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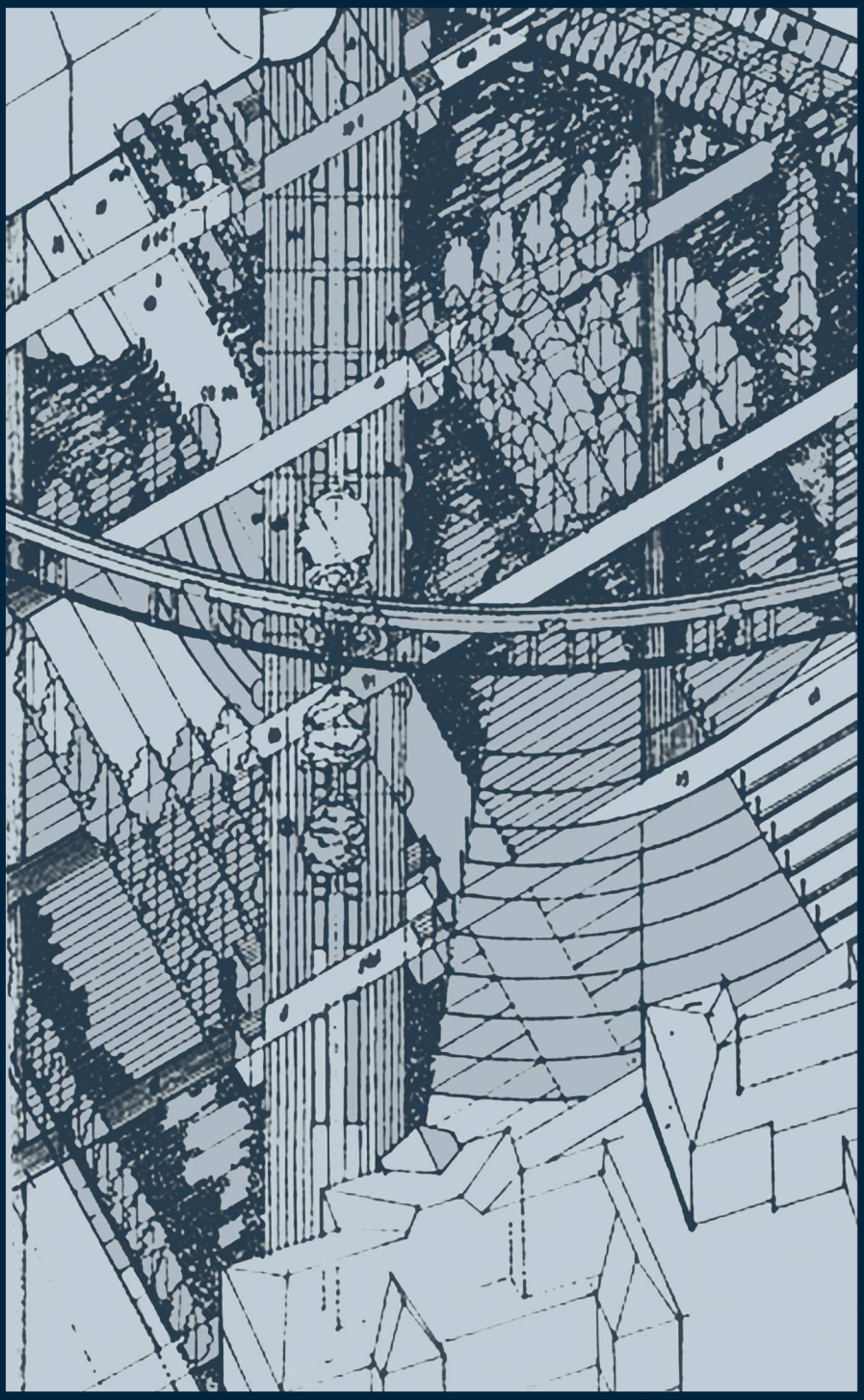

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SCOPE AND AIMS

The review is concerned with a multi-disciplinary approach to spatial, regional and urban planning and architecture, as well as with various aspects of land use, including housing, environment and related themes and topics. It attempts to contribute to better theoretical understanding of a new spatial development processes and to improve the practice in the field.

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EDITORIAL

To move…what is the source and what is the destination of our journey? With limited movements continuing due to the Covid-19 pandemic, are we left to dream of unfulfilled journeys by roaming with our fingertips over the world map? Something reassuring which gives me a source for optimism is that even though we may be prevented from moving physically, we can move in a cognitive sense. This is supported by the fact that a large number of quality papers have been submitted to the Spatium journal in the past 6 months. One possible reason for this is that researchers have dedicated more time to contemplation and to the completion and dissemination of their research to a broad readership. Has that been the glory of a solitary process? Again, from the point of view of a moderate optimist, I'd say that it is a combination of two factors – of being both on one's own and of doing things together. Or, to quote the famous novelist Haruki Murakami:

"In this world, there are things you can only do alone, and things you can only do with somebody else. It's important to combine the two in just the right amount."

– Haruki Murkami, After dark

So, the "right aggregate" that we present in this issue of Spatium is a product of research being conducted in various parts of the world: from Finland to Serbia and Greece, as well as from Croatia, Montenegro, Eastern Europe and Russia, to Indonesia and Australia. The contributions, which are all the product of intensive scientific research, are dominantly represented by original scientific papers. As with previous issues of Spatium, a number of topics are covered by issue No. 44. They include: planning policy reforms and their selective application; managing the polycentralization of metropolitan areas within the post-socialist urban context; synergistic solutions for accomplishing a flood resilient city; potential insolation and solar duration analysed through high spatial resolution grids; statistical research on the perceptions of students regarding walking distances to/from bus stops in relation to their campus; scrutinizing the design of public spaces and its evolution from one context to another; the development and spread of the city block system with the emerging Art Nouveau style; and the relations between characteristic human needs and their fulfilment in a living space.

We hope that our Open Journal System helps the authors to have their papers evaluated in a timely manner in the double-blind reviewing process. My wish is to thank all of the reviewers, as well as the technical, copy design and layout editors who contributed to this issue of Spatium for their collaborative work and support during the whole process towards publishing the papers.

Jasna Petrić
Editor-in-Chief

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DIFFERENTIAL APPLICATION OF PLANNING POLICY DEEPENING THE INTRACITY DIVIDE: THE CASE OF GREATER SYDNEY, NSW, AUSTRALIA

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Urban planning policies in New South Wales (NSW), Australia are continuously being reformed, in order to make them more economic development friendly. These reforms are concerned with making development approvals easier and faster. The implementation of these reforms and their outcomes in Greater Sydney, NSW, vary according to the local socio-economic conditions. The affluent communities in Greater Sydney are very concerned about these reforms and actively resist their application in their areas. They are successful in avoiding the application of reformed urban planning policies. However, the lower socio-economic parts of Greater Sydney in the outer areas are not able to engage with these urban policy issues. The reformed urban policies are fully applied in the poorer areas, often resulting in excessive and poor-quality urban development. Past research on urban planning policy development, application and outcomes in Sydney has not investigated selective planning policy application and its differential outcomes. This paper analyses the selective application of some recent urban planning policy reforms as they relate to socio-economic division in Greater Sydney. The research argues that the selective application of urban planning policy in Greater Sydney is reinforcing socio-economic division there.

***Key words*: Divided city; inequality; Sydney; urban planning policy.**

INTRODUCTION

The Australian urban planning system has been shifting over the years in response to economic growth, urban development and suburban expansion (Searle and Bunker, 2010). Urban ascendency in Australia is different from other countries, as the state governments are unswervingly responsible for urban planning, major infrastructure and service delivery (Davidson and Gleeson, 2018). The majority of people live in urban areas, and speedy urbanisation brings opportunities as well as social difficulties (Davidson and Arman, 2014). Consequently, the social order has become more complicated in terms of population growth pressures and increasing community responsiveness (McFarland, 2011). Moreover, Forster (2006) argues that regardless of economic growth, the levels of social polarisation, exclusion, residential differentiation and access to urban opportunities have transformed into a complex system and have certainly deteriorated.

The social order of Australia is heading for increased socio-economic inequality (Berry, 2014; Pusey and Wilson, 2003; Cox, 2011). Uneven outcomes of the discriminatory application of planning policy are significant contributors to the ongoing inequality. International literature points out that the dominant class of socio-political groups uses planning in order to facilitate and retain control in a society (Fainstein and Fainstein, 1979). At the root of neoliberalism, the driving force behind planning reforms is exploitation, inequality, and domination (Brenner and Theodore, 2002; Harvey, 2003). Australian market-driven policy practices have shaped divisions in cities (Freestone and Hamnett, 2017), and unequal access to opportunities created by urban amenities favours the needs of some groups above those of others (Whitelegg, 1997).

In Australia, state governments (including that of NSW) have complete constitutional authority over urban planning. Local

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government is not recognised in the Australian constitution. Local planning is entirely governed by state legislation, policies, regulations and instruments. In Australia, local councils or municipalities have very few functions. They provide basic services such as stormwater drainage, waste collection, and they take care of local libraries and parks. They have some say in local urban planning matters, but it is the state government that sets planning frameworks, provides strategic planning direction and approves all local plans. On average, local councils are very small too: in Greater Sydney alone there are 33 local councils. All urban planning beyond the very local area, such as metropolitan planning, is directly done by the state. Larger development projects are also directly approved by the state. The EPAA (Environmental Planning and Assessment Act) 1979 is the main planning legislation in NSW. The New South Wales (NSW) urban planning system has been reformed over the last two decades through the inspiration of fast-paced urban development and economic growth. The state government has also enacted a wide variety of urban policies and programmes to administer the planning and development of Greater Sydney. Searle and Bunker (2010) define these features of the urban planning system as the 'Australian style of metropolitan planning' (p. 163).

The NSW state's urban planning arrangements are complex (Brunner and Glasson, 2015) and in a constant state of reform (Piracha, 2015). Khan *et al.* (2015) assert that numerous reforms were initiated in the state planning systems over recent years. The NSW planning reforms aim to centralise, speed up and privatise the planning systems (Piracha, 2010). The urban planning reforms in Australian states are informed by various theoretical political approaches (Legacy *et al.*, 2014). Neoliberalist economic efficiency is a strong motivation underpinning the reforms in NSW (Gleeson, 2017; Piracha, 2010, 2015; Rogers, 2016; Troy, 2018).

The EPAA 1979 was enacted to increase community engagement in urban planning. However, the Act has been reformed several times in the past two decades by the state to limit local participation (MacDonald, 2018; Piracha, 2015). NSW urban planning has been criticised for not ensuring desirable community engagement (Gurran, 2007). In fact, in the process of planning reforms inspired by the neoliberal framework, community engagement has become compromised (Schatz and Rogers, 2016). The reduced scope for community engagement has not affected all parts in Greater Sydney uniformly, since in some (affluent) parts of Greater Sydney, there has been significant community engagement in the form of community opposition (Gurran and Phibbs, 2013). There is a difference in the implementation and outcomes of the urban planning policy reforms between the affluent and poor parts of Greater Sydney.

The application of planning policy in Greater Sydney is unequal, and there is an increasing gap between the higher and lower socio-economic parts of the city. Even when urban policy is applied uniformly across Greater Sydney, the outcomes are not the same everywhere (Piracha, 2016). The disparity in planning policy application could be partially explained by vigorous local opposition in affluent areas. A typical case of opposition would be very high resistance to the provision of any additional dwellings. On the other hand, on occasions when the state is under pressure from local communities, it exempts affluent areas from specific urban planning policies. Recent examples of this in Greater Sydney are the council amalgamations and medium-density housing code policies.

The NSW state government initiated local council or municipality mergers in 2016-2017 to increase economic efficiency. The council mergers, or amalgamations, were implemented in the less affluent parts of Greater Sydney, where local councils were already very large. Due to resistance, including challenges from influential local communities, the state abandoned its planned council amalgamations in the higher socio-economic areas. After partial application of the amalgamation policy in Greater Sydney, there are very large councils in the west and south-west and small councils in the north and the east. It is much easier to influence local politicians and local councils in a small council setting. Selective application of the medium-density housing policy in 2018 (Saulwick, 2018a) is another recent example, whereby the affluent councils have secured delays in policy implementation. The policy facilitates subdivision of existing houses into two or more, thus increasing the dwelling density. There is a need to explore the unequal application of urban policies and the exercise of power, through which the participatory process is managed and articulated towards particular outcomes that may lead to further division in the community.

Though NSW urban planning policy has been acknowledged as an essential topic for research, there is a shortage of contemporary studies on the selective application of urban planning policy and its consequences. Various urban scholars have highlighted how power relations and differently positioned actors operate in cities (Bengt and Per Gunnar, 2017). Numerous Australian studies (Brunner and Glasson, 2015; Bunker *et al.*, 2017; Gleeson, 2017; Gurran and Phibbs, 2013; MacDonald, 2015; Piracha, 2010, 2015; Rogers, 2016; Ruming *et al.*, 2014; Ryan and Woods, 2015; Troy, 2018) have investigated the urban planning policy process, outcomes, and community participation in planning, using various theoretical constructs such as neoliberalism, managerialism, post-political theory, and agonism. None of that research identifies or acknowledges that planning policy reform and the selective application of the same are creating cities within a city in Greater Sydney.

In addition, Australian planning literature seems not to fully acknowledge that community engagement in or community resistance (NIMBY- Not-In-My-Back-Yard) to urban planning policy can be a vehicle for self-interest. Affluent areas are successful in resisting planning policies and exerting a strong influence over the NSW planning system (Urban Taskforce, 2018). The literature often assumes communities to be benign, noble, and altruistic. In reality, however, community opposition can seek selective urban policy application in affluent parts of Greater Sydney (Piracha, 2016). This study aims to analyse discrimination in the application of urban policy and its consequences in Greater Sydney. It also aims to examine and resolve the following questions: how are current urban planning policies being applied differentially in Greater Sydney? How is the differential application of

policy producing uneven outcomes? And how is the formal planning process creating gaps between various parts of Greater Sydney?

The following sections describe the theoretical framework, outline the research methodology, explain the Greater Sydney divide, and analyse the impact of NSW urban planning policies and practices on the socio-economic divide in Greater Sydney.

THEORETICAL CONSTRUCT

Planning is often treated as an upholder of public interest. However, some scholars argue that planning represents the interest of capitalism (Allmendinger, 2009). Allmendinger (2009), citing Hay (1999), stated four broad Marxist conceptions of the state, that it: exists as an expression of the repressive might of the ruling class; is the instrument of the ruling class for enforcing the class structure; provides necessary capitalists interventions; and forms class domination in a society (p. 84). Thus, the unequal situation and antagonistic relations in cities are not imposed, but rather they are the outcome of capitalistic policy (Harvey, 1973). The state tries to convince the subordinate classes by claiming that the policy progression is for the interest of the state (Allmendinger, 2009).

Brenner and Theodore (2002) argue that cities have become the dominant political and ideological vanguards through which the supremacy of neoliberalism is being cemented. Thus, neoliberalism indicates new forms of political-economic ascendency grounded in the extension of market interactions (Larner, 2006). Neoliberal strands of the theory are well-traversed for planning in Sydney, NSW (Piracha, 2010, 2015; Rogers, 2016), in fact, Randolph and Tice (2017) argue that in the background of the Sydney divisions is neoliberal political hegemony.

Foucault (1980) also tackled the concept of hegemony arguing that urban and regional planning has a broader notion of power and domination in modern society. His argument is also supported by Richardson (1996), who contends that the influence of any policy depends on the wider undercurrents of power. Foucault (1990) argued that power is not imposed on individuals, but instead, individuals exercise it over themselves and others through widely accepted forms of organised behaviour. Consequently, power is utilised to serve the interest of vested groups, thereby enabling inequalities (Richardson, 1996).

Bent Flyvbjerg, taking the Foucauldian perspective on the role of power relations in planning, argued that power defines the physical, economic, ecological and social reality (Allmendinger, 2009). Social power is unequally distributed, and the dominant social, political and economic structures determine who shouts and who listens (Allmendinger, 2009).

The community opposition to planning and development has typically been referred to as the process of NIMBYism. NIMBY is defined as anti-development community opposition to the introduction of public facilities in urban areas (Barlow, 1995). Dear (1992), citing the 1989 Daniel Yankelovich Group national survey, outlined the NIMBY advocates as high-salaried, educated, skilled and homeowners. Petrova (2016) labelled NIMBY resistance as the egoism, ignorance, and craziness of some residents interested in defending their greensward and placing private benefits at the forefront instead of public benefits.

Dear (1992) also argued that undue opposition inspires selective application of urban policies and regression of the urban community into a new feudalistic society. In the same vein, this research argues that the NIMBY opposition of affluent communities in Greater Sydney pushes exclusion from the application of planning policies. The intention of these policies is to provide more dwellings and related infrastructure to accommodate the growing population. Affluent NIMBY communities typically do not want more people to come in even when their inner-city suburbs are the most suited for a population and density increase. The above-discussed theoretical concepts of power, neoliberalism and NIMBYism can help in an analysis of the planning policy application differences in Greater Sydney.

METHODOLOGY

To critically explore NSW urban policy application and its consequences, a qualitative research method was applied in this study. Qualitative research data characteristically rely on opinions, concepts, and understandings (Bolderston, 2012). Qualitative data can be collected in many ways, such as orally (primarily interview-based), textually (creative, documentary and landscape) and observationally (Winchester and Rofe, 2010). This article conducted a textual study or content analysis of the relevant documents. Content analysis allows for compelling explorations of the research questions by studying documents (Downe-Wamboldt, 1992). The study analysed textual materials from leading Australian newspapers, books and journal articles, reports, websites and other materials from NSW government sources.

This research also extracted data from the Australian Bureau of Statistics (ABS), in order to produce evidence on the spatial discrepancy in the demographics and socio-economics of the Greater Sydney areas. The ArcGIS mapping software was used to visualise and present the demographics and socio-economic statistics.

This research argues that along with the existing socio-economic divide, Greater Sydney's urban policy practices are also spatially divided, which is adding to the socio-economic divide between parts of Greater Sydney. It emphasises the need to search for unbiased planning practices and appropriate community engagement mechanisms for the disadvantaged communities in Greater Sydney.

THE GREATER SYDNEY DIVIDE

There is a significant spatial division in Greater Sydney in terms of socio-economic opportunities and urban amenities. Residents of Sydney experience place-based disadvantage (Pawson and Herath, 2015), and the growing suburban inequality has been a concern (Forster, 2004). The division of Sydney has been characterised by an oblique line extending from northwest to southeast. The line separates the well-off and well-served north and east from the less well-off south-west and west. Piracha (2016) has characterised this as the

NIMBY Land and Bogan[2]-Land divide. Figure 1 depicts the imaginary line that separates the two parts. Buxton *et al*. (2012) have described the two parts typical of Australian cities: higher income, educated, professionally employed residents are in affluent areas of the inner and middle-ring suburbs, and the lower-income and less-educated residents are in the outer suburbs. Bangura and Lee (2019) demonstrate that the affluent northern and eastern regions of Greater Sydney have higher income growth and lower unemployment, whereas the less affluent western region has lower annual income growth and higher unemployment.

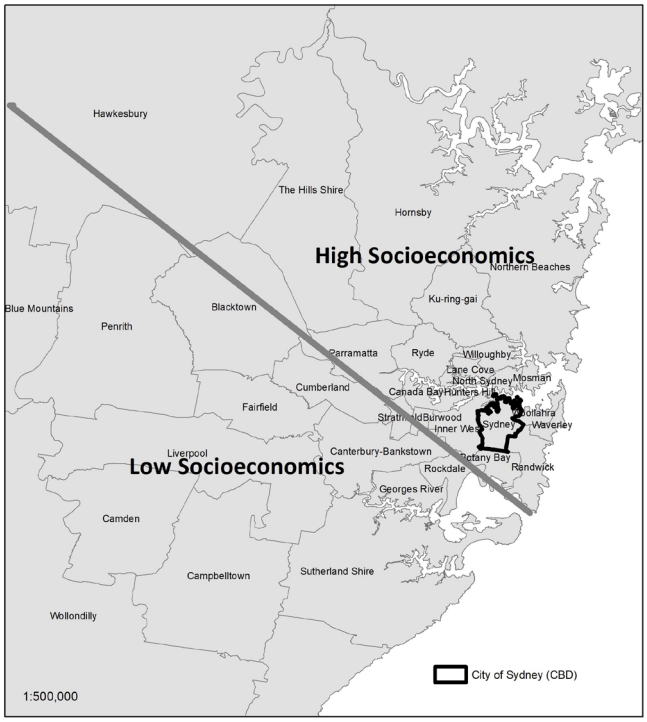

Figure 1. The line dividing Greater Sydney into higher and lower socio-economic areas
(Source: Drawn by authors using ABS (Australian Bureau of Statistics) digital local government boundaries)

The aforementioned dividing line separating the two parts of Sydney has also been characterised as the "Latte Line" (Saulwick, 2016) and the "Goat Cheese line" (Chrysanthos and Ding, 2017). Almost every conceivable social, economic, cultural, political and ecological indicator would confirm the existence of this have and have-not divide.

The managerial and professional jobs, indeed, employment in general, is concentrated above the line (Lee *et al.*, 2018), in addition to which the health outcomes are much worse below the line (AURIN, 2019), the rental stress is much higher below the line (Lee *et al.*, 2018), and the HSC (Higher School Certificate) results of the schools above the line are much better (Ting and Bagshaw, 2016). The canopy cover and rainfall above the line is much higher. The summers are cooler, and winters are warmer above the line (GSC, 2018). The density is much higher below the line and has been growing much faster (Committee for Sydney, 2018; GSC, 2018), with the less advantaged areas in Greater Sydney accommodating the bulk of additional housing (GSC, 2018), too. The list of indicators demonstrating the divide is as long as one's imagination; however, only housing affordability will be explained in detail.

A study by Koziol (2018) has pointed to Sydney as the most unaffordable city in Australia. Figure 2 shows the housing price divide in Sydney. Property prices in advantaged areas are growing faster than in the have-not disadvantaged areas of Greater Sydney. This is because the supply of new dwellings is very low in affluent areas and the amenities and job opportunities are very high (GSC, 2018). The residents of lower-income areas are increasingly shut out from areas with good access to jobs, transport, and services (Troy *et al.*, 2017). According to Irvine (2019), if the government spent $7.3 billion to provide 125,000 affordable dwellings closer to the jobs and transport (in affluent areas), it would return $19.8 billion to the economy.

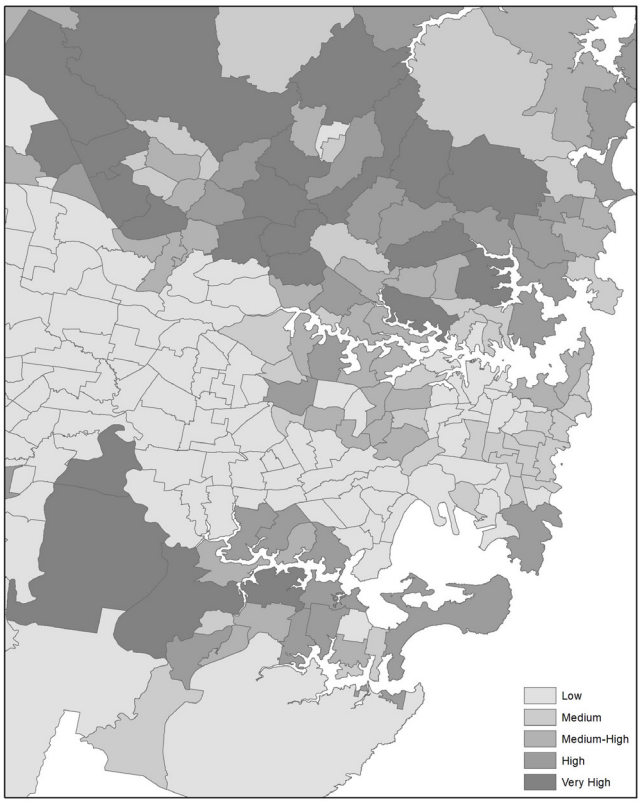

Figure 2. Sydney Metropolitan housing prices
(Source: Drawn by authors with ABS Census 2016 data at SA2 (Statistical Area 2) level)

In NSW, many lower-income residents are being displaced from the neighbourhoods in the east and north of Sydney (Troy *et al.*, 2017). A four-bedroom house in the west is lower in price than a studio flat in the east of Sydney (Gladstone and Hanna, 2018). Lee *et al.* (2018) have analysed the spatial distribution of average rent across Greater Sydney (Figure 3).

By the early 2000s, lower-income households had effectively been displaced from inner-city locations, mainly through urban renewal (Randolph, 2004). Cities are facing new

[2] An uncouth or unsophisticated person regarded as being of low social status. Source: https://en.oxforddictionaries.com/definition/bogan

ghettoisation, as the affluent residents are keeping themselves exclusive (Harvey, 2003). Southwest and western parts of Greater Sydney are also transforming into lower socio-economic ethnic ghettos because of the state government planning policy divergence (Pike, 2018). The planning policy is pushing people to live far away from the affluent suburbs that are closer to jobs. Lee *et al*. (2018) argue that living in the west is associated with longer commute times. Gleeson and Randolph (2002) termed this as 'transport poverty', which is a widespread problem in western and south-western Sydney. In addition, the white-collar jobs are positioned in the north and east of the city, while the blue-collar jobs are concentrated in the south and west (Lee *et al*., 2018).

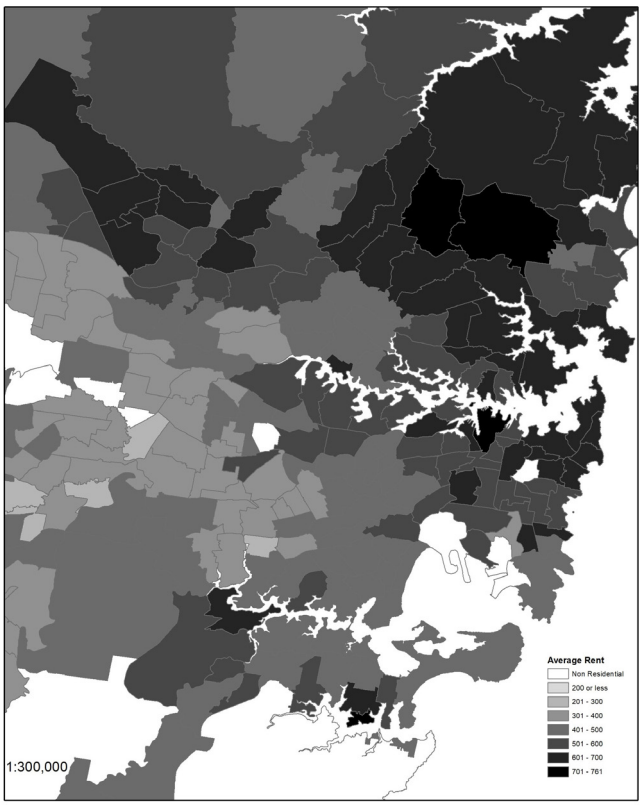

Figure 3. Greater Sydney average rent
(Source: Drawn by authors using ABS 2016 census data at SA2 (Statistical Area 2) level)

The NSW State Government proposed council amalgamations in 2015. It aimed to reduce the number of councils from a total of 43 to 25 in Greater Sydney and 152 to 112 in the whole of NSW. By September 2016, the NSW government had created 20 newly merged councils in NSW and eight of them were in Greater Sydney. The councils that were merged in Greater Sydney were mostly in the western and south-western lower socio-economic areas. Five proposed mergers in Greater Sydney were first postponed due to community resistance and then abandoned by the state government on 27 July 2017 (Nicholls and Saulwick, 2017). The state did not persist with the remaining mergers involving 14 eastern and northern affluent councils due to resident antagonism.

The NSW State government introduced the Low Rise Medium Density Housing Code (Housing Code) on 06 April 2018 to ease the housing shortages and to increase affordable housing (NSW DP&E, 2018b). The new Housing Code was executed in 82 councils of NSW on 06 July 2018; however, the Housing Code was deferred until 1 July 2019 for 50 local councils due to the local opposition (NSW DP&E, 2018a). In June 2019, the NSW Department of Planning formed an expert panel to revise the Housing Code for implementation by the end of 2019. In September 2019, the Department of Planning further deferred the application of the Housing Code until July 2020, and the exemption of councils from the code continued till July 2020. In response to the review panel advice, slight adjustments were completed on 01 July 2020 to the Housing Code, which includes changing the name to 'Low Rise Housing Diversity Code'. Finally, from 01 July 2020, the housing Code was applied to all local government areas in NSW.

The postponement of the council amalgamation and Housing Code in some councils was due to robust community opposition. Affluent and smaller councils in the advantaged east and north of Greater Sydney were able to resist policy reform implementation, whereas the bigger councils in the poor south-west could not resist it (Farid Uddin, 2018), thus leading to planning policy differentiation in Greater Sydney.

DISCUSSION AND ANALYSIS

Cities around the world have experienced a great deal of change in their sociodemographic geographies for decades. These transformations also have complex effects on the neighbourhoods within metropolitan areas (Foote and Walter, 2017). Historically, a divided city is indeed nothing new (Marcuse, 1993). Forster (1999), in his analysis of the evolution of Australian cities, cited the example of Britain where the city authorities did not impose minimum standards of facilities in working-class areas, and certain places were left neglected. Pike *et al*. (2016) explained the uneven development and diverging social conditions and opportunities in cities in the UK. Gleeson (2017) argued that the recent urban policy practices of Australia are 'econometric characteristics of contemporary neoliberal urbanism (p. 206)'. New directions in planning and policy-making emphasise relationships between rational processes and the normative 'chaos' they are surrounded by (D'Aoust and Lemaire, 1994) that leaves behind 'rationalistic' policy-making (Richardson, 1996). In a neoliberal urban system, hidden forces of power, politics, and the market, are responsible for bringing about urban changes (Farid Uddin, 2019).

