Key Problems of Fire Safety Enforcement in Traffic and Communication Centers (TCC)

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Abstract. A Traffic and Communication Center (TCC) means facilities designed and used to distribute and redirect flows of humans and motor vehicles while they get serviced and operate. This paper sets forth the basic problems of fire safety enforcement on the TCC, and the causes that slow down human and vehicle traffic speeds. It proposes ways to solve the problems of fire safety enforcement on the TCC, in the Russian Federation and elsewhere. Engineering solutions are proposed for TCC design, with key outlooks of TCC future development as an alternative way to organize access in transportation.

1. Introduction

In the recent 25 years, the Russian Federation and other nations have been confronted with a problem of organizing transportation without significant delays in different communities. Ongoing growth of privately owned motor vehicles, growth of migrant labor flows and shipments, appearing multi-purpose business and recreation centers complete with their logistics – these are the reasons why the transport infrastructure lags behind the growing car fleet, and this is an adverse influence on the throughput capacity and commuting time\([1, 2]\). Currently, hours can be lost on the road in congested traffic.

Around 1990s, among the multitude of economic, political and purely routine problems that must remain beyond the scope of this study, governments on every level realized the problem of massively affordable housing; this called for numerous housing estate projects while the commuting problem was pigeonholed for later times. So the transportation problem did not arise overnight, and hardly because “government fails to do the job”, it was just a result of the objective laws of urban development in general\([1-14]\). This hypothesis is supported with the fact that the same problems persist globally in other cities and megalopolises.

Figure 1. Congested motor traffic has become a serious problem
2. Methods

The problem can be efficiently solved using a comprehensive approach. This is why the city developed and enacted a whole set of parking toll rules and regulations, restricted heavy truck entry in city districts, etc. A strategic concept of mass transit was also worked out, which envisages, among other things, building of transfer hubs or traffic and communication centers.

A traffic and communication center is facilities designed and used to distribute and redirect flows of humans and motor vehicles while they get serviced and operate. Such structures are best built in areas that have integrated mass transit lines: subway, railway, suburban public commuting, air terminals, publicly and privately owned motor vehicles. Such efforts will optimize human and motor traffic flows, integrate the variety of means of transportation, reduce the load on road infrastructure, at the same time creating more comforts for humans in the urban environment [15].

Other nations have had similar traffic hub solutions that deserve special consideration. Such examples include the underground bus terminal plus subway station built under the Kamppi Trade Center in Helsinki (Finland), and the Boston Hub in the United States.

![Figure 2. A traffic and communication hub in a foreign nation](image)

It must also be noted that in addition to changing the type of transport – the interchange function, most important outlooks for traffic and communication hub building lie in that they should combine social, recreational and business functions. Such facilities comprise shopping and catering businesses, service providers, branches of banks and insurance companies, offices and accommodation services. As an example, the Boston Hub boasts an arts gallery, while a policlinic exists in the Tokyo Hub.

![Figure 3. Draft overview of a traffic and communication hub project](image)
It is worth mentioning that the Russian Federation does have such projects. In Moscow, among others, there is a fully functional traffic and communication hub known as Planernaya – Moscow’s first such facilities. The TCC has mass transit stops, a 600 car spaces parking area, shopping and catering units. This is in fact a multi-profile center complete with mass transit facilities. The Russian capital has comprehensive program that is to build about 220 traffic and communication nodes in the city’s different areas. As we said above, the most promising future direction for TCC is to make both the facilities themselves and their individual rooms multi-functional. Federal Act 123-FZ in Article 32 regulates in detail the classification of buildings, structures and fire safety bays in terms of firefighting functionality. The fire safety class serves as basis for all future applicable firefighting requirements [5, 12]. In the trivial situation, after the functional fire safety class is assigned, one can decide such things as the number of fire bays needed based on the project area, degree and limits of building structures fire resistance, characteristics of escape routes and fire exits, list of firefighting equipment and systems, and other fire safety related requirements.

