CROATIAN URBAN TRANSPORTATION SYSTEMS IN 2020: SUSTAINABLE URBAN MOBILITY SURVEY

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Abstract

Faced with a variety of challenges generated by growing urbanization, cities worldwide aim at redesigning their transportation systems and making them more efficient, better integrated and sustainable. The purpose of this paper is to evaluate the current state of Croatian urban transportation systems in such a context. The survey of the Sustainable Urban Mobility Project 2.0 by the World Business Council for Sustainable Development was implemented in capturing the perspective of the local population (N=2484). Transportation systems' users are key stakeholders in achieving urban transportation system sustainability. Their behaviour provides useful input for city planners, transportation service providers and destination management. The mobility patterns, behaviour and attitudes of urban residents are therefore used as indicators of the functioning, accessibility, multimodality and integration of urban transportation systems. Regardless of the fact that most respondents commute daily, the majority of respondents do not feel restricted by the available urban mobility options. Reliance on cars in everyday travel is not surprising, and this option is followed by a substantial share of respondents using public transportation (PT) and walking. Other alternative options are only partially utilized (bike sharing, car sharing and combinations of modes are not considered a viable option for most) and only a small proportion of respondents display intermodal habits. Practical and social implications based on research findings also take research limitations (foremost the convenience sample) into consideration. Further research should build on this research and emphasize urban transportation options in the context of urban tourism.

Key words: urban transportation systems, urban mobility, mobility patterns, Croatian urban mobility systems

1. INTRODUCTION

The world's population is increasingly city-based, and in the EU 75% of total population is urban (The World Bank, 2019). Faced with the multifaceted challenges of growing urbanization, cities worldwide will need to influence change or otherwise face a bleak future, being unable to maintain functionality and satisfy citizens' needs.

Urban mobility causes around 40 % of all CO_2 emissions and up to 70 % of other pollutants from transport (European Commission, 2019). Investments in more sustainable mobility are expected to boost productivity, attractiveness and overall quality of urban life (Arcadis & Cebr, 2017). Mobility systems influence city liveability while facilitating community interaction. Addressing alternative mobility options (PT, ride sharing, vehicle sharing, micro-mobility etc.) is inevitable in fighting the negative effects of traffic.

The notion of accessibility is inextricably linked to the mobility concept through the definition of urban accessibility (European Commission: Directorate-General for Mobility and Transport, 2017). Improving a city's mobility is often burdened by cost concerns and bureaucracy (Arcadis & Cebr, 2017) and there is no single mobility management approach able to address the specific features of every mobility system.

Sustainable urban mobility is only possible when the "mobility culture" - attitudes towards travel, transport and traffic choices - is the result of institutionalized measures incorporated into society, with pricing, regulations and education being the key (WBCSD, 2015). Sustainable urban mobility is a strategic priority of the EU, contributing to the "smart, sustainable and inclusive" objectives of the Europe 2020 Strategy (European Commission, 2010).

European urban mobility systems are the most mature systems and the leaders in mobility performance (Van Audenhove et al., 2014). Although some European cities are ranked among the most successful sustainable urban mobility systems on a global level (Arcadis & Cebr 2017; Van Audenhove et al., 2014), they have nevertheless been coping with growing urban mobility challenges and the negative impacts of transport activities on the climate, the environment and citizens' health. It is therefore essential to enhance mobility while at the same time reducing congestion, accidents and pollution in all European cities (European Commission, 2019a).

Croatian urban transportation systems both cause and reflect the mobility patterns of its users. The existing research on mobility patterns of Croatia's citizens (Mrnjavac & Slavić, 2018) (Slavić & Mrnjavac, 2019) indicates a strong car-dependency, and highlights urban PT and micro-mobility shortcomings in addressing mobility systems demand. Although a valuable insight, the existing research did not address the user satisfaction nor rank the importance of individual aspects of mobility options in urban surroundings. Also, the Croatian transportation system users were not previously profiled in relation to urban mobility to such extent. With the purpose of evaluating the current state of Croatian urban transportation systems this paper explores the mobility patterns, behaviour and attitudes of the surveyed urban residents, guided by the research question(s): Are urban mobility systems in Croatia sustainable? Are urban mobility systems in Croatia integrated? Are urban mobility systems in Croatia multimodal? Are urban mobility systems in Croatia accessible? Are urban mobility systems in Croatia appropriately managed?

The paper starts by providing theoretical background to the topic related issues. The sections that follow focus on explaining the implemented methodology and presenting the results of this research. The conclusions drawn at the end of the paper are substantiated by urban mobility management improvement suggestions in line with practical and social implications. Notwithstanding its potential research limitations, this research adds to the body of knowledge on urban population mobility-related behaviour.

2. THEORETICAL BACKGROUND

2.1. Sustainable Urban Mobility

Cities worldwide are increasingly facing the variety of challenges of advancing urbanization, population growth (United Nations, 2018), infrastructural shortcomings, and unsustainable politics. Approximately half of the global population is urban (Ritchie & Roser, 2019; United Nations, 2018), and this proportion is expected to increase by 2050 (World Economic Forum, 2017).

Urban settlements are hubs for knowledge, economic activity, innovation and welfare (European Commission, 2017a, p. 6). Residents share the same space and therefore the same transportation infrastructure. As the quality of urban lifestyle greatly depends on an efficient transportation system (Przybylowski, 2018), investments in more sustainable and better mobility options are expected to contribute to competitiveness, productivity, attractiveness and overall quality of life of cities (Arcadis & Cebr 2017).

A sustainable urban mobility system is accessible, safe, integrated, efficient, environmentally friendly, and able to meet the demands of all (European Commission, 2013). Almost two decades ago, WBCSD (2004, p. 6) outlined sustainable mobility as "the ability to meet society's need to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values, today or in the future." It is still coherent to the EU focus on multimodal, "sustainable, energy-efficient and respectful of the environment" forms of mobility (European Commission, 2020c).