Sydney, like other cities, has been experiencing socio-economic changes for a long time (Stilwell and Hardwick, 1973). Urban expansion of Sydney in the disadvantaged west and the south-west has large swaths of low-income housing, rapid densification and poor quality development (Forster, 1999; Piracha, 2016). Sydney is somewhat different from other cities, though, as its urban planning policies seem to be reinforcing the socio-economic divide through somewhat unusual mechanisms.

The following sub-sections analyse some recent planning policies as examples of unequal urban policy application in NSW and differential outcomes for the have and have-not parts of Greater Sydney.

Council amalgamation

In the process of council amalgamation reform, the residents of the eastern and northern councils exercised consolidated NIMBY opposition against the proposed amalgamation plans and utilised all forms of engagement opportunity to halt the reform (Farid Uddin, 2018). However, the less affluent councils and their residents failed to actively engage and oppose the mergers. For example, lower socio-economic status Canterbury City Council, with a 34 square kilometre area and a population of 145,100 (2011), generated 14 submissions related to the council's merger proposal, but was merged, whereas higher socio-economic status Hunter's Hill Council, that avoided merger, with 6 a square kilometre area and population of 13,900 (2011) generated 23 submissions on the amalgamation proposal to the Independent Pricing and Regulatory Tribunal (IPART) of NSW (IPART, 2015). In addition to community activism and NIMBYism, the affluent councils of Botany Bay, Hunters Hill, Ku-ring-gai, Mosman, North Sydney and Strathfield also started legal action against the reform. The state government abandoned merger proposals for some councils. The councils that avoided mergers were Burwood, City of Canada Bay and Strathfield Municipal councils; Hornsby Shire and Ku-ring-gai councils; Hunter's Hill, Lane Cove and City of Ryde councils; Mosman Municipal, North Sydney and Willoughby City councils; and Randwick City, Waverley and Woollahra Municipal councils (NSW Government, 2018). All councils that avoided mergers were from the northern and eastern affluent parts of Sydney (Figure 4).

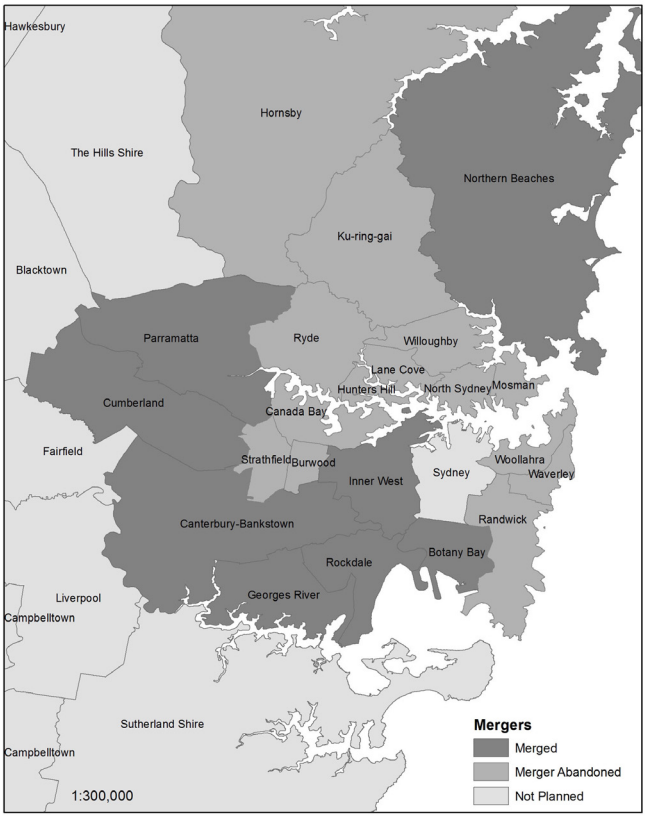

Figure 4. The Greater Sydney council mergers (Source: Drawn by the authors using ABS standard local councils digital boundaries)

The state government's failure to fully implement amalgamations has caused enormous inconsistencies in the size of the councils in Greater Sydney. For example, the forced amalgamation of lower socio-economic south-western Canterbury and Bankstown councils created a mega-council of 360,000 people, and by the abandonment of amalgamation policy for affluent areas, the Hunters Hill Council persisted with 14,000 people (Saulwick, 2017). Piracha asserted in Pike (2018) that 'small councils mean small neighbourhood/community groups can easily pressurise or influence councils to stymie any proposals to increase density.'

Low Rise Medium Density Housing Code

The Low Rise Medium Density Housing Code allows the subdivision of individual houses into more dwellings to increase the housing supply; however, the new Housing Code was not implemented uniformly in all councils. There was some strong resistance from affluent communities in the application of the policy, who argued it would lead to over-development. They argued it would cause traffic problems and destroy the local character. The Housing Code deferment started for the affluent Ryde Council. The reason was pressure from the local government and politicians (Saulwick, 2018b). Other affluent Sydney councils emulated the Ryde tactic so that they could also avoid NSW planning policies related to medium density development (Urban Taskforce, 2018).

The Housing Code was applied in some councils while others were granted an exemption from the new rules. The state government permitted the inner and middle-ring suburbs and their councils to resist the urban planning policy for more medium-density housing provision. It thus hindered people who strive to live closer to jobs and amenities (Gittins, 2018). This is another example of where urban planning reform is contributing to division and inequality in Sydney.

The exercise of power

The areas that exercise power to exclude themselves from the urban planning reforms are the highly advantaged areas located mainly in the north and east of Greater Sydney (Figure 5). More than 90% of the residents in the dark grey areas in the map fall in the top three deciles of the ABS Index of Relative Socio-economic Advantage and Disadvantage - IRSAD.

An example of the power of local activism in affluent areas is the case of the redevelopment of a club building. The local community in the affluent eastern Sydney suburb of Bronte successfully prevented the increase in height and bulk of a proposed redevelopment of a mixed-use building in an area that is close to the Sydney CBD. The residents utilised their socio-political power and used social media to effectively lobby, involving media, politicians and other influential actors in their opposition to the redevelopment (Williamson and Ruming, 2015). In the Bronte RSL case, the residents' group submitted 1,100 objections against this relatively small redevelopment (Property Observer, 2017). Thus, the plan to provide extra units and space was unsuccessful in the light of active community involvement and opposition. The amount of community engagement in

Bronte is very significant, considering its low population of 6,733 (2016 Census). In the case of the Ryde Low-Rise Medium Density Housing Code deferment, socio-political power was the dominant force in obtaining an exemption from the policy reform (Saulwick, 2018b). In the case of the merger of Auburn, Holroyd and Parramatta councils to form the new City of Parramatta and Cumberland Councils, the policy reforms were applied in order for political elites to gain party-political benefits (Munro, 2017).

Figure 5. The most advantaged areas of Greater Sydney (Source: Drawn by authors using ABS SEIFA-IRSAD (Socio-Economic Indexes for Areas - Relative Socio-economic Advantage and Disadvantage) data)

Uneven policy – uneven outcomes

Richardson (1996), citing Bachrach and Baratz (1962), contended that power not only relates to decision making, but also extends to the creation or reinforcement of social and political values and institutional practices in agenda-setting, to protect the interests of particular groups. An example of such an exercise of power is the redrawing of Parramatta Council's boundaries. In 2016, local council amalgamation policy merged Auburn and Holroyd councils, which have a lower socio-economic position, with the poorer southern parts of Parramatta, to form the new Cumberland Council. On the other hand, Parramatta Council received the affluent Olympic Park area from Auburn council. Other affluent areas to the north were also added to Parramatta. These areas were extracted from the Hills Shire and Hornsby councils. The whole exercise led to a thorough separation of communities of lower and higher socio-economic levels in Cumberland and Parramatta Councils, respectively.

The newly formed Cumberland council has a low base rate and no trade or industry (Kembrey, 2015; Munro, 2017). The newly amalgamated Parramatta Council to the north has a much higher socio-economic level. This redrawing of the local councils has consolidated a much stronger conservative vote bank for state and national constituencies in Parramatta.

Rise of exceptionalism

Exemption from the planning rules has promoted exceptionalism in Greater Sydney. Exempting affluent parts of the city from medium-density planning policy has set a precedence and has opened the floodgates of affluent councils demanding exemptions from various long-existing state planning policies. The affluent Northern Beaches Council (June 2018) requested an exemption from the Affordable Rental Housing and Housing for Seniors or People with Disability NSW state planning policies (Northern Beaches Council, 2018). Similarly, North Sydney Council (July 2018) asked for an exemption from planning proposals from the private sector until July 2020 (Urban Taskforce, 2018), and Lane Cove Council (February 2019) requested a change in the planning rules to permanently prohibit the operation of the housing code in its R2 low-density zone (Lane Cove Council, 2019). Affluent areas are now capable of manipulating and avoiding urban planning policies (Urban Taskforce, 2018).

NIMBYism of the affluent

Numerous studies have confirmed that people of higher social and economic class are more likely to become active in neighbourhood engagement with the urban planning process, whereas those on lower-income have not always had their community interests represented (Greene and Pick, 2012). Unsatisfactory and spatially differentiated community participation in implementing urban planning policy has led to unpopular changes (Thorpe and Hart, 2013). The ability to participate in planning activity is different in different regions of Sydney. The residents of affluent areas are very vocal and active in matters related to planning. According to Piracha (2016), "among the NSW planning apparatus, the community engagement philosophy for Sydney seems to be 'NIMBY land' is too hard," and if you "dump" excessive development on BOGAN land (a euphemism for have-nots) "they will not even notice it."

The Sydney affluent neighbourhoods' NIMBY residents, who vigorously opposed council amalgamation, are also actively opposing the new Housing Code. They also claim a suitable place for new housing in Sydney's west (Bull, 2019). In any case, it is easy to add a new development in western Sydney due to the lack of community engagement in planning issues. Bull (2019) also points out that:

> "Lack of density and population growth in posh Sydney is now becoming an established fact that is hiding in plain sight in the Greater Sydney Commission's[3] metropolitan policies".

NIMBYism enables resistance to the implementation of urban change in a neighbourhood (Esaiasson, 2014). NIMBY

[3] Greater Sydney Commission is the agency responsible for allocating additional dwellings and population to different parts of Sydney Metropolitan.

resistance is positioned against social equity as it is the opposition of a small number of people. It is argued that community opposition is higher in the affluent areas (Davison *et al*., 2013). By means of the active opposition, NIMBY areas allow less new housing development than those in the west and south-west of Greater Sydney (Taylor and Gladstone, 2018). That results in the adverse outcome of the high density and low amenity ethnic ghettoisation of the south-west and west, and low density and high amenity leafy east and north of Greater Sydney.

The above-discussed council amalgamation reform and housing code policy analysis, as well as the examples cited, show that the state advances the interests and aspirations of the social elites. Affluent groups have social and political control on planning policies, and consequently, they are becoming more privileged in the urban system. On the other hand, certain groups can effectively be excluded from the negotiating and bargaining game by institutional barriers or by the maneuvers of other groups (Harvey, 1973). The shaping of any policy depends on the inclusive, dynamic forces of power (Richardson, 1996). Indeed, state-led reinforcement of urban renewal has become prototypical of neoliberal urban planning policies that support the preferences of an explicit class of people (Hochstenbach and Musterd, 2018).

CONCLUSION

Inequality in Greater Sydney is growing; consequently, Sydney's standing as a global city is declining (Vogel *et al*., 2020). In Greater Sydney, the urban planning system and its reforms are reinforcing the city division by exempting well-off areas from planning rules, in particular, those related to accommodating additional dwellings or population. The NIMBY groups of active, vocal and connected residents are avoiding the application of urban policy (Williamson and Ruming, 2015). The unequal and selective application of urban policies leads to a more divided city. After the implementation of the amalgamation plan, a western Sydney council moved all of its waste facilities into the private sector and closed down some of its community amenities (Sansom, 2016). The development of new dwellings is greater in disadvantaged western Sydney than in the affluent inner west, eastern, lower north or northern suburbs (Saulwick and Wade, 2016). Due to the lower availability of housing closer to jobs and urban amenities, housing prices and rent are exclusively higher in the affluent suburbs compared to Sydney's western suburbs (Gladstone and Hanna, 2018). Lee *et al*. (2018) argue for the expansion of affordable housing in the north, and provision of more white-collar jobs in the west and south, as well as improved public transport connectivity in Greater Sydney, in order to reduce the have and have-not division. This paper has shone a light on the contribution of urban policy changes to Greater Sydney's inequalities. It has described how community resistance in affluent parts of the city is leading to the unequal application of urban policies and thus deepening the urban division. The scenario of the Greater Sydney situation is not necessarily exclusive; this sort of inequity in applying urban policy might also exist in others parts of the world. This paper can serve as a template to study the urban policy divisions in other cities.

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HOW DO PASSENGER AND TRIP ATTRIBUTES AFFECT WALKING DISTANCES TO BUS PUBLIC TRANSPORT STOPS? EVIDENCE FROM UNIVERSITY STUDENTS IN GREECE

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The spatial arrangement of public transport systems seriously affects their ridership and thus the fulfillment of sustainable transport goals. This paper examines the case of students at Aristotle University of Thessaloniki and investigates their perceptions regarding a critical spatial attribute of public transport, that is, the walking distance they have to cover to/from bus stops when they commute by bus to their campus. A questionnaire survey was conducted to collect relevant data from 300 students and a set of statistical inference methods was employed to explore whether student-specific attributes relate to the walking distances they consider to be acceptable. Empirical findings highlighted weak relationships between user/trip specific attributes with regard to students, and their walking distance preferences for the bus public transport services they use. The majority of students consider that the maximum acceptable walking distance can be higher than the standard value of 400 meters. Moreover, they would be willing to walk more than they currently do in order to reach a bus stop with higher service frequencies to their campus. The study concept and findings could assist in delivering a more successful spatial design of bus public transport systems which serve university campuses. A more sparsely positioned network of bus stops would provide better opportunities for personal physical activity but should not yield increased total travel times; and they should incorporate local user expectations. Public transport agencies could also benefit from achieving higher service speeds which, in turn, would reduce energy consumption and operating costs.

Key words: **public transport; bus stop; walking distance; spatial design; university students.**

INTRODUCTION

Public transport has been widely recognized as one of the key elements for the sustainable development of modern societies. Worldwide, bus travel remains the most patronized mode of public transport, illustrated by its 63% share of all public transport journeys that were made in 2015 (UITP, 2017). One of the fundamental aspects of designing bus public transport systems is their spatial arrangement. It pertains to the arrangement of bus networks in urban space with respect to the relationships between bus stations, bus routes and the urban environment (Wang *et al*., 2020). Node proximity (distance to the nearest public transport stop/station), network density (number of public transport stops within a 10 min walking distance) and network centrality (mean distance to network nodes by a specific transport mode) are the basic metrics that have been proposed to characterize the spatial configuration of urban transport networks (Gil, 2014). In this respect, bus stop spacing constitutes a critical spatial feature of bus public transport networks, which defines the node proximity and network density. Bus stop spacing also has a major impact on overall travel time, since it affects walking distance to/from stops, along with travel speed, and therefore demand (TCRP, 1996). From the passengers' point of view, walking distance

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to/from bus stops has been recognized as an important factor affecting public transport availability (CEN/TC 320, 2001) because, in fact, public transport is an option for a trip only when the stops are within a reasonable walking distance from one's origin and destination points (TCRP, 2013). Although typical values already exist for deciding such walking distances (FHWA, 2008; UN, 2019 etc.), in practice, the maximum number of meters that a person will walk to a bus stop depends on individual, trip and area specific characteristics such as age, gender, income, trip purpose, pedestrian environment, terrain, and so on. (Alshalalfah and Shalaby, 2007; El-Geneidy *et al*., 2010; TCRP, 2013 etc.). Therefore, the examination of local conditions and population attributes is a prerequisite for designing public transport networks, since unsuitable spatial design decisions may result in inappropriate walking distances and social inequalities, thus preventing certain communities or categories of citizens from using public transport.

This paper examines the perceptions of a certain population group, i.e. university students, regarding the walking distances to/from the bus stops they use for commuting to their campus. University students are generally considered as a relatively young age group with low car ownership rates, who are mostly captive users of public transport (Kobus *et al.*, 2015; Zhou, 2012). This study considers university students at Aristotle University of Thessaloniki (AUTh) in Thessaloniki, Greece. The objectives of this study are to:

- Indicate the walking distance preferences of university students, in terms of the maximum walking distance to/from bus stops which they consider acceptable; and
- Investigate whether certain user-specific attributes (such as gender, income, place of residence) and trip-specific attributes (such as total travel time, trip frequency, trip mode) are related to student walking distance preferences.

The remainder of the paper is organized as follows. The next section reviews the importance of spatial arrangement in public transport networks, as well as typical values and factors which influence the walking distance to/from bus stops. Section regarding the Case Study describes the study area and the data collection process. The data we analyzed, and the corresponding methods, are presented in the Data and analysis section. The results are reported and discussed in section: Results and discussion, and the conclusions are given in the last section.

LITERATURE REVIEW

The spatial arrangement of bus public transport systems greatly impacts mobility patterns, land use development, and the modal split, and thus the environmental footprint of transport systems. In general, the aim of optimizing the design of public transport networks is to fulfil passenger expectations, and it therefore refers to minimizing travel and operating costs, travel time, and necessary transfers, as well as to increasing catchment areas in order to achieve higher ridership figures (Farahani *et al*., 2013). Daganzo (2010) and Badia *et al*. (2014) studied bus public transport network models which would fit the topological and urban transport properties of cities and minimize public transport users' and agencies' costs, while supporting a modal shift from the private automobile. Amiripour *et al*. (2015) demonstrated that the enhancement of bus network designs with genetic algorithm-based methodologies can incorporate experience-based suggestions and reduce the number of transfers required. In terms of urban development, Wang *et al*. (2015) provided strong evidence regarding the positive association between the number of bus stops within walking distance (300m –1500 m) of a property and that property's sale price in Cardiff, UK. Similar findings were also highlighted in the case of Xiamen, China, where the most accessible properties by bus (in terms of distance from bus stops and travel time) were valued comparatively higher (Yang *et al*., 2019). Route spacing, stop spacing and route operating headway have been key variables for determining and assessing the properties of bus public transport networks in past studies (Wang *et al.*, 2020).

With regard to stop spacing, according to the United Nations agenda, convenient access to a bus/low-capacity transport system is achieved when residing within 500 meters' walking distance from a bus stop (UN, 2019). Among public transport practitioners, planners and researchers, a maximum walking distance of 400 meters to reach a bus stop is generally considered as comfortable for all people (Daniels and Mulley, 2013; El-Geneidy *et al*., 2010; Gutiérrez *et al*., 2011; Hess, 2009; Kraft, 2016; Murray and Wu, 2003; Murray *et al*., 1998; TCRP, 2013 etc.). However, empirical findings often prove that this standard underestimates the actual willingness of public transport passengers to walk (Alshalalfah and Shalaby, 2007; Burke and Brown, 2007; El-Geneidy *et al*., 2010; Kramar *et al*., 2015). This happens because, in practice, the maximum distance that people will walk to public transport stops/stations varies depending on the situation (TCRP, 2013). First, passengers seek to minimize their travel time and therefore the duration and distance of the walking segment of their trips (Agrawal *et al*., 2008; Murray, 2003; Pavlyuk, 2015). Secondly, user-, trip- and area-specific characteristics are factors which may also influence the length of the acceptable walking distance. Past research results, however, do not always agree with regard to the list of these factors and the nature of their influence. More specifically, Alshalalfah and Shalaby (2007) studied whether travel and personal characteristics are related to walk access distances to rail and road public transport stops/stations in Toronto, Canada. According to their results, the trip purpose, trip length, age and gender of public transport users do not have a significant relationship with walking distances to/from stops/stations. However, they found that these walking distances are positively associated with household car ownership rates and bus service frequencies. El-Geneidy *et al*. (2010) analyzed more than 37,000 public transport trips in the Montreal metropolitan region, Canada, and observed walking distances to/from bus stops which exceeded the rule of thumb of 400 meters. They used regression modeling techniques to indicate that, inter alia, household car ownership rates, work trips, rail public transport modes, income, students, male travelers and bus service frequencies are positively correlated with walking distances, while the number of transfers, age and return-to-home trips are associated with comparatively shorter walking distances. Jiang *et al*. (2012) highlighted the

importance of environment features related to walkability (e.g. safety, comfort, enjoyment etc.) in the walking distances observed for passengers using the bus rapid transit system in Jinan, China. In the same study, trip and trip makers' characteristics, such as occupation, gender, age, car ownership and trip purpose did not significantly affect the walk access distances. Lemoine *et al*. (2016) explained that users of the bus rapid transit system in Bogota, Colombia, regardless of their socioeconomic status and gender, are willing to travel longer walking distances (more than 500 m) to reach the system's stops due to its higher travel speed and quality of service. Wang and Cao (2017) examined the effects of built environment factors on the length of the walking distance covered by public transport passengers in the egress stage of their trips in the Minneapolis-Saint Paul metropolitan area, USA. They employed regression analysis methods and showed that job density, number of stops, land-use mix and intersection density may affect walking distances differently, depending on whether the locations under examination are within or outside downtown areas. More recently, Ragaini et al. (2020) studied the relationship between individual (personal and trip) characteristics and the walking distances to bus stops in Tasmania, Australia using a sample of 944 adults. They discovered that those who walked to more distant bus stops were associated with comparatively greater levels of personal physical activity. Tao *et al.* (2020) analyzed relevant data from the Minneapolis-Saint Paul metropolitan area, USA, and emphasized the importance of spatial attributes, such as population density, job density and intersection density over the traditional socioeconomic and trip attributes, for predicting walking distances to public transport stops.

CASE STUDY

In this paper, the study population consists of the AUTh students who, more or less frequently, commute by public transport buses to the AUTh campus in Thessaloniki, Greece. Thessaloniki is the second biggest city in Greece, with 973,997 residents in its functional urban area (Eurostat, 2020). The city is heavily urbanized, with a relatively high population density of 16,505.4 inhabitants per km^2 (ELSTAT, 2020).

The AUTh campus covers an area of about 33.4 hectares. It is located in a central location of Thessaloniki's functional urban area (Figure 1). Two main arterial roads surround the campus on its north and south sides which enable the campus to be connected with all of Thessaloniki's districts. Use of the land adjacent to the campus pertains to recreational, commercial and residential activities. The AUTh campus includes nine (9) university faculties, with a total of 60,000 enrolled students, making Thessaloniki host to one of the highest proportions of university students in Europe, i.e., 151 university students per 1,000 inhabitants (Eurostat, 2020).

The main travel modes for daily trips in Thessaloniki are: car (41.3%), motorcycle (11.0%), public transport (33.7%), taxi (3.0%), bicycle (1.7%) and walking (9.2%) (MoT, 2019). Public transport services in Thessaloniki are currently provided only by buses, and although during the recent economic crisis period public transport ridership has been increased, the overall quality of services and infrastructure

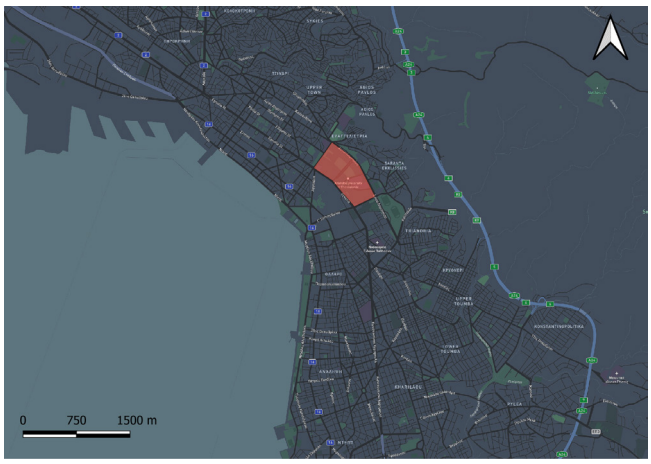

Figure 1. Location of AUTH Campus in Thessaloniki's functional urban area. Map data © Mapbox © OpenStreetMap (Source: Mapbox, 2020)

still needs improvement (Papagiannakis and Vitopoulou, 2015; Verani *et al*., 2015). There are 13 fixed bus lines which offer direct or indirect connections between the AUTh campus and all districts within Thessaloniki's functional urban area. Table 1 presents their service characteristics and classifies them into three categories: (a) main urban lines that provide high frequency connections between the primary transport hubs in the city through main arterial roads, (b) basic urban lines that provide medium frequency connections between the western or eastern urban districts of Thessaloniki and a main transport hub or terminal located in the city center, and (c) suburban lines that are bus feeder services between Thessaloniki's suburbs and a main transport hub or terminal in the city center (Georgiadis *et al*., 2014). Overall, these 13 lines account for approximately 30% of the total annual public transport ridership figures in Thessaloniki (Toskas *et al*., 2013). Their corresponding bus stops, which serve AUTh campus, are presented in Figure 2. Figure 2 shows that these bus stops are located in all main and secondary streets that border the AUTh campus and are well distributed amongst the university faculties. The average bus stop spacing is approximately 250 meters south of the campus and 350 meters north of the campus.

To meet the study objectives, a questionnaire survey was designed and performed through face-to-face interviews with AUTh students. The survey was conducted in October 2015 during the fall semester period. A total of 300 valid interviews were completed.

To ensure a representative sample of responses, a stratified sampling procedure was followed. The required sample of 300 students was obtained from nine (9) strata, in accordance with the AUTh faculties. The size of each stratum was determined by its student population share in AUTh's total student body. This sampling procedure was adopted because while bus stops are common for all students, the walking distances to their faculties may differ. The interviews were based on a structured questionnaire that had three (3) parts. The first part included questions on the personal attributes of the survey participants, such as their age, gender, income and place of residence. In the second

part, students were asked about their travel preferences when commuting to/from AUTh. In order to quantify their travel experiences, respondents provided a detailed report on the duration of their public transport trips by bus and distance walked to/from AUTh. In the third part, students shared their opinions on the walking distance to/from bus stops which they consider as acceptable, along with their views on the existing spatial arrangement of bus stops that serve the AUTh campus. The survey questions and results are presented in the following section.

the minimum basic gross salary being 683 euros at the national level (2015 figures) (ELSTAT, 2020). Almost all the respondents were undergraduate students. All categories with regard to place of residence and year of study were represented satisfactorily in the answers that were finally collected. Only a small percentage of students were frequent private car users. The majority of students selected bus as the most frequent travel mode to commute to AUTh. Walking also had an important modal share. This modal split reconfirms past survey findings for the AUTh campus

Table 1. Service features of the bus lines for the AUTh campus (Source: UTOT, 2020)

Line No	Service frequency (min.)		Mean length of line (km)	Bus size	Line Category
	Peak period	Off-peak			
2; 10; 31	5-10	10-15	~11	Articulated (~120 passengers)	Main Urban
7; 14; 15; 17; 27; 28; 24; 37	~10	15-20	~8	Mostly medium (100 passengers)	Basic Urban
58; 83	~10	15-20	~18	Medium (100 passengers)	Suburban

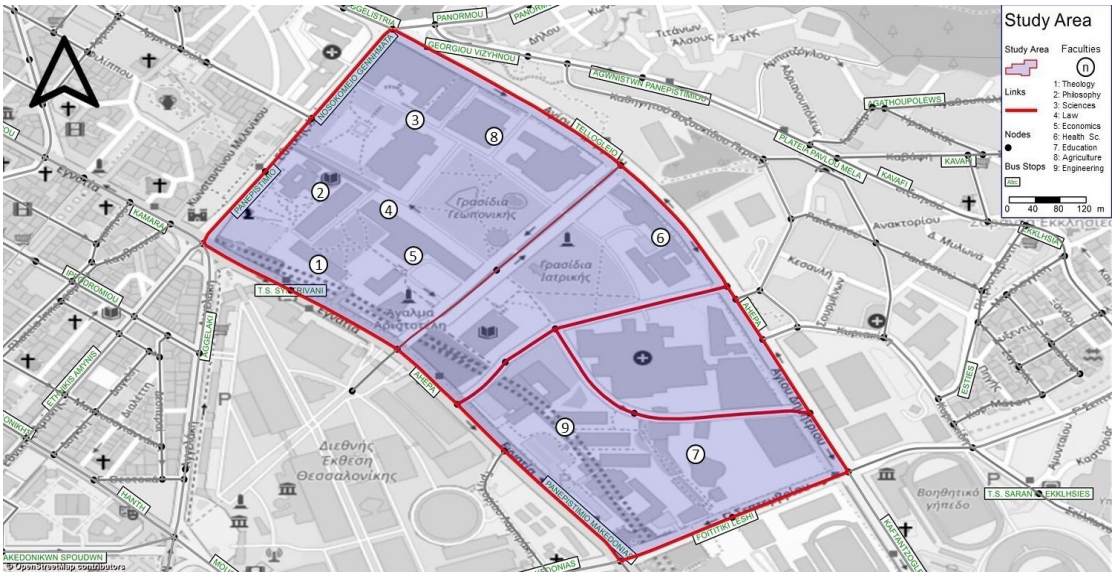

Figure 2. Spatial arrangement of bus stops and faculties in the AUTh campus. Map data © OpenStreetMap contributors, CC BY-SA (Source: OSM, 2020)

DATA AND ANALYSIS

Data overview

Table 2 presents the dataset we considered for this study. Each survey question (third column) was assigned to a certain variable (second column). In total there were 22 variables that are grouped into three (3) categories (first column). These categories coincide with the three (3) discrete parts of the questionnaire, which were explained in the previous section. To save space, the fourth column of Table 2 summarizes the questionnaire survey results[2].

Table 2 shows that most of the participants were female, belonged to the 18-25 age group and their personal monthly income was less than or equal to 600 euros, with

(Pitsiava-Latinopoulou *et al*., 2013). In most cases, walking time to/from bus stops did not exceed 5 minutes, but walking distances may differ between the first and the last leg of the bus trips. We achieved a satisfactory representation of responses for all the bus stops surrounding the AUTh campus. Regarding walking distance preferences, the maximum acceptable walking distance to/from bus stops mostly varied between 200 and 600 m. In general, students were prepared to walk more to catch a more frequent bus line. Finally, most of them did not think that a modification of the current spatial arrangement of bus stops would provide a tangible reduction to their walking distances.

