Abstract
Development of St. Petersburg, a metropolitan area with multifunctional urban centres and agglomeration, is a non-alternative model of urban development. The most critical and priority areas will be the North in the Primorsky districts (with established resorts on the ground of being built Lahti-Centre) and the South in Pushkin districts (with suburban palaces and parks). The creation of two centres means the redistribution of citywide functions and shifting of 15% of employment to these facilities, as well as the removal of the vehicles from the historic centre. Both centres have a prestigious housing, active regions of international transport corridors, e.g. the North (Scandinavia) and the South (the Baltic countries and Europe). Of particular importance is ‘Pulkovo airport node’, in the heart of South district that became the subject of discussion and design in the M.L. Petrovich Laboratory of city planning.

Keywords: convention and exhibition centre, agglomeration, a satellite town, internal and external transport paths, transport and logistics complex.

1. Assumptions for ‘Expoforum and Aerocomplex Pulkovo’ development
1.1. Transport urbanism and agglomeration aspect

Currently, transport and urban planning is inconsistent and illogical, formalised and unconditionally, spontaneous and fleeting, depending on the customer and the authorities. The reason for this trend is not only the demands of the market ‘time – money’. The main thing to blame is the lack of professionals of transport, especially urban planners, which in Soviet times were prepared by the speciality ‘Urban Construction and Management’, Public transport’, ‘City planning’. They were multilateral, intelligent, with a broad range of thinking, able to discuss and defend their point of view, even ‘at the top’. That is why it was hard to fit transport urbanism into the rigid framework of time and money. Today, it is a different way: in the market conditions, the presence of risks, limitations and instability, the traditional creative urban planning gives way to modern commercialism, more responsive to the customer and the authorities, and not the consumer – citizen and passenger.

Indeed, orthodox traditional urban planning required a huge investment, time, and meticulousness. Nowadays, it is mostly irrelevant and ineffective
because most often it is done in the postulate that ‘it is easier’ and faster ‘on the thumb track’. It does not bring relief and comfort to the lives of citizens in the ‘concrete jungle’ and drives the city to a standstill, ’ferries wheel’ of transport problem.

An example would be the auto-road approach for the organisation of transport services of convention and exhibition centre (CEC) ‘Expoforum’, albeit with modern multi-level intersections and pedestrian crossings and Pulkovo Airport, but with new traffic jams in the days of St. Petersburg International Economic Forum (SPIEF). Agglomeration principle, which was revived in urban planning, requires expansion of the airport Pulkovo airport node and an increase of internal and external transport circuits. Beside the airport complex Pulkovo I-II-III with the terminals, Aviagorodok, and Academy of Civil Aviation (ACA), the following objects have to be included in the consideration (Shabarova, 2016):

– Convention and exhibition centre ‘Expoforum’, which accepted thousand people in 2016;
– Adjacent to the CEC ‘Expoforum’ neighbourhoods;
– Unique complex of the Pulkovo Astronomical Observatory;
– A new residential area – ‘South Town’ (176 billion Roubles; Kovalev, 2016) and Tuutari park;
– City and urban village – Pushkin, Kolpino, Krasnoye Selo, Shushary, Alexandrovskoe, Pulkovskoe, and Aviagorodok;

– South and Kuzminskoe cemetery with a temple-chapel and the church of J. Qvarengi Smolensk Icon of the Mother of God.

The designed transport system of the CEC ‘Expoforum’, satellite city ‘Southern’ should operate taking into account the surrounding districts of Pulkovo Airport, and others facilities. The main burden concerning the realisation of agglomeration and local intra-city transport communications satellite town ‘Southern’, should be carried out by railways, with maximum use of existing rail infrastructure.

Moreover, modern transport urban planning should resolve transport crises and collapses by the use of innovative techniques (e.g., new types of transportation and rolling stock, hubs, and interchange transport nodes) and logistics technology of organisation and management of passenger flows. Advanced urban transport planning in the best way satisfies the needs and requirements of travellers to the movements ‘from the ’door to door’ and ’just in time’, with low risk, low interchanges and time consumption.