Used to illustrate sustainable mobility, the *"new reverse traffic pyramid"* (Bicycle Network, n.d.) includes "rideables" or "micro-mobility" (e-scooters, segways, hover boards, mobility scooters, e-bikes, one wheels, and others), a group placed right under the top modes of walking and cycling. When properly addressed, the "micro-mobility" options play a significant role in delivering multimodal integrated mobility solutions and have the potential to reduce congestion and improve air quality in cities by replacing car trips (European Commission, 2019). However, integrating different aspects of urban mobility on a daily basis is not an easy task (Decker et al., 2012; Okraszewska et al., 2018; Przybylowski, 2018).

An "efficient, safe, connected and adaptable mobility system" absorbs social and economic functions, and offers infra and superstructure for human activity (Arcadis & Cebr 2017, 7). It is the responsibility of urban authorities to develop their cities' capacity and facilitate the implementation of innovative mobility solutions (Urban

Agenda for the EU Partnership for Urban Mobility, 2019). However, not all cities have sufficient capacity and resources for sustainable development. Most are seriously underequipped, limited by budget, capacity and/or knowledge, and achieve less than half of the potential they could if they were to apply best practices across all operations (Van Audenhove et al., 2014, p. 6).

Conventional approaches to transportation planning and management are not substantial in dealing with problems caused by the current urban mobility patterns. New solutions are required to transform urban mobility systems into more sustainable ones (Urban Agenda for the EU Partnership for Urban Mobility, 2019).

2.2. (Redesigning) Urban Transportation Systems

The wealth, size or maturity of a city does not imply a sustainable and functioning urban mobility system and, in opting for an integrated multimodal mobility system, urban authorities need to constantly evaluate all components and the overall system's performance (Arcadis & Cebr 2017). New integrative approaches to planning and managing mobility are being developed as urban authorities try to encourage a behavioural shift towards cleaner, more sustainable transportation modes like walking, cycling, PT or shared car use (European Commission, 2017a).

Urban "mobility ecosystems" need to be remodelled or extended in order to accommodate changing travel habits and demand expectations (more convenient, faster, more predictable and/or more individualized services) (Van Audenhove et al., 2014). There are different responses to a variety of mobility needs (e.g. Cheng et al., 2019) but the change towards more sustainable transportation is steady and lengthy (Kamargianni et al., 2016).

The *Mobility Management* (MM) concept aims to achieve mobility behaviour change on the individual level through "soft" measures such as information and communication, organising services and coordinating stakeholder activities (EPOMM). Correspondingly, traffic and demand management refers to measures to improve the flow and efficiency of traffic (European Commission, 2017b, p. 28). *Transportation Demand Management* (TDM) does this through the rational use of traffic infrastructure and by reducing the need for car-dependant travel.

Travel, transport and traffic choices influence urban sustainability (WBCSD, 2015). The attainment of sustainable (mobility) targets in a society can only be the result of institutional efforts, i.e. mobility policies (ibid.). Advances in urban mobility (new technologies, new service concepts and business models) also imply changes in urban mobility governance and planning (Urban Agenda for the EU Partnership for Urban Mobility, 2019) in order to reconcile the often conflicting requirements of national and local policies (economic, social and demographic objectives, spatial planning and zoning, environmental protection, construction and modernization of transport infrastructure, public services) and the needs of the local population.

Innovations require the "system level collaboration" of all stakeholders (Van Audenhove et al., 2014) which is the only promising option that car-dominated communities have in dealing with the growing urban deterioration caused by traffic (European Commission, 2016). At the centre of sustainable urban mobility should be the system's users and their habits, behaviour, travel patterns, preferences, and

attitudes towards urban mobility (Brčić et al., 2016; Lindenau & Bohler-Baedeker, 2014). However, if transport stakeholders are dependent on public finances, their access to system upgrades and innovation will be limited.

2.3. SUMPS

The EU is funding transportation infrastructure and promoting cross-border long-distance mobility through TEN-T (Trans-European Transport Network), i.e. the EU transportation policy (European Cyclists' Federation, 2019). At the same time, in line with the EU principle of subsidiarity, urban mobility is managed at the local level. This implies coherency of regulations and policies on all levels to allow interoperability and continuity (Urban Agenda for the EU Partnership for Urban Mobility, 2020). Mechanisms to provide (EU) financial support to innovative projects and mobility services need to be better tailored, in line with the characteristics and dynamics of innovative mobility solutions (Urban Agenda for the EU Partnership for Urban Mobility, 2019).

The EU advocates for *Sustainable Urban Mobility Plans* (SUMPs) in dealing with the major traffic-related challenges of urban settlements (European Commission, 2020b). SUMP is a core element of the EU urban mobility policy, that takes into account the whole functional urban area (the city together with its surroundings, rather than the administrative unit) and cooperation across different policy areas, different levels of government and with all relevant stakeholders (Urban Agenda for the EU Partnership for Urban Mobility, 2019b). The EU encourages this "people-centric approach" (European Commission, 2017b) and empowers cities to implement SUMPs by providing guidelines, training, networking and funding opportunities through the ELTIS European Platform (Urban Agenda for the EU Partnership for Urban Mobility, 2019b).

SUMPs help create "sustainable, affordable, accessible and frequent transport for everyone" (European Commission, 2017a) and make it possible to reap the benefits of sustainable urban mobility planning, such as improved quality of life, the generation of (local) economic benefits, improved health and environment, seamless mobility and improved access by multi-modal door-to-door transport solutions, more balanced plans in relation to accessibility and mobility needs, and moving towards a new mobility culture by creating a common vision supported by politics, public and institutions. (European Commission, 2017b, p. 7-8).