[2] Full results are available from the authors upon request.

Table 2. Questionnaire survey's variables and statistics

Variable		Question	Answers
USER-SPECIFIC ATTRIBUTES	GENDER	Please select your gender	Male (37%); Female (63%);
	AGE	Which age group do you belong to?	18-25 (95.7%); > 26 years (4.3%)
	EDUC	What is your level of study?	Undergraduate (97.3%); Master's degree/PhD (1.7%); Second undergraduate degree (1.0%)
	INCOME	What is your personal monthly income?	0-600€ (59.7%); 601€-1,200€ (38.7%); Did not answer (1.7%)
	FACULTY	Which university faculty do you study at?	Faculty of Theology (9.7%); Philosophy (19.3%); Sciences (15.7%); Law (8.3%); Economics and Political Sciences (9.3%); Health Sciences (9.3%); Education (6.3%); Agriculture, Forestry and Natural Environment (6.7%); Engineering (15.3%)
	YEAR	What year of your university studies are you in?	First Year (31.3%); Second (18.7%); Third (22.7%); Fourth (14.7%)
	RESID	Please select your place of residence	City center (29%); Eastern city districts (47.3%); Western city districts (23.7%)
	LICENSE	Do you have a valid driving license?	Yes (35%); No (65%)
	CARUSER	If you have a valid driving license, are you the most frequent user of your household's private car?	Yes (13%); No (87%)
TRIP- SPECIFIC ATTRIBUTES	TRMOAR	Which mode of travel do you mostly use to arrive at AUTh?	Public Transport Bus (65.3%); Private car (5.3%); Bicycle (1.3%); Taxi (0.3%); Motorcycle (1.0%); Walking (26.7%)
	TRMODE	Which mode of travel do you mostly use when you leave AUTh?	Public Transport Bus (64.7%); Private car (5.3%); Bicycle (1.3%); Taxi (0.3%); Motorcycle (1.0%); Walking (27.3%)
	FREQ	How often do you perform this trip to/from AUTh? (times per week)	5 times (37.7%); 10 times (48.7%)
	WAKTI1	When travelling by bus from your origin to AUTh, how long (in minutes) do you think you spend covering the distance between your origin and the bus stop?	0-5 (89%); 6-10 (10%); 11-15 (0.7%); 21-30 (0.3%)
	WAIT	When travelling by bus from your origin to AUTh, how long (in minutes) do you think you spend waiting for the bus at the bus stop?	0-5 (51.3%); 6-10 (30.7%); 11-15 (11.7%); 16-20 (5.0%); 21-30 (1.0%); 31-45 (0.3%)
	BUSTIME	When travelling by bus from your origin to AUTh, how long (in minutes) do you think you spend on-board?	0-5 (15.3%); 6-10 (18.3%); 11-15 (23.0%); 16-20 (14.3%); 21-30 (9.7%); 31-45 (11.7%); >45 (7.7%)
	WAKTI2	When travelling by bus from your origin to AUTh, how long (in minutes) do you think you spend covering the distance between the bus stop where you left the bus and the entrance to your faculty?	0-5 (92.7%); 6-10 (7.0%); 11-15 (0.3%)
	WAKDI1	When travelling by bus from your origin to AUTh, how far (in meters) do you think you walk between your origin and the bus stop?	<200 (65%); 200-400 (32.7%); 401-600 (1.3%); 801-1,000 (0.7%); >1,000 (0.3%)
	WAKDI2	When travelling by bus from your origin to AUTh, how far (in meters) do you think you walk between the bus stop where you left the bus and the entrance to your faculty?	<200 (32.7%); 200-400 (63.0%); 401-600 (3.3%); 601-800 (1.0%)
	BUSSTOP	Which bus stop do you mainly use when travelling by bus from your origin to AUTh?	KAMARA (40.3%); PANEPISTIMIO (2%); AHEPA (NORTH) (2.7%); PANEPISTIMIO MAKEDONIAS (8.0%); FOITITIKI LESHI (1.3%); SYNTRIVANI (27.7%); AHEPA (SOUTH) (17.0%); OTHER (1.0%)
WALKING DISTANCE PREFERENCE	WAKDA1	For your usual bus trip to AUTh, what is the maximum acceptable distance (in meters) that you would be willing to walk between your origin and bus stop or between the bus stop where you left the bus and the entrance to your AUTh faculty?	<200 (10.3%); 200-400 (37.3%); 401-600 (34.3%); 601-800 (8.7%); 801-1,000 (3.7%); > 1,000 (5.7%)
	WAKDA2	For your usual bus trip to AUTh, what is the maximum acceptable distance (in meters) that you would be willing to walk in order to reach a bus stop that provides a more frequent bus service to/from AUTh?	200 (20%); 300 (35%); 400 (45%)
	PLACE	Do you think that there is a need to modify the existing spatial arrangement of bus stops around AUTh so as to reduce walking distances between bus stops and the entrance to your faculty?	Strongly disagree (48%); Probably disagree (21.3%); Probably agree (10.7%); Strongly agree (20%)

Analysis setting

In order to analyze the questionnaire survey's results, we quantified, one by one, the variables from Table 2 by assigning a single positive integer to each category of responses collected. The numbering sequence followed the order of appearance that is reported in Table 2 answers. In order to address our first research question, we synthesized the responses we collected from the variables that belong to the "trip specific" and "walking distance preferences" groups. For the second research question, we employed statistical inference methods to examine whether "user" and "trip" specific attributes (Table 2) could explain the walking distance preferences of university students, as these were quantified by the three (3) variables in the respective groups (Table 2). Table 3 presents our initial hypotheses regarding the direction of the relationships between these groups of variables, taking into account the literature review findings and common sense. In short, we expected that the respondents who are more frequent car users, belong to the upper income and age groups and perform bus trips that are comparatively longer in duration (in all or one of their stages) would be associated with comparatively shorter acceptable walking distances to bus stops (WAKDA1 and WAKDA2) and lower satisfaction from the current placement of bus public transport stops (PLACE). The type of variables determined the test statistic we used in each case. When user-specific variables were nominal, Mann-Whitney U (for variables with two categories) or Kruskal-Wallis tests were carried out, while for ordinal variables, Spearman's correlation coefficients were estimated. For all test statistics, the null hypothesis (H_0) we adopted was that there is no relationship between user/trip specific variables and walking distance preference variables. The alternative hypothesis (H_1) is that there is a statistically significant relationship between them. We rejected the null hypothesis for p-values lower than 0.05. All calculations were performed with SPSS software (IBM, 2017).

RESULTS AND DISCUSSION

Maximum acceptable walking distance

Figure 3 compares the current and maximum acceptable walking distances to/from bus stops as reported by the AUTh students who participated in the questionnaire survey. For the majority of the respondents' trips, current walking distances from the points of origin to bus stops (WAKDI1) are lower than 200 meters, and as such they are shorter than the corresponding distances from bus stops to the AUTh faculty entrances (WAKDI2), which mostly range between 200-400 meters. However, the maximum acceptable walking distances for the same trips (WAKDA1) are generally higher, since more than half of the university students (52.4%) would be willing to travel on foot for more than the typical value of 400 meters in order to reach a bus stop that would provide services to/from the AUTh campus. Moreover, if we combine the Figure 3 and Table 2 findings, we conclude that, on average, though WAKDI2 is greater than WAKDI1, WAKTI2 is shorter than WAKTI1, which means that university students develop faster walking speeds when walking inside the campus. This is probably explained by its car-free environment and the fact that students may be in more of a hurry to be on-time for their lectures etc.

The willingness of students to walk further distances than their current ones is also evident in Figure 4. An important share of students (43%) would walk up to 400 meters if they could approach a more frequent bus service to/from AUTh.

Table 3. Initial hypotheses and test statistics used for investigating the relationships between user/trip specific attributes and walking distance preference variables

User and Trip Specific Variables	Walking Distance Preference Variables			Test Statistic
	WAKDA1	WAKDA2	PLACE	
GENDER	Ambiguous	Ambiguous	Ambiguous	Mann-Whitney U
LICENSE	Ambiguous	Ambiguous	Ambiguous	
CARUSER	Positive	Positive	Negative	
FACULTY	Ambiguous	Ambiguous	Ambiguous	Kruskal-Wallis H
RESID				
BUSSTOP				
TRMOAR				
TRMODE				
AGE	Negative	Negative	Positive	Spearman's Rank-Order Correlation
INCOME				
FREQ				
WAKTI1				
WAIT				
BUSTIME				
WAKTI2				
WAKDI1				
WAKDI2				

Figure 4 also shows that opinions are generally in favor of the existing placement of bus stops that envelop the AUTh campus.

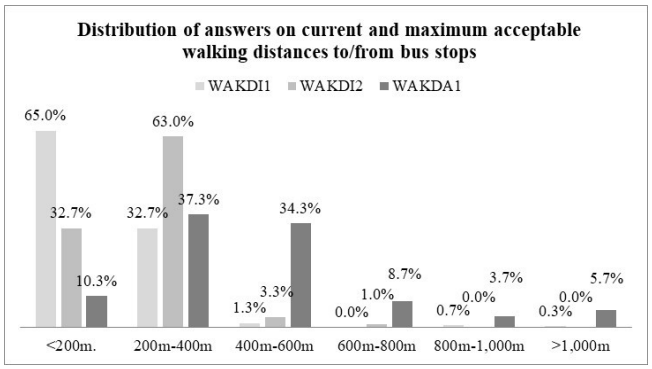

Figure 3. Comparison between current walking distances and maximum acceptable distances to/from bus stops when travelling to/from the AUTh Campus

Overall, the maximum acceptable walking distance for the majority of the university students was found to be greater than the current distance they walk, and higher than the rule of thumb used by public transport practitioners (i.e. 400 m). In line with previous research findings, which emphasized the positive correlation between bus service frequencies and higher walking distances to bus stops (Alshalalfah and Shalaby, 2007; El-Geneidy *et al*., 2010), most AUTh students are willing to walk greater distances, compared to their actual ones, in order to reach a bus stop with more frequent bus services.

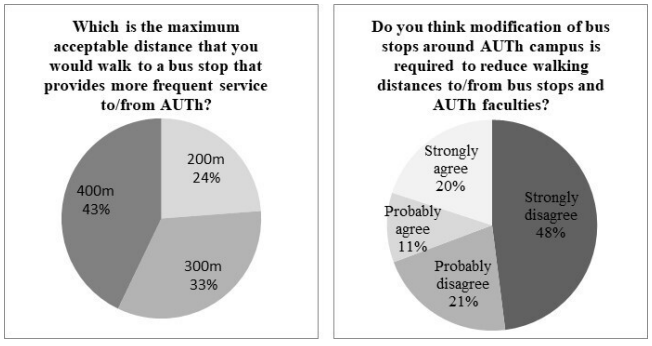

Figure 4. Maximum acceptable walking distances to more frequent bus services (left) and attitudes on current bus stop placement (right)

Impact of user and trip specific attributes on walking distance preferences

In order to investigate our second research question, i.e. whether the above preferences on walking distances to/from bus stops are dependent on specific user and trip attributes, we performed a series of inferential statistical tests, as explained in the Analysis setting. Table 4 presents the Spearman's rank correlation coefficient figures. In almost all of the cases, no user- or trip-specific attribute (first column) is significantly correlated with the three (3) variables that capture the walking distance preferences over the local bus public transport network. Only in three (3) cases are statistically significant correlations found, specifically:

- A positive relationship exists between WAKDA1 and BUSTIME. This means that bus passengers who spend more time on-board are more willing to walk further in order to reach a bus stop. This finding is in contrast to our initial hypothesis and may sound like a paradox. It probably implies that students do not expect comparatively great duration differences among the stages of their bus trips;
- University students for whom bus stops are comparatively more distant from their faculty entrances (WAKDI2) are more willing to walk further (WAKDA2) in order to wait at a stop where they can use a more frequent bus service to/from the AUTh campus. This result disagrees with our hypotheses setting but it emphasizes the relative attractiveness of bus stops where frequent bus lines can be accessed; and
- In line with our initial hypothesis, respondents who were over 26 years old (AGE) are associated with comparatively more statements that asked for a modification on the existing placement of bus stops which surround the AUTh campus (PLACE).

However, though statistically significant, all of the above correlations between variables are very weak, since the corresponding coefficients are lower than 0.2. Therefore, we cannot consider these three (3) user-specific attributes as being critical to the students' preferences on walking distances and placement of local bus stops.

*Table 4. Spearman's correlation coefficients and p-values** for the variables examined*

	WAKDA1	WAKDA2	PLACE
AGE	-0.052 (0.374)	0.046 (0.428)	0.130 (0.025*)
INCOME	-0.085 (0.146)	0.002 (0.967)	0.090 (0.124)
FREQ	-0.076 (0.187)	-0.059 (0.306)	-0.015 (0.795)
WAKTI1	0.017 (0.774)	0.053 (0.360)	0.021 (0.718)
WAIT	-0.047 (0.418)	-0.026 (0.654)	-0.035 (0.552)
BUSTIME	0.133 (0.021*)	0.086 (0.138)	0.032 (0.585)
WAKTI2	-0.016 (0.780)	-0.012 (0.831)	0.072 (0.217)
WAKDI1	0.046 (0.424)	0.092 (0.114)	-0.065 (0.259)
WAKDI2	-0.048 (0.412)	0.149 (0.010*)	0.049 (0.398)

*** (p-values in parentheses)*

Regarding the hypotheses checked against the Mann-Whitney U test, Table 5 shows that the maximum acceptable walking distance to a more frequent bus stop within the female group of respondents is very close to being considered as statistically significantly higher compared to the male group. Possession of a driving license and frequency of private car use did not have any statistically important correlation to the walking distance variables. Similarly, no statistically significant correlations were found for the passenger and trip related variables that were tested by the Kruskal-Wallis test.

Overall, we did not observe any strong or moderate statistically significant correlations between user/trip specific attributes and walking distance preferences. This

means that AUTh students, regardless of their personal and mobility characteristics, generally share similar behaviors and perceptions in terms of their walking distances to/from bus stops.

Table 5. Mann-Whitney U output of SPSS for gender and walking distance to a more frequent bus stop

Ranks	GENDER	N	Mean Rank	Sum of Ranks
WAKDA2	Male	111.00	138.74	15,400.50
	Female	189.00	157.40	29,749.50
Test Statistic	WAKDA2			
Mann-Whitney U	9,184.50			
Wilcoxon W	15,400.50			
Z	-1.942			
p-value	0.052			

CONCLUSION

In this study we investigated a critical spatial attribute of bus public transport systems, i.e. the walking distance to/from bus stops, which is one of the factors determining the quality of public transport services, and therefore ridership. We carried out a customized questionnaire survey to collect data on the preferences and perceptions of AUTh university students regarding the access and egress walk distances they travel when commuting by bus to the AUTh campus. Then, we employed statistical inference tools to explore any relationship between their individual characteristics and their opinions on the bus stop placement and resulting walking distances for the bus services they use.

Empirical findings reconfirmed past related research results, since they highlighted that in the case of AUTh's university students: (a) the maximum acceptable walking distances to/from bus stops can be higher than the typical value of 400 meters considered suitable for the general public and (b) a more frequent bus service could be a motive for walking further to the corresponding bus stop. Statistical inference results indicated that these walking distance preferences are unanimous amongst AUTh's student body and do not critically depend on their personal and trip specific attributes.

These findings can appropriately contribute to the improved spatial design of bus public transport networks which serve university campuses, since it was made evident that students are willing to accept a more sparsely settled network of bus stops, provided that service frequencies are higher. In practice, higher service frequencies can also be achieved, since the bus speed will ultimately be increased if the space between stops is greater. Improvement in the speed of public transport can also reduce energy consumption, and thus, public transport agency operating costs. More sophisticated planning of bus stop spacing, which incorporates user expectations, could lead to improvement in the quality of service and an increase in the public transport ridership, along with providing opportunities for higher levels of personal physical activity. The challenge, however, is to make appropriate decisions on bus stop locations, which should be withing reasonable walking distances from the main centers of campus activities. These decisions should take into consideration the opinions of university students and the topological characteristics of the areas under question.

The low variability of specific personal attributes of the respondents, such as income, age and degree program, did not allow us to sufficiently examine them under our hypotheses. Since we tried to keep the duration of the questionnaire survey under the reasonable time limit of 10 minutes, we did not manage to collect data and thus explore opinions relating to additional spatial design characteristics, such as bus stop design and environment features relating to walkability. Further research should also explore the spatial arrangement preferences of additional population categories so as to support customized decision-making on the design of public transport networks that will encourage the shift to more sustainable transport means. Finally, given that the survey and findings refer to 2015, a follow-up validation research is probably required to sufficiently accommodate any effect due to the introduction of micromobility transport schemes in Thessaloniki (mostly e-scooters) and COVID-19 restriction measures. Such dramatic changes could have possibly influenced passenger viewpoints on public transport services and attributes, along with significantly modifying their mobility behavior and preferences, either permanently or temporarily.

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ACHIEVING USE VALUE OF A LIVING SPACE

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Use value is one of the key terms related to architectural functionality. The term itself denotes the level of usefulness of a living space for its user, i.e., to what extent the space can meet specific human needs. The paper analyzes the relations between characteristic human needs and the possibilities for their fulfillment in a living space. Various studies examining different aspects of use value have often identified it with the quality of a living space. This is why one of the main aims of this paper is to reexamine the thesis claiming that use value is just one part which defines the quality of a living space and that these two terms are not equivalents. On the other hand, the paper presents a systematization of cause-and-effect relations between human needs and the basic principles and parameters for achieving use value within a living space. Although the term has not lost its importance since it was first used, the criteria for achieving a higher level of use value of a living space have not been sufficiently researched. Along with a comparative analysis of the terms value, use value and the quality of a living space, as well as an examination of the characteristic human needs present in each living space and ways of meeting them, the key contribution of the paper lies in defining the principles for achieving use value.

***Key words*: architecture, housing, use value, quality, human needs.**

INTRODUCTION

The *use value*[2] of a flat is a term introduced to science in the 1970s by a group of professors from the Faculty of Architecture in Belgrade (Mate Bajlon, Branko Aleksić and Branislav Milenković). Aiming to examine the principles of the spatial and functional organization of a living space that would enable a flat to be organized with the highest quality within the smallest space, they claimed that what was required was economical construction accompanied by the highest possible reduction of the shortcomings of the flat. The term "use value" of a flat was introduced with the idea of gathering all the criteria they deemed theoretically useful for achieving higher quality flats in the exploitation phase. Since then, several decades have passed and the use of this term is still widespread. However, although the term has often been discussed in science[3], the criteria for achieving a higher level of use value with regard to a living space have not been examined sufficiently. It can be assumed that one of the reasons for this has been the identification of the term use value with the quality of the flat itself.

In the domain of this paper, the use value of a living space will be examined in its narrower interpretation, as part of the quality of a living space. Therefore, the main aims of the paper are: a) to reexamine the viewpoint which sees the use value as just one part in determining a flat's value, and to show that these two terms are not equivalents, and b) to carry out systematization of the cause-and-effect relations between human needs and the basic principles and parameters for achieving the use value of a living space.

The methodological framework of the paper includes a comparative analysis of the characteristic interpretations of the basic concepts on which the research is based - value, use value and quality. Having in mind Maslow's theory of human needs, a scientific basis for the systematization of the cause-and-effect relations between human needs and the basic principles and parameters for achieving the use value of living space has been set out.

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[2] The term *"use value"* has been known in science before. It is considered that it was first used by Karl Marx in his work *The Capital* (1867) where he states that "the usefulness of a certain thing makes it a use value".

[3] Bajlon, 1972, 1975, 1979; Čanak, 1973, 1976a, 1976b, 1978; Čanak and Gavrilović, 1978.

A FLAT'S USE VALUE AND ITS QUALITY

Mate Bajlon, in his book *Housing: Topic 1 – The organization of a flat*, states that a flat's use value "should be measured in relation to the needs, the number of people sharing the space and the structure of a certain family or group that the flat can contain." (Bajlon, 1975). According to his viewpoint, a flat's use value primarily depends on the human needs and the number of users. Furthermore, he states that two flats with the same surface area can have different use values, in the same way that one flat can have different use value, depending on whether it is for one or more people. Apart from this formulation, Bajlon does not engage in a wider interpretation of this term, but rather accepts the term and uses it without previous explanation. Even in his publication entitled *A Flat's Use Value*, the author focuses on analyzing the design principles applied in order to achieve better use value, but not the meaning of the term itself. As significant criteria for assessing a flat's use value, Bajlon states the following: a) separation of children by gender, b) separation of children and parents, c) separation of rooms for personal and communal life, d) gathering the family around the table, e) the option of forming a circular connection, f) the possibility of forming an extended communication area, g) undisturbed reception of guests, h) flexibility and i) open space (Bajlon, 1975).

A significant contribution to this subject was made in research by Mihailo Čanak (Čanak, 1973, 1976a, 1976b, 1978; Čanak and Gavrilović, 1978), in which he analyzed a flat's use value in relation to flexible structures and functional concepts, and examined the systems for assessing a flat's use value and its quality, etc. His study that has exceptional importance with regard to this topic is *Functional concept and a flat's use value*, in which the author, starting from an analysis of the term value in different areas of human activities (philosophy, economics, etc.), sublimates different viewpoints and establishes the definition of the term by which "the flat's use value is reflected in its usefulness in relation to one or more individuals, a family or a society in general, i.e. its ability to positively influence, through its characteristics, human needs, wishes and aims" (Čanak, 1976a). Aiming to examine the possibility of evaluating the use value of a flat, Čanak analyzes the evaluation models applied across the world, but for some reason, instead of focusing on the flat's use value, he directs the model of evaluation towards the exploration of a flat's quality. It can only be assumed that this equation of the term use value and quality was conditioned by author's striving to get a deeper insight into objectifying the criteria and the evaluation model (Čanak, 1984).

With regard to recent references, it is important to stress the article by Dragan Marković, entitled *What is a flat's use value, why is it important and how can it be evaluated?* in which the author states that a flat's use value is the "dimensionally-organizational quality of a certain living space. As such, it can be determined by numeric or relational parameters." (Marković, 2020).

By analyzing the above-mentioned interpretations, it appears that equating the term use value with the flat's quality has led to a certain confusion, which is why it is necessary to focus briefly on a comparison of these two terms and clearly discern whether there is a difference between them (Table 1).

When looking at the previous statements in the context of living conditions, it can be established that the use value determines the usefulness of a flat for a person using it. It is a parameter which indicates to what extent a flat meets the needs of its users during its exploitation. The quality of a flat is defined by a group of parameters determining the positive qualities of a living space, but also the level of satisfaction of both the users' needs and other factors affected by the immediate or wider surroundings (construction, materials, position within the building, area, town, etc.). Unlike the use value of the living space, which is determined by those that use it (individuals or groups) and is specifically different for each person, the quality of a living space is assessed in relation to standards such as generally accepted social norms.

Thus, it can be said that the use value of a living space is in a certain way "personalized", as it depends on the individual needs of real users, while the quality of living space indicates the level to which a certain flat's characteristic fulfills the overall requirements prescribed by norms and standards. Consequently, the quality of the living space is a much wider category, which, among other things, also includes its use value, whose domain of influence is limited to the boundaries of the space itself.

In terms of the quality and use value of the living space, the values stand for measures or guidelines that human inclinations move towards. In this sense, the concept of the value of the living space is a more general category than the

Table 1. Comparison of the terms value, use value and quality

<table>
<tr><th>Value</th><th>Use value</th><th>Quality</th></tr>
<tr><td>... includes characteristics which make objects the aim of human striving. (Panchauser, 1971)</td><td rowspan="2">... is reflected in its usefulness in relation to one or more individuals, a family or a society in general, i.e., its ability to, through its characteristics, positively affect the satisfaction of human needs, wishes and aims. (Čanak, 1976a)</td><td rowspan="2">... is the level up to which a group of characteristics fulfil requirements. (ISO 9000, 2001)</td></tr>
<tr><td rowspan="2">... is the measure creating certain orientations in human behavior and doing. (Životić, 1986)</td></tr>
<tr><td>... is a dimensional-organizational quality of a certain living space. (Marković, 2020)</td><td>... of the flat is the level in current circumstances, determined according to the level of fulfillment of requirements of professional standards and all relevant individual characteristics of the flat, the building and its surroundings, classified on a certain assessment scale. (Todorović, 2016)</td></tr>
</table>

quality of a flat or its use value, which leads to the conclusion that the total use value of the living space is determined by three main parameters: a) use value, b) quality, and c) material value (the price).[4]

Based on the above, it can be concluded that the use value is the domain of usefulness of a living space for its users. It refers to the span of usefulness with a threshold below which normal usage of the space is not possible. Each step outside this threshold belongs partially to the scope of quality of the space.

HUMAN NEEDS

The term *human needs* is used to denote the motives that drive people to carry out different activities. Generally speaking, all human activities can in a certain sense be described as the search for fulfilment of particular needs (Guillen-Royo, 2014). The idea of the systematization of human needs and their relations was first explained by American psychologist Abraham Maslow in his scientific paper "A theory of human motivation" (Maslow, 1943), where he states that human needs can be classified into groups with a clear hierarchy separating them. According to his theory, the lower levels of needs must be satisfied first in order to activate the higher levels of needs. Maslow grouped human needs into a hierarchy of five levels, from the lowest to the highest (physiological needs, safety, belongingness and love, esteem and self-actualization).[5]

Maslow's hierarchy is most often presented in the form of a triangle separated into five segments, in which each group of needs belongs to a certain level. It is thought that higher needs from this hierarchy are activated only after the lower-level needs have been satisfied to a significant degree.

Furthermore, only when one need has been satisfied does its importance reduce for a period of time and the influence of a different need strengthens, which leads to their successive intertwining (Figure 1). Maslow's theory of motivation is considered the most influential theory in the domain of research into human needs.

The satisfaction of human needs is the basis for the functional organization of a living space. However, it is important to stress that the living space cannot satisfy all the stated needs, as there are certain needs which require relations and activities outside the living space, through contact with other people or objects. On the other hand, the role of an architect is to assess which needs have a permanent character, as opposed to needs with a temporary character, as well as to determine the trends in the transformation of temporary needs (Čanak, 1976a).

PRINCIPLES FOR ACHIEVING HIGHER USE VALUE

In order for a living space to have an adequate level of use value, it is necessary for it to fulfil certain principles, which if applied create an opportunity for the space to meet the user's needs. Each principle can have a radical impact on the use value of the living space. Our aim in this paper is to focus more on the overall principles that can influence the use value of the living space, than on their significance (hierarchy) to the users, as these systems occasionally change and are different for an individual user or a group of users.

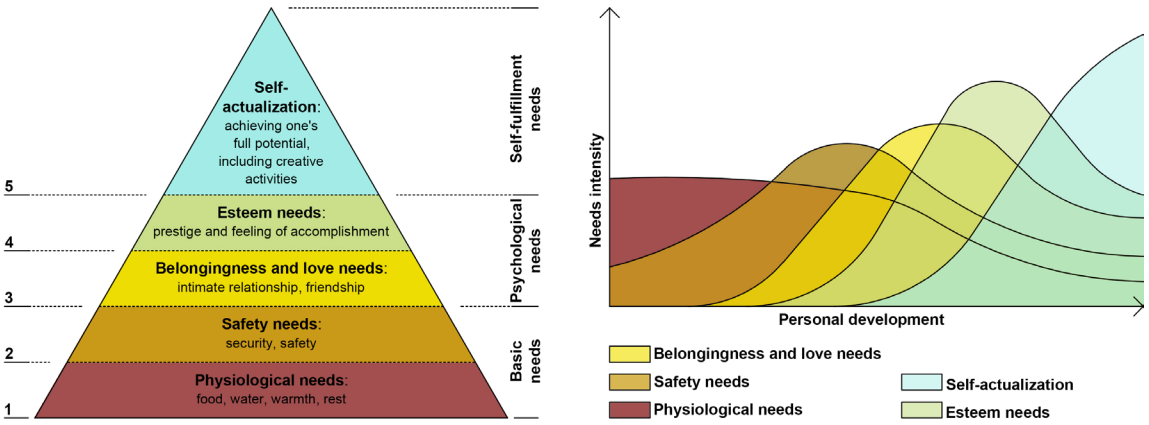

Figure 1. Hierarchy of human needs according to A. Maslow (Source: author's sketch)

[4] Along with these three parameters, we can also discuss "spiritual value" of the living space, determining personal or emotional value of the space for its user.

[5] Physiological needs (the need for air, water, food, sleep and sex); the need for safety (physical, material and medical safety (employment and healthcare), safety of family and possessions); the need to belong (friendships and family ties); the need for esteem (respect, success, respect of others, acknowledgment of person's success); and the need for self-actualization (creativity, morality, spontaneity, problem solving, lack of prejudice, acceptance of facts).

Spatial conditions for satisfying physiological needs

Living space cannot literally offer the answer to physiological needs, but it can, however, represent a spatial frame for these needs to be satisfied undisturbedly. The need for fresh air can be achieved through a system of natural or artificial ventilation, an adequate size and the positioning of the windows and doors to enable adequate circulation and exchange of air in a particular space. Optimum ventilation is achieved by positioning

the entrance and the window opposite each other, which is why the two-sided or three-sided orientation of a living space are more optimal for use.

