Urban Transportation Challenges: Social Issues and Digital Data Analysis

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Abstract. The goal of this study is to determine the contemporary problem areas of urban traffic management policy in Russia. This study applies web content analysis of search engine-generated images to explore visual narratives, social and political categories of urban traffic. It also makes use of cosmogram perspective (external depictions of urban traffic composition with connections traced between its elements). The analysis showed that urban traffic categories constitute public concern and contentious frames. It indicates Russian public opinion anxiety of specific traffic challenges that are usually out of the government and city management agenda. This study also discusses some prospects for urban governance and urban transportation assessment supported by digital analysis technologies.

Keywords: Urban transportation, Road traffic, Urban governance, Social issues, Traffic congestion, Road Rage, Digital data analysis, Visual sociology.

Introduction

Urban transportation combines multiple relationships and a wide range of policies: environmental, technology and innovations, public health and safety, quality of life and social security, mobility of human resources, finance and economy. The growing importance of urban transportation not only contributes to urban development, but also creates new issues for urban policy and communication between city government, stakeholders and public interest groups. At the same time, even challenges [1] that urban transportation presents to urban planning and risk management are largely out of the focus of contemporary urban research because of strict boundaries between jurisdictions and responsibilities of institutional and management structures. Thus, transport-specific problems are found outside the boundaries of the typical management model that evolved in developing countries at the national and urban levels where cities have experienced an explosive growth of motorization combined with uneven development of the corresponding services and infrastructure.

With such imbalance, the new global management standards of urban governance evaluation, which are often based on indicator design and data analysis, have little potential in relation to complex, multilevel and varied all-nation or city-specific challenges to urban transportation development.

Not infrequently, side effects of transport reforms give rise to contentious public demands or protest movements, as post-Soviet Russia has been showing from time to time [2, 3].

Urban management agenda rarely includes non-political and non-social issues. Even anticipatory management agenda and smart city strategies are not free from aberrations of the new digital urban ontology that generates objects without tracing the processes of their origin.

1 Background Review

Contemporary studies of the urban transportation problems described above relate to the lager areas of public policy, which, however, are mostly plagued by economic and operational inefficiency of transport models, infrastructure, etc. This is most relevant to congestion studies, since transportation and mobility are important not only for global urban research [4, 5], but also for sustainable development championed by the smart city strategy [6, 7]. Social issues related to traffic congestions are driven by road rage violence [8], stress and psychological problems [9], as well as by new opportunities offered by the paradigm of traffic digitalization and the necessity to manage free parking space. Longer commute of city residents generates new services that bring economic and social capital, but the downside is the loss of air quality and high carbon dioxide levels, which point towards an imbalance in urban development. Imposing tolls and environmental regulations for balancing traffic risks and compensating the costs of infrastructure maintenance could inspire political contention. The anti-mainland cross-border driving movement in Hong Kong, the protest campaign in Johannesburg after the launch of the "e-toll" system for drivers, and the yellow vests protests in France have shown that the government is trapped by management problems.

The rising transportation-based business models ("on-demand" employment for taxi or last mile deliver services) open the door for debates on uberisation of labor in the modern city [10]. Recent studies in urban geography and anthropology highlight how the popularization of new vehicles in cities affects public life [11], safety, and city environment in general [12, 13].

As preparations for the launching of autonomous urban transport show, technologies not only raise the issue of public morality on the new technology-governed roads [14], but do so in very specific ways because public perceptions differ across the world, as shown by the experiment on modeling of road accidents in the MIT Media Lab: Moral Machine [15].

The situation in Russia is different. In some respects, a number of traffic problems in Russia are similar to developed and newly industrialized countries like China, India, etc. [16, 17]. The post-Soviet transformations related to the change of political regime have contributed to complexity of regional and urban spaces, which creates both limitations and opportunities for local management. Due to lack of citizens' support, administrative regulatory measures and law could be undermined with [18], the high-tech strategies produce managerial aberrations, impose barriers for management

and facilitate public contentions. Even with digital solutions, urban management remains short-sighted, as it uses digital technologies for innumerable data collection and standardization, implementation of performance indicators, dashboards, and further steps to create its own digital twin [19, 20]. The limited effects of digitalization are also linked to complexity and interconnectedness of processes and chains in urban life, where it is difficult to outline the specific areas of regulation.