SUMP implementation supports the decarbonisation of the EU transport sector and the reduction of harmful emissions by 2050 (Urban Agenda for the EU Partnership for Urban Mobility, 2019b), and the methodology (Rupprecht Consult, 2019) is periodically revised and updated. According to *The Urban Mobility Observatory* less than 10 cities in Croatia have SUMPs (ELTIS, n.d.).

2.4. Changing Mobility Patterns

The urban population can be differentiated in terms of motives, dynamics, frequency and distances travelled, habits and attitudes, and the possibility of (and the preference for) using certain mobility modes. The key problems related to

transportation systems, among others, are congestion, social issues (accessibility, inclusion, safety), and environmental problems (European Commission, 2017a), often in relation to the imbalance of demand and supply. The supply is rather fixed in the short run, determined by historical development, spatial-geographical possibilities, traffic management and investments in infrastructure (Falcocchio & Levinson, 2015, p. 39).

The change in transportation behaviour is gradual and requires a socio-technical approach evident in a well-balanced mix of new technologies and investments in social capital (education and regulation, institutionally incorporated into society), accompanied by the implementation of the appropriate mobility and transportation system management measures. The changes are guided by the simultaneous employment of "communicative" (Fujii & Taniguchi, 2006) or "soft" measures (EPOMM, n.d.), and the constraints on (single-occupancy) car usage. This "carrot and stick" approach (Litman, 2003; Meyer, 1999) is still modern, even though it has been in use since the 1970s (Enoch, 2012, p. 20).

People would possibly consider changing their transportation-related behaviour if there were alternative (new, cleaner, smarter, better integrated, inclusive) solutions available. Mobility demand (travel needs and habits) has an evolving character – requiring increasingly convenient, fast, predictable, and more sustainable services (Van Audenhove et al., 2014). New urban mobility patterns call for a resource-efficient transportation system (European Commission, 2011), serving both mobility and accessibility (Jones, 2014). Individual choices are influenced by personal reasons (relocating, changing jobs, retirement), transportation service improvements (better schedules, fleet improvements), subjective changes in perception, and external factors (fuel price) as well (Urban Agenda for the EU Partnership for Urban Mobility, 2019c, p. 5). Mobility interventions include information, promotion, organisation, training, site-based, substitute travel, and supportive measures (Urban Agenda for the EU Partnership for Urban Mobility, 2019c, p. 19).

Individual mobility patterns are monitored through mobile phone data (e.g. (Wang et al., 2018) or social media content analysis (Serna et al., 2017). Activity-tracking is argued to stimulate more sustainable personal mobility by means of feedback (Bucher et al., 2019). Moreover, people respond well to promotional campaigns connecting mobility behaviour (walking, cycling, using PT) with emotions (EC Intelligent Energy Europe, the *Trendy Travel project*). Cultural factors also impact transportation behaviour (Cheba & Saniuk, 2016) and should be considered as part of the urban mobility sustainability evaluation (Macedo et al., 2017).

2.5. Mobility patterns of Croatia's citizens

Prior to this research, there were several studies focused on the transportation-related behaviour of Croatian citizens in the past five years. Some of the results indicate behaviour patterns that reflect on transportation sustainability and are important to consider in the context of this research:

- automobiles play the leading role in daily mobility and prospective changes to mobility are made difficult by the fact that "there is no alternative" available in many areas;

- rail transport in Croatia is not recognised as a form of either daily mobility or tourism-motivated travel (Mrnjavac & Slavić, 2018).
- Despite the high share of cars, PT and walking are a notable part of the modal split of Croatian citizens' daily mobility in 2018;
- action is needed to support bicycle traffic;
- a more competitive PT from the user perspective includes higher PT frequency, more affordable fares and better spatial coverage. There is a lack of online PT ticket purchasing systems, route planners, mobile apps, and other services information;
- the assessment of the quality of individual transportation subsystems in Croatia indicates the lack of quality improvements in all transportation modes (Slavić & Mrnjavac, 2019).
- Most respondents show a tendency to choose different modes of transportation in different circumstances/to perform different activities during the day, which indicates the presence of multimodality;
- residents of the capital city would choose alternative modes for everyday local travel (PT, walking or cycling) if Zagreb upgraded its transportation system to more pedestrian and bicycle-friendly surroundings, with improved and cheaper PT, and worked on creating short distance surroundings;
- although in the context of a hallmark event held in Zagreb, most residents argue in favour of improving the traffic management in Zagreb based on alternative mobility options (expansion of car-free zones in Zagreb, pedestrian zones in event venues, adjusting pedestrian areas of the city to the requirements of blind and disabled people, availability of alternative transportation means (bicycle taxis, electric scooter rental)), and PT upgrades (better PT organization, increased line frequency/more vehicles, more days of free transportation (outside weekends), more night lines) (Slavić & Horvat, 2020).

The existing research did not consider all available alternatives in urban mobility. It also neglected the aspects of user satisfaction, as well as the perception of importance when exploring the individual mobility patterns. Croatia's transportation system users were not previously profiled in relation to urban mobility to such extent. With the purpose of evaluating the current state of Croatian urban transportation systems this paper explores the mobility patterns, behaviour and attitudes of the surveyed urban residents more in depth.

3. RESEARCH METHODOLOGY

The *Theoretical Background* section suggests there are several determinants of urban transportation systems that indicate good mobility management and future-oriented user-centric approach. In evaluating the existing Croatian urban transportation systems, several research questions need to be addressed, primarily concerning the urban transportation systems' sustainability, or more precisely, these systems' functioning, efficiency, accessibility, multimodality and integration. The research started from the hypotheses that the Croatian urban transportation systems are suboptimally sustainable, which is evident from the mobility patterns and attitudes

of the surveyed urban residents. The Sustainable Mobility Project report (WBCSD, 2015) puts forward a set of 19 indicators, attributed to the dimensions of global environment, economic success, quality of life, and performance of a mobility system, in evaluating urban mobility and its impacts. The potential scope of such an approach has resulted in the implementation of the WBCSD (2015) survey for the purpose of analysing Croatian urban transportation systems in 2020 in this paper, making this paper a preliminary communication.