Transportation facilities do not have to bring the negative effect on the city – its population, spatial structure and ecology. Modern transport urban development should be able to find the means of self-financing, not only for the design and construction, but also for the operation by reducing transport costs and winding the range of offered transportation services.
2. Convention and exhibition centre ‘Expoforum’

The new CEC ‘Expoforum’ was created to promote economic development of St. Petersburg, which has a strong potential: more than 250 companies are export-oriented (Expoforum-center, 2016). The urban business trades are provided with 180 countries in the world. St. Petersburg is a recognised centre of tourism, including business. There are business events of the global importance, such as G8 Summit, the G20 Summit, forums and seminars: SPIEF, Russia-ASEAN, the SportAccord, and the International Congress and Convention Association (ICCA) Central European office. Therefore, St. Petersburg has to have the appropriate infrastructure to ensure the important for the city and the country’s relations, as well as events with convenient transportation access.

In St. Petersburg there is also ‘Manege’ and ‘Lenexpo’ convention and exhibition centres, but their limited capacity and location in the city centre, which is inaccessible for additional shuttle vehicles, creates many obstacles in the development of the exhibition business. The restricted capability of those facilities, in the first place, hinders the realisation of SPIEF, which each year gathers more and more participants. Due to the fact that the city authorities consider SPIEF as the ‘locomotive’ of the economy and the city’s image in the world (Forumspb, 2016), in 2007, it was decided to build CEC ‘Expoforum’ in the historic district ‘Pulkovo’ in Pulkovo Heights, between Pulkovo airport and the town of Pushkin.

2.2. The current stance of transport accessibility of CEC ‘Expoforum’

The current accessibility of CEC ‘Expoforum’ is defined by road development, particularly its distance, which reflects the failure of transportation solutions and one-sided solving of the problem. In particular, the distance to the Pulkovo International Airport is 6 km, to the Ring Road (RR) – 4 km, to the highway ‘Moscow-St. Petersburg’ – 3 km, to North Western High-Speed Diameter (WHSD) – 10 km.

Transport complex of the area ‘CEC Expoforum - Pulkovo airport’ includes:

- Rail speed connection by train ‘Allegro’ from Helsinki;
- St. Petersburg highway – Gatchina – Pskov and further to the Baltic countries;
- Suburban lines from the Vitebsk train station and the Baltic train station;
- Southern freight rail bypass semi ring;
- Numerous industrialised and developed access roads to the airport, as well as to current and former businesses and warehouses areas;
– European highways (E-95, E-105, ‘Scandinavia’), federal (M-10, M-11, A-118), regional (R-23) roads, sections of the RR and the WHSD.

Rail transport requires reconstruction and renovation, including construction of new sites and facilities:
1 – High-speed railway (HSR) St Petersburg – Moscow and transformation of St. Petersburg – Minsk in HSR, comprising a part of the New Silk Road;
2 – ‘Aeroexpress’ line from the Baltic train station or Vitebsk train station;
3 – An extension of the metro line Kirovsko – Vyborg branch to Pulkovo Airport;
4 – A line of ‘light’ subway (however, the project has yet to be developed);
5 – Light rail transport (LRT), which is a low-floor light rail (two lines) from the Square Vosstaniya through Kupchino to Pulkovo Airport, and from Kupchino to the CEC ‘Expoforum’.

To the listed alternatives, it is important to add a high-speed toll highway Moscow-Petersburg and a system of road junctions, interchange transport nodes, and parking areas. Currently, CEC ‘Expoforum’ (as well as the airport complex Pulkovo) can be reached by road (car or bus, route 187 and 187a with an interval of 15 minutes during the event days). By shuttle bus (K-545 and K-299) to the bus stop at the St. Petersburg highway with further 7 min. walking distance to the entrance of the passage (Expoforum-center, 2016; Table 1). During the event, the movement of free shuttle service every 15 minutes from the metro station ‘Moskovskaya’ and ‘Leninsky Prospect’ is organised. To get to the CEC ‘Expoforum’ by means of rail is not possible nowadays: the distance to the nearest station Alexanderskaya – 4 km and to Shosseynaya – 6 km, while the distance from the new overpass over the railway to the CEC ‘Expoforum’ is only 1.8 km.

Table 1
Analysis of the existing road transport system.