The need for food and drink is indirectly influenced by the existence of rooms where food is stored, prepared and consumed. These rooms make the daily activities related to satisfaction of these needs easier. In order to carry out activities related to food storage, preparation and consumption of meals undisturbed, an ergonomically designed space is required that is in harmony with the dimensions of a human body. The minumum linear dimensions determining the lower limit of basic room measurements are: for a single-row kitchen – 160cm width, a two-row kitchen – 210cm width, and a dining room – 200cm width. When it comes to satisfying the need for excretion, sanitary spaces must have a minimal width of 80cm for the toilet and 160cm for the bathroom. It should also be considered that when a living space is used by multiple individuals (3 or more), adequate use means the existence of an additional toilet besides the bathroom. The need for rest and sleep under normal circumstances can be satisfied by having a sound-proof room that can accommodate a bed of adequate dimensions. The minimum width of a room with a double bed must be at least 260cm, while a room with two single beds requires a minimum width of 240cm, and a single-bed room must have a minimum width of 190cm. All of these dimensions represent absolute or critical minimums, below which the functions of the living space cannot be carried out normally, which means that the use value of a living space is not a subject that could be discussed in these circumstances (Čanak, 1976, 2014) (Figure 2).

Depending on the organization of the space, room proportions, and the minimum linear depth and width of a room, it is possible to make a general impression of what the necessary minimal surface area is for carrying out normal functions in the living space. It is necessary to emphasize that a room with an adequate surface area, but with an irregular or bent shape, in most cases cannot meet the expected functional requirements, which is why we should aspire to having rectangular (less often-square) proportions of the rooms, in order to achieve adequate use value of the living space.[6]

It is important to stress that the height of a living space does not significantly affect its use value, but rather the perception of the flat's comfort, as well as the air volume required for normal housing functions in conditions without adequate ventilation. The lower limit for the useful height of a room has been determined to be 226cm, below which a longer stay can create the feeling of being uncomfortable and experiencing space claustrophobia (Lourenco *et al*., 2011). The optimum height for a living space which determines its use value is 260cm.

It is important to emphasize that there are a significant number of studies and regulations in which aspects of the minimum dimensions that determine the use value of residential space have been considered. The dimensions mentioned in this research are given only as an example that relates to design practice in Serbia.

Spatial conditions that satisfy safety and comfort needs

One of the main roles of each living space is to meet the need for safety and comfort. Safety in a living space relates to protection from various external and internal influences, while comfort is the feeling of being comfortable in terms of both psychical and psychological well-being while staying in a living space (Chappells and Shove, 2004).

[6] For more information on the principles of dimensioning rooms, determining minimal surfaces, and the depth and width of rooms, see the study "Functional concept and a flat's use value" (Čanak, 1976).

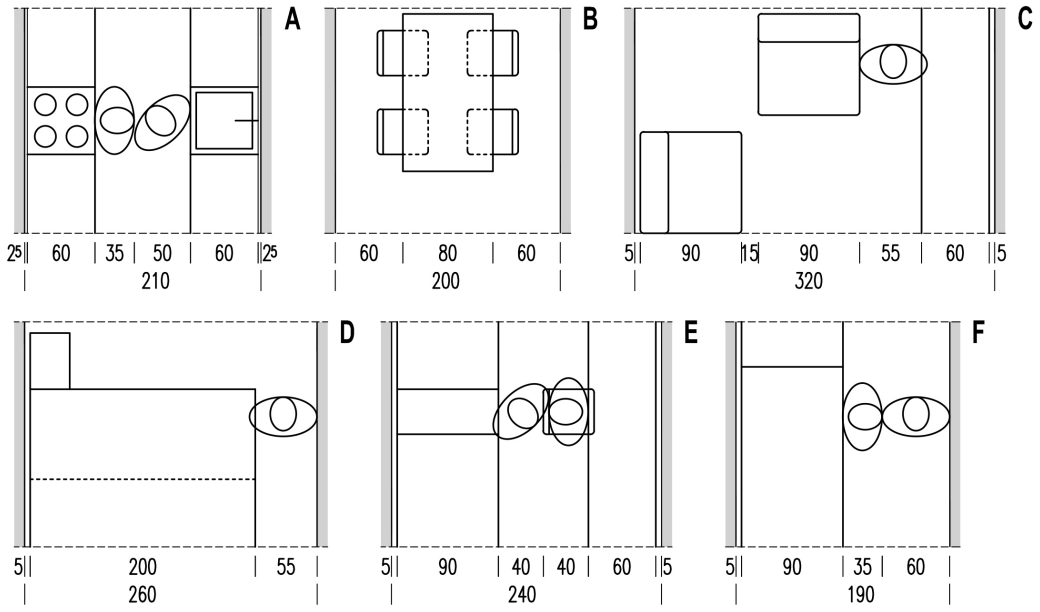

Figure 2. Minimum linear width of a room: a) two-row kitchen, b) dining room, c) living room, d) parents' room, e) room with 2 single beds and f) a room with a single bed
(Source: Čanak, 2014)

What influences the fulfillment of physical safety is primarily the ergonomics of the space and the furniture, the lack of sharp surfaces and angles, and having irregular and adequately dimensioned objects or parts of the space. The parameters that meet the safety needs of a family and their belongings in a living space are mechanisms securing their safety from break-ins, such as safety entrance doors, balcony doors or windows. The need for material security can, in some cases, be fulfilled through the existence of a workspace (office, cabinet, atelier, etc.), which could, if necessary, be a room with a separate entrance where the professional working activity of a user can be carried out. The need for healthcare security and physical wellbeing in a living space can be fulfilled if there are adequately dimensioned rooms for personal hygiene (bathroom and/or a toilet) and space for relaxation and recreation in the form of a fitness room or a gym.

The most significant group of parameters comprises those that satisfy the need for privacy and isolation, especially important in living spaces with multiple users, regardless of whether it is a family or a group of strangers using the same common space – *coliving* and *cohousing* models of housing. Bajlon states that the minimal social conditions to be secured within a flat are: "the possibility to satisfy the personal needs (work, rest, isolation, etc.) of every member and the option of taking part in common forms of family life, within the boundaries and up to the scope that the available means allow" (Bajlon, 1979). The need for privacy and isolation can be fulfilled by the use of several design principles: a) by separating the activities of children and parents, b) by separating the children according to gender, c) by separating the rooms for personal and common life, d) by using a circular connection and e) by using separate entrances.

Separating children's and parents' activities is recommended as different generations of users have different interests, needs and dynamics. Separation can be executed through the physical segregation of activities inside a particular space. It is thought that the healthy psycho-physical development of a child requires the closeness of their mother, and for children to sleep in their parents' room up to the age of three, while the separation of a child into a room of his or her own should be done by the age of six at the latest (Dinić, 2003). After the age of thirteen, when the child is in the final phase of forming their personality, it is necessary to have the option of separating him or her from other family members within the same living space. For this reason, it is advisable to introduce an auxiliary entrance to the flat which allows undisturbed use of the space and a higher level of privacy within the living space (Alfirević and Simonović Alfirević, 2019).

Separation of children by gender is recommended due to their different psychological and social needs and the dynamics of growing up. It is important to take into consideration equality among the children in a family and for them to have equal space while growing up.

The separation of space for personal and communal life makes it possible to have simultaneous group and individual activities. Pre-school children have the need for more intensive contact with parents, whereas this need steadily decreases by the age of twelve, so that after the age of thirteen a child will express more need for periods of privacy in their own individual space (Dinić, 2003).

By applying a circular connection and introducing an auxiliary entrance, it is possible to achieve a higher level of privacy, as the users do not disturb each other when carrying out their chosen activities. Circular connection enables the option of alternative movement in the space and reduces the possibility of meeting other users or guests, which from the parents' point of view is not essential, while adolescents express it as one of their most characteristic needs. In order to achieve adequate spatial independence of individual and common spaces, it is desirable to have the option of forming a circular connection which excludes the zone of the living room or to have one or two rooms directly connected with the entrance zone (Alfirević and Simonović Alfirević, 2018).

Spatial conditions for satisfying the need for belonginess

Belonginess is a need of key importance in the social development of any person. The need to communicate with others (family and friends) within a living space is most often carried out in spaces designed for gatherings. In order to fulfil its purpose, a gathering space (living room, multi-purpose room, salon, etc.) must have adequate dimensions for the expected number of users (regular users and guests). In two-generational and three-generational families it is advisable to have separate gathering spaces, i.e., for a living space to have at least two centers. The presence of only one center can lead to conflict, for instance in situations when social contacts among younger family members and the reception of guests by older family members coincide (Montgomery, 1972). In living spaces of medium and lower standards, in most cases it is customary that the gathering center for users is the living room, while, if necessary, the dining room space can also be included, as it is closely connected with the living room either as an independent room or as a part of the zone of the so-called "extended communication area". According to Bajlon, the extended communication area was the result of the need to "find the form of family gathering at the common table, in cases when the lack of space in the flat did not allow other forms of gatherings" (Bajlon, 1972).

Spatial conditions for satisfying the esteem need

Esteem needs (self-esteem, success, respect by others and acknowledgment of one's own achievements) represent a higher level in the hierarchy of life needs, which are most frequently met in contact with others and are not directly connected to the spatial context. However, the need to achieve and most of all, to show off success, can be related to one's physical surroundings in that a person wants to show off his or her success and material status, not only in terms of the style of the living space, but also in terms of the space having a larger surface area where the person lives or receives guests, in order to artificially create the feeling of respectability. According to Jelena Ristić, "the concept of structure and shaping of the family homes of the elite is connected to 'class expectations', i.e., the need for some social classes to establish their own hegemony through the presentation of their living space to show off their social status, social value or lifestyle" (Ristić, 2009).

Space conditions to satisfy self-actualization needs

The need for self-actualization, similarly to the previous group of needs, relates to psychological needs of a higher level and mostly does not depend on spatial conditions. The need for creativity and some form of creative activity can be related to the physical context in that there should be certain spatial conditions for undisturbed activity that contributes to a person's creative expression. In an ideal case this would be a hobby room, which, depending on the activity, can have different characteristics, while in some cases and in spaces with a smaller surface area, the hobby room can be integrated into a living room zone.

DISCUSSION

Through parallel analyses and the systematization of relations between characteristic human needs in a living space and the options (principles) for their satisfaction, it can be concluded that a living space provides physical conditions to meet the basic human needs (physiological and psychological), while higher level needs are most often satisfied in social relations outside the living space (Table 2).

As we mentioned previously, human needs make a complex system of motives, some of which regularly and cyclically take turns and complement each other, as is the case with physiological and partially with psychological needs, whereas some needs develop and build up and are present less often. When designing a living space, it is necessary to pay attention not only to satisfying constantly present (cyclical) needs, which is primarily achieved by adequate spatial and functional organization of the living space, but also to take into consideration satisfying developmental needs, which requires a flexible spatial frame that can reflect their changing nature.

If we look back at the topic of use value of a living space and the options for achieving it, it is important to stress that "an ideal" living space is one which provides different

Table 2. Review of the characteristics of human needs in a living space and the possibility of meeting them

Human needs in a living space		Living space potentials for meeting these needs
Physiological needs	The need for air	• Natural or artificial ventilation of space
	The need for food and drink	• Space for storing food • Space for preparing food • Space for having meals
	Excretion need	• Sanitary space (bathroom and/or toilet)
	The need for rest	• Rest space
	Sexual needs	• Rest space
Safety and comfort needs	Physical safety need	• Ergonomics of space and furniture
	The need for family safety	• Break-in safety
	The need for safety of belongings	• Break-in safety
	Material security need (employment)	• Work space
	The need for health, safety and good physical condition	• Personal hygiene space • Space for rest and recreation
	The need for privacy and isolation	• Separation of children and parents • Separation of children by gender • Separation of rooms for personal and communal life • Circular connection that allows intimate access to night zone • Living space with two entrances
	The need for comfort	• Optimal equipment of rooms • Optimal dimensions of rooms
Love needs	The need for belonging and feeling loved in a family	• Space for family gathering (living room, dining room, kitchen, extended communication)
	The need for friendships outside family	• Room for receiving guests
Esteem needs	The need for esteem within the family	---
	The need for esteem outside the family	• Space for receiving guests • Space for accommodating servants
	The need for self-esteem	---
Need for self-actualization	The need for independent activities	---
	The need for contact	• Space for gathering
	The need for directed social activities	---
Artistic and knowledge needs	The need for knowledge	• Space for reading (cabinet, library)
	The need for art	• Space for work
Altruistic needs	The need to help others outside the family	---
	The need for social engagement	---

spatial conditions for the regular and complete satisfaction of most human needs. The primary potential of a living space includes rooms that allow basic life activities, with adequate dimensions for meeting the specific needs of the users. On the other hand, when it comes to living in a group, the aspects of the users' privacy and socialization become quite important.

An important aspect requiring exploration is also the level of furnishings. If the space includes inadequate, non-standard and excessive furniture, the dimensions of otherwise optimal useful space will be reduced, as "cramming" the space with furniture reduces the experience of spatial comfort, meaning it also lessens the use value of the living space.

By comparing the terms *quality* and *use value* it was concluded that the use value of the living space makes up a significant part of its quality, and that it refers to the boundaries of the space actively used and defined by the gross useful area and room height, as opposed to quality, whose determinants exceed the spatial frame, which is why it is impossible to establish equivalency between these terms.

CONCLUSION

The paper presented a systematization of cause-effect relations between human needs and the basic principles and parameters for achieving the use value of a living space. By analyzing characteristic human needs, the paper offered the most significant solutions for achieving the use value of a living space. The importance of the research is reflected in the possibility of using its findings when forming the pattern or procedure for evaluating the use value, which would be an adequate counterpart of the Flat Quality Certificate, based on assessing the parameters of a specific flat in relation to the concept of quality level and average human needs. With regard to the statement that a flat's use value is "personalized", as it depends on the individual needs of its users, assessing the use value, along with a Flat Quality Certificate, would be of importance to the end user, as it would serve as proof of the level of use value of the space owned by this user. On the other hand, the structure of principles and parameters presented can be the basis for conceptualization of the project task, through conversation with a known user who requires the design of the living space as a solution to the specific hierarchy of his or her personal needs.

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RANKO RADOVIĆ'S APPROACH TO THE PLANNING AND DESIGN OF PUBLIC SPACES THROUGH PROJECTS FOR CITIES IN FINLAND AND SERBIA

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Ranko Radović (1935-2005) was one of Serbia's most notable architects, urbanists, and professors, with a prominent influence on European scholarly discussions on planning urban centers and public spaces, which have come to light not only through his research design proposals but also through numerous publications, seminars, conferences and lecture notes. The importance of Radović lies in his profound and early understanding of urban issues that became common across Europe in the late 20th and early 21st centuries. He focused on the composition, ideologies, traditionality and innovation of cities, while striving to create paradigmatic shifts in urban design with the parallel retainment of strong cultures. Radović, strongly influenced by his European experiences, created urban schemes based on his strong ideals that were a product of deep urban perception and collective criticism deriving from his experiential research. As a result, this paper seeks to show and discuss how his time and practice in Finland, and particularly his research designs for the areas of Herttoniemi and Vuosaari in Helsinki (1995-1996), shaped how he perceived the concepts of urban spatial identification, geometry, and historicity, and how these elaborations evolved through his urban planning and design schemes in Serbia's northern province of Vojvodina (1997-2000).

***Key words*: Ranko Radović, urban planning and design, public spaces, historic centers.**

INTRODUCTION

Ranko Radović (Podgorica, 1935 – Belgrade, 2005) was a notable architect, urbanist, and professor, primarily active in Europe through his practice and academic career. Additionally, he was a council member of the International Union of Architects (UIA) (1984-1990), and was elected four times as President of the International Federation of Housing and Planning (IHFP) (1984-1992). Furthermore, Radović's architectural and urban design activities involved more than 29 completed buildings and more than 50 urban planning and design projects. While his projects in the 1970s and 1980s focused on cities in Sri Lanka, Algeria, Luxemburg, and Yugoslavia, his projects of the 1990s and 2000s involved cities in Finland and Vojvodina – Serbia's northern province.

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Ranko Radović's urban planning and design projects achieved a common strategic theme, whereby the architectural narrative was continuously connected with the attributes of the house and qualities of the shelter inside urban settlements, as he strived to place individual objects within their context, and integrate architectural typologies that abide by the broader and localized issues of the corresponding urban morphology (Radović, 2005b). Particularly in his later work from the '90s, working on public spaces, Radović led a large number of projects in which he focused on the objects of urban design and their relevance to his wider ideas on urban habitation. These ideas were inspired by the urban planning and design subjects of influential urban thinkers and authors including Lawrence Halprin, Gordon Cullen, Jean Castex, Jean-Charles Depaule and Philippe Panerai, and also the writings of Rob Krier, Aldo Rossi, and Nan Elin – these were concepts that Radović continued to develop in his theoretical work and analysis throughout his career (Gubić and Leontiadis, 2018).

In 1996, Radović arrived in Novi Sad to found and head the Department of Architecture and Urbanism at the Faculty of Technical Sciences at the University of Novi Sad, later working with local governments to come up with new urban planning and design proposals for different public spaces that belonged to historic urban centers. Before this move, he lived in Finland, where he held the privately funded 'Eliel Saarinen' Professorship at the Centre for Urban and Regional Studies (CURS) at the Helsinki University of Technology (1991-1996), and was also a consultant to the Urban Planning Office of Helsinki. This consultancy involved the development of urban studies in Helsinki and other Finnish cities, characterized by their high degree of development compared to global standards, together with a high degree of urban culture.

This paper's main goal is to highlight some fundamental categories of consideration that characterize Ranko Radović's ideas for urban planning and design, influenced by the relevant historicity of cities, for example in the new parts of Finnish cities and the towns of Vojvodina, Serbia's northern province. The choice of these two countries with diverse national identities was directly associated with Radović's experience and affiliation with them, borrowing elements of his philosophical urban design evolution and applying them to these two different national contexts. Therefore, it is critical to study and analyze how his evolving concepts of what is important in an urban core were applied to these two different urban backdrops (Finnish and Serbian), studying the types of semiological elements that were borrowed in each case. The aim is to ultimately study how the environmental spatial elaborations of concepts offer both a sense of thematic reference (i.e. 'belonging') and architectural elements that aid the ability to identify a foreign space that has not been visited before, creating a memory through those spatial elements (Leontiadis, 2015b). Consequently, the incentive for this study is in the realization of the importance of Radović's studies and urban projects for cities both in Finland and Vojvodina in Serbia. One result of this paper is that projects are documented and preserved for further evaluation and debate on city centers, which is how Radović expected his work to be used: as a platform for future processes within more detailed studies, plans and projects for cities in Finland and Serbia, as an evolution of his contribution (Gubić and Leontiadis, 2018). More particularly, this paper discusses Ranko Radović's urban planning and design schemes for the areas of Herttoniemi and Vuosaari in Helsinki in Finland (1995-1996), and Sremska Mitrovica (1997), Kula (1999), Apatin (2000) and Zrenjanin (2002) – all found in Serbia's northern province of Vojvodina.

THE GEOMETRY OF URBAN SPACE; LINES AND SHAPES

Radović's concentration on the geometry, patterns, shapes and lines of urban spaces is evident throughout his work, both through how he expressed his drawings and what he wrote about in his contemplations on existing conditions and proposed designs. For example, when writing about the city of Helsinki, he chose to emphasize the configurations of lines and shapes created by the *'complex patterns'* of the streets. Radović translated these into a "double relevance, as traffic arteries and social spaces support the functions and activities of the capital", creating a variety of streetscapes that provide "an inspiring testimony to the rich texture of urban life" (Radović, 2000c, p. 85).

Holding on to the use of the word 'arteries' and the existential description of urban objects becoming essences of communicative processes within the city, it is crucial to mention Radović's anthropomorphic handling of architecture, expressed through his careful and detailed wire-frame drawings of urban contexts that seek to 'nudify' the urban geometry. In fact, he described Figure 1 below as "the precise urban anatomy of the fabric, because 'we can love only what we know'" (Radović, 1996, p. 122) – a paraphrase of Leonardo Da Vinci's justification of his extensive and scrupulous anatomical sketches and drawings of the human body. This anatomical curiosity is strongly evident in Radović's drawings and projects for the city centers in Finland and Serbia presented in this paper.

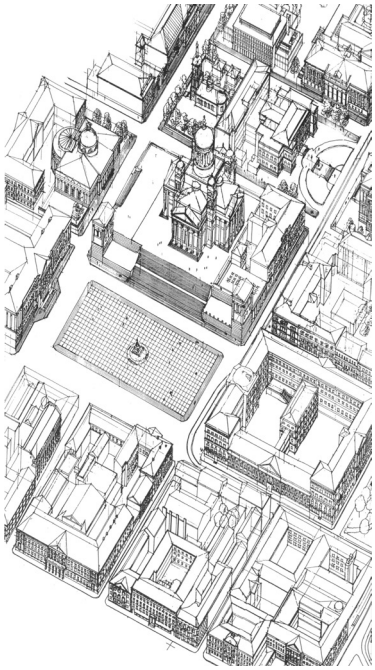

Figure 1. Ranko Radović's isometric drawing of Central Helsinki (Source: Ranko Radović 1996, p. 122)

The suggested complexity of Radović's urban patterns becomes a criticism of modern design, which he described as one-dimensional and repetitive urban spaces, with rigid architectural typologies and isolated buildings, surrounded by more or less organized 'free space'. Through the suggestion of more complex patterns and meaningful geometric shapes, he, therefore, sought to bring out the spiritual and cultural pluralism of a contemporary city (Radović, 1998), an idea that he pushed further by creating *thematic designs*, which are elaborated in the following section. His admiration towards the design language of synthetic bold and volumetric geometries was evident earlier on, through his mention of Pikku-Huopalahti in Helsinki in his *Finnish Experience 1991-1995* (Radović, 1996) – a neighborhood primarily built in the 1990s using prominent geometric shapes: circles, squares and triangles, to form residential housing.

The urban design study carried out for the city of Sremska Mitrovica (Figure 2) was a contribution of collective visions on the geometric configuration of the city at its urban core, through a proposal suggesting strict pedestrian lines and "that returns to the harmony of Hadrian's villas with one long bow" (Radović, 1997a, p. 1). In this arrangement, there was no central axis dictating the overall composition, causing the impression of an aerial view (Figure 2) that was lacking organization, concept, or order – an assumption that was hardly the case, taking into consideration the city's Roman heritage (mentioned in the 4th century BC as Sirmium (Curta, 2001)), and Radović's reference to the design of Hadrian's villa and the way in which the columns were replicated to link Sremska Mitrovica with its past (Gubić and Leontiadis, 2018). On the other hand, to connect two squares in the urban core with the axial street leading to the park, Radović chose to first cut the street using a circular antique structure as a kind of urban cultural gesture, inspired by Italian principles of public open urban space design and the notion of a religious landmark as a reference point of orientation. Here, Radović took on a more contemporary and slightly abstract vision of structural connectivity for his arrangement, further highlighted through his handwritten intentions (Figure 2) in which he noted the Emperor Hadrian's Latin axiom "varius, multiplex, et multiformis", translated as "diverse, manifold, and multiform" (Karivieri, 2019, p. 284), adjectives that strongly describe the principles of his Sremska Mitrovica design.

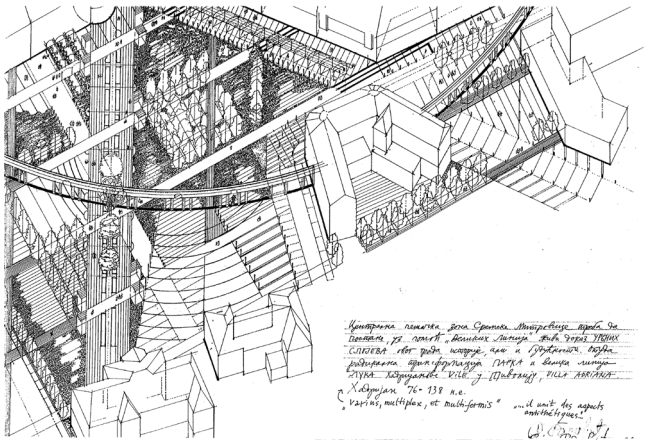

Figure 2. Design proposal by Ranko Radović for the central square of Sremska Mitrovica in Vojvodina, Serbia, 1997
(Source: Radović's family archives, courtesy Mirjana Popović Radović)

It is interesting to explore the similarities between Figure 2 and Radović's urban design research for the Herttoniemi area from 1992/1993 (Figure 3), carried out earlier in his career, in which he explored the possibility of the bow and dense use of urban land, in a non-symmetrical arrangement. In his relevant texts, he enigmatically wrote about the idea of "forces making towns", creating a "great influence on the built urban spaces of use and life" (Radović, 1996, p. 43).

The design proposal for Sremska Mitrovica (Figure 2) further suggested several sharp geometric transversal links with regard to the entire vegetation, transforming the park into a dynamic pedestrian ensemble, in which tree-lines were a key urban and design motif of this proposal. For Radović, implementing greenery in cities was more than an additional design motif: it was a sign of a greater urban culture (Radović, 2004b). This claim was further supported when he wrote that one of the most successful 'new cities' in Europe was Finland's Tapiola, which was planned, designed, and built from 1951 until the 1970s as a well-developed outcome of Ebenezer Howard's 'garden city' model (Radović, 2005a). Consequently, Radović's implementation of green elements in urban arrangements became a thoughtful part of his overall design compositions and geometries, as he sought to improve not only on-situ urban arrangements but the wider urban landscape configuration as well. As a result, even though his geometrical arrangements seemed to be inspired by the traditional Roman construction gestures of colonnades and arcades, the additional implementation of green objects became a vital part in the overall urban composition.

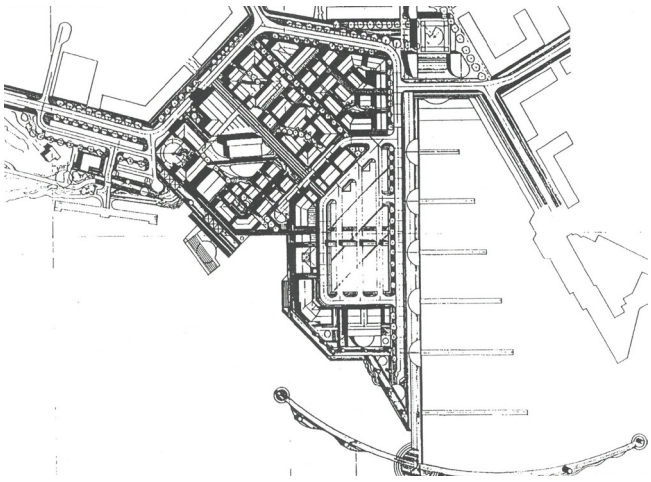

Figure 3. Design plan proposal by Ranko Radović for the Herttoniemi area in Helsinki, 1992/1993
(Source: Ranko Radović 1996, p. 42)

Along similar lines, the study carried out for the city of Apatin (Figure 4) began to decipher further parameters that influenced Radović's design solutions, since in this project he demonstrated a straightforward design with geometric principles that seemed to follow up on the 1990s movement based on tectonics and geometry. Consequently, the design gestures reach further back in their values, abiding by the phenomenological approach of the 1960s and 1970s in which certain solutions found relevance to a deeper semiological purpose in pursuit of "creating a cognitive apparatus of progressive intentions" (Leontiadis, 2015a, p. 922) while defining a genuine identification of a certain place. To break down this analysis further, the tectonics and geometry of the composition are especially evident in Figure 4 below, with its three-dimensionality of pure shapes and forms, creating access routes in several directions: a four-line three-way alley beginning in the main street, initiating the motif of a gate, and a long street shaft supported by a one-line three-way alley, starting at the health center in the middle of the street profile. In the study, certain directions in the city center are additionally supported by single lines of trees and a linear geometric paving pattern, street lighting,

billboards, masts, and other relevant urban furniture. Similar to the two new proposed buildings, the museums of beer and boats have a circular base, a shape that is repeated on the center's paving through patterns that have linear lines cut through them. These geometric patterns, which become transformed from three-dimensional built shapes to the patterns of the ground, almost bring to mind Stan Allen's contemplations of 1997, causing "an intuition of a shift from object to field," and "non-linear dynamics [...] of evolutionary change" (Allen, 1997, p. 24). In his proposal, Radović visually concretized Allen's suggestion to examine the "implications of field conditions", while allowing buildings to "reflect the complex and dynamic behaviors of architecture's users and speculate on new methodologies to model programme and space" (Allen, 1997, p. 24). Nevertheless, Radović's geometric structuring is not so obvious, which is why it is radical and implied, basing its organization on what was already there historically, at the same time taking new compositions a step further to integrate everything into the wider urban fabric. For this reason, buildings that are secondary to the main components are discrete and become part of the existing syntax: they have only one or two floors, oriented to the street, while the ground floors are open to the public. However, the main buildings proposed in the city center are higher than the existing architecture, suggesting a geometric hierarchy. Similar to Cecil Balmond's tectonic and geometric contemplations of 1998, the "new structure animates geometry: It reawakens an original inspiration of form, enquiring of space itself as to its nature and interpretation" (Balmond, 1998, p. 83).

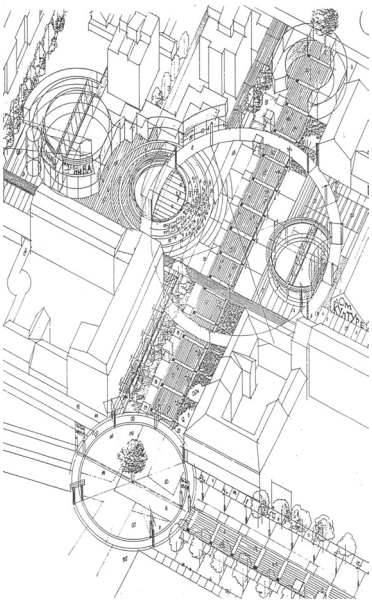

Figure 4. Design proposal by Ranko Radović for the central square of Apatin in Vojvodina, Serbia, 2000
(Source: Ranko Radović, 2000a, p. 20)

Much of this three-dimensionality of design found in the Apatin proposal is also evident in Radović's earlier proposal for the area of Vuosaari (a neighborhood in the city of Helsinki), demonstrating the strong influence of those earlier years in the development of his evolving conceptual contemplations (Figure 5). Comparing the two figures (4 and 5), it is interesting to observe the added complexity and more synthetic characteristics of the Apatin proposal (Figure 4), deriving from a stricter and more straightforward configuration of the Finnish example (Figure 5).

