Cable Railway as Component of Accessible Environment

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Abstract. This article presents a systemic analysis method. Students must form project thinking in designing an accessible urban environment. This method is demonstrated via intercomplementary aspects. The social aspect is shown via the consideration of program requirements for mobility-impaired people. The nature and climate aspect is shown via the consideration of the monsoon climate in Vladivostok in winter. The city-building aspect is shown via the priority of ensembles when environmental facilities are introduced. The architectural aspect is shown via the comprehensiveness and multi-functional character of the suggested space. The economic aspect is demonstrated via the proposal of possible services in the designed space at the state and private levels. The cultural aspect is demonstrated via the aesthetic perception of the content of the environmental design of the suggested facility. That being said, the research took into consideration the requirements of composition design, city-building architecture, and transport engineering. The authors show an example of the inclusion of the requirements from the current respective regulations in place in Russia in the project work. The integrated treatment of all these aspects is shown in the project result. The result is a draft-project for a transport communication node uniting public, service, and production infrastructure.

1. Introduction

This article dwells upon the systemic analysis method for solving complex project problems.

During the training of an architectural designer, it is vital to get students to study the existing urban situation with all of its aspects and factors. One should remember that: “Advanced training for designers is a key requirement in the contemporary approach to the relevant design. It is crucial to provide a lookahead professional and universal cultural training to specialists working under the constantly changing conditions of today” [7p.4]. It is especially important in the accessible environment design that benefits the disabled, elderly, and other mobility-impaired groups of people. Urban transport is a key component in the achievement of this goal. At the current stage of urban development, the focus in such a study shifts to the secondary (auxiliary) transport system. The method presented in the article contains an instrument that manages multiple requirements for the implementation of state program problems. The authors shall discuss the following requirements: social, nature-and-climate, city-building, architectural, and cultural. How can one integrate auxiliary transport systems in the accessible environment requirements? This article presents a mechanism for project integration and suggests an engineering result.
2. Problem statement
The government of the Russian Federation has approved the state program for Accessible Environment to be implemented in 2021-2025 for the Russian society to reach a new level of humanism. The goals of the program are numerous and they include, inter alia, “...the provision of equal access to prioritized facilities and services for the disabled and other mobility-impaired groups”, This program includes three subprograms. The first program is aimed at: “...the creation of accessible conditions for prioritized facilities in education, children recreation, public transport, and culture” [5]. In this article, the authors are going to look at the technical (engineering) component of the implementation of this subprogram.

The development of cities in the XXI century largely depends on the ability of each of its residents to move around by themselves irrespective of any physical restrictions or disabilities. It is a basic need for any person to use a full range of benefits that a big city can provide. It is crucial to understand that “Transport is an important factor for accelerating the material progress and increasing the standard of living. The time savings achieved through it become a decisive social criterion of the comfort of living in a city” [2p.5].

A developed transportation system provides city dwellers with the access to all public facilities, companies, and mass recreation areas. It happens both on workdays and holidays. In other words: “…when describing the urban lifestyle, researchers point to the significant distance between workplaces and residential areas, in other words, the necessity of commuting” [7p.45].

Nowadays, cities use another perspective to view the reconstruction of the environment. It takes into account the access to city-wide transport systems for every resident irrespective of their physical mobility of remoteness. In this context, people with impaired mobility cannot be seen as regular architecture consumers. This fact must be specifically taken into consideration by the designers of the urban environment. “This category of ‘architecture’ consumers shall be seen regarding the social structure identifying groups with specific requirements to the parameters of the environment” [1p.116].

This perspective on the urban environment is especially relevant for Vladivostok as an active terrain city. The high spots of the terrain are usually occupied by historical centers and new ‘sleeper’ neighborhoods. The formation of an accessible environment for such parts of a city calls for special attention. Public transport often cannot reach these locations because of technical restrictions, and this problem cannot be solved in a linear fashion. A different approach should be applied: “a current state of public transport development is characterized by the operation of various means of transport in an integrated manner” [2p.15]. Here’s where the auxiliary transport systems emerge. “The goal of these transport systems is the service, i.e., they should be closely connected to the transport system of a city” [2p.187].

Today, such systems are actively introduced into the overall transport systems of cities. They can be delicately integrated with pedestrian traffic on the high spots and connect those with the city transport routes. Moreover, “the urban lifestyle is characterized by large distances between workplaces and residential areas. Commuting is perceived as inevitable, and thus it is vital to provide accessibility and comfort for the everyday commute” [7p46]. In support of this point, consider several examples.