The urban traffic space also becomes a field for ethnic, legal and economic conflicts, due to shadow and informal economy, legal bias, rampant drivers' behavior, and the overlapping of public, political and private spheres in a hybrid political regime that often depends on patrimonial relations. This means that solving the traffic problem requires more attention and deeper understanding of indirect effects and relationships which, however, are often neglected. Accordingly, mismanaged issues are ready to be pushed into the area of public initiatives and often politicized discontent.

Contemporary Russia provides interesting examples of the politicization of road traffic issues at different levels. One example is the recent attempts of an anti-governmental leader to manage digital claimant initiatives by the creation of the on demand crowd service "RosYama," designed as a platform for complaints about the necessity of road repairs. The goal was to give city inhabitants an instrument for control of urban infrastructure and management [21]. Another case is the creation of "StopXam," a vigilante movement which showed the social polarization of pedestrian-driver relations [22]. When Platon, the new system of vehicle tolls, was imposed, truck drivers launched Anti-Platon, a cross-regional protest campaign that highlighted socio-economic challenges to Russian government [23].

The hybrid nature of current urban traffic problems in Russia is not limited to the certain functional characteristics of urban transport. It requires understanding the broader context of urban and national life, which creates challenges for scholars and management strategists.

On the other hand, this field of research requires not only an interdisciplinary approach and a special research agenda, but also specific methods of data analysis. One example of such analysis paradigm is attribute analysis of geo-tagged images of cities used to characterize the identity of urban spaces [24].

Another line of research develops the conceptual city perception of Kevin Lynch [25] and employs it for advanced analysis of the visual data from commercial services (e.g., Google Street View), photo-sharing websites (e.g., Flickr) or crowd-sourced images to assess such qualities of urban spaces as transport accessibility, safety, preservation of natural environment, etc. [26].

2 Data and Method

The purpose of this article is to determine the problem area of traffic management policy in Russia using digital analysis of visual data. In contrast to urban studies, where the analysis is based on perception of objects and their configurations, our

interest relates to broader understanding of road traffic, including the sources of possible social antagonisms.

In respect to this question we implemented the research perspective formulated by the anthropologist John Tresch, who called it the cosmogram concept. Cosmograms are "external depictions of the elements," between which connections are traced. These elements and their combinations encompass world we live in, no matter what the nature of each element is (whether it is material or ideal) [27]. Another methodology for cosmographical analysis of the social realm is ANT (actor-network theory). It enables the analysis of far-reaching and persistent chains of elements that frame urban transportation as spatial co-relation of events, routine processes, frames of communication and human actions.

Our research on urban traffic governance recognizes that traffic and its elements are the matters of public concern and seeks the means to describe them and identify them as parts of social agenda or political contention.

For such purposes, semantic analysis was applied for web content to create visual narratives and distinguish social and political categories of urban traffic. The visual sociology perspective provides public concerns related to, frames, and perceptions of the key elements of traffic ontology: transportation, drivers, vehicles, traffic issues, etc. Following this principle, we attributed traffic-related objects and human actors to social and political agenda.

The usual challenge of this research optics is linked to sampling and limits of data validity. Our innovative research design makes use of the visual narrative principle where the researcher has to follow visual artefacts in the space of public knowledge. Internet was considered such space, which provides complex interrelated reality, arranged by recent events that attracted public attention, social agenda, and algorithms of search engines.

This paper uses a new source of data, the most popular search engines in Russia (yandex.ru and google.com), to analyze visual representation of the following traffic categories: vehicles, traffic, road users, traffic issues (four key words for web search query for each category). For each category, the sample size was limited to 500 images per one search engine with default browser settings. The defined samples have two time frames: 2014 and 2020. Images from the samples with a particular focus on the road traffic attributes were manually coded one or more times. Images without evident visual attributes were not coded.

3 Results

Table 1 contains data only on selected (24 of 46) attributes that are mentioned further in the text. For this reason, some categories and data with less importance were excluded from the table. Generally, it shows general public awareness and concern of urban traffic in Russia in relation to the following traffic attributes in 2014: government regulation, traffic incident, drivers' gender, drunk drivers, traffic congestion and road rage.