The research data was gathered based on a structured questionnaire, through online surveys (due to COVID-19) and by using *Goggle Forms* as an instrument. This research adopted the survey from the *Sustainable Urban Mobility Project 2.0* report (2015) by the *World Business Council for Sustainable Development* (with minor modifications – not using all the questions from the original, and adding 2 questions from the Special Eurobarometer 422a "Quality of Transport" (TNS Opinion & Social Network, 2014)) to further explore daily mobility patterns. The survey included 57 questions, distributed across 10 sections.

In line with the research scope and focus, the online survey was used to explore the mobility patterns and attitudes of Croatian citizens towards the urban transportation systems they use. The survey was translated into Croatian and was available online from March to June 2020. The respondents are aged 18 and over, residing in urban settlements or gravitating to them for functional or leisure reasons.

The survey was conducted with the help of the full- and part-time students of the Faculty of Tourism and Hospitality Management in Opatija, as voluntary participants in this research, trained and instructed on how to approach the research subjects and motivate their participation. The role of students was entirely an intermediary one, with the respondents personally filling out the online survey.

Representing the number of properly completed surveys, the sample size (N=2484) is considered substantial to make educated statements about the urban mobility demand in Croatia, with a certain probability. The method of research execution and the research design resulted in a convenience sample, partially even in a purposive sample.

Starting with the socio-economic context in relation to mobility behaviour, the questionnaire mostly dealt with traffic-related habits and daily patterns, as well as the respondents' opinion, attitudes and satisfaction with urban mobility aspects and available options. *Microsoft Excel* was used to check, filter and analyse the data. The analysis was approached primarily through descriptive statistics. Discussion on the research results recognizes the limitations of this research.

3.1. Research Limitations

Unlike the sample size, the sample type (convenience and, to a certain extent, a purposive sample) is somewhat restrictive in forming general conclusions. The conclusions can therefore be only indicative, but nevertheless offer valuable insight into Croatian urban mobility and the narrow body of existing knowledge.

The online survey did not include all questions from the original. Some questions (potentially less important in the context of this research) were intentionally rejected by the authors, thus hoping to reduce the time needed to complete the survey and

achieve a higher response rate. The authors do not consider this had any influence on the quality of the obtained data sets in relation to the scope of this research.

The authors recognize the fact that the descriptive analysis is only the foundation for more advanced analysis. Nevertheless, the idea for this paper was to serve as preliminary communication in one stage of more elaborate research.

Although the aim of convenience sampling was to achieve a better distribution of age, gender and region in the sample, the result was an uneven representation of the different groups of respondents. The socio-economic attributes reflect on mobility patterns, and the uneven representation of the sample groups limits the contribution of this research findings to the general knowledge on urban mobility.

Despite the fact that the survey included people from all (21) Croatian counties, the sample is unevenly distributed and the conclusions therefore do not evenly represent the current state of the national mobility systems. On the other hand, the most represented areas (Primorje-Gorski Kotar County (21.34%), the City of Zagreb (19.44%), Zagreb County (15.66%), Krapina-Zagorje County (8.53%), Karlovac County (6.64%) and Istria County (6.48%)) are also areas with some of the highest proportions of urban population and are therefore suitable to be taken into consideration.

4. RESEARCH RESULTS AND DISCUSSION

In this section, research results are presented at the level of the total sample and, separately, for the group of respondents that declared feeling limited by the transportation system in their daily mobility, and are then put into context with the existing body of knowledge on urban mobility, its modes and user behaviour.

4.1. Research Results

The results of surveying the sampled population (N=2484) of residents of urban settlements in Croatia, older than 18, are subdivided into sections, corresponding to the sets of questions represented in the survey.

4.1.1. Respondents' Profile

The majority of respondents are female (66.22%). The most represented age group is the younger adult group (18 to 29), accounting for 74.19% of respondents, while the rest of the respondents are largely of labor active age. Approximately one in four respondents has a faculty degree (23.47%), and the majority hold secondary school qualifications (75%). A large share of respondents are employed (43.60%) either full time or part time, and are followed in share by students (41.67%) and the unemployed (9.34%).

The greatest share of households that the respondents live in are made up of three (30.31%) or two adults (29.97%) and with no children (59.38%) or with one child under the age of 18 (26.41%). There is a tendency of owning more than one vehicle per household. The respondents indicate owning mostly 2 cars (38.77%), no

motorcycles (78.54%) and 2 bicycles (27.70%). In addition, only approximately 5% of the respondents own other transportation means (e-scooters, delivery vehicles, maritime means). Aside a driving license that allows operating a car (75.44%), most respondents have a scooter/moped driving license (12.84%). However, almost a quarter of the respondents have no driving license (24.24%).

There are some vulnerable groups of transportation system users represented in the sample, although in a small share. These are people older than 60 (1.49%), pregnant woman (0.97%) and people of impaired mobility (0.85%).

4.1.2. The Respondents' Everyday Mobility Patterns

In total, 52.90% respondents live directly in the city (in the urban center) and another 29.35% commute to it regularly. Others (16.55%) visit from time to time. Interestingly, approximately 1 out of 3 respondents feels restricted in terms of daily mobility in relation to the available transportation system offering and the transportation system limitations.