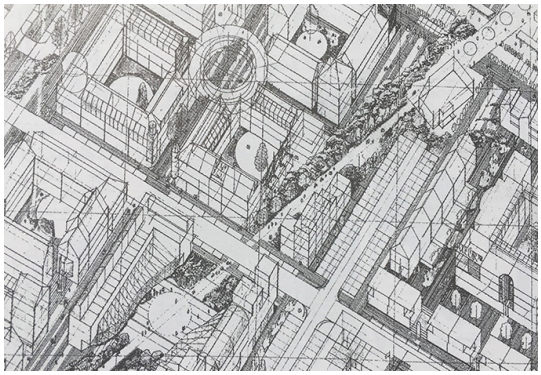

Figure 5. Design proposal by Ranko Radović for the Vuosaari area of Helsinki, 1995
(Source: Ranko Radović, 2005b, p. 282)

Further elaborating on his earlier Finnish approach to the Vuosaari neighborhood, it is interesting to study the gestures of colonnades and arcades in his research design for the Pauling 'Urban Factory' (Figures 6 and 7), in an effort to add significant elements to the existing factory's facades to integrate it into the surrounding urban environment. This is part of a wider plan to which Figure 5 also belongs, in an effort by Pauling Company to renew the area and its surrounding land. This design proposal implements the open vertical elements of the colonnades in strategic ways that both open up the composition to the surrounding area's main axis of urban circulation (Figure 6) and promote the pedestrian use of the adjacent street (Figure 7). As a result, the colonnades multiply the potential of urban activities and interactions, similar to the intentions of the colonnades and arcades seen in the design of the city of Apatin (Figure 4). However, the geometric order in which this is accomplished is different, whereby a specific ambience is contemplated by the use of an amphitheater form (semi-circular by nature), designed for outdoor activities such as recitals, lectures, poetry nights, etc. In any case, the geometry of the arc is apparent even in the more linear arrangement of Pauling 'Urban Factory' seen below, acting as a suggestion for opening up to the surrounding urban fabric.

The geometry of urban forms in Radović's designs is often translated into the shape and configuration of the circulation and traffic – a gesture that was widely used in European proposals nearly two decades later. For example, in his proposal for the city of Kula, implemented during Yugoslavia's politically turbulent times, Radović suggested an urban planning approach of street circulation in which he closed traffic in Kula's Lenin Street, creating vital urban pedestrian walks. It is interesting to observe that this type of configuration is very similar to what was recommended later in the Europe 2020 strategy on sustainable urban mobility plans and more "targeted action on urban road safety" (European Commission, 2013, p. 1-6), emphasizing his early

European influence in paradigmatic urban configurations. Meanwhile, Radović discussed the "sustainable, smart, and inclusive growth" of cities, later suggested by Caprodossi and Santarelli as "slow paths and urban networks" (Caprodossi and Santarelli, 2012, p. 103) that add to the overall quality of the urban space, "emphasizing the prevalence of circular processes instead of linear ones" (Sargolini, 2012, p. 173). Furthermore, Radović's concern with circulation and traffic also translated to bicycle paths, which he considered an important factor of urban culture missing from Serbian cities and towns that were newly planned from the '50s and onwards, compared to Finland's 840 kilometers of bicycle and pedestrian paths serving Helsinki's 500,000 inhabitants (Radović, 2003). This concern of his is evident, for example, in the design of Apatin's radial expansion of pedestrian routes (Figure 4), causing the area of the square to be visually divided into several parts/areas, with each acquiring a unique character. Therefore, in addition to the physical structure, the space further gains interest due to its newly defined and specific contents, and function.

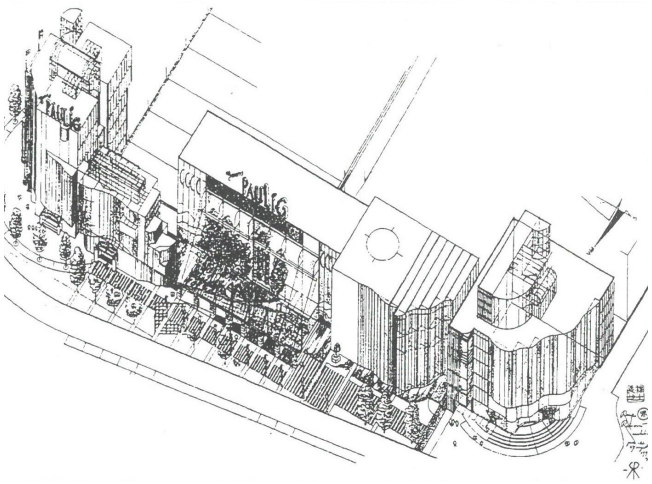

Figure 6. Research design proposal by Ranko Radović for Pauling 'Urban Factory' in Vuosaari in Helsinki, Finland, 1995. The image expresses the west side that is open to the area's main axis (Source: Ranko Radović 1996, p. 52)

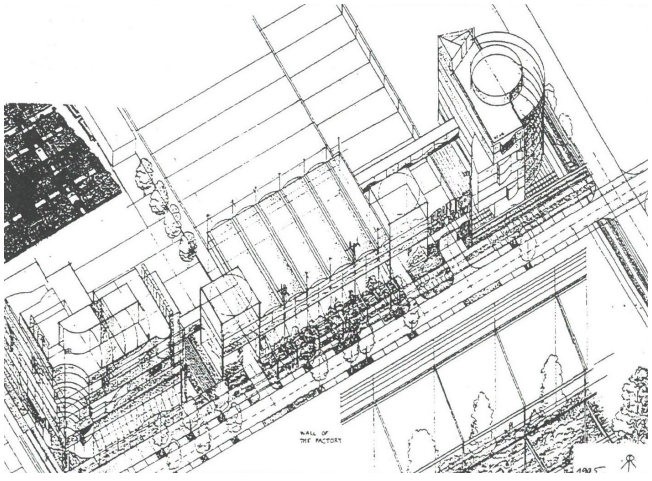

Figure 7. This image expresses the east axis, promoting the pedestrian use of the street. (Source: Ranko Radović 1996, p. 52)

THE IDEOLOGY OF URBAN SPACE; PRAGMATISM AND IDEALISM

Radovic's ideology of urban space is readily expressed through his writings and lectures, demonstrating a holistic understanding of the environment for which he spoke, through what he calls *'sensitive urban planning'*. Highlighted in his volume on the Finnish experience, which set his foundation for later planning in Serbian cities, he expressed his concern for "taking care of all dimensions and interests in urban matters, trying to combine pragmatic realities and high ideals, and developing the pluralistic, complex and integrated thinking of the urban functions, as of the urban spaces" (Radović, 1996, p. 33). This 'sensitive planning' approach is mentioned in more of his writings, elaborating on a process of exploring "the simplicities and weaknesses of post-war architecture and urban planning as a lesson" (Radović, 1998, p. 39).

Later, in 2004, he further elaborated on 'thematic planning', breaking down its main characteristics in "the interdisciplinarity, complexity and integrated social / political / cultural / economic[...] / spatial and construction issues" (Radović 2004a, p. 1). It is further interesting to speculate on the way in which he proposes a pragmatic analysis of such an idealization, which he described as "an integrative approach" involving "layered analysis" and "sensitive relations with many different urban dimensions and aspects" (Radović, 2004a, p. 1).

During Radović's involvement with a series of workshops and seminars that took place in the city of Zrenjanin before the relevant urban design competition, he was able to elaborate on his ideologies that were highlighted by the main topics of the events, concerning how the city of Zrenjanin had been a cultural and economic center of the region for 600 years, but at that time faced certain urban problems and loss of its recognizable spatial identities, along with its 'genius loci' (i.e. *the spirit of a place*) (Gubić and Leontiadis, 2018). Therefore, even though the competition took place a few decades after the surge of the phenomenological uprising in architectural and urban planning in the 1960s and 1970s, this presented an opportunity to use whatever knowledge happened from then and until the early 21st century, and tie it back to the influential essence of finding and elaborating on the place's true identity.

On the idea of good design for urban space, Radović emphasized the presence of well-identifiable urban forms that are readable, safe-moving, public and semi-public, while also following the Italian guidelines of Camillo Sitte found in *City Planning according to Artistic Principles* (Sitte, 1945). Strongly influenced by these writings, Radović sought to consider the spaces in between, together with the total harmony of the environment – this approach indeed followed many of the semiological theories that support the hidden relationships between a building and the surrounding site, as well as the public spaces around those buildings (Radović, 1996). In fact, when initiating studies such as those for Apatin and other cities in Vojvodina, Radović hoped that his conceptual experimentations and definitions could be used by the local government as a basis for further planning in various urban centers, establishing a framework for further

urban development, while also setting the ideological framework of the city's organization.

In his design for the city of Apatin (Figure 4), we see his intention to create a central urban area with "more radical supplements to become a real magnet" (Radović, 2000, p. ii), in pursuit of referencing an original inspiration and ensuring an evolutionary interpretation. His intentions, as he pointed out, were not to remain bound to the already occupied/bordered space but become synchronized, both with the existing context and with the advantages of the potential new part of the center. This envisioning was organized in three directions: 1) the program and quality of content; 2) the spatial coordination and connections, and; 3) the details and arrangement of the ambience according to the highest standards of contemporary urbanism. These clarified intentions began to mature earlier on, from his Finnish explorations, as seen through the urban design research for the Herttoniemi area (Figure 3), in which he discussed a means of "hierarchical urban structure" of urban greens, acquiring the additional touch of a higher standard, as mentioned earlier in this paper. Additionally, he highlighted the importance of understanding the concept of a "city within a city", in which new areas are independent, homogenous and self-sufficient (Radović, 1996, p. 45) – referring and relating to his later mention of spatial coordination and connections.

Looking again at Balmond's *New Structure and the Informal*, which is highly relevant here, we read concurrent thoughts on the theoretical architectural and urban outlook, combining the tectonic with deciphering 'the spirit of a place', in which the architect extracts "hidden energies to a building", improvising gestures through non-apparent connections, and putting together equilibriums in ad hoc instances; Balmond describes these as informal acts of release that set architecture free from fixed notions of an urban grid that otherwise acts as a cage, leading to more diverse urban topographies (Balmond, 1998, p. 83). Radović found examples of such ideals early on in the Finnish city of Tapiola; "one of the most important achievements in post-war urban planning and development – and not only in Finland," with its "typical combination of urban-rural-natural forms to produce a particular townscape," or "mental space" (Radović, 1996, p. 23). Therefore, it is not strange to see the highlighted importance of green elements, not only in his later town designs in the province of Vojvodina, but also in his more mature written works.

THE TRADITIONALITY OF URBAN SPACE; HISTORICISM AND CULTURE

Radović's concern for traditionality and its preservation within the urban context are evident in a number of his writings and his participation in relevant congresses, such as the 10th *International Federation for Housing and Planning* [IFHP] Urban Planning / Design Summer School with the theme 'To Regenerate Urban Heritage'. Concerned with the ongoing topic of globalization and the endangerment of past architectural and urban achievements, Radović could strongly empathize with this event's incentive, recognizing the "need [for] a change of paradigm in evaluating the characteristics of urban and semi-urban communities as testimonies of their own time and society – regarding urban and cultural heritage as a resource and projecting these values into the future" (Helsinki University of Technology, 2004, p. 1). This same event, showed an even earlier devotion to the importance of historicism and culture in the design of cities, for example in the 7th IFHP Summer School, the objective of which was intervention on existing townscapes while "keeping in mind their traditional value and relevance in the modern urban life" (Helsinki University of Technology, 2001, p. 1). These events seemed to have been of strong interest to both Radović and those who participated, resulting in his establishment and leadership of IFHP Urban Planning / Design Summer Schools in Finland for 10 consecutive years, the last one being in 2004.

The circular antique structure that cuts the urban blocks of the city of Sremska Mitrovica (Figure 2) seems like an attempt to narrate the layers of the city, together with an effort to reinterpret and transform certain urban motifs through their symbolic signs of gathering, continuity, pluralism, and social integration. These expressive layers are a pragmatic expression of the previously mentioned ideological approach of a "layered analysis" (Radović, 2004a, p. 1), which finds application in the narration of history. Here, Radović was trying to link the present condition with tradition in a unique way, through sharp walking pathways, large curves, and the implementation of paving, urban furniture, lighting, and other purposeful elements that suggest a narration within the street.

Traditionality comes not only in the sense of honoring a city's past but also in the way in which it expresses its influences and inspirations. For example, this type of traditionality is evident in the tree-configurations in the design for Sremska Mitrovica, which resemble Roman colonnades and arcades – an idea that is also elaborated upon in the geometrical explorations of Radović's urban shapes.

Traditionality is important when it comes to redesigning cities, such as in the case of the city of Kula in 1999. Here, Radović supported a traditional approach of simplification, similar to the developing possibilities for green urban centers following a deep economic crisis, involving the "simplification of town planning processes [...] [and] the revision of regional spatial plans" (Zifou, 2015, p. 159). This approach gave importance to the original intentions for the city, combined with a more straightforward language that sought to immediately target the city's fundamental needs with a parallel strategic calculation of urban planning gestures that might also be needed in both the near and distant future. This is where traditionality must be considered closely with contemporaneity and a nation's current state, which in any case, is a result of a chain of events that still relate to gestures and decisions of the past – whether planning politically, urbanically or both. This idea further relates to Eckardt and Sanchez's work *City of Crisis* (2015), in which wider urban issues are justified as a result of a nation's overall state, including poorly managed or lack of appropriate cultural diversity, and miscalculated urban planning gestures.

During the period in which Radović produced his design proposals for public space interventions and urban development within historically significant public spaces, making contemporary interventions was both common and

challenging, partially highlighted by Ananiadou-Tzimopoulou and Yerolympos' 2000 European study on certain historical European squares and the pursuit of their contemporary interventions. Such works highlight challenges similar to those faced in connection with Radović's research designs for Finland and Serbia, dealing with matters of character, scale, physical space, and ecological factors (Leontiadis, 2015b), in a parallel effort to avoid "imitation, false naturalism, the insertion of falsely decorative elements, statues, or false works of art, urban equipment, or illumination that trivializes the space, elements that are inappropriate for the site and the particularities of the project" (Ananiadou-Tzimopoulou and Yerolympos, 2000, p. 113-114).

All of the elements described above highlight Radović's theoretical conviction that relationships between buildings should be modest and simple, retaining both a socially visual and urban energy (Radović, 1996). Another important aspect of his concern was the quality of texture of the urban fabric, which he suggested to be "open, consistent, diverse and tolerant to changes and spontaneous, unplanned events and activities" (Radović, 1996, p. 103). These descriptions not only touch upon the phenomenological influence noted earlier, which puts weigh on the important factor of human behavior and perception within designed spaces, but they also support Lewis Mumford's (1938) earlier ideas on the flexibility of space, aiming to meet human needs through variety.

THE FUTURISM OF URBAN SPACE; INNOVATION AND TECHNOLOGY

To further examine the thought processes behind Radović's design and theoretical contemplations, it is fair to argue that all of his intentions were expressive dimensions of urban culture, which were supposed to simultaneously form creative environments for future innovation and technology. Even though Radović was an advocate of traditionality with a deeper sense of thematic and ideological planning, his rulings did not seem to oppose possibilities for the futurism of urban space. In fact, he spoke of the creation of an analogy of the urban environment with machinery and industrial products, only possible at the level of technology. This, he claimed, only expanded to the very spirit of our cities and districts towards the creation of their form, their function, and their landscape (Radović, 1998).

At a roundtable organized in Zrenjanin in 2001, Ranko Radović stressed how the development of Zrenjanin's city center was an opportunity for rethinking urbanism while creating productive planning opportunities that within the next 5 or 15 years could radically change the state of the city. He mentioned that such changes should not be by means of 'revolutionary gestures' or be affected by prejudice towards 'inherited' urban elements or by certain titles of governmental influence (Gubić and Leontiadis, 2018). This goes along with the post-modern thinking that was present at that time, seeking to suggest more active design alternatives that would go steps beyond the idealized images of the urban collective past (Mallgrave and Contandriopoulos, 2008), similarly to the 1999 conceptual framework made known three years earlier by Ben Van Berkel and Caroline Bos through their UN Studio, renouncing architects and planners as "the fashion designer[s] of the future […] speculating, anticipating coming events and holding up a mirror to the word" (Van Berkel and Bos, 1999, p. 27-28). Radović seems also to have been drawn into this contextualization of a polemic state of 'deep planning' that relates to an attempt to create social reinterpretations in the city.

Later, Radović published the text 'Zrenjanin's Center – Cross-checking Urbanism Today', advising on ways to push the city towards reaching its desired state. He wrote:

> "The perfect city design, from big avenues to urban details and urban furniture, can exist only at the place and in a time when the spirit of the city and the spirit of the place are known, when urban space means something and has a power to reflect its citizens' needs, goals, and ideals" (Radović, 2001, p. 53).

What takes place in these writings is what was mentioned earlier: a contemporary approach of offering semiotic significance to elements while knowing and understanding their historical importance. On these thoughts, remembering also Alan Colquhoun's Historicism and the Limits of Semiology of 1972, we discern Radović's parallel stress on understanding both the historical context, and any changes that are related to their accompanying ideologies. Furthermore, Radović's characterization of urbanism as an "art", as stated earlier, is very similar to Colquhoun's descriptions of urban systems as aesthetic systems "grouped under the fine arts and the applied arts" (Colquhoun, 1985, p. 130-131) – all of which retain certain properties of a 'critical tool'. Ultimately, the deciphering of the city through its details should reflect a multivalent understanding of its citizens, therefore, bringing together the tectonic and the structural, with the 'spirit' of the place.

CONCLUSIONS

Radović's approach to planning and designing public spaces seems to demonstrate a sequence of evolution and development from his Finnish years to his sequential research designs within the Serbian context. During both of these periods, Radović demonstrated a special interest in specific categories of investigation concerning the geometry of the urban space, its ideological characteristics, the integration of traditionality with regards to the relevant cultural context, and the future possibilities for the spatial transformation of the places he studied and designed. The selection of these categories as part of this research was influenced by Radović's theoretical preference, as demonstrated in his written texts, his lectures, and his conference discussions. However, these preferences of thematic investigation are also evident through his drawings, in which he seemed to illustrate and bring out elements that called the observer to decipher their semiotic meaning. These often wire-frame drawings sought to expose the fundamental urban geometry of the place, ensure an interpretation of an evolving urban hierarchy, bring out the historical and cultural attributes of the greater composition, and present a futuristic vision of expressive innovation and potential technological integrations.

Therefore, Radović's analysis not only sought to express and reflect the culture of the Finnish and Serbian cities which formed his context, but also to create possibilities for future interventions that would find values on which to stand, creating a semiological basis for construction. It seems that

Radović took such interventions of any new architecture into the existing urban and natural environment very thoughtfully, using a combination of synthetic innovations in a flexible and sensitive manner. This sensitivity was his primary concern, aiming to suggest subtle interventions that add to the semiology of a place rather than to the grandeur and radicality of its design – a revitalized approach, as stated by Radovic, which builds onto a city's lost strength during times of what he called *'tired urbanism'* (Radović, 1998).

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ART NOUVEAU IN ZAGREB: THE NEW MOVEMENT'S SIGNIFICANCE TO THE PROFESSION OF ARCHITECTURE

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This paper traces the implications of Semper's *Bekleidung* theory on working processes in the field of architecture in Zagreb. The idiosyncrasies of the work of freshly graduated architects in a peripheral Austro-Hungarian city are analysed, both in the context of developing and spreading the city block system and the appearance of the new Art Nouveau style. Buildings in this new modern style, which appeared in 1897, were built sporadically throughout the city's urban fabric, which generally consisted of historicist residential buildings at the time. Parallel to historicism, the demand for Art Nouveau from clients grew, especially around the turn of the 20th century. At the time, typical migration processes resulted in the arrival of a well-educated populace that would commission Art Nouveau buildings in the coming years. The unique characteristics of Art Nouveau style, especially its ability to directly engage citizens and transmit messages of modern times, proved to be an important determinant in its increasing popularity in the city. Many professions and products were advertised on the façades and ornamentation of buildings, the main bearers of Art Nouveau style.

***Key words*: Art Nouveau, Zagreb, architectural profession, Semper's *Bekleidung* theory.**

INTRODUCTION

This paper provides an analysis of the development and construction of the city of Zagreb and the work of architectural firms in what was a peripheral Austro-Hungarian city, in order to identify trends typical of the late-19th and early-20th century, using a significantly reduced sample from an area far smaller than Vienna. Zagreb, with its quickly growing urban fabric, has been recognised as a typical Austro-Hungarian city, in which sporadic examples of Art Nouveau buildings appeared at the turn of the 20th century, parallel to more than 60 years of firmly-rooted historicist canon (Witt-Dörring, 2015). The intent is not to analyse the detailed stylistic determinants of the time, but rather to observe the typology of buildings and the clients who commissioned them, as well as particular eminent Art Nouveau buildings, and to reflect upon how changes to the stylistic canon affected the work of the small number of architectural firms that existed in the city at the time. After a general elaboration of the state of the construction industry and the building principles used in the city, a relationship will be established with the then-influential architectural theory of Gottfried Semper. Its determinants will then be verified, and the organisation and work of one of the most established architectural firms in Zagreb, Hönigsberg and Deutsch, will be presented, in order to shed light on poorly known differences in the way Zagreb's architectural firms worked. These differences came about with the introduction of Art Nouveau projects and academically trained architects into hitherto well-coordinated historicist practice. It will then be further affirmed that the increase in production of historicist buildings in well-situated, well-functioning firms that were somewhat reluctant to change – in terms of the speed with which their employees were prepared to

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answer to the increase in commissions – opened the issue of authorship and made room for creative and autonomous invention in what had previously been routine, efficient professional practice. Finally, it is concluded that these transformations led to a re-definition of architecture as art and to a change in the status of academically trained architects, becoming equal to that of artists.

CONSTRUCTION – BUILDING OWNERS – ARCHITECTURAL FIRMS

The significant influx of residents and related building activity in Zagreb from 1870 to 1910 was caused by the construction of a railway line connecting Zagreb with the capitals of the Monarchy – Vienna and Budapest – on the one hand, and an unexpected natural disaster on the other – an earthquake (Domljan, 1979). The earthquake struck in 1880, immediately creating opportunities for vigorous architectural renewal. Due to the urgency of the situation and the increased number of commissions, architectural firms worked using pre-existing designs for residential buildings, which resulted in a standardisation of the urban fabric, allowing buildings to be built with a short turnaround after the purchase of land (Laslo, 1984-85). After being connected with the centres of the Monarchy, Zagreb began to grow from a city on the administrative and political periphery into an ever-stronger economic centre. This is confirmed by the exceptional growth in the number of buildings comissioned by monetary institutions, as well as the appearance of an entirely new type of building that would mark the entire period without precedent – the rental apartment house. Similar to the circumstances in Vienna (Blau, 1999a, Schubert, 2018), the construction of rental apartment houses and the property speculation inherently connected with them became an important, if not vital, determinant in increased construction and the related development of a street grid in Zagreb.

As the modernisation of the city generated the need for the construction of this type of building, the city administration used the legal tools of building codes and urban plans to curb uncontrolled trade in property and the filling of city plots as dictated by entrepreneurs. Plots were built upon arbitrarily until the mid-19th century, when a board was founded to introduce a building permit procedure, which defined the legal framework for the urbanisation of the city (Dobronić, 1983). A new class of wealthy citizens appeared, who invested in projects for this new type of building. The city administration attempted to both encourage and control the purchase, construction, and sale of city plots along the perimeter of city blocks in order to build rental houses. The orthogonal city matrix proved fertile ground for the city's expansion eastward and westward, while building codes determined what could be built on a particular plot (Figure 1). Precise regulations for residential buildings were not drafted in Zagreb until the 1930s, and these prescribed in detail the dimensions of some types of rooms, residential hygiene standards, and the architectural elaboration of buildings. Until this time, the design and construction of rental blocks was significantly less controlled, which meant that their development was partially left up to clients, architects, and master builders (Laslo, 1984-85).

Figure 1. Initiation of the orthogonal city grid in Zagreb (Source: Digital collection of the National and University library in Zagreb, Zagreb city plan, Dragutin Albrecht, 1864)

Although a certain number of representative buildings, most of which were residential buildings with or without rental flats, were built along main city thoroughfares, the remainder of the urban fabric that dominated the city consisted mostly of buildings constructed according to standardised, stereotypical projects. The aforementioned wealthy class built these buildings; however, many members of poorer classes took advantage of the favourable construction situation and made use of the exceptional opportunity to become homeowners. This favourable construction situation was fueled by a city order freeing new buildings from taxation for 10 years, as well as by favourable short-term bank loan terms, which provided strong impetus for the construction of this new type of building (Timet, 1961). Inspired by these favourable conditions, entire city blocks soon became open building sites. This increase in the number of buildings simultaneously put significant pressure on the few existing architectural firms, and it was certainly in their financial interest to reorganise their work and business methods to meet this increased demand. The modernisation of the city would accelerate even further after World War I, when the majority of the city's blocks were built upon within a span of ten years (Timet, 1961). Due to insecurity and the cyclical appearance of crises, the construction of housing would become one of the safest forms of investment in Zagreb, and thus the most sought-after kind of architectural project. Increased interest in architectural projects did not come exclusively from clients from the business community, but also from the owners of architectural firms themselves (Bagarić, 2018). They had a good understanding of the business environment, as well as of procedures and protocols in the creation of drafts and the issuing of building permits, and they saw participation in these building circumstances as an exceptional opportunity. A few architectural firms, thus, not only drafted and carried out numerous projects according to the plans of others, but also invested, built, and participated as stakeholders and designers in the work of companies and organisations that invested in the construction of residential buildings. This practice was a continuation of the work of the 19th-century builders' guild. The builders' guild both designed and executed projects regularly, meaning there was no border in

between architectural firms and construction firms. This is supported by the fact that the builders' guild was dominated by master builders (*Baumeister*), who often worked together with entrepreneurs, while legislation equated the status of master builders with that of architects.

ART NOUVEAU RENTAL APARTMENT HOUSES – AT THE CROSSROADS BETWEEN CLIENTS AND ARCHITECTURAL FIRMS

The appearance of Art Nouveau style constituted a turning point in architectural practice, especially in the construction of new residential buildings amidst the city blocks, consisting almost entirely of historicist buildings. The change was marked visually with the construction of the first rented apartment house by Dr. Rado in 1898 on the representative Green Horseshoe Prospect by Atelier Fischer & Hrubý, but it could also be claimed that the change equally affected the architectural profession (Figure 2). The usual protagonists in housing construction – master builders and so-called *entrepreneurial associations* that both designed and built buildings – had garnered great experience through the mass reproduction of historicist rental houses according to the choice of a historicist style by their clients. Now, demand was increasing for professional architectural firms that employed architects educated at technical universities (Technische Hochschulen) or arts academies (Akademie der bildinden Künste), the two types of institution that usually trained European architects at the time (Long, 2016).

With the appearance of Art Nouveau, it became common for building designs from the imperial centre in Vienna to be copied, and this was also the case in Zagreb. Historicism was the initial stylistic choice of the local aristocracy, as well as of wealthy citizens who followed their trends. After freedom of movement was awarded to the rural population in 1848, large waves of migration took place throughout the Monarchy (Blau, 1999b), and Zagreb was no exception to this. Numerous highly educated doctors, dentists, pharmacists, lawyers, civil engineers, and many others moved to Zagreb; in addition to their primary professions and their professional activity in Zagreb, they also saw the opportunity to become entrepreneurs and property owners, as well as to invest in the construction of rental buildings. Within the context of the liberal economy and free market in which these individuals did business and competed, as well as their need to advertise and directly address society, Art Nouveau served as the architectural answer this class of citizens sought.

Their need to communicate and represent the aspirations of modern times became especially apparent in one architectural element – the façade, for which Art Nouveau offered a formal innovation. Street-facing façades took on an important role in representing the educated, entrepreneurial-oriented bourgeoisie; their shallow and freely-used ornamental decorations were used to advertise their numerous businesses, professions, and products (Fatović-Ferenčić and Ferber Bogdan, 2018). Eugen Rado, and the aforementioned Dr. Rado building, is one representative of this phenomenon. Rado, a dentist of Hungarian descent, moved to Zagreb after completing his schooling in Vienna. He rented a flat in a building on Zagreb's main square, where he lived and opened a dentistry practice (Fatović-Ferenčić, 1998). After six years of work, he invested in a construction plot on the central city thoroughfare and built a rental apartment building exclusively to profit from rent (Bagarić, 2011). With the capital he earned, he soon decided to construct a commercial and residential building at a prestigious, central location – Ban Jelačić Square – where he relocated his dental practice and lived with his entire family. Aside from the dental practice and his five-room flat, the remaining floors were again intended for rent. There is no need to stress that both of these rental buildings were built in Art Nouveau style. The second one, with its representative elevation, faced the square and featured metal letters that advertised the dental practice, while the selection of a prestigious city location served as an affirmation of Rado's reputation, his numerous clientele, and general success. The square-facing façade was richly ornamented: the first floor had two symmetrical loggias with glass elements within a fine metal sub-structure, and the remainder was filled with organic motifs; the sloped roof was covered in green glazed tiles, and a sign advertising the dental practice featured symbols of the medical profession.