<table>
<thead>
<tr>
<th>Type of transport</th>
<th>Distance, km</th>
<th>Average speed, km/h</th>
<th>Number of stops</th>
<th>Travel time (without traffic jams), min</th>
</tr>
</thead>
<tbody>
<tr>
<td>The bus from the metro station ‘Moscowskaya’</td>
<td>12</td>
<td>12</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Taxi</td>
<td>12</td>
<td>30</td>
<td>As required</td>
<td>45</td>
</tr>
<tr>
<td>The shuttle bus from the metro station ‘Leninskiy prospect’</td>
<td>15</td>
<td>25</td>
<td>non</td>
<td>35</td>
</tr>
</tbody>
</table>
Table 1 shows that even in the absence of traffic difficulties, the travel time is relatively long. Meanwhile, it is necessary to take into account the additional traffic jams on busy highways of Moscowskaya, Pulkovskoe, and Petersburgskoe, as well as Danuyskiy, and Moscowskiy venues.

The comfort level is also not sufficient: the crowded buses, the walking distance of about 1 km. The stable auto-road approach for the transport service of the area (as well as the city as a whole) is another urban planning mistake of St. Petersburg, which exacerbates the critical situation, not only in the city centre, but also in the new peripheral regions. Petersburg newspaper (Fontanka, 2014) has already stated two years ago that transport is the only weak point of the ‘Expoforum’. The investments for the expansion of the Petersburgskoe highway of 1.3 billion Roubles do not resolve the situation with public transport. ‘Gazprom’ declared its readiness to extend the metro line to the CEC or Aeroexpress-line Pulkovo. In response to the statement, it was proposed to build a new passenger railway platform, 1.5 km from Luga branch direction from the Baltic train station. However, the working project documentation is still not provided.

2.3 Transport alternatives for CEC ‘Expoforum’

The implementation of transport proposals for CEC ‘Expoforum’, most of which concerns roads, do not provide a clear picture of long-term development. It can be considered as another ‘patchwork holes’, without a systematic and incremental transformation of the network in the transport and logistics complex (TLC) on the basis of an integrated rail transport. Currently, in Russia, there is no clear methodology and strategies for integrated and intelligent transport systems development with priority to public transport in metropolitan areas, agglomerations, and big cities. There are even some options, enormous and capital-intensive infrastructural facilities, the functioning of which sometimes exacerbate the transport situation, bringing it to collapse. This statement is well illustrated by the preparation of the transport systems in the cities of 2018 World Cup.

The world experience shows, especially the European practice (e.g., the S-Bahn-Leipzig to the famous fair ‘MM’, which is already in older for more than 900 years) proved that trips on the railway transport, especially in ‘rush hours’, take significantly less time than a by car. It is due to the presence of a separate off-street path for traffic. Rail transport is diverse by functions, track facilities and rolling stock; it is more economical and environmentally friendly mode of transport.

In St. Petersburg, the idea of the application of rail transport for servicing CEC appeared in the following forms:
1 – monorail from Pulkovo Airport to the CEC ‘Expofoorum’ with its continuation through the Pulkovo Heights to the residential area of CEC and further to the satellite city Southern;

2 – local (only intra) tram from the CEC ‘Expofoorum’ to new rail platform, which is not connected to the proposed light rail line from Square Vosstaniya through Kupchino to CEC ‘Expofoorum’. The two proposed alternatives are not competitive: they are not only experimental and difficult to build, as well as capital-intensive with long payback periods. More important is that they do not solve the problem of direct radial travel from city centre to the airport complex Pulkovo and CEC ‘Expofoorum’ and chordates trips Airport Complex Pulkovo - CEC ‘Expofoorum’ satellite town Southern.

During the SPIEF-2016, the new risky alternative has appeared. It was a new type of transport mode - Hyperloop One, which is a vacuum high-speed train that can move inside the closed tube (idea E. Maska, 2012). The new facility, according to the ideas of the author, will not be a subject to accidents. Moreover, it is two times faster than an airplane, 3-4 times faster than high-speed trains (up to 1220 km/h), and it is cheaper by 10 times. The trains run on solar energy. Passengers will not need to adapt to the time schedules, since these transportation capsules will move with short intervals, like the subway.