Commuting accounts for most of the weekly trips (with 73.35% of the respondents traveling 5 or more times per week to work or study), typically starting from 7 to 8 a.m. (33.98%), and being 15-30 minute (36.27%) or 1-5 kilometer (32.37%) long trips. Leisure ordinarily generates 2 or 3 weekly trips (39.78%), with more emphasis on shorter trips.

The principle mode of daily travel (Table 1) is a car (53,.4%), commonly used "always" (34.6%) or "most of the time" (19.40%). The two other valid choices are PT (23.11%) and walking (16.95%), although in a smaller proportion.

Table 11. The preferred modes for everyday urban mobility

Transportation mode	No. of respondents	Modal share
Car	1320	53,14%
PT	604	24,32%
Walking	421	16,95%
Bicycle	109	4,39%
Motorcycle	17	0,68%
None	12	0,48%
Total	2484	100%

Source: author contribution

Among the intermodal options the combination of walking and PT has the primary role in daily mobility for 23.47%. The intermodal options that involve bicycle travel (bicycle and PT, and bicycle and walking) are avoided by around eight in ten people (Table 2).

Table 12. The principal commute mode choice

	Always	Most of the time	About half of the time	Less than half of the time	Never
Car	34,66%	19,40%	12,96%	16,55%	16,43%
Motorcycle	1,17%	1,25%	5,48%	5,31%	86,80%
PT	16,14%	16,47%	13,49%	18,84%	35,06%
Ferry	1,21%	0,64%	4,91%	6,08%	86,80%
Bike	2,82%	5,43%	13,04%	16,14%	62,56%
Walking	13,65%	18,12%	19,93%	19,77%	28,54%
Car & PT combination	6,88%	7,05%	10,91%	16,51%	58,66%
Bike & PT combination	1,97%	2,25%	6,36%	6,32%	83,09%
Walk & PT combination	12,84%	10,63%	13,45%	14,81%	48,27%
Bike & Walk combination	3,18%	3,90%	7,81%	10,43%	74,68%

Source: author contribution

The respondents justify their mode preferences mainly with "travel speed" (52.46%), but also with "contents and facilities' availability" (24.1%), "convenience" (22.83%) and "lack of alternatives" (17.47%). In relation to the preferred daily travel mode, *car drivers* rationalize their preferences with "travel speed" (77.42%) and "convenience" (59.92%). *PT users* are either faced with "lack of alternatives" (39.90%), or choose PT due to "contents and facilities' availability" (33.45%) and "convenience" (31.71%). *Cyclists* explain their choice with "speed" (51.38%) and "ecology" (36.61%), while *pedestrians* consider their mobility mode to be "convenient" (41.33%) and well supported by "contents and facilities' availability" (28.50%).

4.1.2.1. Public Transportation

Buses and trams are the types of PT most often used by the respondents. People who avoid using PT regularly attribute this to PT's lack of frequency and flexibility ("PT schedule does not fit the individuals' needs", 24.36%), lack of comfort (22.10%) and questionable "cleanliness" (21.42%). It is therefore not surprising that for more than eight out of ten respondents "the punctuality" of PT and "the real time information (on routes, timetable and delays)" are ranked as the most important aspects of PT (Table 3). These are followed by "personal feeling of safety" and "vehicle safety", and "the fare".

"The punctuality" and "cleanliness" of PT are actually the aspects of PT the respondents are mostly dissatisfied with (the total of "extremely dissatisfied" and "dissatisfied" is 38.93%, for both aspects). Interestingly, PT cleanliness was also ranked satisfying by a higher share of respondents (the total of "satisfying" and "extremely satisfying" is 40.86%), immediately after "punctuality" (42.43%)

4.1.2.2. Car Sharing

A large share (93%) of the respondents "never" or "almost never" use a car-sharing scheme. The reason for such behavior is found in the absence of car-sharing schemes in some cities (23.07%), followed by "the complexity of car-sharing (e.g. registration, use, billing)" – 10.91%. Interestingly, 57% of the respondents were not able to explain the reasons behind such behavior.

The "cost of using the system" and "the cleanliness of the cars" are ranked as the most important features of car-sharing, while "easiness to use the car-sharing system" and "the quality of the cars" are considered the least important (see Table 3).

Table 13. The aspects of different modes ranked according to their importance

AM	PUBLIC TRANSPORTATION	AM	CAR SHARING SYSTEM	AM	PUBLIC BIKE SCHEME
4,45	The punctuality of PT	3,69	Cost of the system	3,76	Cost of the system
4,38	Real time information (routes, timetable, delays)	3,66	Cleanliness of the cars	3,67	Number and locations of the bike renting stations
4,34	Feeling secure using PT	3,66	Quality of customer service	3,65	Number of bikes available
4,30	Safe vehicles	3,52	Number and locations of the parking spaces	3,64	Quality of the bikes
4,30	Cleanliness	3,51	Number of cars available	3,63	Easiness to use the shared bike system
4,19	Fare	3,51	Easiness to use the shared car system	3,62	Customer service
4,10	Easy ticketing	3,50	Quality of the cars		
4,06	Accessibility of the PT vehicles, stops and stations				
3,92	Available (personal) space				
3,85	Comfort of PT stops (seats, lighting, shelter)				
3,74	Comfort (seats, noise, temperature)				
3,72	Availability of seats				

Source: author contribution

4.1.2.3. Bike Sharing

Less than 5% of the sample uses public bike services (daily, weekly, or monthly). Around half have no specific reason, while the rest attribute their behavior to "the lack of public bike schemes" (23.40%), "too few renting stations or the inconvenient

locations of renting stations" (13.79%), and "the number of bikes available" (9.27%) or "the complexity of use" (9.02%).

"The cost of using the system" is ranked as the most important aspect of public bikes, followed by "the number and locations of the bike renting stations" and "the number of bikes available" (Table 3).