The ensemble of 6 escalators in Medellin (Colombia) is a part of a larger program to renovate deprived areas, including Community 13. One of the first steps taken by the government was the installation of six escalators at the cost of 6.7 million dollars. They became a symbol of the area's revival. Community 13 is located at 380 m above the sea level and it is a remote and very poor sleeper neighborhood. The construction of sheltered escalators and a motorway made the daily descents and ascents for the residents working in a lower portion of the city significantly easier. Moreover, the government compensated the residents for lands expropriated to build escalators and car roads by providing them new homes. The escalators of Medellin’s 13th neighborhood have become the first open-air construction built in a poor area. Thus, the government showed the residents of Community 13 that they can count on the government’s support. The considerate attitude of the government to the
daily needs of their citizens can be manifested in the organization of transport communication (Figure 1,a).

The Mechanical Ramps network of urban escalators in Vitoria Gasteiz (Spain). Vitoria Gasteiz is a city in the Basque Country in the North of Spain. It is the capital of the Alava province and the Basque Country autonomous community. It is the second-largest city in the community after Bilbao. Glass-roofed escalators (4 pcs) have only the lifting function. They are installed in a passage that climbs 16 m. This passage connects two streets and crosses two more. The escalators were installed in a historic part of the city as a reaction to the abundance of tourists and the barrier-free environment requirements. This architectural facility is integrated into the historical context, it is very aesthetically pleasing, and it also features stone steps and a ramp for cyclists. It is a comprehensive solution with high-level design culture (Figure 1, b).

The construction of a cable railway in Vladivostok (Russia) started at the initiative of Nikita Sergeyevich Khrushchev in 1959. The length of this cable railway was 183 m, and two rail cars that can take a total of 35 people run along this railway by cable haulage. This line connects Pushkinskaya st., and Sukhanov st. located 30 meters higher. Previously, the cable railway used to connect the Polytechnical Institute blocks. Its cars are filled with students rushing to their classes from morning till evening. Today, the cable railway passengers include tourists, mothers with baby strollers, and mobility-impaired people. The Vladivostok cable railway presents a great opportunity to see the Golden Horn Bay vista both from a car and from an observation deck at the top station (Figure 1c).

![Figure 1. a) escalator in Medellin; b) escalator in Vitoria Gasteiz; c) cable railway in Vladivostok.](image)

The technical solutions mentioned above are modern, aesthetically pleasing, and relevant to their contexts. They can sometimes be seen as a means to relieve social tensions. It can be stated that the cable railway and special escalators are the most efficient and convenient types of off-the-street lifting transport. “Indeed, the carrying capacity of a cable railroad is not huge but it is still very convenient for cities with mountainous or hilly terrains” [2p.28].

Therefore, the cable railroad can be viewed as a potential component of an accessible environment in the case under study.

### 3. Methods

The examples given show the primary area of development, where each object is seen as an individual signature solution. Every solution represents a sum of multiple factors, conditions, and requirements. Thus, the best approach to solving such problems today is the systemic method. Any systemic method is deployed according to its context. “The systemic approach is the most promising and effective one in solving increasingly difficult urban system management and design problems” [7p.36]. The context as a whole can be represented by several aspects: social, city-building, architectural, cultural, and climate. The social aspect is the basic one, and it is determined by the requirements of the state programs for Accessible Environment and Quality and Comfort of Urban Environment” [5,6]. The program requirements are aimed at helping people with impaired mobility to use the public transport facilities. Besides, they strive to maintain freedom of choice in receiving more benefits from living in
a big city. These requirements predetermine the appearance of additional components in the formation of an accessible environment.

The second aspect is connected with *nature and climate*. Vladivostok is an ocean city. The monsoon climate is characterized by stifling, warm and humid summers, and cold and windy winters with high humidity levels. For Vladivostok, it is also typical to have more clear sunny days in winter than in summer. The terrain of Vladivostok predetermines steep ascending or descending streets. Sidewalks in microdistricts feature numerous long and uncovered flights of stairs. Snow, ice, and strong northerly winds make inevitable daily movements very uncomfortable. The third aspect is the *architectural* one. The requirements for an accessible and comfortable environment state that long flights of stairs should be sheltered completely. The most popular spots require some mechanical equipment. The cultural aspect forms an artistically-rich and aesthetically pleasing urban environment. In the case considered, “it is possible to refine the interiors of the designed facility with plastic artworks to transform the environment into a new cultural symbol of the place [4p.191].”