In-depth study has shown that attributes of traffic categories mainly follow social frames of personal risks perception and mobility limitations (car accident, bodily injury, traffic congestion, road rage, privileges of public servants, crime and security experience, driving while intoxicating, environment and weather conditions, car expenditures, engine emissions, bumpy roads). They also provide evidence of social stratification (public transport, shared taxi and cargo vehicles, motorcycles and bicycles, presence of women and children, social inequality) and conflicts (road rage, protest actions), as well as political relations (government regulations, traffic privileges of high-rank officials, protest actions).

The connection between road traffic and government regulation practices is relatively evident in this time period: the images show a large quality of regulation markers (high proportion of images with restrictive traffic signs, traffic control procedures, vehicle impoundment, etc.). There are also references to protest actions and conflicts with state officials, mostly because of traffic privileges for cars of public servants with emergency flashlights.

We defined tree major issue-related attributes of road traffic for year 2014: traffic congestion, road accidents, and road rage (drivers' aggression). First, traffic congestion had high-value connections not only with incidents where cargo vehicles or public transport were involved, but also with the impact of nature (encounters with wild animals, bad weather conditions, natural disasters), construction works that had relation to urban development and the work of the city utility services. Second, road accidents were connected with public transport and cargo vehicles, but also with minibuses (marshrutkas), motorbikes, and cycles. Road accidents also define social and gender inequality. Third, road rage had direct reference to contentious politics. As previously mentioned, they are related to protest actions, government regulations, social inequality, and traffic priorities granted to public servants.

Despite the unifying drive of government regulations and public contention towards them, the cosmogram of Russian road traffic in 2014 could be displayed as a hybrid association of elements with high perceived risks and uncertainty for the drivers and the public in general. These risks were attributed to different types of drivers and vehicles. For example, the analyzed images of marshrutkas, old Soviet- or Russian-manufactured cars typically showed ethnic attribution (labor migrants from Caucasus and Central Asia countries). On the other hand, the analyzed data gave us another interesting evidence on public function of vehicles as markers of social status and power mediators (expensive car = road rage = traffic privilege). For this reason, car expenditures and vehicle types are important factors of drivers' stratification on the road.

A comparison with this year's data shows that public perception of traffic objects and their relations has significantly changed. Most notably, public attention to road situation in general and, in particular, to traffic congestion has increased. This focus on traffic situations and their participants confirms the inefficiency of current regulations or even a crisis in transport planning in many Russian cities, as it shows that traffic congestion is one of the key challenges for road traffic in Russian cities. In this respect, we can define the relationship between bad situation on the road and car accidents, as well as with the problem of driver fatigue. An evaluation of changes in the general data dynamic will show the developments of Russian cultural, social and political perception and interpretation of road traffic.

First, to a large extent, a number of groups were legitimized as road users and traffic participants: motorcyclists, women, and the elderly people. In the public perception, they no longer appear as traffic problems or carry exclusive blame for accidents where they participate.

On the other hand, cyclists are sometimes still assessed as undesirable (problematic) road users, and ethnicity still often as a basis for negative perception (more often in relation to taxi drivers, rather than drivers of marshrutkas).

Second, there is a general decrease in public perception of road traffic as a dangerous activity that carries a threat to its participants, which is well demonstrated by a decrease in attention to such elements as car accidents and road injuries, speed measuring cameras, road rage, and drink- or drug-influenced drivers. The decline in attention to speed cameras is most notable, since their use has traditionally been associated with the need for drivers to have proof of their innocence in a traffic incident before the traffic police.

At the same time, road traffic continues to focus on the problem of road safety for children. At the level of public practices this is associated, for example, with the mass use of stickers proclaiming that there is a "Baby on board." This warning sign has become legitimized among drivers.

Third, the issue of road traffic has largely lost the political context that was previously associated with the issue of road privileges (emergency flashlights) for civil servants, perceived as result of bribes, and gave rise to various protest actions.

At the same time, our data shows notable decrease in public attention towards poor road quality and road construction works, which could be defined as a positive effect of mass urban reconstruction and transport policy in Russian regions.