4.1.2.4. Personal Vehicles

Of the total number of respondents with a driving license, almost one in ten "(almost) never" drives or drives "a few times a year". Most are inclined to make "daily" car trips (61.7%). Different aspects of car transportation are evaluated as almost equally important by the drivers, with "traffic safety" and "feeling of personal safety" being slightly more important than the other aspects (Table 4).

"Traffic congestion" (65.86%), "the lack of parking spaces" (60.67%), "too expensive parking fares" (43.52%) and "the poor road infrastructure" (23.51%) are considered the key issues of driving in the city.

Table 14. The aspects of different modes ranked according to their importance

AM	DRIVING (a car/a motorcycle)	AM	INTERMODAL TRIPS
4,45	Traffic safety	3,78	Integration of time schedules
4,44	Feeling of personal safety	3,74	Availability/location of connecting points
4,29	Signposting for road users	3,72	Frequency of connecting PT
4,27	Quantity and location of parking spaces	3,71	Distance to walk from mode to mode
4,26	Quality of road infrastructure	3,70	Integration of ticketing system of PT
4,23	Lighting of urban streets for driving at night	3,69	Quality of trip information and route guidance
4,23	Parking tariffs	3,67	Signposting to find connecting mode
4,18	Traffic circulation		
4,17	Accessibility of parking spaces by foot		
4,10	Real time traffic information		

Source: author contribution

4.1.2.5. Intermodal Trips

Intermodal trips are part of the mobility patterns of some respondents. Namely, 13.77% of the respondents are intermodal travelers ("daily" or "a few times a week"); 8.62%, "a few times a month"; and 14.05%, "a few times a year". Still, the majority of surveyed people (63.57%) favor a single mode of travel. Each of the intermodality aspects is considered "important" or "extremely important" by more than 60% of the respondents. The intermodal trip aspects ranked as the most important are "the integration of time schedules of PT", "availability/the location of connecting points" and "frequency of connecting PT" (Table 4).

The reasons for not making intermodal trips more often are found in "physical difficulty to make the connections because of distance or steps" (26.01%), "lack of

information about the other modes to be able to effectively make connections" (25.97%) and lack of PT schedule integration ("the waiting time between the two modes is too long") (18.24%).

Those actually using intermodal transportation options (n=905) find "distances to walk from mode to mode" and "the availability/the location of connecting points" the most satisfactory. The same people are the least satisfied with "the integration of time schedules of different modes (bus, tram, train)" and "the number of available alternatives to make the journey".

4.1.2.6. Using Smart Phones and Mobility Apps

Only a small proportion (2.98%) of the sampled population has no smartphone. The three out of four of those who use it are aware of smartphone supported mobility tools. Nevertheless, the majority (61.48%) does not use those tools. Those who do, prefer *Google Maps* (58.20%) and PT apps (for ticket purchasing or schedules) (14.69%). Other mobility tools (either web-based or apps) are not as used by the respondents (e.g. *Waze*, *Uber*, *Moovit*, and *Bolt* are used by approximately 5% or less).

4.1.2.7. Active Mobility Modes

Only 4.55% of the total sample ***cycles*** "daily". Most of the respondents cycle "(almost) never" (35.63%) or "a few times a year" (33.57%). The justification for the observed behavior is found in the shortcomings of the existing infrastructure ("too few dedicated lanes for cycling", 32.43%; "the roads are of poor quality for cycling", 31.76%; and "the bike lanes are of poor quality", 24%). Predictably, the sampled population ranked the aspects of safety as the most important factors of cycling in the city (Table 5). "Traffic safety" in general is perceived "extremely important" and "important" by a total of 81.04%, followed closely by "the feeling of personal safety" (78.54%), "the way other road users treat cyclists when on mixed use roads" (78.02%) and the "lighting of biking facilities and urban streets at night" (76.21%), as well as "the availability of dedicated lanes for cycling" (76.53%).

Table 15. The aspects of different modes ranked according to their importance

AM	CYCLING IN THE CITY	AM	WALKING IN THE CITY
4,25	Traffic safety	4,34	Feeling of personal safety
4,15	Feeling of personal safety	4,25	Lighting of sidewalks and urban streets at night
4,12	The way other road users treat cyclists when on mixed use roads	4,17	Availability of sidewalks in the city
4,09	Lighting of biking facilities and urban streets at night	3,94	Availability of car free streets in the city
4,07	Availability of dedicated lanes for biking	3,90	Width of sidewalks in the city
4,01	Security of the bicycle parking facilities	3,82	Signposting of directions and destinations for walking
3,97	Quality of road surface of the bike lanes	3,81	Quality of the pavement of the sidewalks in the city

3,97	Width of bike lanes		
3,92	Signposting of directions and destinations for biking		
3,75	Number and the location of bicycle parking facilities in the city		

Source: author contribution

Less than 10% of the respondents declare ***walking*** "(almost) never" or "a few times a year", mostly because of the lacking pedestrian infrastructure ("too few sidewalks", 19.63%; "too few car free areas", 15.08%) or the infrastructure's characteristics ("the sidewalks are poorly lit", 15%; "the sidewalks are of poor quality", 11.96%). Nevertheless, most respondents walk daily (52.21%). The sampled population finds "the feeling of personal safety" a primary aspect of walking in the city (the total of "extremely important" and "important" is 83.82%), followed by the infrastructural features related to safety, like "the lighting of sidewalks and urban streets at night" (82.41%) (Table 5).

4.1.2.8. Delivery Services

For most, online shopping and home deliveries are used only "a few times a year" (46.65%). Still, many (33.37%) recognize the advantages of delivery services and have their packages delivered "a few times a month". Regarding the most important aspects of delivery services, "the availability of such service" is more important than "the price", while "the price" is ranked ahead of "flexible delivery times" and "the ability to have the package delivered to an alternative address".