Moscow Mayor and Chairman of the Board of Hyperloop Technologies Inc. signed a memorandum on the development of the concept of the use of Hyperloop technology in the capital. The head of St. Petersburg, too, favoured of this idea. However, again, it can be just experimental fantasy. In contrast to the fantasy, author proposed the actual use of the railway lines in the form of city high-speed railway (like S-Bahn type) so as to serve not only the CEC ‘Expofoorum’, satellite town ‘Southern’, the airport complex Pulkovo, but also two agglomerative centres of St. Petersburg, e.g. North and South.

3. Methodology conversion of transport and communication space ‘Pulkovo Airport node’
3.1 Vision and strategy

Conceptual parcel of transport transformation is reduced to three basic points:

1 – Focus of the project on transport and logistics system (TLS) on the basis of an integrated rail transport,

2 – Organisation of direct high-speed rail connections ‘agglomeration-city-airport’,

3 – Development of inter/multimodal transport in St. Petersburg areas of international transport corridors (in Scandinavia, in the Baltic States and Western Europe) and national transport corridors (in the Murmansk direction to Northern Sea Route and Yamal, to the projected railway lines: Northern latitudinal and Belkomur).


On the ground of conceptual assumptions, the project strategy is
developed and further implemented. It is reduced to three design scenarios
(pessimistic, conservative and real, and optimistic), depending on the economic
and political situation in the country and the city, as well as the financial
mechanism of the project. The implementation options can be reduced to basic
forms of methods and approaches to the design and realisation:

1. Alternative-variant: the goals proposals and design decisions are
developed at all levels;
2. Step by step: the development of the project from the current state to
the target;
3. Parallel development of the project and its implementation units
(based on the master-plans).

### 3.2 Approaches and methods of assigning alternatives

The forerunner for the assignment of alternatives and options is the justification
of the approach to goal-setting and design problems. In the real situation in
Russia, the following two possible options are practically feasible:

The first approach is *traditional* that, however, takes into account the new
modern approaches and methods of design, from a variety of which the most
appropriate and adequate for the transport and urban planning are the following:

- flexibility and continuity of the general design of the city and its
  transport (at all stages that allows preserving the ‘flavor and soul’ of the urban
  space, so as not to turn it into a ‘concrete jungle’);
- digital technologies and their penetration in the management of the city,
  its space, its transport (external, suburban, and urban); their influence on the
  radical change in ways of shopping and types of communication between
  people, ways of interacting and relations between citizens and the authorities;
- tandem (inseparability and unity) among modes of transport, as well as
  between transportation and media. Tandem creates a new range of vehicles and
  services on the basis of standard logistics requirements of passengers to the
  travelling with the one-stop service in the chain: a passenger – a service on-
  line/off-line – the urban environment. Due to the spread of the tandem between
  various operators, transit and transport business develops;
- simulation (digital) of the transport flows, innovative processing
  solutions and the creation of ‘smart’ transport systems;
- 3-dimensional simulation models (3D) of digital design of business and
  master plans;
- flexible design practices, planning and decision-making that meet actual
  transition to flexible methods of implementation in a changing market
  environment.

These approaches and methods of modern design were to some extent
used by the author during the development of general design plans at all major
stages of the Sochi-2014 and Sochi-2030 (Shabarova, 2014), as well as Kaliningrad-2018-2035 at the stage of justification of investments.

The advent of flexible methods of digital design and implementation of information services in the city, transportation, and social networks have changed the following aspects:

1 – traditional methods of transport services on the market. The main indicator became the financial factor: self-sufficiency, profitability as well as the image of the system and the satisfaction of the authorities by the suggested solutions. However, it does not always coincide with the abilities and desires of the passengers;

2 – impact (most often negative) on the person and the health (including social), on human life and its interaction with the daily lives of other citizens, the city and nature, and its space and transport.