Figure 2. Art Nouveau façades of the Rado rental apartment house (Source: Živković, 1977)

The entrepreneurial spirit of Rado was shared by the newly arrived and well-educated citizenry who, by the end of the 1890s, counted for 69% of the registered citizenry (Laslo, A. 1984-85). The arrival of new inhabitants from many cities and towns throughout the Monarchy increased, especially in the decades prior to the turn of the 20th century, which coincided with the boom in the presence of Art Nouveau style on building façades. One of the symbols of Art Nouveau in Zagreb, the Kallina apartment house, was commissioned by Josip Kallina, who arrived from Prague; after studying engineering in Prague and serving as an administrative clerk in Vienna, he relocated to Zagreb, where he became a

manufacturer, trader, and landowner. The Kallina apartment house was built with flats for rent, however it also contained a storefront for Kallina's factory, which sold and distributed ceramics products. As the building's façade is covered in ceramic tiles, it has been called "Zagreb's Majolikahaus", however, while the Viennese Majolika is covered in tiles with floral motifs made by the Winerberger company, the building in Zagreb is covered with tiles that served as an advertisement for the Kallina factory's locally made products. Additionally, like the Wiener Werkstätte [Viennese Workshops], Kallina also produced ceramic masonry heaters in Art Nouveau style, which corresponded to tendencies in Vienna (Klobučar, 1960). Viennese Art Nouveau artists believed that abolishing the hierarchy between the fine arts and the applied arts would allow the style to enter into the everyday life of citizens more easily, which would lead to an affirmation of the belief that one becomes a modern man through the purchase of modern products that have undergone an artistic transformation, which was in this case in the Art Nouveau style.

GOTTFRIED SEMPER'S *BEKLEIDUNG* THEORY

Otto Wagner made a key step towards defining the new style of modern times through his statement and practice of abandoning the re-use of older architectural styles. This belief was founded in the utilitarian design of the new form (Nutzstil), and not its mere innovation, as well as in a consideration based on Gottfried Semper's 1860 material theory of evolution. Semper's *Bekleidung* theory was a radical answer to the practice of historicism, which blossomed in the 19th century; it claims that the architectural whole is based on four elements, only two of which will be key to our considerations here: the roof and load-bearing structure and, in contrast, the external non-load-bearing envelope (Semper, 1989). His theory is founded on a strong criticism of and opposition to the contemporaneous historicist practice of schematic reproduction and the entirely arbitrary application of a wide range of different motifs on building façades. In his true search for the scientific foundations of architecture, he saw such eclectic tendencies as highly incorrect and inappropriate solutions that did not reflect the true social tendencies of the time. The task of these two elements is twofold: the load-bearing structure defines and protects the interior, which is experienced directly and physically, while the outer envelope refers to the exterior and is perceived impersonally, exclusively visually, and transmits pictorial information to passers-by (Hvattum, 1995, Hvattum, 2001, Hvattum, 2004). The task of the envelope is not exclusively to narrowly convey the structural truth of the building. Instead, its task is much broader – to communicate much more than just the structure. Regardless of what happens behind it, he claims that the façade is a separate, entirely independent theoretically elaborated element that follows its own logic and communicates with its own surroundings. It takes on a symbolic role, conveying the deeply rooted cultural conventions of the time, thus also becoming a part of and truly participating in the social life of the city. Semper's theory thus deciphered the position and meaning of the outer envelope, also providing society as a whole with an understanding of its own historical position through the interpretation of the messages placed there (Mallgrave, 1988, Otto Wagner, 1993). Otto Wagner also relied significantly on the principles of Semper's theoretical ideas in his professional activities (Topp, 2004). Not adhering completely to Semper's allowance for the façade to transcend the simple symbolic potential of the load-bearing structure, as his numerous critics have noted, Wagner often relinquished the opportunity to achieve a higher level of artistic freedom on façades. Wagner's formula of realism in architecture and his derivation of art from mere tectonics and material givens has been recognised as the only divergent point between him and Semper. Additionally, Wagner considered that the basic artistic talent necessary to practice architecture was drawing skill, which was not only an important criterion for enrolment in the Special School of Architecture at the Viennese Academy of Fine Arts, of which he was vice rector, but also for involvement in the Wagner Atelier. For this reason, Wagner's assistants were all highly trained in drawing, which was a prerequisite for work on his architectural projects (Boyd White, 1989). Drawing skill affirmed the perception of architects as equal to artists, and a trained hand was a crucial tool in communicating one's ideas (Nierhaus, 2015). We shall now analyse the working processes of the Hönigsberg and Deutsch architectural firm through the lens of the logic of Semper's theory, which is founded on the free artistic design of the façade and the distinction between the roles of the façade and the load-bearing structure.

THE UNIQUE IMPACT OF ART NOUVEAU ON ZAGREB'S ARCHITECTURAL SCENE

This research is intended to highlight the direct influence of Semper's aforementioned theory on the internal organisation and nature of the work of architectural firms. This phenomenon became especially common in Zagreb around the turn of the 20th century due to incentives for the standardisation of the urban fabric and the imperative to build as quickly as possible, accompanied by a strong growth in the number of architectural commissions received by well-established firms in a relatively short time. The number of employees increased along with the number of commissions; the internal organisation of how firms worked also changed, becoming fairly systematic and bureaucratic in the best-established firms.

One of these was court architects Leo Hönigsberg and Julio Deutsch, who dominated the historicist landscape in the 1890s and 1900s. The firm was founded in 1889, paradoxically the same year Wagner published the first volume of his "Einige Skizzen, Projekte und ausgeführte Bauwerke" [Sketches, Projects, and Executed Buildings], in which he announced a break with the uncritical recycling of previous styles. The domination of this duo in Zagreb was aided by the fact that the established master builders, who were exclusively active until this point as the main driving force of construction, were gradually retiring, thus removing themselves from competition with a new generation of professionals, who found new ways of working and communicating with clients. Hönigsberg and Deutsch frequently published their works in Austrian, German, and Hungarian professional journals; they also entered selected

works for presentation at domestic exhibitions alongside artistic associations. The sudden increase in architectural commissions in these years was so great that their opus included nearly every tenth newly built building in Zagreb; their total production was twice that of the next competitor (Laslo, 2003). With a few exceptions for wealthy clients on representative city thoroughfares, the majority of what they built, in terms of the architectural quality of the designs, does not exceed the limited commercial standard widely accepted for residential buildings built in historicist styles. By comparison, in 1863, a total of 9 two-storey buildings and 20 one-storey buildings were built (Bedenko, 2000). The total opus of Hönigsberg and Deutch numbers more than 100 new buildings; if all additions, renovations, and courtyard structures were included in this number, it would be significantly higher, if not double. Hönigsberg and Deutsch used a form of internal organisation in which, "in accordance with modern principles, the owners were the first of all bureaus in Zagreb to establish a division of labour and teamwork with a large number of employees" (Laslo, 2003). Bearing this in mind, it follows that one of the largest firms in the city provided employees with specialist training for particular segments of project development. The practice of creating and drawing only some segments of projects led to a separation between master builders, educated technicians and trained architects. The first ones did the majority of work involving floor plans or cross-sections of buildings made according to existing templates, thus a smaller number, or even just one academically trained architect was needed to design the non-standard parts of an architectural project. The majority of these non-standard parts of tasks related to the artistic aspect of façade designs and supervising the coordination of the entire project. Creativity was needed for such tasks and they could not be conceptualised according to the templates circulating in the office. Thus, for wealthy clients and especially for the rental apartment buildings that were being commissioned in abundance, unique, creative façades were designed that transmitted the messages of modern times, and behind these were mostly conventional residential or business floor plans, which would long remain unchanged. They were characterised by a template-based division into enfilades, which represented the residential and living areas of flats that were oriented towards the street, and a number of service spaces positioned facing the interior of the city blocks. Whether built in Biedermeier, historicist, or Art Nouveau style, the floor plans of flats remained the same, resistant to change, or as one renowned Croatian analyst has noted, "One applied ornamental system was replaced with another, but the principles of composition, the organisation of space, and the load-bearing structure remained the same" (Bedenko, 1997). The same situation also held in the rest of the Monarchy, where Moravánszky noted that: “Because the critique of historicism in architecture meant rejecting traditional architectural decoration rather than spatial organisation (symmetries, axial compositions, hierarchies, etc.), the search for alternatives started as the renewal of ornament” (Moravánszky, 1998).

The aforementioned division of some tasks within firms followed or were extensions of legal regulations for particular fields of technical professions. According to an 1886 "Order on the Management of Construction Firms", construction engineers could only deal in building construction in areas that "do not demand rich architectural decoration", while the same order established the scope of work of authorised architects as "all kinds of artistic structures" (Jurić, 2002). Regulations thus supported and provided a legal framework that channelled architectural expertise towards only one specific kind of design, which required the creative force of the architect and which was in high demand from young clients. Art Nouveau façades addressed the urban populace through ornamentation, which became a key determinant of the style.

Architectural practice during the historicist period was internally organised, led by the principles of economy and simultaneous increases in efficiency. According to schematic residential floor plan layouts, which had to be adjusted to fit the dimensions of the plot of land a given building was being built upon, only pre-prepared schemas of neo-Renaissance, neo-Baroque, or neo-Rococo façades were changed depending on the client's preference. "Florence, Rimini, Rome, and Venice; Brunelleschi, Bramante, and especially Michelangelo, Sansovino, and Palladio; Italy in the fifteenth, and especially the 16th century; all of these are an enormous source" (Dobronić, 1983) used by historicist architects for inspiration and various elements of composition. These façade templates, like the working regime, could not be used for unique commissions, and especially not for clients who expressed Art Nouveau as their stylistic preference. Hönigsberg and Deutsch, as many researchers have noted, had no affinity towards the Art Nouveau style and as practitoners were uninterested in designing projects in the Art Nouveau canon. Very early on, they hired Vjekoslav Bastl, a young architect who was still studying at the Vocational School of Construction in Zagreb, and who was tasked with taking commissions exclusively for Art Nouveau clients. The working procedures within the firm led to the difficult, uncertain attribution of a string of projects, which were ultimately signed by the firm instead of by individual architects (Jurić, 1995). Both of the aforementioned rental blocks, Dr. Rado and Kallina, have been attributed to Vjekoslav Bastl, who designed them as a Hönigsberg and Deutsch employee (Figure 3). Additionally, as a graduate of Otto Wagner's special programme at the Viennese Academy of Fine Arts, from the Construction School, Bastl obtained a good education and solid knowledge, especially on the design of rental houses, which were taught as an architectural type in the first year of the programme. His design for a residential and commercial building with a photo studio published in "Der Architekt" in 1900 displays a serious, rational floor plan and a mastery and understanding of Wagner's design guidelines, which were intended to result in an economic floor plan and had the end goal of finding a prototypical solution for residential space in a growing city. We may analyse the Kallina building design in this light; its floor plan design, as opposed to its famous façade ornamentation, is somewhat awkward. Not only is access to the floors through a surprising layout of flights of stairs, these wings are situated along the courtyard-facing façade, thus obstructing light and air flow to the flats. Additionally, shared walls between two apartments with an otherwise standard floor plan are also

poorly designed; bathrooms and service spaces are located along the street-facing façade, with windows identical to the representative enfilade of residential rooms. As a result, the Kallina house's street-facing rooms could not be redistributed flexibly, severely limiting what was one of the main features of this particular scheme of organisation (Figure 4). This analysis allows for the possibility that a less skilled employee may have made the floor plan design, with Bastl allowed the opportunity to direct his creative energy exclusively towards the Art Nouveau façade. Bastl's work in the office mainly centred on façades, particular creative details, and the relationship between the façade and the load-bearing structure through the cross-section. The fact that Bastl was prepared to stand behind a mere two Hönigsberg and Deutch buildings as their author at a 1906 exhibition of the "Croatian Society of Arts", as recent research has shown, may confirm the previous assumption. Another significant piece of information in this regard is an advertisement run by the firm in Austrian professional journals in 1895 seeking "an academically trained architect with work experience" (Pavković, 2007). Deeper analysis shows that the advertisement seeks exclusively one educated architect with experience, not multiple architects. Due to the nature of work in one of the city's busiest firms, one would expect the need for a greater number of experienced architects. Likewise, the advert sought an academically trained architect – not an architect with a diploma from e.g. a polytechnic – one who had not only academic training in art, but who could also innovate and provide original solutions to commissions from individual clients. A particular distinction has also been noted in the work of Wagner's practice, where the difference between drawings and the execution of ornamentation on residential buildings at the time provide indications that Wagner usually allowed his students and artists to handle façade decoration projects, while he himself directed his attention to other design aspects, finding creative solutions and rational floor plans in accordance with building regulations while attaining the maximum possible usage of a particular plot (Schubert, 2018).

Figure 3. Zagreb's Majolikahaus (Kallina Rental apartment house) (Source: Private collection)

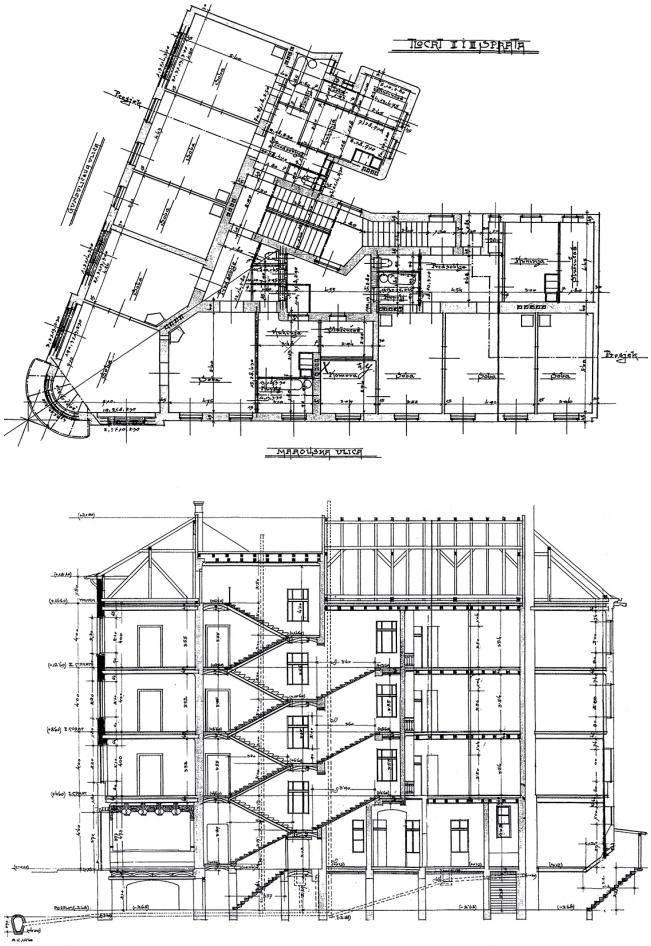

Figure 4. Floor plan and section of the Kallina Rental apartment house (Source: State Archives in Zagreb)

CONCLUSION

This attempt to link the brief appearance of Art Nouveau in Zagreb with the work of architectural firms places in the limelight the specific position of academically trained architects within professional organisations. It is significant to note that Art Nouveau buildings were built in Zagreb even before the arrival of architects schooled in Vienna, the centre of the Art Nouveau movement at the time. As researchers have already noted, this phenomenon is attributed to a rich influx of architectural periodicals to the library of the Vocational Construction School, as well as those that were delivered to practices of a few architectural firms in the city.

In the technological sense, it is worth mentioning that rental apartment houses were not advanced and demanding structures. In fact, the entire burden of building rental houses fell upon well-trained local craft businesses and construction firms that had garnered experience with the construction of historicist buildings, for which they had designed a series of statues and various types of sculptural ornaments. As rental blocks were not representative of the state – this was the task of cultural or educational institutions, designed by experienced arhitects from the Monarchy's urban centres – they were mostly designed and built by well-trained local firms. The increase in the number of commissions

for residential buildings influenced the division of labour at Hönigsberg and Deutsch, resulting in a redistribution of routine tasks according to pre-existing templates to less-educated staff, while they sought academically trained architects for their façades. As the main determinant of Art Nouveau was the ornamentation on the façade, and no legislation existed allowing academically trained architects to work independently, these highly-educated architects were put to work on this specific architectural task. Of the few actors who dealt in the production of Art Nouveau buildings, Vjekoslav Bastl is given a prominent place in the literature due to the number and quality of his projects, which had long been attributed only to the Hönigsberg and Deutsch architectural firm. In the literature to date, researchers generally attribute the design of the firm's buildings to Hönigsberg, one of the partners, while Deutsch is known as the firm's office manager and dealmaker. The firm's numerous employees became tied to the scope of work and number of commissions, as opposed to at the turn of the century, when master builders worked alone since the demand for construction work was low.

This boom in the number of commissions came at the turn of the century, when buildings attributed to particular architects as well as firms began to appear. The autonomy of architects did not support the fact that this professional title could also be attained by those who had no scholastic qualifications, but those who had attained sufficient professional knowledge through practice. Academically trained architects were thus left with only two choices after graduating – either employment and apprenticeship at a well-situated architectural firm in the city or employment with the city administration, which hired engineers and architects to carry out tasks related to city planning and organisation. The brief period of Art Nouveau brought decisive changes that led to the affirmation of architects as independent artists, and eventually emancipated the entire profession of architecture. This issue would finally be settled after World War I, when independent architects began founding small autonomous architectural offices in Zagreb and signing plans with their own names. Finally, a prominent difference in the way the architectural firms were named determined very much the kind of tasks they undertook. Hönigsberg and Deutsch regularly worked both as an architectural office and a building firm, while those who had artistic ambitions frequently called their firms 'ateliers'. While the interwar period encouraged architects to found their own architectural firms, the aforementioned trends in the division of labour, mass production of residential buildings, and the specialisation of architects would once again become current after World War II, in an entirely different socio-political framework.

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SPACE-TIME HIGH-RESOLUTION DATA OF THE POTENTIAL INSOLATION AND SOLAR DURATION FOR MONTENEGRO

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The assessment of the potential use of renewable energy resources requires reliable and precise data inputs for sustainable energy planning on a regional, national and local scale. In this study, we examine high spatial resolution grids of potential insolation and solar duration in order to determine the location of potential solar power plants in Montenegro. Grids with a 25-m spatial resolution of potential solar radiation and duration were produced based on observational records and publicly available high-resolution digital elevation model provided by the European Environment Agency. These results could be further used for the estimation and selection of a specific location for solar panels. With an average annual potential insolation of 1800 kWh/m^2 and solar duration of over 2000 h per year for most of its territory, Montenegro is one of the European countries with the highest potential for the development, production, and consumption of solar energy.

***Key words*: potential insolation, solar duration, Montenegro.**

INTRODUCTION

As a result of increasing energy demand and related environmental concerns, renewable energy sources (RES) have been receiving increasing attention over recent decades. Among the different RES, the sun is an abundant, free, and clean source of renewable energy that can be used to generate heat and electricity (Mekhilef *et al*., 2011; Hosenuzzaman *et al*., 2015; Rustemli *et al.*, 2013). Solar thermal systems are now widely used for heating water, heating and cooling space, food refrigeration, desalination, drying, cooking, power generation (concentrating solar power system), etc. (Mekhilef *et al.*, 2011; Kannan and Vakeesan, 2016). Despite its numerous advantages, solar energy plays a negligible part in the global energy supply, although certain solar technologies, i.e., photovoltaic (PV) systems, have rapidly developed over recent decades, with system prices falling by about 80% between 2008 and 2016 (Waldau-Jäger, 2016). Moreover, the levelized costs of electricity generated from utility-scale PV systems were competitive with fossil fuels in 2018 (International Renewable Energy Agency [IRENA], 2019).

The European Union aims to increase the share of RES in the gross final energy consumption from 20% in 2020, to 32% by 2030 and 55% by 2050 (European Parliament, Council of the European Union 2009, 2018; European Union 2012). According to the Energy Community Treaty, to achieve this goal, all EU countries—including non-EU countries that follow EU regulations on RES—should adopt National

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Action Plans (NAPs), and other regulations to further increase the exploitation of RES. For instance, in Germany, the share of RES in the gross final energy consumption in 2018 was 16.6%. However, the contribution of RES to the gross electricity production was 37.8%, mainly from wind (18.5%) and solar PV (7.7%) (Federal Ministry for Economic Affairs and Energy, 2019). Over 1.6 million subsidized PV power plants, with a total nominal capacity of approximately 45.9 GW, were installed by 2018 in Germany (Fraunhofer ISE, 2019).

Concerning solar energy systems, the spatial and temporal distribution of solar radiation is a key component for the selection of their location, planning and performance simulation. The estimation of solar radiation is very important for remote areas where data obtained by ground station measurements are unavailable. Interpolation techniques are appropriate for lowland areas with a weather station density of one station per 1000 km^2 or more (Ruiz-Arias *et al*., 2009). Empirical models have been developed to overcome limited ground-level measurements of solar radiation based on other observational records, i.e., air temperature (Almorox *et al*., 2011; Yacef *et al.*, 2014; Hassan *et al*., 2016), cloudiness (Ehnberg and Bollen, 2005; Badescu and Dumitrescu, 2013; Kostić and Mikulović, 2017), precipitation (Matsuda *et al*., 2017), humidity (Yang and Koike, 2002), air pollution (Zhao *et al*., 2013), sunshine duration, (Ångström, 1924; Prescott, 1940; Wang and Zhang, 2010; Chen, *et al*. 2013; Suehrcke, *et al*. 2013; Yao *et al*., 2018), etc. For example, Adeala *et al*. (2015) used multiple weather parameters to estimate the monthly average daily global solar radiation for the nine provinces of South Africa. Although satellite measurements provide a less accurate solar radiation value compared with ground-level measurements, they provide better spatial-temporal coverage. Several studies have indicated the advantages of combining satellite and ground-level measurements of solar radiation (D'Agostino and Zelenka, 1992; Journée and Bertrand, 2010; Lu *et al*., 2011).

Šúri and Hofierka (2004) determined three groups of factors that affect the interaction between solar radiation, the Earth's atmosphere and its surface: (1) Earth-Sun geometry (declination, latitude, solar hour angle); (2) topography (elevation, slope, aspect, and shadows); and (3) atmospheric attenuation (gases, clouds, solid and liquid particles). The first two groups can be modelled using trigonometry with a high level of accuracy (Liu *et al*., 2012). Topographic solar radiation models use information derived from Digital Elevation Models (DEMs) within a geographical information system (GIS) to provide rapid and accurate estimation over a wide geographic area (Tovar-Pescador *et al*., 2006; Hofierka, 2013). Modelling the third group of factors is possible with a certain level of accuracy because of the dynamic nature and complex interactions in the Earth's atmosphere (Šúri and Hofierka, 2004). Nevertheless, several software packages offer different methodologies for estimating solar radiation, such as Solei in IDRISI (Miklánek, 1993), SRAD as part of TAPES-G (Terrain Analysis Programs for the Environmental Sciences – Grid version) (Gallant and Wilson, 1996), Solar Analyst in ArcView and ArcGIS of ESRI (Fu and Rich, 2002), and the r.sun module of GRASS GIS (Geographic Resources Analysis Support System) (Šúri and Hofierka, 2004). Luković *et al*. (2015) used a DEM with a 90 m × 90 m resolution in the SAGA GIS (System for Automated Geoscientific Analyses) environment to map solar radiation in Serbia.

The main aim of this study was to create an open access solar radiation database for Montenegro and to analyze spatial-temporal variations. For this purpose, we applied a methodology proposed by Luković *et al*. (2015), adding improvements regarding the spatial resolution of input data layers, resulting in higher modelled outputs, and calibrating outputs based on observed measurements at eight weather stations. Such accurate and high spatial resolution solar radiation data are useful, not only for energy generation purposes, but also in various fields of applications in climatology, ecology, engineering, land management, and environmental science (Dubayah and Rich, 1995; Šúri and Hofierka, 2004; Tovar-Pescador *et al*., 2006).

THE PRESENT SITUATION OF ENERGY PRODUCTION AND CONSUMPTION IN MONTENEGRO

Montenegro ratified the Paris Agreement in 2016, thereby taking responsibility to limit the rise in global temperature by 1.5 °C in the second half of the 21st century. Efforts towards achieving this goal include reducing CO_2 emissions by 30% by 2030 compared to 1990 (Djurovic *et al*., 2018), and increasing the portion of energy produced from renewable sources, among which solar energy should be a priority.

In 2017, RES in Montenegro achieved a 32.3% share of the gross final energy consumption, i.e., 50.1% in the electricity sector, 36.1% in the heating and cooling sector, and 0.8% in transport (Energy Community, 2020). The target regarding the share of RES in the gross final energy consumption for 2020 was set to 33%, while the sectoral targets were set to RES having a 51.4 % share of the gross final electricity consumption, 38.2 % of the gross final consumption of energy for heating and cooling, and 10.2 % of the final consumption of energy in transport (Energy Community, 2014). Thermal power plants generate 53.9% of the total electricity, the rest comes from hydropower plants (42.1%) and wind turbines (4%) (Regulatorna agencija za energetiku Crne Gore, 2018). The contribution of solar energy to the gross electricity generation from RES in 2017 is negligible (0.1%) (Energy Community, 2020) and it is below the expected 0.7% for 2020 (Energy Community, 2014). During the period 2012 to 2017, within the project "Solar Katuns", 243 PV systems were installed in summer pasture settlements in the mountain areas of Montenegro (Government of Montenegro, Ministry of European Affairs, 2017; Regulatorna agencija za energetiku Crne Gore, 2018). According to the Energy development strategy of Montenegro (Ministarstvo ekonomije Crne Gore, 2014), expected PV power generation in 2030 is 52 GWh, which is ~1.4% of the national target for RES electricity production for 2030. The solar thermal energy will contribute to energy saving in the building sector, since it will substitute a great part of the electricity used for domestic water heating. Considering the absence of observational records for solar radiation in Montenegro, globally available solar radiation maps for the territory of Montenegro are generated based

on satellite data (Ministarstvo za zaštitu životne sredine, kopna i mora Republike Italije, 2007).

PHYSICAL GEOGRAPHIC CHARACTERISTICS OF MONTENEGRO

The study area of Montenegro comprises almost 3% of the Balkan Peninsula, covering an area of 13812 km^2 (Burić *et al.*, 2015), of which 210 km^2 are occupied by internal waters. Montenegro is characterized by complex orography that consists of a narrow Adriatic coastline (300-km long) stretching in the southern parts of the country, a limestone region in its central parts and the mountains of Montenegro, averaging more than 2000 m above sea level in the northern parts of the country (Figure 1).

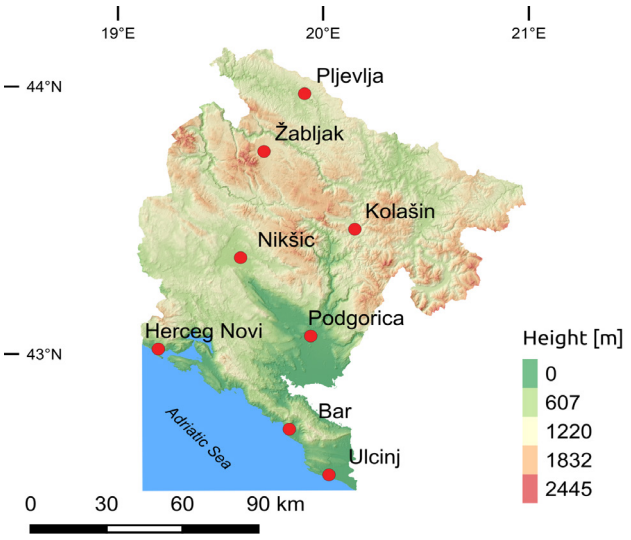

Figure 1. The geographical map of Montenegro, with the locations of weather stations

According to Koppen's classification of climate, most of Montenegro exhibits characteristics of a Mediterranean climate, characterized by hot and dry summers and mild and rainy winters in the south and coastal area, whereas the central parts of the country exhibit characteristics of a moderate-continental climate. In the higher mountainous areas in the north, which are over 1000–1200 m above sea level, there is a continental climate with cold winters and hot, humid summers with well distributed rainfall (Burić *et al.*, 2013; Burić *et al.*, 2014). The average amount of annual rainfall ranges from about 800 mm in the northeast to above 4000 mm in its southern parts, where one of the wettest areas of the Mediterranean region is located (Ducić *et al.*, 2012). The average annual temperature ranges from 4.6 °C in Žabljak (1450 m a.s.l.) to 15.8 °C in Budva (2 m a.s.l.). The highest temperature of 44.8 °C was recorded in Podgorica (49 m a.s.l.). The coastal area receives up to 2600 h of sunshine per year. In the central plain areas, there are also a large number of sunshine hours: during winter it is similar to the amount of solar radiation of the coast, but relatively less in summer. Based on calculated averages for the period 1971–2000 the annual sunshine hours range from 2560 h/year for Ulcinj, 2479 h/year for Podgorica, 2239 h/year for Nikšić to 1589 h/year for Pljevlja (Italian Ministry for the Environment, Land and Sea, 2007).

METHODOLOGY AND DATA

Grids of potential insolation (INcoming SOLar radiATION), which represent the amount of solar radiation received at the Earth's surface (Petersen *et al.*, 2016) and the duration of solar insolation (Li *et al.*, 2011), were produced for Montenegro for 2018 in the SAGA GIS (Böhner *et al.*, 2006) open-source software environment using the "Potential Incoming Solar Radiation" tool (Conrad, 2010). This tool calculates diffuse, direct, and total insolation, together with the duration of insolation for a certain period, aggregated to a specified time resolution. The latest version of SAGA GIS offers the r.*sun* algorithm (Šúri and Hofierka, 2004) for the calculation of insolation indices. Since the algorithm does not take cloudiness into consideration when calculating insolation parameters, the daily outputs require correction. Therefore, the outputs were multiplied by the daily Insolation Clearness Index (ICI) grid that characterizes the sky clearness (Beyer *et al.* 1997; Šúri and Hofierka 2004).

Despite the fact that SAGA offers a different combination of input parameters, our focus was on the most prevailing factors of the spatial variability of the radiation/insolation: topographic indices derived from digital surface models (DSM), geographical coordinates and ICI. Moreover, data on the observed duration of insolation from weather stations were also used for calibrating the duration of the insolation grids.

The European Digital Elevation Model (EU-DEM), implemented under the Copernicus program and provided by the European Environment Agency (2016), was used in this study as a digital surface model. It is a new hybrid product, primarily based on SRTM DEM and ASTER GDEM data with a 25-m grid cell resolution.