4.1.3. The Patterns of Respondents Feeling Restricted in Daily Mobility

Approximately a third of respondents feel restricted in terms of daily mobility in relation to the available transportation system offering and/or the transportation system limitations. They predominately live directly in the city (80.70%), in households made up of three adults, own one car and one or two bicycles, and study (47.37%) or work in the city (44.30%). Curiously, almost none (<1%) of the vulnerable group representatives (pregnant women, mobility impaired people, and the over-60s) reported feeling limited in daily mobility due to urban system determinants. There is a slightly larger share of people with no driving license (34.21%), and there are fewer respondents holding a car driving license in relation to the total sample.

The proportion of weekly travel to work or school and leisure purposes is consistent with the total sample, as are the commute distances covered. However, the duration of all trips is notably longer (rather than 15-30 minute-trips, it takes 30-60 minutes for around half of the respondents). This could be partly due to a higher proportion of PT trips on an everyday basis (40.35%). This group also has a slightly higher share of bicycle trips and a smaller share of car commutes. Also, this group tends to use car-sharing services more often, probably due to the services' availability. Interestingly, although there is also a higher availability of public bicycles, this does not affect their higher usage. People who consider they are limited in everyday mobility tend to choose intermodality more often (30.70% in comparison with 13.77%

on the general sample level, daily and weekly). They appreciate "availability/location of connecting points" more than other aspects of such travel. "Speed" and "convenience" are the main reasons behind expressed preferences in modal choices.

Active mobility modes (cycling and walking) are extremely low in share. No one cycles, and only 4.63% recognize walking as part of their daily mobility. Since the respondents expressed no specific reason for such inactive behavior, the substantially smaller share of active modes and its potential negative effects should be examined by mobility management authorities. More than half of the respondents (54.05%) that reported feeling limited in daily travel use smartphone apps to deal with daily mobility needs, unlike the 38.52% at the total sample level.

4.2. Discussion

With more than 80% of respondents living directly in the city or commuting to it daily, one could argue that the challenges of growing urbanization (Ritchie & Roser, 2019; United Nations, 2018; Van Audenhove et al., 2014) are present also in Croatia. Consistent with such a conclusion is the fact that around one third of the respondents said they felt restricted in terms of daily mobility in relation to the transportation system offering and its limitations. However, this group of mobility system users is more inclined to use PT, car-sharing and intermodal options more often than the general sample.

Car-dominated daily mobility patterns of Croatian citizens are consistent with some previous research (Mrnjavac & Slavić 2018; Slavić & Mrnjavac 2019; TNS Opinion & Social Network 2014). Nevertheless, the modal split reported in this paper is different than previous ones, reported in 2014, 2016, and 2018.

Those inclined to using their cars daily (61.7%), rationalize this with perceived travel speed and convenience, although this is not necessarily true. The car has been "the victim of its own success" while the number of cars on the roads often leads to congestions and results in a lower level of mobility than expected (European Cyclists' Federation, 2009). Four out of 10 PT users are faced with a lack of alternatives. Among the active mobility modes, cyclists explain their choice with "speed" (51.38%) and "ecology" (36.61%), while pedestrians consider their mobility mode primarily as "convenient" (41.33%).

Bicycles are the most effective mobility mode for short and medium distances (Küster, 2018), and almost half of all car trips in EU cities are shorter than 5 km (European Commission, 2020a). The fact that the combination of different modes with bicycles is never an option for more than 80% of respondents potentially indicates using less sustainable options for a large proportion of shorter trips, the ones that could be done by bicycle.

Improving intermodal options would require "seamless integrated transport chains" - door-to-door information and ticketing, smooth interchanges at PT stations, integration of regional transport with the "last mile urban trip" (European Commission, 2017b, p. 24). The integration of bicycles and PT could provide seamless transitions, more attractive prices and travel times in comparison with cars, and a healthier mobility option (European Cyclists' Federation, n.d.; Urban Agenda for the EU Partnership for Urban Mobility, 2020). The current research results

indicate that the most important aspects of making intermodal trips are the "integration of time schedules of different modes of PT", "availability/location of connecting points", and the "frequency of connecting PT". Schedule integration is the intermodality aspect the Croatian citizens are the least satisfied with and one of the principle reasons for avoiding using intermodal options.

Public transport is key in an accessible and sustainable urban mobility system and cities in Europe need to continue investing in reliable and affordable PT (Urban Agenda for the EU Partnership for Urban Mobility, 2020). Doubling the market share of PT would help fight the negative effects of urban travel and create pleasant life environments (Van Audenhove et al., 2014). Apparent from this research, PT in Croatian cities is mostly road transportation (buses). PT punctuality and real time information (on routes, timetable and delays) are considered the most important aspects of PT.

For senior citizens, people with disabilities or other reduced mobility groups, PT is on many occasions the only option for independent travel (European Commission, 2017b, p. 20) and its quality reflects the social inclusion of and accessibility for people of reduced mobility (European Commission, 2017a, p. 6). Around 80 million people in the EU have a disability, preventing their full social participation (ibid. 8). Since people of impaired mobility are represented in a small share in this research, discussing the general behavior and patterns of those mobility systems' users has little or no ground, although interestingly, almost none (<1%) of the vulnerable group representatives in this research reported feeling limited in daily mobility due to mobility system aspects.

Alternative and micro-mobility options are not fully recognized as part of urban mobility systems in Croatia, despite their potential the European Commission (2019) is aware of. Some mobility users are prepared to sacrifice individual mobility preferences in pursuing the sustainability cause, leading to the rapid penetration of new mobility services like car sharing and bike sharing (Van Audenhove et al., 2014). Shared mobility options and potential are under-utilized in Croatian cities, and this is mostly attributed to the lack of sharing systems.