The second approach – technological method of organisation (‘how to do’, ‘how to design’, ‘how to implement’). In the modern interpretation, the technology is applied science on the practical ability to transform the initial state of the transport services in new types of services that have beforehand settled parameters. Concerning transport services of delivery of passengers from ‘door to door’ and ‘just in time’, the terms technological aspect and the technology, reflect improvement (modification):

– transport and transport process (rolling stock and infrastructure) for the organisation of traffic (the variety and versatility, differentiation.);
– simulation techniques and planning of all types of transport and passenger flows (forecast, the medium-term, current and operational) and control;
– inter/multimodal flows with the use of corridors (international, national and regional) for the development of transport and transit business,
– interchange transport nodes and the stopping infrastructure for passenger services and technical devices (routeing and placement of stops, control of passenger schedule, and the timetable of rolling stock);
– information support of passengers ‘on-line’, Wi-Fi with the use of new communications: GLONASS, Galileo, glass-fiber optical communication;
– methods of optimisation and calculation of costs of public transport service by expanding the range of services, reduce their costs and justify the socially protected tariffs;
– logistic principles (in the organisation of flows in general and in some areas, the interaction modes of transport) in a system of transport services on the basis of integration of departments for the effective functioning of each of them.

Regarding urban public transport, technological approach to the public service implies a single passenger transportation technology in a comfortable environment and intermodal traffic with minimum costs and with standard quality of service and safety, taking into account the requirements of the city,
the population, the passenger, and the ecology. Modern technological approach should allow for the next aspects:

- market conditions of modern finance the design and construction;
- transport heritage, or rather, a change of attitude to it, e.g. to destroy or save;
- the relevance of the use of existing image and transport potential based on personal and foreign experience.

The essence of the technological method of assignment and selection of alternatives of the design solution is reduced to the targeted increase in transport service efficiency of the population (without Napoleonic plans) on the basis of innovative readjustment and upgrading of existing infrastructure, rational management of new construction with the allowance for the logistics principles of the transport system operation, and its structural units at the request of the passenger.

Creation of modern transport technologies (e.g. rolling stock) costs money and the participation of competent professionals. The development of proprietary technologies is cheaper than buying them (sometimes already obsolete and uncompetitive) abroad. Meanwhile, in Russia, after the elimination of IKTP (Institute of Complex Transport Problems), practically there is no serious application of the science about transport and passenger flows (such as in Germany, the teaching Prof. Gerhard Potthoff). Therefore, the implementation of the modern methods of transport services is actual (especially rail transport), concerning Russian conditions, experience, mentality, the market, and the real possibilities. One can cite the examples of the capital Moscow exhibits of Urbanised Forum (MUF-2016). Moscow is actively pursuing the urban programme, noticeable at the international level: Moscow Small Ring Railway (MSRR), ‘My Street’, and Noviy Arbat). In preparation for the Forum Moscow not only to absorb the international experience, but also broadcast their practice, contributing to the international urban development (for example, at the Biennale in Venice, 2016).

Nowadays, it is important to understand the new technological trends and methods, to rank them and actively use in the design and management of public transport, particularly by calculating the effects of their implementation and identifying risks. Cities and their individual planning areas (with transport unit) have to apply the modern technology of flexible management and design, dramatically changing the face of cities and creating an attractive (or vice versa) urban spaces, including in the new peripheral formations. The technologies, which are used, do not have to violate the existing architectural and structural logic, as well as positive familiarity of the old city and its centre. It is the essence of the urban transport development.
4. Railway in the city

4.1 The role of railway transport in the city

One of the ways but not a cure should be the innovative development of existing railway network of St. Petersburg, which can serve beyond the considered Pulkovo territory, to the city and its surrounding metropolitan area, and agglomeration. In Russia, there is a misconception on the approach to solving the problem of traffic jams by the extensive development of roads and overpasses. However, road construction:

1 – ‘provokes’ the influx of vehicles, increasing traffic and leading to ‘ferries wheel’;

2 – fundamentally and irrevocably change the healthy urban planning structure to the ‘concrete-dead’ urbanised, uncomfortable, and adverse for humans environment.

An exit from ‘ferries wheel’ can be provided by the application of the following two principles:

1 – the priority of public transport, particularly electrical rail;

2 – ‘to each their own’: differentiation of types of transport by function, passengers by the placement and frequency of occurrence, the power and range of flows. The main thing here is not to oppose to rail transport other modes of transport and mutually exclusive competition, but on the contrary their interaction tandem.