The daily Insolation Clearness Index data were obtained from the NASA Langley Research Center (LaRC) POWER Project (Stackhouse *et al.*, 2020). These data were provided in vector format as points spread over a 0.5 × 0.5 degree (approx. 55.5 × 55.5 km at the Montenegro average geographical latitude) grid for a specified time period and region of interest. In this manuscript, we use daily data for 2018. Daily measurements were rasterized and downscaled to a resolution of 25 m using cubic spline interpolation (Figure 2).

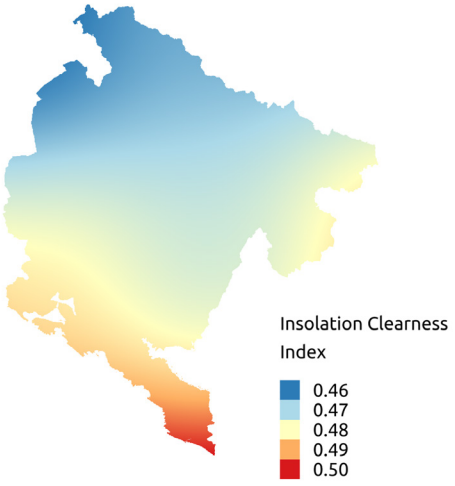

Figure 2. Insolation Clearness Index (ICI) map for Montenegro in 2018 (lower index values indicate more cloudiness)

Monthly data on the observed duration of sunshine in hours were collected for eight weather stations in Montenegro: Bar, Herceg Novi, Nikšić, Podgorica, Kolašin, Žabljak, Pljevlja, and Ulcinj (Figure 1). The grid of solar duration obtained by the SAGA Potential Incoming Solar Radiation module was calibrated with observational data in order to obtain more reliable outputs.

RESULTS

The grids of potential insolation and solar duration with 25-m spatial resolution were calculated for each day of 2018. The grids obtained were aggregated at monthly and annual levels. The monthly and annual values for potential insolation and solar duration are given in Table 1. Based on statistics for the overall grid cells values, median values (Md) and interquartile ranges (IQR) between the 75th and 25th percentiles were also calculated.

Table 1. Monthly and annual potential insolation (PI) [kW/m^2] and solar duration (SD) [hours] with respective medians (Md) and interquartile ranges (IQR) for 2018. Statistical measures are based on all pixels over the territory of Montenegro for the corresponding time period

Month	*PI*	*PI_Md*	*PI_IQR*	*SD*	*SD_Md*	*SD_IQR*
Jan	74	74.6	44.3	74.7	81.4	29.1
Feb	73.6	74.8	31.4	60.8	65.1	22.7
March	107.9	110.4	27.1	108.5	113.6	26.7
April	186.7	191.9	21.1	194.4	198.7	33.1
May	211.2	215.4	12.1	227.4	233.8	41.5
June	211.2	213.5	21.7	229	230.9	38
July	238.8	241.7	19.7	249.4	250.7	45.2
Aug	230.8	236.4	18.5	274.3	280.5	35.3
Sep	197.7	203.2	36.3	219.4	224.9	35.3
Oct	129.7	133.5	44.4	154.9	162	33
Nov	81.2	82.7	43	70.6	75.8	28.4
Dec	67.3	67.9	45.8	73.9	79.7	36.3
Annual	1810.2	1854.3	323.2	1976.5	1980.2	364.9

The highest potential insolation is recorded in July (238.8 kW/m^2), whereas the greatest number of sunshine hours is in August (274.3 h). December is the month with the lowest potential insolation (67.3 kW/m^2), whereas solar duration is the lowest in February (60.8 h).

In order to check the sensitivity of the results regarding the spatial resolution of DEM, the same procedure was repeated with an SRTM DEM with a spatial resolution of 90 m. The results obtained for both potential insolation and solar duration were similar, suggesting that the algorithms provided in *r.sun* module are invariant to spatial resolution.

Solar duration (SD) was also used as a measure of incoming solar radiation. The maps showing the duration of insolation were calibrated with *in situ* measurements from eight weather stations. Monthly summaries from SAGA GIS were paired with monthly in situ measurements, and simple linear regression was performed. The output model parameters for calibration are given in equation (1):

$$\text{SCAL} = 1.5436 \cdot \text{SSAGA} - 72.3342 \quad (1)$$

where SCAL is a calibrated grid value of SD and SSAGA is a grid value of SD generated using the SAGA Potential Incoming Solar Radiation module.

In order to validate the model, 10-fold cross validation was performed at a monthly level. The resulting Root Mean Square Error (RMSE) was 23.9 h/month and the Mean Absolute Error (MAE) was 19.9 h/month with a coefficient of determination R^2 = 0.93. A Scatterplot of the SAGA *calculated* and *in situ* measurements with a regression line is shown in Figure 3.

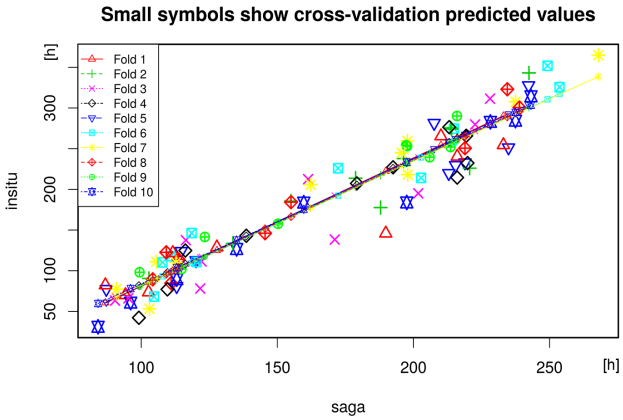

Figure 3. The scatterplot of SAGA calculated and in situ measurements of solar duration in 2018

DISCUSSION

Almost identical values for the average/mean and median for both PI and SD in Table 1, indicate their symmetrical distribution over the area of Montenegro.

The spatial pattern of the annual potential solar radiation (Figure 4) shows lowland areas and the southern slopes of the mountains in Montenegro receiving generally the highest amount of solar radiation. On the other hand, the western parts of Montenegro receive the lowest portions of potential solar radiation.

Higher IQR values (higher than 30 kW/m^2) for potential insolation are characteristic for autumn and winter months, which means that during that time of year, differences in PI values are pronounced, depending on the spatial location.

Figure 5 shows that the greatest annual solar duration in Montenegro is in the coastal and central parts of the country (over 2000 h). The lowest annual number of sunshine hours (below 600 h) is mainly over the western slopes in the mountainous areas of Montenegro.

In contrast to potential insolation, higher IQR values (higher than 30 h) for solar duration are characteristic for spring and summer months, which means that during that time of year, differences in PI values over the area of Montenegro are more pronounced, depending on the spatial location.

The maps (grids) of monthly and annual aggregations of potential insolation and solar duration for Montenegro in 2018 are publicly available and freely accessible at URL: http://osgl.grf.bg.ac.rs/en/materials/insolation_mne/.

Furthermore, data and corresponding metadata are published through Geoserver and Geonetwork, which are standard services for data and metadata dissemination, supported by the Open Geospatial Consortium (OGC) and Open Source Geospatial Foundation (OSGEO). As per OSGEO:

> "GeoServer is a web server that allows you to serve maps and data from a variety of formats to standard clients such as web browsers and desktop GIS programs. Data is published via OGC standards based interfaces, such as WMS, WFS, WCS, WPS" (OSGeo, 2020).

Data can be sought or downloaded in various standard formats for a specific location of interest. These platforms have a long and proven history of successful applications in various domains (Yu *et al*., 2013; Cignetti *et al*., 2019; JeeHee *et al*., 2019).

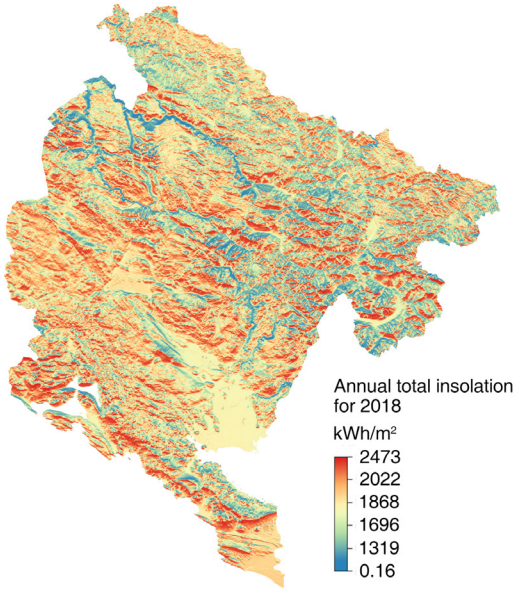

Figure 4. The grid of annual potential solar insolation in 2018

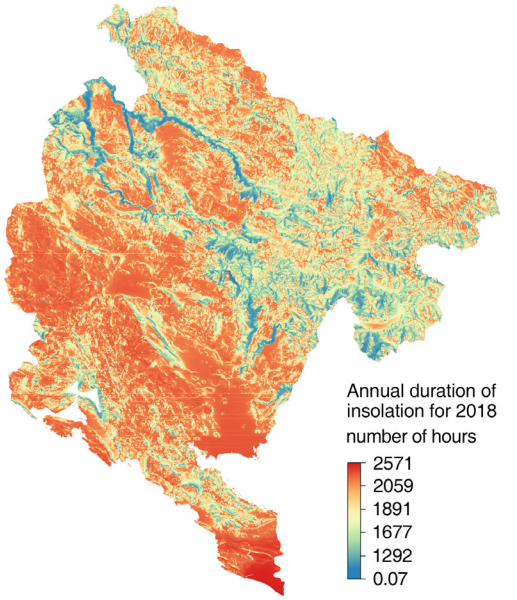

Figure 5. The grid of annual duration of insolation in 2018

All maps (grids) are open access, freely available to download in raster GeoTIFF format with a resolution of 25 m. They are georeferenced in the UTM (Universal Transversal Mercator) projection, which enables their usage for planning and designing the future production and consumption of solar energy for the whole of Montenegro. The high spatial resolution of the grids produced makes them suitable for both regional and sub-regional studies. Please refer to this paper when using these data.

CONCLUSIONS

This paper presents the first database of potential insolation and solar duration at a high spatial resolution (25 × 25 m) for the entire area of Montenegro. The resulting solar duration database was additionally calibrated with a regression model with a high coefficient of determination (R^2 = 0.93).

Considering the relatively small area of the territory of Montenegro, large differences in the annual values of solar radiation cannot be observed. Montenegro shows great potential for solar energy systems, as the number of sunshine hours is over 2000 h per year over most of the territory of Montenegro and more than 2500 h per year along the coastal areas. The amount of solar radiation in Montenegro, especially in the coastal and central areas, is comparable to the amount of solar radiation in European Mediterranean countries. Since the results obtained show very high solar radiation in the coastal and central areas of Montenegro, the use of solar thermal energy in Montenegro is strongly recommended. As in other Mediterranean countries, the solar power systems do not require high levels of performance, because of the generally high solar radiation and mild characteristics of the climate. Since tourism is one of the national priority sectors in Montenegro, the highest economic benefits might be achieved through the implementation of passive as well as active solar architecture (solar collectors for heating in households and tourist facilities) (Ministarstvo za zaštitu životne sredine, kopna i mora Republike Italije, 2007). The methodology presented in this work is applicable for the calculation of solar irradiation on the scale of higher resolution (i.e., roofs of buildings). However, to obtain such precise and detailed results for solar radiation, a good quality digital surface model, based on a stereophotogrammetry or Light Detection and Ranging (LiDAR) technology survey is required (Protić *et al*., 2018). Supported by systems for spatial visualization, decision modelling and spatial decision support, these results are powerful tools that can be used in urban planning (Marić *et al*., 2016).

Considering the potential of Montenegro in solar energy, solar architecture should be subsidized through different national projects and initiatives.

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USING THE ZOPA MODEL TO SYNERGIZE THE DIFFERENT INTERESTS OF LOCAL AND CENTRAL AUTHORITIES IN AN ADAPTIVE CITY PLAN TOWARDS FLOOD RESILIENCE IN SURAKARTA CITY, INDONESIA

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Surakarta City, a secondary city in Indonesia, has been threatened by floods for many decades due to the overflow of rivers and an inadequate urban drainage system. On top of that, inelastic time-bound city planning has made the city susceptible to ever-increasing flood threats. The local authority has attempted to minimize flood risk through particular structural mitigations of the urban drainage system, which it has authority to do, while the overall responsibility for flood control and river management is under central authority. The different responsibilities of these two different levels of authority have led to gaps and overlaps in relation to the same objects of interest. On one hand, the city authority is concerned with city planning, and on the other hand, the flood control and river management authority is responsible for combatting flooding problems and river management within the watershed. This issue is an interesting point to investigate. In order for Surakarta to become a resilient city, it is imperative to synergize the efforts of these two different levels of authorities. This study aims to find the synergistic and optimal solutions by means of a negotiated planning and management system that involves both authorities. Critical evaluation and assessment of relevant documents, field observations, and measurements, as well as acquiring expert opinions were the main methods used in this study. We propose a ZOPA (Zone of Possible Agreement) model to optimize agreement among the stakeholders. The model essentially highlights the common interests and sets aside the conflicting points among stakeholders. The study found that there are potential points to negotiate with regard to the division of responsibilities through a shared vision of the coordinated institutions and shared planning and management in the direction of synergistic determination.

***Key words*: flood-resilient city, adaptive urban planning, synergistic determination, flood risks, Surakarta, Indonesia.**

INTRODUCTION

General Overview

Developing flood resilience in cities could be regarded as a response to their vulnerability due to flooding, which is one of the impacts of climate change (Jabareen, 2013; Bulkeley, 2013). We subscribe to NASA's (2020) definition of climate change, which is a long-term change in the average weather patterns of local, regional, and global climates, as a result of global warming. The most visible threat to the city by climate change impacts is flood risk that leads to the loss of life and property (Huong and Pathirana, 2013; Khailani and Perera, 2013). However, the flooding problem may not be the sole threat to the resilience of urban areas; the reality is that the impacts may either be cumulative or synergistic. Therefore, the challenge is for city plans to be able to dynamically respond to forceful threats resulting from temporal and spatial changes. A response to this challenge would require adaptive local-based city planning instead of time-bound inflexible master planning (Ahern, Cilliers and Niemelä, 2014). The international standard practice of flexibility in city plans in order to respond to external

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dynamics is applied in some countries, including Indonesia. Adaptive city planning to cope with flood dynamics must be tabled for discussion and negotiation with stakeholders, particularly with the authorities beyond the span of control of the city authority, for instance, the flood control and river management authority. Flood control and urban drainage plans must be streamlined into city planning (Boogaard *et al*., 2016), and equally importantly, cities must be an integral part of the overall river basin development plan. In reality, the integration of flood risk management into spatial planning is not easy to implement as many interests emerge. In many cases, during the early stages of flood control projects, the cities in question face the constraint of having to prepare spaces for adaptable flood risk reduction, as it requires vast floodable land areas to be utilized during flood events, namely, completely vacant urban land or land occupied by flood-proofing infrastructure. However, in the post-operation of a flood control project, economic development can go hand-in-hand with the flood control program, in that if a city can be freed from its flooding problem, urban economic development might be propelled to grow. While cities must provide space for economic activities that usually need high density built-up areas, in contrast, a large open space is needed to accommodate adaptable spaces for flood risk on limited urban land. Furthermore, cities are developing and need land to accommodate the growth of urban built-up areas. This issue has long been a persistent problem in many cities in Indonesia, including Surakarta City. In flood control projects in Jakarta, Surabaya, and Bandung, for instance, even though the land has been designated in the Official Gazette by the city for a particular purpose, the owners of the land are individuals, not necessarily the city government. In Indonesia's legal system, when a national law comes into effect, it must be obeyed by everyone after being passed by parliament, countersigned by the President of Indonesia and placed in the official gazette, the so-called, *Lembaran Negara*.

With regard to the study area, to understand the institutional setting of flood control responsibility, one must comprehend the complexity of coordinating two authorities in the event of concern over a flood. These authorities are Surakarta City Authority, and the Bengawan Solo Flood Control and River Management Authority. While Surakarta City is a local authority that has the administrative function of serving the citizens of Surakarta, the Bengawan Solo Flood Control and Water Management Authority, hereinafter called *BBWS-BS* (*Balai Besar Wilayah Sungai Bengawan Solo*), is a central government agency under the Ministry of Public Works and Human Settlements that has a technical function in controlling floods and managing water resources within the Bengawan Solo River Basin. These two authorities do not share a corresponding geographical boundary (Figure 1). However, both share the same interest in mitigating floods and droughts and providing a water supply to Surakarta City through Bengawan Solo and its tributary Kali Pepe, which are two rivers passing through Surakarta City that frequently cause flooding problems there. The unique correlation between the two authorities, most of the time, generates either overlaps or gaps in their operational functions that highlight the necessity for synergistic and coordinated action.

Surakarta City, the study area, is geographically located within the Bengawan Solo River Basin. The geographical intersection between these two entities and the complexity of their interests are schematically exhibited in Figure 1.

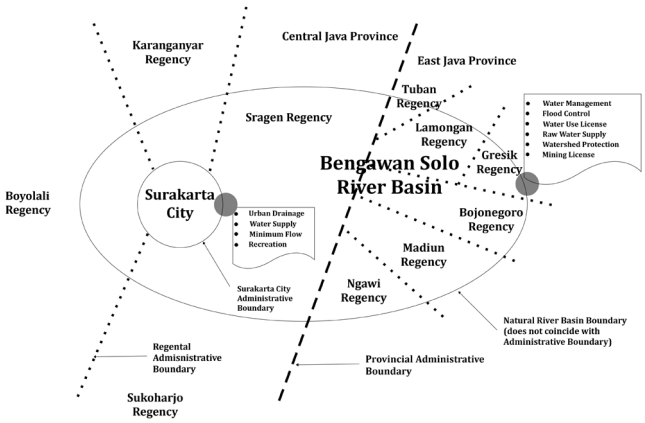


Figure 1. The intersection of Roles and Administrative Boundaries of Surakarta City and Bengawan Solo River Basin

Figure 1 presents the intersection between the administrative boundary of Surakarta City and the natural boundary of the Bengawan Solo River Basin. The figure also shows the roles of both authorities associated with flood and water management. Surakarta City lies within the river basin, and obviously, the Bengawan Solo River Basin covers parts of three regencies in Central Java Province: Sukoharjo, Karanganyar, and Boyolali. In the East Java Province, the Bengawan Solo River Basin covers the six regencies of Ngawi, Madiun, Bojonegoro, Gresik, Lamongan, and Tuban. This overlapping makes the roles of Bengawan Solo Flood Control and the Water Management Authority (BBWS-BS) extremely complex with regard to managing the river and water. This is the reason for the use of the hydrologic (natural) boundary of BBWS-BS instead of the administrative boundary.

In terms of its geographical characteristics, Surakarta City partly lies down in the floodplain of Bengawan Solo River, and it is passed by several tributaries, because of which it possesses a high risk of flooding. Pepe River is one of the Bengawan Solo tributaries that carries water inside the city. This river passes through the center of the city, and it, therefore, has a mutually important role in urban development. While Surakarta City needs this river for urban drainage, the river generates problems for the city. Floods have occurred in the city many times due to the overflow of this river. The high density settlements in Surakarta City mean that there is a higher risk of loss of life and property when a flood happens. The biggest floods in the city occurred in 1966, covering almost one-third of the city (Surakarta Disaster Management Agency, 2014). Recent floods occurred in 2016, and now there is a lower flood frequency. Responsibility for flood mitigation seems to overlap between Surakarta City Authority and BBWS-BS. Surakarta City Authority seeks to develop flood mitigation in order to create a flood-free city, while for BBWS-BS, as the river management authority, flood mitigation is one of its main roles. However, BBWS-BS does not focus only on flood mitigation in Surakarta City, but its responsibility for

flood mitigation is implemented in the entire river basin, which spans 548 kilometers in two provinces and seventeen regencies and cities. Because of this situation, gaps and/or overlaps concerning the flood mitigation responsilibilities of BBWS-BS and regencies or cities often occur.

The study aims to understand the constraints that exist in the two authorities i.e. Surakarta City and Bengawan Solo Flood Control and Water Management Authority (BBWS-BS) in their flood mitigation strategies, their efforts towards making Surakarta a resilient city, and their search for mutually exclusive solutions. The coordination of the city plan and BBWS-BS master plan are a prerequisite for synergistic works. Mainstreaming the city plan into the BBWS-BS master plan or integrating the local plans into the BBWS-BS master plan would be able to elevate the flood mitigation and adaptation efforts with regard to climate change impacts.

Adaptive City Plan and Resilient City: A Theoretical Background

A city with a high degree of vulnerability to floods and droughts needs to be an adaptive city (Jabareen, 2013; Verebes, 2013). To accomplish adaptive city planning, a collaborative planning process that works towards building consensus among all city stakeholders is necessary (Innes and Booher, 1999; Vandenbussche *et al*., 2017). An adaptive city means the city has strong assimilative power through the empowerment of the most dynamic city resources, namely people (Goldstein, 2012; CAC, 2018), which can eventually achieve a climate-adaptive city, in which the city greenery is abundant (Jim, Lo and Byrne, 2015). These arguments are suitable for Surakarta City.

An adaptive city plan can be seen as a reaction against the traditional static master plan and a strategic response to the need of urban dynamics (Whitehead, 2013; Jenks, 2000; Halleux *et al*., 2012). Nicholls and Cazenave (2010) argued that with the issues of global warming and a rise in sea-levels, the city is encountering a problem that needs high adaptability, and a rigid city planning response would not be suitable. The threat of the sea level rising, as an impact of global warming, is a clear danger for coastal cities (Yin *et al*., 2009; Nicholls, 1995; Hallegatte *et al*., 2011). The impacts of global warming on coastal cities were predicted by Gornitz (1991).

The key facet to coping with higher threats of flooding, as faced by Surakarta City, is the need for synergistic efforts among coordinated institutions and authorities, which is unavoidable if shared goals are to be accomplished (Merrey and Cook, 2012). Facilitating such coordination by the unification of an organizational framework is a pre-condition of synergistic efforts (Wright and Snell, 1998; Malone and Crowston, 1990; Burke *et al*., 2006). While there is no clear intersection of roles and responsibilities of the agencies involved, no coordination can be accomplished and silo effects hamper the synergy between related agencies, as presently reflected in the operation of Surakarta City and BBWS-BS.

A Brief Summary of the Planning Hierarchy in Indonesia

Indonesia has a unitary state system, which administratively consists of 34 provinces, 416 districts (some literature refers to regencies), and 98 cities. Amid the unitary system at the national level, all the regencies have autonomous authority in many aspects, apart from for monetary and defense systems. The planning system in Indonesia is primarily based on Law No. 26/2007 regarding spatial planning and management and its numerous derivatives, which consist of central and local government regulations, presidential regulations, ministerial regulations, and the like. Different provinces or regencies have a different style of planning system depending on the local conditions. However, it must be consistent with the higher legal entity and regulation (national planning system). Based on Law 26/2007, the spatial planning system in Indonesia essentially follows the political administration hierarchy of central-provincial-district/city, in which central or national planning is positioned at the top of the hierarchy, and therefore guides all lower plans i.e. provincial and district/city plans.

The planning system in Indonesia is an inter-departmental and inter-sectoral domain. It does not belong to a sole agency. Despite many actors in the planning system in Indonesia, which makes the planning coordination complicated and more difficult, there are two main agencies responsible for spatial planning, which are the National Development Planning Board (*Bappenas*), and the Ministry of Public Works and Human Settlements (*PUPR*). While the Bappenas is mainly responsible for administration and coordination, the PUPR is responsible for technical matters.

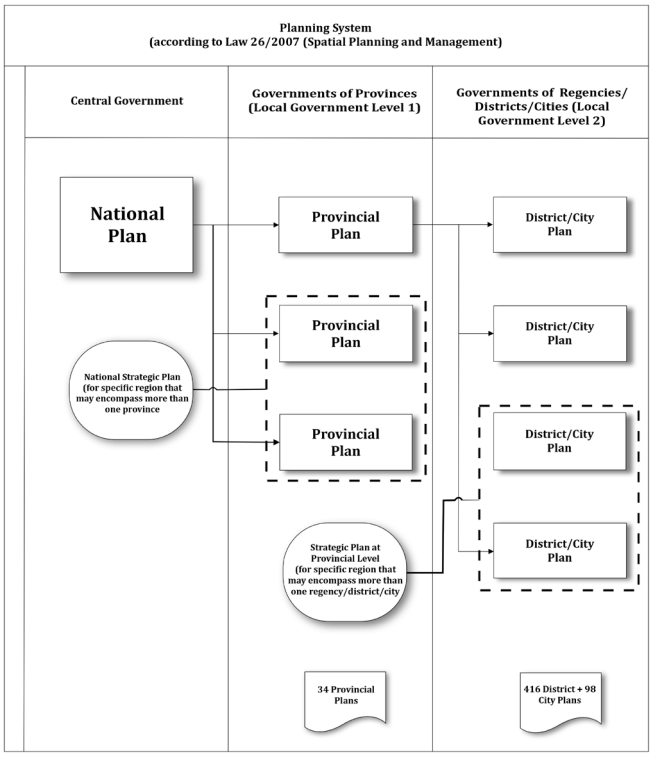


Figure 2. Planning Hierarchy in Indonesia (Source: Authors, based on Law No. 26/2007)

While the highest legal domain of the urban and regional planning system in Indonesia is the national plan, the first derivative of the national plan is the provincial plan, then the second derivative (of the national plan) or first derivative of the provincial plan is the local plan. the local plan can be either a district plan or a city plan. Besides those plans,

national strategic plans are also derivatives of the national plan. a national strategic plan is a plan for a special region within one or more provinces, with a strategic value from the national viewpoint and interest. Furthermore, there are the provincial strategic plans, which may cover two or more districts/regencies. Similarly, at the district/regency levels, a district strategic plan may also exist, depending on the district/regency. The hierarchy of the planning system in Indonesia is shown in Figure 2.

The Study Area

Surakarta City (Figure 3) is geographically a plain with an altitude of 95 to 105 meters above mean sea level. The city area is 44.06 km^2, with some tributaries passing through the city, namely the Anyar River, Pepe River, Jenes River, and Tanggul River that discharge into Bengawan Solo. About 93% of Surakarta City lies within 0.2% of the Bengawan Solo River Basin area (Ministry of Public Works and Housing, 2015), which is frequently flooded due to the overflow of Bengawan Solo and Kali Pepe. The existing capacity of the urban drainage of Surakarta City is about 50 m^3/second, which mainly comes from surface runoff, discharged into four tributaries, and finally into Bengawan Solo (BBWS-BS, 2017). However, if the water level in Bengawan Solo is high relative to its tributaries, the flow from the tributaries will not be able to discharge into Bengawan Solo. In this case, Surakarta City will suffer from floods.

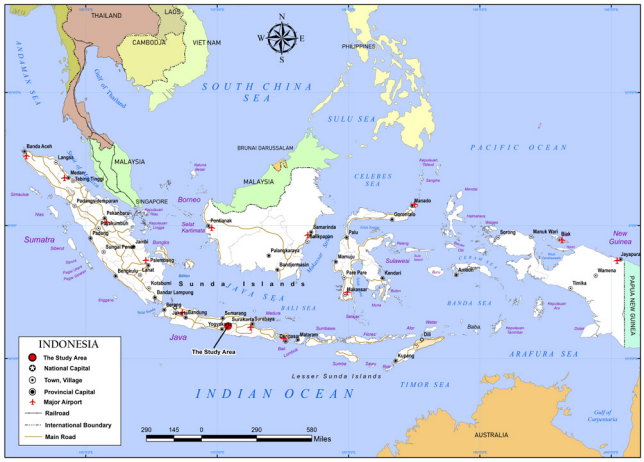


Figure 3. Indonesia and the Study Area (Surakarta City)
(Source: Nations Online Project)

Surakarta City has been experiencing annual floods due to the overflow of the Bengawan Solo River and its tributaries, particularly Kali Pepe. This flooding has been coupled with inundation from prolonged stagnant surface runoff resulting from inadequate drainage capacity. However, the root cause of the inundation is the intense built-environment in the city, in particular the extensive development of its hardscape e.g. buildings and roads, which significantly reduces the infiltration rate (Valinski and Chandler, 2015). Surakarta City is predominantly covered by built-up areas, as shown in Figure 4.

The built-up areas in Surakarta City, as shown in Figure 4, cover 82.37% (36.29 km^2) of the city, and non-built-up areas (including presently unutilized land) cover 17.63% (7.77 km^2) (Surakarta Statistics Agency, 2019). Built-up areas grew by only 0.23 hectares during 2014-2018, or only 0.005% of the total city area. The non-built up areas are scattered across the city in the form of small plots of land. Walk-through observation of the built-up areas found that the city is largely dominated by impervious surfaces, for example, roads, pedestrian areas, and paved yards. With an inadequate capacity of micro drainage and a lack of interconnection in the existing micro drainage and macro drainage systems, Surakarta City would be susceptible to flooding even without an overflow contribution from Bengawan Solo.

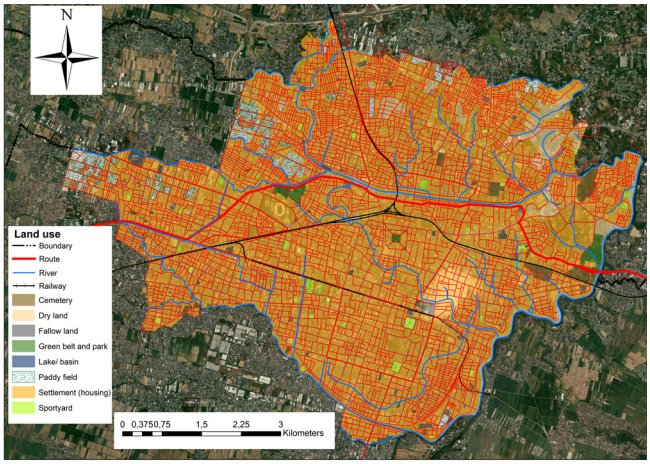


Figure 4. Predominant types of Existing Land Use in Surakarta
(Source: Municipality of Surakarta, 2012, with the author's modifications)

The Surakarta spatial plan, which indicates the future land use in Surakarta, is worrying because, for example, although the green spaces including city parks, river green belts, and cemeteries only cover approximately 807.7 hectares or 0.18% of the total area, and an increase of built-up areas is planned to a level of 95% coverage in 2031, increasing the density along particular roads three times, and decreasing open space and urban greenery to only 5% in 2031. Furthermore, there are no clear plans to cope with urban drainage i.e. a reliance on existing micro drainage rather than the construction of new drainage channels (Municipality of Surakarta, 2016). These situations highlight the absence of attention paid to the clear threat of flooding in the future.