The growing importance of cargo-carrying processes should be noted separately. Together with other trends, it indicates, in general, a more rational perception of transport and road traffic. In terms of popular traffic culture it may indicate a transition from the paradigm of romantic vehicle ownership to a model of practical vehicle use. The focus on expensive cars (11.6% in 2020) is more of a marketing nature than a social one, given the reduction in social inequality.

Notably, the car remains the tool of personal self-representation and identity, including the political aspect of historical memory, which is recorded in relation to the theme of remembering the Great Patriotic War (1941-1945), promulgated by media campaigns and the popular practice of placing celebration posters as symbols of honor. This visual attribute (≤1% in 2020) was not detected in 2014.

Finally, we can note that the perception of road traffic in Russia largely corresponds to the trends witnessed in developed countries: there is more demand for automotive innovations (car-sharing, electric vehicles, etc.), opportunities for people with disabilities, and environment-friendly traffic.

One other issue, which links developments in Russia to the situation in developed countries, is rather a problem than a benefit: there is increased use of mobile devices by road users, which causes public concerns about safety (using a phone while driving).

Table 1. Selected visible attributes of Russian road traffic: comparison of key traffic categories

Name of the attribute	Vehicles		Road traffic		Road users		Traffic issues		Ratio for all categories	
	2014	2020	2014	2020	2014	2020	2014	2020	2014	2020
Transport regulation, traffic police actions	6.2	2.1	25.1	24.6	38.0	10.4	29.4	31.1	27.2	16.2
Traffic congestion	3.3	5.0	9.2	38.5	0.2	0.0	0.6	20.0	2.6	14.6
Cargo-carrying	30.3	21.1	3.6	0.4	1.5	22.0	8.3	5.4	9.1	12.9
Public transport	21.3	25.9	10.4	2.5	2.1	5.0	6.6	1.6	8.5	10.8
Children	0.0	0.6	11.9	15.7	4.7	9.8	1.7	7.1	4.4	6.9
Traffic incident	1.1	1.2	4.3	3.8	11.2	16.8	9.0	3.6	7.4	5.1
Dashboard camera and traffic surveillance	0.6	0.2	0.6	1.3	2.2	2.1	8.0	7.0	3.3	2.7
Traffic injuries	0.0	0.1	0.0	0.2	4.2	5.1	3.7	2.2	2.5	1.6
Minibus (marshrutka)	2.1	1.9	0.8	0.3	1.5	1.9	2.1	1.2	1.6	1.4
Taxi	1.3	0.5	0.6	0.0	1.1	5.3	0.5	0.9	0.8	1.4
Cycles	2.0	0.8	1.9	0.7	0.3	1.6	0.9	2.1	1.1	1.3
Gender	0.1	0.1	0.2	0.1	4.6	2.1	4.6	3.0	2.9	1.3
Mobile device	0.0	0.2	0.0	0.0	0.5	1.9	0.2	1.0	0.2	0.7
Social inequality	0.0	0.0	0.0	0.2	1.5	0.4	1.8	2.0	1.0	0.7
Motorcycle	1.4	0.6	2.3	0.7	0.7	0.2	2.3	0.8	1.6	0.6
Road rage	0.0	0.0	0.1	0.2	2.5	3.1	0.2	0.0	0.9	0.6
Bumpy road	0.4	0.0	4.7	1.6	0.2	0.0	0.2	0.4	1.1	0.4
Drink- or drug-influenced driver	0.1	0.0	0.1	0.0	7.6	1.8	0.5	0.3	2.7	0.4
State officials' priority	0.5	0.2	0.4	0.5	0.3	0.2	1.5	0.7	0.7	0.4
Protest action	0.0	0.0	0.7	0.2	0.1	0.2	2.6	1.0	0.9	0.4
Elderly people	0.0	0.0	0.1	0.0	1.9	1.0	0.3	0.6	0.7	0.4
Driver fatigue	0.0	0.0	0.0	0.1	0.5	1.6	0.0	0.0	0.2	0.3
Ethnicity	0.0	0.0	0.0	0.1	0.4	1.0	0.2	0.0	0.2	0.2
Crime and security	0.3	0.0	3.9	0.0	1.8	0.0	0.6	0.0	1.6	0.0

Notes: Data are given in percentage terms. Zeroes show that some attributes are irrelevant for specific traffic categories or years.
Sample size: 30000 images. The total number of coded traffic attributes: 15874.