Rail transport, thanks to its branched historical tracing is able to solve the problem of high – speed communications in the city and eliminate traffic jams in towns. It can be provided due to the diversification of functions in favour for the intercity passenger transportation, adjustment of railroad structures and operating modes of devices for the use of citizens in accordance with their requirements, through the introduction of a service with a high demand on the market. Socio-economic competitiveness of railways in the context of globalisation (including service and traditional security) stimulates additional services for passengers.

The change of the importance of rail transport (including rail) caused, in addition to the traditional passenger transport classification, the development of relevant up to the present day’s classification of five rail systems. It was developed in 2008 by professionals, experts from the analysis of the 100 largest cities in Europe. It is conditional and terse, but gives an idea of the types, power, emphasising the importance of rail transport in a global market economy, the widespread crisis of the transport and traffic jams in the cities of Europe. It also allocated a place for the system City-Rail (or S-Bahn), that can be adequate to the present situation in St. Petersburg.
4.2 The methodology of transformation of intercity stations in S-Bahn system

Term S-Bahn (in Russian language, high-speed city rail) means passenger public rail transport (in the narrow-minded language – ‘city trains’) in the towns. The methodology of transformation was proposed by the author in 1975. The system S-Bahn occupies a middle position between the traditional rail and U-Bahn, which causes confusion in the concept, even among experts. Metro should be treated as a special case of the railway for intercity transport over relatively short distances.

Therefore, both systems are characterised by the same features and functions, but there are differences. About a similar transformation of the suburban, but in the city, railway stations into a modern high-speed off-street system for the first time in the USSR, was stated in the draft of the CTS-Riga-1990 (with S-Bahn-Riga) in 1975. The factors for the justification of high-speed city rail were not finances and not improvement of the efficiency of commuter traffic, but an inconsistent planning and passenger situation: the high mobility of the population (685 trips per year), and the motorisation rate (around 50 cars per 1,000 inhabitants compared to 12 on average in country). Instead of the desired by the government of the Republic metro and light rail system, an S-Bahn-Riga was offered, using existing sites of the railway (102 km plus 30 km of temporarily unused, 24 boarding platform in the city).

One factor in favour of a system S-Bahn-Riga was the possibility of its incremental and phased construction and further operation, which was not possible to obtain in the case of underground systems. On the whole, four alternatives have been developed, and then for the selected two competitive alternatives additional two variants for development were proposed. Further on, for the recommended S-Bahn-Riga two more sub-options were designed, including the new underground construction. The proposed benefits were estimated for four groups of traffic in the city: 1 – urban and intercity high-speed transport, 2 – speed urban transport as part of intermodal, 3 – urban transport on tourist routes, 4 – other transport services.

Meanwhile, the situation in 80-90s was not in favour of the proposed option (Shabarova, 1986). The reasons, which prevented realisation, were mental inertia and conservatism of designers, authorities, and railway workers themselves. There was no political will. The author managed to revive the idea of high-speed city rail and implement it in the Sochi-2014 project. The author proposed the system of the city high-speed railway (S-Bahn-Sochi) on the Black Sea coast from Tuapse on the basis of the modernisation of the existing single-track railway sections and new construction of S-Bahn-Krasnaya Polyana to the mountain cluster in the form of so-called light rail transport.
5. Conclusions

The considered example of the development of the light rail transport is worthy of imitation in St. Petersburg and its metropolitan area. The first step in this direction can be the implementation of the ideas for the conversion of transport and communication space of node Pulkovo Airport and CEC ‘Expoforum’, as well as for a new stadium for the 2018 World Cup on Krestovsky Island in St. Petersburg. These ideas can be used for other infrastructure projects likewise.

Railways are a universal form of transportation, which do not create congestion on the network, and at the same time represent an economical and environmentally friendly mode of transport. Railways are able to integrate into any transport system at different levels of service, being flexible and resilient to modernization and innovation. Modernisation of the rail network should be started with the suburban railway network, since it maintains a comfortable living environment in a crowded city, and save scarce urban land due to the absence of multiple and multilevel road interchanges. The last but not least important point is that railways can be considered as careful means of transportation in respect of the historical heritage of the city and poor urban greenery. Therefore, a renaissance of electric rail transport in Russian cities is so desired in the recent years.

References

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