference highlights the diversity of approaches to urbanisation, dependent on the specific cultural and historical conditions of a region. In both cases, the railway acted as a catalyst for development, but the directions and priorities of these changes varied according to local circumstances.

Equally significant was the impact of the railway on cultural changes in Bishkek. The influx of migrants led to the formation of a new social landscape where diverse cultures and traditions intersected and interacted. This diversity contributed to the enrichment of the city's cultural life, as new social connections and interactions stimulated the development of urban culture. The railway served as a bridge, connecting various cultural and ethnic groups, leading to the formation of a unique urban identity (Matsiuk *et al*., 2023). These changes were driven by the need to adapt to new living and working conditions brought about by the railway.

Similar processes can be observed in other regions where railways have been instrumental in cultural transformation. For instance, a study by E. Aksoy & N. Gültekin (2007) on the modernisation of Turkish cities highlights the role of railway complexes in these processes. In Turkey, as in Bishkek, the railway became a significant factor in cultural change. However, unlike Bishkek where the changes were more comprehensive, in Turkey modernisation was primarily focused on stylistic changes in architecture. Railway stations and public buildings constructed during the modernisation period became symbols of new trends, integrating traditional and contemporary architectural elements. These changes reflected a desire for renewal and modernisation that became characteristic of cities developing along railway lines.

The architectural changes in Bishkek, prompted by the development of the railway, also involved the integration of new building materials and technologies. This was essential for ensuring the durability and resilience of structures that needed to withstand increased loads and meet the new demands of the urban environment. In this context, the research by E. Kido (2016), focusing on modern railway stations in Japan and Europe, provides valuable comparative insights. It discusses the coordination of architectural and engineering solutions to achieve aesthetically balanced and functional outcomes. In both Japan and Europe, as in Bishkek, architectural changes were driven by the necessity to adapt to new growth conditions. However, in Japan and Europe, the emphasis was placed on technical excellence and aesthetic diversity, reflecting a desire to create harmonious and functional urban spaces. In contrast, the changes in Bishkek were primarily dictated by economic and social realities that required the modernisation of urban infrastructure to support sustainable growth (Dooranov *et al*., 2024).

A comparison of research on Bishkek and other regions indicates that approaches to the development of railway infrastructure varied according to local characteristics and historical context. For instance, in the study by Ž. Jurković *et al*. (2021), focus on the sustainable development of the city of Osijek in Croatia, there is an emphasis on integrating railway corridors into contemporary planning while preserving cultural and historical heritage. In Osijek, as in Bishkek, the railway became a crucial component of urban infrastructure; however, the approaches to its development and integration into the urban environment differed. In Croatia, the primary focus was on preserving cultural heritage and harmonising new transport corridors with historical buildings. In contrast, Bishkek's emphasis was on the historical and socio-economic analysis of the railway's impact on the city's development. Both studies highlight the necessity of a comprehensive approach to planning railway infrastructure, yet the focal points vary according to the region under investigation.

In Bishkek, railways have contributed to population growth, industrial development, improved transport accessibility and infrastructure, as well as cultural and demographic changes. The impact of railways on urban processes has highlighted the need for strategic planning and investment in transport infrastructure to ensure sustainable development. The railway has acted as a catalyst for change, initiating modernisation processes that have affected all aspects of urban life. The development of railways in Bishkek, as in other regions, has led to significant changes in the urban environment. In each case, these changes had their own unique characteristics, determined by the geographical, cultural, and historical context. However, common to all studies is the recognition of the importance of railway infrastructure as a key element contributing to the modernisation and development of cities. The railway has become the foundation for the formation of new urban structures, where industrial zones and transport corridors played a central role. This change was made possible by the introduction of new technologies and building materials, which allowed for the adaptation of urban infrastructure to new growth conditions. The railway in Bishkek has become a symbol of progress, opening up new opportunities for economic and social development, underscoring its important role in the city's history.