Car sharing is a more sustainable alternative to private car use (European Commission, 2017a, p. 25), but only around 7% of the respondents use it. Bike sharing makes commuting more efficient, increases connectivity in a city, and enhances productivity in the urban economy (European Cyclists' Federation, 2018). However, bike-sharing schemes are never used by 95.5% of the respondents in this research.

Unlike the urban car drivers, the largest share of all respondents does not consider safety-related issues the main issues of road traffic. An average respondent is focused on urban mobility issues that result from car-dominance in the modal split (congestion, lack of parking, parking cost, poor road infrastructure). All these negative effects of road traffic require a balanced approach, consistent with reducing car trips while at the same time providing alternatives and/or more efficient use of existing infrastructure (EPOMM). In other words, the situation calls for the implementation of MM or TDM measures.

Active mobility modes are clean, efficient modes particularly suited for short distance urban trips (European Commission, 2017a). There is a notable lack of comparable statistics on walking and cycling in the EU (European Commission &

COWI, 2017) and, therefore, a lack of key performance indicators for active modes. In Croatia, there are no comprehensive travel surveys conducted at the national level. More than half of the respondents in this research reported walking "daily" and for around a quarter, "the combination of walking and PT" is the first daily mobility choice. Unlike walking, only around 5% of Croatian citizens ride a bicycle "daily", and around 60% do it "never" or only "a few times a year". People feeling limited by the mobility system in terms of daily mobility use the active modes even less frequently. For both cycling and walking, the infrastructure is ranked high on the list of active mode important aspects.

Of the surveyed citizens, 97% own a smartphone, and 75% are aware of available smartphone mobility tools. More than half do not use those tools, while the rest use the most basic ones like the *Google maps*. Also, the majority of respondents do not use home deliveries, which could reduce the burden on the urban mobility system.

In relation to the research scope and research questions, after analysing the data and discussing the findings, the research results indicate that urban mobility systems in Croatia:

- could be more sustainable and integrate (more) environmentally-friendly modes like micro-mobility options and other alternatives to car trips. For example, public bike schemes are unavailable in many cities, and cycling and walking infrastructure is perceived as lacking or of poor quality.
- do not function optimally. Citizens often report a lack of alternatives for everyday trips, and justify not using some alternatives to cars with the fact that they do not exist in many cities.
- are limited in multimodality, missing intermodal connections and offering narrow intermodal options.
- need further integration. There are almost no intermodal trips that include bicycles and all respondents want seamless transportation chains (joint ticketing, integration of time schedules, walkable distance from mode to mode, and availability/the location of connecting points). There is also a substantial share of single-mode travel, mostly among car drivers.
- are mostly safe. Being ranked among the most important aspects of different modes, safety satisfaction indicates that the system is actually safe for persons and travel means.
- limit daily mobility due to system features. Respondents whose commute is longer than the recorded average of 15-30 minutes, and the majority of respondents who travel by PT daily, feel restricted. Car orientation results in many negative impacts on personal mobility; pedestrian and bicycle infrastructure are lacking; and sharing systems are not present in many, if not most, cities.
- lack "soft" measures, primarily (real-time) communication to users, evident from the fact that only 38.52% of the total sample uses smartphone apps, of which 58.20% uses Google maps, as well as the fact that only 14.65% of respondents use PT apps to deal with daily mobility needs.
- are under-efficient, and unable to meet the demands of their users.

Based on the available research the authors argue that with regard to the maturity and sustainability of the modal split, urban mobility systems in Croatian cities should either undergo fundamental redesign of the mobility system to become more focused on PT and sustainability (*Rethink the system*), or fully integrate the travel value chain to foster seamless, multimodal mobility (*Network the system*). Some cities could also focus on *establishing a sustainable mobility core*, able to satisfy short-term demand (Van Audenhove et al., 2014, p. 7).

In addressing the mobility system issues determined by this research, Croatian cities would need to start from a vision of sustainable (future) urban mobility (potentially in the form of a SUMP (Rupprecht Consult, 2019), which only a few Croatian cities have). Based on the established behaviour of the surveyed respondents, towns and cities in Croatia need to focus more on providing more mobility options (choices) in the form of PT, shared mobility, as well as other alternatives and micro-mobility modes. A combination of quality improvements and service upgrades, allowing for private financing or public-private cooperation, together with urban mobility demand management measures, would help to enhance the sustainability of Croatian urban mobility systems.

5. CONCLUSION

There is no perfect mobility system nor is there a single solution for all urban problems caused by growing population, urbanization, and non-adequate authority responses. Although a nation of relatively small urban settlements, Croatia should learn from the global transportation-related negative trends and empower cities, as well as encourage its citizens, to initiate a behavioural change on an everyday basis as far as travel is concerned.

As argued in this paper, mobility in urban areas facilitates growth and employment (European Commission, 2019a) and enables cities to act as hubs of knowledge, economic activity, innovation and welfare (European Commission, 2017a, p. 6). It is therefore inevitable that mobility systems and services will need to be upgraded while at the same time reducing the negative outputs of transportation (congestion, accidents and pollution).

This paper implemented a *Sustainable Mobility Project* survey in assessing the mobility patterns of Croatian citizens and the features of existing urban mobility systems. The paper identifies both the potential and the shortcomings of existing mobility systems, reflected in behaviour and attitudes towards mobility among users of those systems. While the quality of urban life greatly depends on an efficient mobility system, the current state implies the need for (more) investments in more sustainable and better mobility options, which are expected to contribute to the cities' competitiveness, productivity, attractiveness and overall quality of life (Arcadis & Cebr, 2017). New and innovative urban mobility solutions require strong involvement of both public and private capital (Urban Agenda for the EU Partnership for Urban Mobility, 2019).

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