Discussion

The research method used for this study is not free from limitations. The main issue is related to data collection, as search engine algorithms are often opaque and require precisely formulated search queries. Moreover, data selection is dependent on news-makers, social agenda, web-optimization of information sources, and web-marketing. On the other hand, public consciousness is also influenced by regular use of multisided communication and the Internet, so it experiences a similar influence of various agendas and media. A solution to this limitation is the use of different data sources depending on specific research task.For further research based on web-sourced images, we intend to include more image attributes and make use of computational analysis. This research method has been tested in recent studies of objects and their compo-

sitions with traced connections, which used visual data analysis for “scenes understanding” [28].

Respectively, key elements of further research plans include: introducing efficient and reliable methods of analysis; a focus on perception as indicator of social transformation in the human-centered perspective; a focus on system cognition that makes it possible to verify attributes of images with software algorithms or manual coding; and development of spatial (country, region, city, place) and issue-specified (description, keywords and tags) data analysis.

As for the technical aspect, our plan includes overcoming the limitation of sample size while preserving the sufficient level of accuracy and quality of image recognition. This technological development will facilitate deeper categorization of the visual content while defining lager number of attributes, powering up algorithm-driven cognitive network analysis.

The analysis of digital data on social issues has some implications for urban management that are related to new opportunities of digital instruments for data mining in general. In addition, it is extremely important to avoid reduction of complexity of urban processes and relations among road traffic elements, in particular to standardized metrics and dashboards that can seem a convenient measuring tool for the purposes of urban management and planning. This is a part of the general challenge of the managerial paradigm of new digital ontology of space, which the researchers of modern management technologies are focused on and often criticize [29].

At the same time, the development of this research area allows not only to assess the dynamics of problem perception in time and place, but also to identify new relevant points of focus of public attention and predict the future agenda (as new elements of cosmogram in the area under research). That point is demonstrated by the data from 2020, where we see the emergence of new elements: car-sharing, attention to people with disabilities, personal electric transport. From this point of view, even in the machine learning model of urban assessment such methodology and framework of analysis allows to understand reality instead of reducing it, because this approach includes post-analysis of the samples, where images are compared and new categories of perception are defined. This technique is important for education and development of the automatic recognition software.

In this logic, regular revision of machine learning algorithms supports and contributes to the development of decision-making processes for regional management in countries with significant territorial differentiation by levels of socio-economic development and socio-cultural dominants in problem agendas.