CONCLUSIONS

The construction of the Turkestan-Siberian railway, along with the establishment of stopping points and access routes to industrial facilities, dictated the forced directions of urban development, often affecting areas less suitable for residential construction than those occupied by railway infrastructure. The railway also facilitated the growth of existing industries and the establishment of new industrial enterprises, ensuring their uninterrupted operation through the delivery of raw materials and the transport of finished products. Consequently, nearly all industrial facilities associated with the Frunze station were situated along the railway corridors. This resulted in the fragmentation of the urban structure, a lack of clear zoning, an expansion of urban land, deterioration of transport and engineering services, challenges in forming the planning structure and development of coastal areas, as well as a worsening of the environmental situation.

The analysis of the impact of the railway hub on the urban structure of the city revealed a dual relationship between the development of the railway and the growth of industrial districts. The expansion of the railway hub facilitated industrial growth, while conversely, the rise of industry complicated the railway infrastructure within the city limits. The railway also had a significant influence on the formation of the intra-city transport infrastructure of Frunze, the main routes of which were determined by the limited number of crossings and overpasses over the railway lines. The construction of facilities such as the Frunze-2 station, Dzerzhinsky Boulevard, the eastern industrial zone, and the combined heat and power plant contributed to the emergence of large-scale developments. This led to the creation of interesting architectural and spatial solutions, such as the Vokzalnaya Square complex, the railway workers' park in Pishpek, and the panoramic view of Sovetskaya Street visible from the pedestrian bridge of the overpass.

The research findings underscore the need to pay special attention to Bishkek's railway junction to create a more advanced urban structure, as railway functions have long been taken into account as an urban planning factor. It is important to maintain the capital's status as a major transport and distribution centre in the future. Future research could delve into a detailed analysis of the railway infrastructure's impact on the environment, including changes to ecosystems, air quality, and noise pollution levels. Additionally, it could explore the potential of modernising railway infrastructure using advanced technologies such as automation and digitalisation to enhance the efficiency and environmental friendliness of the transport system.

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CONFLICT OF INTEREST

None.

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Вплив залізниці на розвиток Бішкеку

Анотація. Метою даного дослідження був детальний аналіз впливу залізниці на розвиток міста Бішкек. У дослідженні використовувалися історико-аналітичні та географічні методи, аналіз архівних документів, картографічних матеріалів та наукових публікацій для з'ясування впливу залізниці на зростання Бішкеку. Результати дослідження показали, що будівництво Туркестано-Сибірської залізниці відіграло ключову роль у формуванні міської структури Бішкека. Залізниця сприяла економічному зростанню міста, збільшенню населення та промисловому розвитку. Навколо залізничних станцій і шляхів виникли нові житлові та промислові райони, що призвело до значного розширення міської території. Крім того, залізниця покращила транспортну доступність міста, сприяючи розвитку торгівлі та міжрегіональних зв'язків. Вплив залізниці також позначився на архітектурі міста, що характеризується появою будівель і споруд, характерних для залізничної епохи. З часом роль залізниці в житті міста дещо зменшилася, проте її історичний вплив залишається значним. Дослідження показало, що залізниця сприяла не лише економічному розвитку, але й культурним змінам у Бішкеку. Поява залізничного вузла призвела до посилення міграції та зміни демографічної структури міста, залучення нових мешканців і трудових ресурсів. Залізниця також сприяла розвитку інфраструктури та комунальних послуг, таких як електрифікація та водопостачання, що покращило якість життя в місті. Зрештою, залізниця стала вирішальним фактором інтеграції Бішкеку в регіональні та міжнародні транспортні мережі, підвищивши його стратегічне значення в регіоні. Залізниця відіграла важливу роль у становленні та розвитку Бішкека, здійснюючи багатогранний вплив на його економіку, соціальну структуру та містобудування. Історичний досвід розвитку залізничної інфраструктури міста може слугувати основою для планування його майбутнього розвитку

Ключові слова: архітектура залізничного вокзалу; міжрегіональне сполучення; містобудування; міський каркас; транспортна мережа