Also, taking the concept of accessible urban environment for low-mobility citizen categories as premises, one needs to focus on activities that ensure safety of disabled individuals [5, 14, 15, 9]. Having estimated the number of persons able to simultaneously use the transfer hub under normal operation conditions and during emergency evacuation, one can embark on comparative analysis to find the necessary space areas so that the required dimensions can be adopted as standard values [10, 11]. This, however, takes more than just knowledge of flow kinematics, which can be the same for flows of different physical nature. The priority here will be mechanisms that determine interaction between components of the system to be described by the resulting kinematic relations. As a system, pedestrian traffic flow is an aggregate set of elements – individuals, each of whom is a living system (unlike elements of mechanics or other inanimate items or particles etc.) [18]. In mechanics, bodies move driven by forces that are transferred from one body to another. According to our data, depending on flow density, changes in the moving speed of low-mobility senior citizens follow the same pattern as described earlier with the formula:

$$V_{Dj} = V_{0j} \left(1 - a_j \ln \frac{D_j}{D_{0j}} \right),$$

(1)

where $V_{Dj}$ – random function of flow speed in $j$-th path type, for its density $D$, m/min; $V_{0j}$ – random speed of free flow moving over $j$-th path type (for its density $D \leq D_{0j}$), m/min; $a_j$; $\ln (D_j / D_{0j})$ – mathematical expression of human response to increased flow density, with: $a_j$ – coefficient of human adaptation to movement over $j$-th type path with growing density; $D_j$ – density of human flow in $j$-th section; $D_{0j}$ – threshold of flow density in a section $j$-th path type, after which density begins influencing the moving speed of humans that go along with it.

Because until recently, fire safety regulations prohibited the use of indoors mechanical transport (elevators and escalators) to evacuate humans during fire emergency, studies of their functioning in the traffic and communication center system were very limited [13, 14, 17]. For example, even as early as in 1960s, science research determined the need for conditions “to organize phased evacuation assisted by mechanical indoors transport and vertical movement devices” for pedestrian traffic.

Key architecture-related trends for TCC include use of multiple illumination space (atriums), opaque structures used as external enclosures, ensuring no firewalls are built when buildings are divided into fire bays. All such project solutions deserve special attention, with extra compensating efforts done to organize fire safety in facilities under consideration

3. Results
As regulated in Federal Act No. 123-FZ, Section 2 of Article 78 [1], and also in Section 8 of Article 6 of Federal Act No. 384-FZ, should preparation of project documents require departure from any provision contained in Federal standards and building codes of the list enclosed, or should the
requirements to safety and reliability therein contained prove insufficient, or should such provisions be missing altogether, then preparation of the project pack and the very construction of the building or facilities must proceed in line with specific custom engineering specification (CES), which shall be written and coordinated following the procedure officially adopted by the competent agency of the Federal executive government, to contain the comprehensive range of engineering and administrative activities designed to enforce fire safety on the project.

Also in accordance with RF Federal Government Decree No.87 of February 16, 2008, “Organization of Project Pack Sections and Requirements to Content Thereof” (Section I, par. 5), should the provisions of official civil engineering standards and regulations prove insufficient for preparation of a project pack for capital construction, or in the event that such provisions do not exist, then preparation of the project pack must be preceded by the phase of CES writing and coordination following the officially established procedure. Apparently, the need to write a CES may arise on any project where applicable regulation happens to be inadequate in terms of reliability and safety. In any event, given the operation specifics of respective facilities, the large number of individuals pertaining to all mobility categories, extended length of escape ways, and many other features, under Federal Act No. 123, Article 6, par. 1, estimating the risk of fire emergency will be the key principle underlying compliance assessment of such facilities [22, 23]. Such are long established criteria of fire safety, and currently they also apply to unique and complex engineering facilities and structures, as well as projects not covered by fire safety regulations as such. Fire safety experts representing the RF Emercom Department of Supervision, RF Ministry of Civil Construction, RF Emercom Fire Safety R&D Institute, public and private expert organizations, have a firm and established judgment about the need to use tried and trusted methods of assessment as the most relevant and adequate way to support adopted solutions in project design and engineering [19].

4. Conclusion
An adequate and rational approach to design of traffic and communication hubs is the logical way to address a topical issue of problem-free transportation. The first step on the path to a solution would be to examine in depth the pedestrian traffic flows expected to pass through the TCC, since ensuring safety of humans in any fire emergency is a paramount priority [4, 16, 20].

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