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References

1. Rodrigue, J-P.: The Geography of Transport Systems. 5th ed. Routledge, New York, Ch.8. (2020).

2. Lonkila, M.: Driving at democracy in Russia: protest activities of St Petersburg car drivers' associations. Europe-Asia Studies 63(2), 291-309 (2011).
3. Evans Jr, A. B.: Protests in Russia: The Example of the Blue Buckets Society. Demokratizatsiya. The Journal of Post-Soviet Democratization 26(1), 3-24 (2018).
4. Rode, P., Floater, G., Thomopoulos, N., Docherty, J., Schwinger, P., Mahendra, A., & Fang, W.: Accessibility in cities: transport and urban form. In: Meyer, G., Shaheen, S. (eds.) Disrupting Mobility. Lecture Notes in Mobility, pp. 239-273. Springer, Cham (2017).
5. Hesse, M.: The city as a terminal: The urban context of logistics and freight transport. 1st edn. Routledge, New York (2016).
6. Bătăgan, L.: Smart cities and sustainability models. Informatica Economică. 15(3), 80-87 (2011).
7. Debnath, A. K., Chin, H. C., Haque, M. M., Yuen, B.: A methodological framework for benchmarking smart transport cities. Cities. 37, 47-56 (2014).
8. Shinar, D., Compton R.: Aggressive driving: an observational study of driver, vehicle, and situational variables. Accident Analysis & Prevention. 36(3), 429-437 (2004).
9. Sansone, R. A., Sansone L. A.: Road rage: what's driving it? Psychiatry (Edgmont). 7(7), 14-18 (2010).
10. Malin, B. J., Chandler C.: Free to work anxiously: Splintering precarity among drivers for Uber and Lyft. Communication, Culture & Critique. 10(2), 382-400 (2017).
11. Wray, J. H.: Pedal power: The quiet rise of the bicycle in American public life. Routledge, New York (2015).
12. Golub, A., Hoffmann, M., Lugo, A., Sandoval, G.: Bicycle Justice and Urban Transformation. Routledge, New York (2016).
13. Vivanco L. A.: Reconsidering the bicycle: An anthropological perspective on a new (old) thing. Routledge, New York (2013).
14. Fleetwood J.: Public health, ethics, and autonomous vehicles. American journal of public health. 107(4), 532-537 (2017).
15. Awad, E., Dsouza, S., Kim, R., Schulz, J., Henrich, J., Shariff, A., ... Rahwan, I.: The moral machine experiment. Nature. 563(7729), 59-64 (2018).
16. Li, F., Yao, X., Jiang, L., Li, Y.: Driving anger in China: Psychometric properties of the Driving Anger Scale (DAS) and its relationship with aggressive driving. Personality and individual differences. 68, 130-135 (2014).
17. Mina, S., Verma, R., Balhara, Y. P. S., Ul-Hasan, S.: Road rage: prevalence pattern and web based survey feasibility. Psychiatry journal. 2014 (2), 1-7 (2014).
18. Ma, S., Tran, N., Klyavin, V. E., Zambon, F., Hatcher, K. W., Hyder, A. A.: Seat belt and child seat use in Lipetskaya Oblast, Russia: frequencies, attitudes, and perceptions. Traffic injury prevention. 13(1), 76-81 (2012).
19. Kitchin R., Lauriault T. P., McArdle G.: Knowing and governing cities through urban indicators, city benchmarking and real-time dashboards. Regional Studies, Regional Science. 2(1), 23-25 (2015).
20. Mattern, S.: Mission control: A history of the urban dashboard. Places Journal, https://doi.org/10.22269/150309 March (2015), last accessed 2020/02/29.
21. Ermoshina, K.: Democracy as pothole repair: Civic applications and cyber-empowerment in Russia. Cyberpsychology. Journal of Psychosocial Research on Cyberspace. 8(3), Article 4 (2014).
22. Gabdulhakov, R.: Heroes or Hooligans? Media Portrayal of StopXam (Stop a Douchebag) Vigilantes in Russia. Laboratorium: Russian Review of Social Research. 11(3), 16-45 (2019).

23. Østbø, J.: Between Opportunist Revolutionaries and Mediating Spoilers: Failed Politicization of the Russian Truck Drivers' Protest, 2015–2016. Demokratizatsiya: The Journal of Post-Soviet Democratization. 25(3), 279-303 (2017).
24. Zhou, B., Liu, L., Oliva, A., Torralba, A.: Recognizing city identity via attribute analysis of geo-tagged images. In: European conference on computer vision, pp. 519-534. Springer, Cham (2014).
25. Lynch, K.: The image of the city 11. MIT Press, Cambridge (1960).
26. Liu, L., Zhou, B., Zhao, J., & Ryan, B. D.: C-IMAGE: city cognitive mapping through geo-tagged photos. GeoJournal. 81(6), 817-861 (2016).
27. Tresch J.: Technological world-pictures: cosmic things and cosmograms. Isis. 98(1), 84-99 (2007).
28. Zhou, B., Lapedriza, A., Xiao, J., Torralba, A., & Oliva, A.: Learning deep features for scene recognition using places database. In: Ghahramani Z., Welling W., Cortes C., Lawrence N. D., Weinberger K. Q. (eds.). Advances in neural information processing systems 27 (NIPS 2014), pp. 487-495. Springer, Cham (2014).
29. Kitchin, R., Lauriault, T. P., McArdle, G.: Knowing and governing cities through urban indicators, city benchmarking and real-time dashboards. In: Regional Studies, Regional Science, 2(1), 6-28 (2015).