The *city-building* aspect unifies several aspects in one ensemble. The architectural ensemble always acts as an artistic system [3p.365]. This is confirmed by a systemic method selected by the authors. The goal is, however, not just to integrate the cable railway in the existing structures. It is necessary to find a comprehensive solution to form an architectural ensemble at the location. The new structure should improve the aesthetic appeal of the place and make it more individualized. “Architectural ensemble is a specific synthesis of individually interpreted composition systems of single structures and their groups that subject to an ideological and artistic concept and expressing it on an individual basis” [3p.365].

The *economic* aspect is also important. Any new public building is a full-fledged economic player that brings income (taxes) to the city. It can be possible if a transport facility is adjoined to a public space providing some social and commercial services.

The analysis shows that it is necessary to consider all of the factors mentioned above to achieve this, which is only possible with a comprehensive formation of public spaces. “It is not uncommon for modern public centers to combine services and commerce with transport functions” [3p.332].

To implement the method, consider the typical urban situation in Vladivostok.

### 4. Findings

The findings of the research and the systemic analysis are manifested in a project proposal developed during the classes. Project simulation was carried out through the design of a pedestrian link between Partisanskiy Prospekt and Nerchenskaya St. in the Leninskiy district of Vladivostok. This 152-meter stretch of a road has a 102-meter sidewalk and a 50-meter (113-step) street stairs. The level drop between the streets is 21 m (Figure 2).

![Figure 2. Current situation.](image)

The stretch of the road under analysis connects a group of residential blocks of flats with public transport facilities on the Prospekt. It is a part of many people's daily routes. “Commuting to work is the most stable type. It drives the peak loads on transport <...> The largest amounts of people go to work from the residential ‘sleeper’ areas” [2p.153].
Some bus routes connecting all of the city parts run along Partisanskiy Prospekt. It is an illustrative and responsible pedestrian connection. It is popular irrespective of the season or the day of the week. Having consolidated all of the aspect requirements and conditions, we formulated a comprehensive solution: a covered cable railway with a public building. The cable railway itself runs on an overpass in a covered 'warm' pipe. One passenger car runs in the pipe along the rails. The pipe also has a staircase for pedestrians, as well as rest decks. Besides, the interior of the pipe can be refined with street sculpture, indoor plants, and street furniture. The carrying capacity, speed, and running frequencies were determined according to further calculations. The communications pipe has glass covers to accumulate the warmth from the sun. It can bring significant savings in the maintenance and operations of the entire system. The cable railway has heated buildings at its ends for passenger boarding and drop-off. The lower building on Partisianskiy Prospect is adjoined to a new 6-story office building. To facilitate the servicing of all population groups, the first and the second storeys locate state and municipal social departments. The storeys in the middle are rented out to businesses. On the fifth and the sixth storeys, a two-level observation deck is set up. The building features staircases, wheelchair ramps, and a lift. The top station on Nerchenskaya st. consists of a lobby for platform access and a dispatcher's office that controls the traffic (Figure 3).

![Figure 3. The project proposal. a) general plot-plan, b) overall view.](image)

The load-bearing structure is represented by a metal frame. It consists of metal columns and cross beams (50SH4 I-beams). Metal tension bars act as ties. Lift slabs are made of solid reinforced concrete plates of 200 mm thick.

General conclusion: Typologically speaking, the authors developed a transport communications hub combining service, public, and industrial infrastructure. “...as a result of complex development of the transport and city functions, a specific type of units is formed, whose structure includes transport communication facilities, pedestrian links, trade facilities, as well as administrative, business, and other services” [3p.350].

5. Conclusion

The systemic approach is relevant in project searches when solving complex program problems. The systemic analysis allows one to bring all the aspects together. “The integral character of urban development sets up higher requirements for public transportation, which means that the reduction of non-productive time spent on movement, as well as the comfort and safety of rides, are becoming the factors facilitating the solution of problems associated with the improvement of working conditions and urban life” [7p.3]. All of this predetermines the increase in the significance of auxiliary transport systems as a part of a uniform urban infrastructure in the XXIth century. These systems are becoming more humanistic nowadays. Their ability to get the ‘big’ transport closer to homes represents the implied care for each of the city residents. The cable railway can often solve the problem of accessing urban transportation systems. Thus, it can be viewed as an important auxiliary component in the formation of an accessible environment.
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