River flooding is a stochastic process (Todorovic, 1978; Brath *et al.*, 2006; Snyder *et al.*, 2003), and so the size of a flood cannot be determined exactly. Similarly, urban drainage is dictated by rainfall, which is also a stochastic process. To determine the rainfall and drainage capacity, a statistical approach is usually employed. This statistical uncertainty must be carefully considered in the methodology.

METHODS

We investigated various interests of the urban and regional planning stakeholders in Surakarta City and three regencies in the Province of Central Java, as well as six regencies in the Province of East Java and those sharing administrative boundaries with the Bengawan Solo Flood Control and Water Management Authority (BBWS-BS). The stakeholders include local authorities, people affected by flooding, community-

based organizations, non-governmental organizations, and academics. The investigation of stakeholders' interests includes their roles in the regional and city planning process, their advocacies in a flood-resilient city, their contribution to the regional and city development, and their willingness to sacrifice egocentric interest for a shared vision and goal.

We gathered numerous critical documents from the Ministry of Public Works and Human Settlements, the National Planning Development Board, the Local government of Surakarta City, the Local Planning Board, Statistical Agency, BBWS-BS, and other associated agencies and offices. The theoretical background was assessed based on reliable scientific sources e.g. journals and books. A review of past research and reliable documents was carried out to look at the theoretical and experimental parts of similar issues. The roles, responsibilities, and functions of BBWS-BS were carefully assessed. Observations along the upstream part of Bengawan Solo River, which directly affects Surakarta City, and along Pepe River were undertaken to understand the estimated capacity of the existing primary urban drainage of Surakarta City under statistically uncertainty conditions.

The opinions of institutional experts were also acquired through a structured interview, in order to understand the negotiated responsibilities of related stakeholders towards a win-win situation. The interview was also carried out on a separate occasion to investigate the interests of the stakeholders. A set of designated experts from universities, government institutions, and independent observers were selected. Their opinions were recorded and tabulated in an aggregate format.

We employed a ZOPA (Zone of Possible Agreement) model in order to reach common ground related to a shared vision and goals among the stakeholders. No zero-sum game was introduced, that is sacrificing one side and benefitting the other side. The ZOPA model adopts four principles that must be understood and agreed upon by the stakeholders. These principles are (1) non-distributive strategies embraced by each stakeholder (2) no zero-sum game (3) share equivalent roles and responsibilities (4) accomplishing a win-win solution must be understood by both authorities. The ZOPA negotiation model is socially and culturally possible and acceptable within most societies in Indonesia, as most people are rooted in communities that value attachment and inseparableness. Indonesia's state philosophy also addresses this matter explicitly.

The ZOPA mechanism is implemented through a '*Musrenbang*' (*Musyawarah Rencana Pembangunan*), which is an annual meeting of the stakeholders, including citizens, to discuss issues relating to current and near-future development. Since we focused the definition of a resilient city on a disaster-associated issue i.e. a flood, the goal of a flood-resilient city is that it possesses an adequate capacity of human capital and infrastructure to cope with current and future threats of flood disasters. With this focus, the authorities concerned with water-associated disasters and water supply i.e. Surakarta City Administration and Bengawan Solo River Basin Authority, need to negotiate to accomplish a shared goal. The post-negotiation process of ZOPA is supposed to lead to a formal agreement between these two authorities on Surakarta being a resilient city, in which BBWS-BS acts as a technical advisor for the Surakarta City authority.

RESULTS AND DISCUSSION

Model of Negotiation towards the ZOPA (Zone of Possible Agreement)

The different interests of the existing authorities, particularly the Local Government of Surakarta City and Bengawan Solo Flood Control and Water Management Authority, can be synergistically combined into a common goal, as both authorities retain a strong and clear intersection. The intersection, which can be tabled for negotiation through the ZOPA mechanism, is Surakarta becoming a resilient city.

ZOPA should be introduced during the annual meeting hosted and led by the Surakarta City authority, with participants from BBWS-BS, representatives from the local government of Central Java Province, East Java Province, representatives from the Regencies of Karanganyar, Boyolali, and Sukoharjo (in Central Java Province), as well as the Regencies of Ngawi, Madiun, Bojonegoro, Gresik, Lamongan and Tuban (in East Java Province), academics, NGOs, CBOs, and representatives of Surakarta City citizens. The ZOPA aims to accomplish a shared goal, which is a win-win solution based on the four principles agreed upon by the stakeholders before the negotiation takes place. The ultimate goal is making Surakarta City a flood-resilient city, given its present status as a flood-vulnerable city.

Because the parties involved have different development goals and priorities, it is difficult to compromise without an optimal shared goal that is beneficial for both authorities. The goal of a flood-resilient city is then a reasonable one, with a systematic program of implementation and synergistic activities. Inauspiciously, the city authority has never explicitly launched a campaign for Surakarta to be a flood-resilient city, even though local academics have voiced their concerns on this matter. This gap has existed for years, and the post ZOPA would probably bridge this gap towards explicit progress in Surakarta becoming a flood-resilient city.

Increased density is encouraged from an urban planning viewpoint. However, increasing the density per se without being coupled with an increase in the amount of open space and urban greenery will trigger the possibility of an unsustainable city planning process. The most optimum approach from a sustainable development viewpoint, in order to cope with an increasing population and urbanization, is to increase the urban density, but at the same time leaving more open spaces. It means a transformational process from horizontal living to vertical living. The city authority's property rights for urban land must be expanded by acquiring vacant land, non-productive land, abandoned land, and brownfields through normal and legal transactions. By normal transactions, it means that the city authority acquires the land through commercial trading, while a legal transaction is acquiring abandoned land using legal non-commercial process. By this arrangement, the susceptibility of the city to floods will be reduced.

The role of BBWS-BS, according to the Minister of Public Works and Human Settlements concerning organizational

management (2016), is to plan, implement, maintain, conserve and control the destructive power of floodwaters, manage water resources e.g. rivers, lakes, irrigation systems, swamps, fish ponds, groundwater and other raw water sources, and the urban drainage system within the Bengawan Solo River Basin. By this legal designation, the planning and implementation of urban drainage in Surakarta City should also be under the jurisdiction of BBWS-BS. Then, the urban drainage system of Surakarta City could support the system of Bengawan Solo River Basin being managed by BBWS-BS. However, the city will not receive very much attention from BBWS-BS regarding its demand for urban drainage and water, unless a shared goal is agreed upon. The lack of attention from BBWS-BS has left the necessary plan untouched by both authorities, since the overall responsibility belongs to BBWS-BS, and it has not prioritized the demand in its own plan or program.

Despite the interdependence of the authorities, there is no integrated plan and policy, which may lead to a gap in the planning and policy with regard to a flood mitigation system. A severe gap may also hamper the program, and in the worst case may lead to disaster. For example, the delay in implementing urban drainage has already generated significant floods in the city because of the relationship between BBWS-BS and Surakarta City. A possible negotiation between BBWS-BS and Surakarta City should not be based on distributive strategies, or a zero-sum game or a win-lose approach, but rather a look into the shared vision and Zone of Possible Agreement (ZOPA) since both are government agencies working at a different level of authority with different scopes of work, and coercion would not be necessary, and therefore a win-win solution could be achieved. Distributive strategies need a prerequisite of a strong coordinating agency which is respected by both authorities and is currently non-existent. A zero-sum game may not be workable within the structure of the public administrative system in Indonesia, as Indonesia has a union system in which all elements of the system must synergistically collaborate. Thus, ZOPA is the remaining option.

During the negotiation, it is necessary to understand that both authorities are independent agencies. Surakarta City is not a subordinate of BBWS-BS or vice versa. They can both agree on a shared vision and unification of their framework, and also shared roles within their responsibilities. With these similarities, a Zone of Possible Agreement (ZOPA) can easily be reached, and an agreement can be accomplished. In order to achieve a ZOPA, its four principles must be understood by all of the stakeholders, and these two main agencies, in particular. When the ZOPA is agreed upon, a standard operation based on possible what-if situations must be formulated and agreed upon, and ultimately both must understand that the agreement is a shared accomplishment towards achieving a shared vision. This is illustrated in Figure 5. A similar process can also be applied to other cities or regencies within the Bengawan Solo River Basin for different roles. The negotiation processes and results can be documented and could become a precedent for when similar issues arise. Some adjustments would be needed for new situations as they would not be the same, but this could be a good example to follow by BBWS-BS or other cities and regencies.

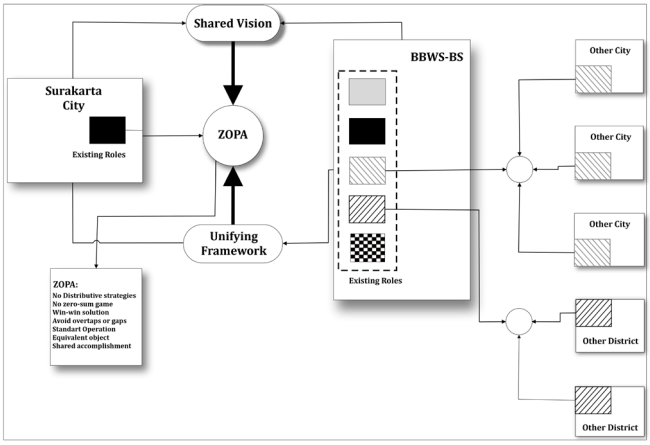


Figure 5. Negotiation towards shared Accomplishment

Since in Indonesia there are ninety big and small Flood Control and Water Management Authorities covering different scopes and areas, but with similar roles, the model could be applied to similar problems for a win-win situation and optimal solution in these ninety authorities.

Adaptive city plan for Surakarta towards becoming a flood-resilient city within the context of ZOPA

Upon agreement with the main agency, which is responsible for the provision of the system and infrastructure of flood mitigation and urban drainage, the path to becoming a flood-resilient city is practically dependent on the Surakarta City Authority, since potential constraints on coordination among related agencies have been settled. Historically, the main threat of natural disaster affecting the resilience of Surakarta City is flooding. However, recent studies have found that there is also a potential peril of earthquakes in Surakarta.

Within the framework of ZOPA, water-associated and other disasters, in the interests of Surakarta City and BBWS-BS, may also be tabled for negotiation. Based on data released by Surakarta Disaster Management Agency (BPBD), the prominent disasters associated with climate change that happened in Surakarta during 2010-2017 are shown in Table 1. Fire outbreaks could not be categorized as natural disasters, as they can be caused by the carelessness of human beings i.e. short circuits of electricity (the most frequent causes), uncontrolled fire during cooking, or arson. However, they are included in the table due to their remarkable frequency. Mitigating the effects of fire is made easier by improving building safety, which is fully controlled by human beings. Flooding and storms are two climate-associated events that cannot be precisely predicted, since they are a stochastic process rather than a deterministic one.

As shown in Table 1, there were no floods in Surakarta for three consecutive years, in 2009, 2010, and 2011, due to the successful flood infrastructure in the Bengawan Solo and Pepe Rivers. The mitigation of water-associated disasters is within the works scope of BBWS-BS. However, the flood frequency increased during the 2015-2017 period at the operational commencement of BBWS-BS. The other types of

disaster have not been a significant threat, although should be considered in the planning of a resilient city. The focus on Surakarta becoming a resilient city is on climate-associated disaster only, particularly water-associated disasters. Urban flood and urban drainage are two important climate associated aspects. A city that is resilient against urban floods attempts to minimize the loss of life and property without directly confronting the power of nature, but rather adjusting to this powerful force. In such a case, within the ZOPA framework, the BBWS-BS could become a leading authority.

The Surakarta Flood-resilient City Plan should consider drainage density since it is reasonable that the larger the density, the lower the probability of flooding (Baker, 1977; Patton & Baker, 1976). As defined by Horton (1945), drainage density is the ratio between the total length of drainage channels and the area of the watershed within which the drainage channels are situated. It also describes the degree of development of the drainage network. The total drainage capacity and drainage density should aim towards having fewer floods in the city. The present drainage density (D_d)

Table 1. Prominent Disasters in Surakarta: A Point for ZOPA Discussion [frequency]
(Source: National Disaster Management Agency, 2018)

Disaster	2009	2010	2011	2012	2013	2014	2015	2016	2017
Tropical Storm*	2	0	2	0	1	1	2	0	1
Floods	0	0	0	2	1	0	2	3	3
Landslide	0	0	2	0	1	0	0	0	4
Fire Outbreak	28	0	37	46	26	109	78	60	78

Note: *Category 1-3 on Saffir-Simpson Scale

To properly develop a flood resilient city plan, one must first understand the essential parameters of urban flooding from the viewpoint of the safety of people and property, as seen in Figure 6. The parameters contained in Figure 6 refer to the safety of citizens in terms of the flood velocity and depth of floodwater. These essential flood safety parameters should be taken into account in a careful analysis by BBWS-BS as a technical authority. These safety parameters are an important point to be discussed by the authorities, in order to avoid loss of life due to flooding. City planners under the Surakarta City Authority must carefully incorporate flood variables e.g. flood velocity, floodwater depth, and flood risk maps. A flood-risk map should usually be produced as a model for various scenarios regarding the flood return period and potential inundation, then the risks i.e. loss of life and property could be estimated for the inundated area, as well as the depth of floodwater, and flood velocity. Some scenarios of flooding and corresponding risks could be incorporated into the Surakarta Resilient City Plan.

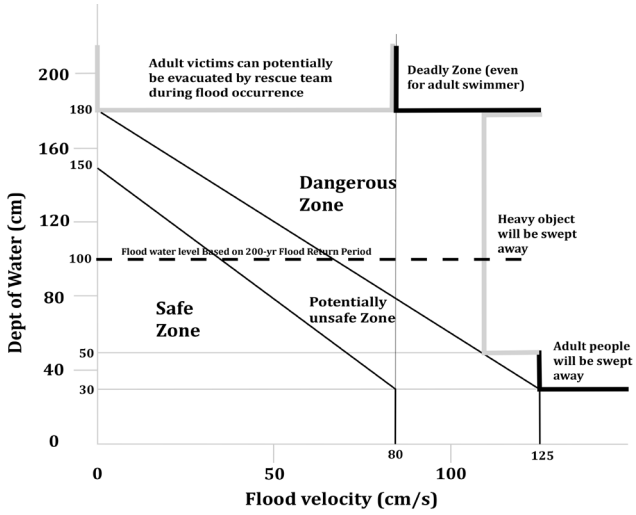


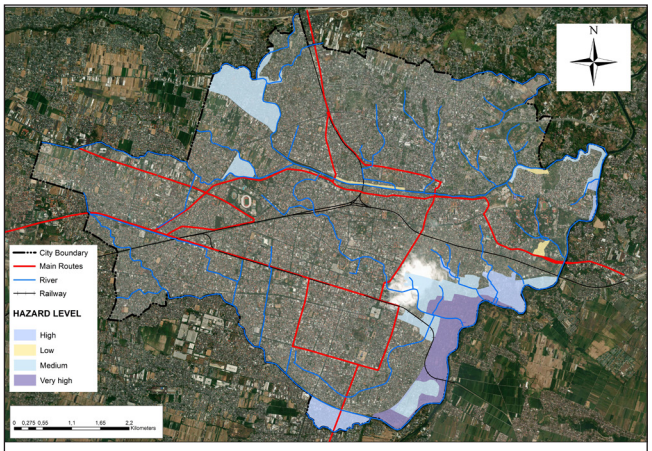
Figure 6. Fundamental Parameters of Flood Safety

in Surakarta is about 1.6. In the resilient city plan, the D_d should be about five times the current drainage density. The drainage density should be implemented in phases in order to adjust to the dynamics of the city. This specific issue in Surakarta City Plan is largely based on the inputs from the BBWS-BS in the post-ZOPA stage.

Based on the estimation of a 200-year flood return period, it is predicted that the flood discharge of Bengawan Solo River will cause a one-meter flood depth, covering one-third of Surakarta (refer to Figure 7). Based on the observation, the average ground slope of Surakarta City is between 8/100 and 15/100, and with the existing urban texture signified by a high building density, the estimated floodwater velocity is stagnant to 0.5 meter/sec. According to these variables, the flood-resilient city plan must designate a specific flood vulnerable zone and suggest that within this zone, the floor elevation must be higher than 1.0 meter from the existing ground elevation.

A zoning ordinance that designates the building types, flood level (which will be evaluated periodically), floor elevation, foundations, and a roofing system that withstands a certain degree of flooding and tropical cyclones must be in place and attached to the land use plan. The plan must provide some necessary examples of best practices for flood-proofing buildings and using cyclone-withstanding roofs, as shown in Figure 8.

Figure 8a exhibits an elevated floor above a designated flood level. The designated flood level was determined by means of a model. In this case, for the 200-year flood return period, the maximum flood water level will be about 1.0 meter above the existing ground level. Thus, the elevation of the floor must be above the designated flood level. If an embankment is cheaper than a concrete pile with the same degree of safety, the elevated floor is placed on the embankment, enhanced by a retaining wall, as shown in Figure 8b. These illustrations are the only example contained in the ordinance.



* Flood hazard level is based on the calculation of flood characteristics and land morphology classification. The flood characteristics include flood frequency, flood duration, and depth of inundation.
* The flood frequency is categorized into annual flood occurrence and uncertain flood occurrence. Meanwhile, the flood duration is classified by less than 12 hours, 12 to 24 hours, more than 24 to 48 hours, and more than 48 hours. The depth of inundation is divided into up to 50 cm, more than 50 to 100 cm, more than 100 to 150 cm, and more than 150 cm.
* The land morphology is identified into fluvial landform, volcanic landform, and structural landform. The fluvial landform has the highest risk of flooding, otherwise, the structural landform is the lowest risk of flooding.
* The classification of flood hazard levels is the result of a summary of the scores of flood characteristics and land morphology classification. Generally, the high flood hazard level is due to the high risks of flood characteristics, and land morphology classification. Meanwhile, the medium flood hazard level is related to the flood characteristics or the land morphology classification having low scores.

Figure 7. Flood hazard in Surakarta City (Source: Surakarta Disaster Management Agency, 2014, Municipality of Surakarta, 2012, with the authors' modifications).

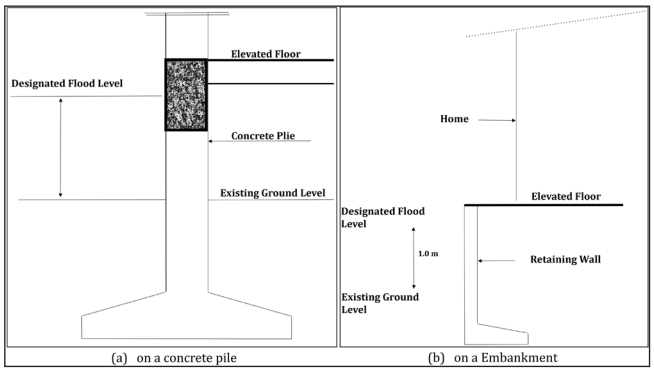


Figure 8. Elevated Floor

While Surakarta City Authority should implement specific details of the flood-resilient city, BBWS-BS should implement the overall flood control within the river basin. There should be a clear boundary between the responsibilities of BBWS-BS and Surakarta City Authority. BBWS-BS is expected to set a flexible floodplain plan, particularly in the surrounding areas of the rivers passing the urban centers. While the floodplain would only fulfil its role during the flood season, during the dry season, the floodplain could be utilized for temporary purposes such as a playground, sports field or city garden (Figure 9).

This synergy in planning should be reflected in the shared Surakarta Resilient City Plan, and it goes against the traditional silo mentality of uncoordinated planning between Surakarta City and BBWS-BS. Some potential advantages of a shared plan are shown in Table 2, which compares the uncoordinated silo plan and the resilient city plan.

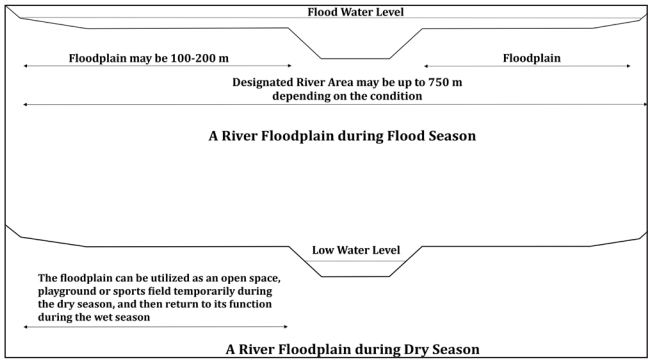


Figure 9. River Floodplain Plan by BBWS-BS

Table 2. Comparison between Silo Plan and Shared Surakarta Resilient City Plan

Aspect	Traditional Silo Plan	Surakarta Resilient City Plan
Characteristics	Silo and uncoordinated	Synergy and integrated
Time Horizon	10 years, rigid	5 years and adaptive
Outcomes	Some conflicts may exist	Synergistic goal
Guide to citizens	Only authority understand	Good practices available
Program	Some gaps or overlaps	Collaboration
Budget	Waste may be generated	More efficient budget
Target	Bias	Focus

The Surakarta Resilient City Plan with the support of BBWS-BS would be able to synergize and coordinate the implementation to accomplish the common (shared) goal of a resilient city against flooding. Two different levels of authorities negotiated by suppressing the respective egos and nullifying the silo mentality will give the advantages of urban development and sustainability. This process could be replicated, as BBWS-BS has a similar issue with regencies along the Bengawan Solo River.

CONCLUSIONS AND WAY FORWARD

Presently, BBWS-BS must deal with eleven regencies and one city along the rivers from upstream to downstream. Surakarta City is the most important city, as it has a strategic position as a cultural-based tourist city that needs a full infrastructure and facilities. Since the regencies have different characteristics, it would be unsuitable if a single strategic plan with the cities and regencies is proposed. Therefore, the negotiation process based on a shared vision must take place. If some of the regencies share their common vision, the process can be simplified.

A different thematic plan, for example, a resilient city plan, can be introduced by any regency based on its local spatial characteristics. There is a difference between the theme of flood resilience for a coastal city or regency and that of a city or regency with an irrigation (river) system in the inland region. The need to legalize the plan into a city ordinance or equivalent regulation in a regency is very

important. Implementation of the plan is the most crucial step in its success or failure. Once the plan becomes a city or regency ordinance, the plan must be guided and executed accordingly. Commonly an ordinance at the city or regency level needs operational guidance, but in this case, to shorten the bureaucracy and ensure the program's execution, the ordinance is expected to be written in a very detailed manner for smooth implementation.

Some ideas on the thematic plan for the regency can be proposed to be negotiated with BBWS-BS, for example, a Coastal City Development Plan for the Tuban and Gresik Regencies, or an Aquaculture and Agriculture Region Plan for Ngawi, Bojonegoro and Lamongan Regencies. The theme can be determined by the Development Planning Agency of the Regency in the respective regencies before the negotiation with BBWS-BS. One important mechanism for BBWS-BS is that this water management authority must be open for the best solution for the region.

If the ZOPA model is adopted by Surakarta City and Bengawan Solo River Basin in the planning process associated with the flood-resilient city and water resources management it could probably be upscaled to the international level, as it uses the universal principles of a non-distributive approach and win-win solutions. For instance, the Mekong River Basin, which encompasses China, Cambodia, Lao, Myanmar, Thailand, and Vietnam, could implement this model, even though the implementation process would face new challenges and constraints. However, with a non-distributive approach in mind, it would be possible to accomplish this. After the negotiation in this example, there would be the need for an international committee to be established to represent the respective countries, with members from all countries concerned. This model can also be adopted by international river basins like the Nile River and others.

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A HYPOTHESIS ON A COMPREHENSIVE APPROACH TO MANAGING THE URBAN POLYCENTRALIZATION OF POST-SOCIALIST METROPOLITAN AREAS

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Managing the polycentralization of metropolitan areas can contribute to a more even pace of development of built-up areas; it can also increase the economic and temporary accessibility of urban centers. This study, attempts to synthesize the main hypothetical provisions of a comprehensive approach to managing the development of polycentric metropolitan areas in post-socialist countries. It presents the necessity for modeling not only the core city, but also the entire metropolitan area when managing polycentralization. The study reveals the formalized stages of how a polycentric metropolitan area evolves and presents a comprehensive analysis on the main problems of a technological and methodological, administrative and legal nature in managing the development of polycentric metropolitan areas. It also highlights the significance of comprehensively developing the transport infrastructure and the prevalence of information and telecommunication technologies within the metropolitan area, as well as the spatial compactness of the metropolitan areas for the polycentralization progress. It is considered that the specific features of the post-socialist urban process can affect polycentralization, including (post-) suburbanization, reurbanization, and gentrification. Finally, measures are suggested in the field of scientific research and technologies, and municipal and regional management aimed at increasing the manageability of developing polycentric metropolitan areas in a post-socialist urban planning context.

Key words: **polycentric metropolitan area, sub-downtown, sub-center, satellite city, post-socialist urban planning.**

INTRODUCTION

A polycentric city emerges if there is more than one large urban center of social and business activity that has a significant societal and economic impact on the entire city and its metropolitan area. The polycentric city develops as an alternative to the monocentric one, in which there is only one large center of diverse public attraction and business activity. Usually it is a historical center, or downtown. The polycentralization of the city, as an optimization process in relation to the urban structure, can begin due to: its rapid spatial and population growth; a rise in commuting that becomes unacceptable in terms of its duration and speed of movement; and the stratification and development of the community. The development of urban polycentricity is an attempt to organize a more even, equitable distribution of space in the centers of social production and mass consumption within the urban area (Gaĭkova and Kiselëva, 2019), as well as to reduce the average time needed to reach public centers (downtowns, sub-downtowns).

Polycentric urban areas already exist objectively in developed countries. Polycentric development trends occur in many big cities around the world (Gaĭkova and Kiselëva, 2019) although with some exceptions, for instance, in Germany (Krehl, 2018). An interdisciplinary research area devoted to the problems of development and maintenance of urban polycentricity has arisen over recent decades. Many research papers from American, Chinese, European, Russian economists and economic geographers, specialists in the field of spatial planning, urban planners, architects, sociologists, mathematicians, etc., evidence this.

In the post-socialist countries of Eastern Europe and Russia, the problem of polycentric urban development is gaining relevance, with similar development scenarios in sub-centers (sub-downtowns). In spite of the notable amount of analytical research already carried out, there is still little

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evidence of much conceptual research aimed at synthesizing the basic features of polycentric urban development in post-socialist circumstances.

The purpose of the study is an attempt to develop a hypothesis about a strategy for the sustainable development of the large polycentric post-socialist city and its metropolitan area (with a population of more than 0.5 million people). The results may be useful in urban master-planning and even the architectural design of sub-downtowns.

A POLYCENTRIC CITY OR A POLYCENTRIC METROPOLITAN AREA?

It is important to study how influential state or regional spatial planning strategies are on urban polycentric development. What is the threshold scale of a territory under spatial development? And what is the most direct influence on intra-urban polycentralization?

Urbanization has affected almost all regions of the world today and continues to expand. In developed countries, urbanization has turned into "super-urbanization": the capital and largest cities of the continents grow and condense as a priority. Moreover, this development comes at the expense not only of rural settlements, but also of smaller second-tier cities (Shubenkov and Shubenkova, 2018; Bontje, 2007).

The "agglomeration effect" relevant today (Krasheninnikov, 2016) is based, from a spatial point of view, on the principle of clustering. Clusters are geographically localized voluntary associations of enterprises (Maslak *et al*., 2018) that provide either an industry, or mix-of-uses covering the needs of any inhabited territory, including the urban district or the city as a whole.

The trend towards the polarized shrinkage of urbanized territories has led to the development of metropolitan areas and larger populated urban realms, including conurbations, commercial (mega-) corridors and megalopolises (Gutnov and Lezhava, 1977; Lang *et al*., 2019, Nelson and Lang, 2018). With regard to an urbanized territory, the agglomeration principle (simplified, exchange between populated territories) and the clustering principle are, respectively, the functional and morphological sides of developing polarized urban structures. Such structures are based on pronounced dominant centers of public and financial attraction (Mazaev, 2019a), which ensures enhanced rates of economic growth of the parent territory as a whole. Thus, the comprehensive principle of spatially polarized development within urban territories is one of the basic characterizing features of future urbanization processes in the developed world.

However, the endless growth of the largest poles of resettlement systems is unprofitable from the point of view of equable spatial development on national and regional levels, and it can even lead to a violation of social justice in terms of the spatial availability of centers of public attraction. All of the above tend to increase the attention of researchers and policymakers towards better management of polarized resettlement systems (Mazaev, 2019a) through polycentralization, which can also arise spontaneously, probably as a latent social response to a trend in urban development, mostly in accordance with economic and production priorities.

The European concept of multilevel polycentrism includes all of the developing levels of spatial and urban planning, from the continental to intra-urban scale. However, there is no distinct evidence that managing polycentralization on the continental, national and inter-regional levels of spatial planning directly influences the spatial organization of emerging polycentricity at the intra-urban level (Pomorov and Zhukovsky, 2016b, 2019).

In the national and regional organization of polycentricity, the goal of authorities is a more *even* distribution of public goods and centers of attraction across cities. Cities are considered in such cases as a kind of "map dots", indifferent to their internal spatial structure, being monocentric or polycentric (Nordregio, 2005). The Japanese experience in the successive development of the polycentric Tokyo metropolitan area over many decades can additionally evidence this feature of spatial polycentricity (Sorensen, 2001).

Thus, it can be concluded that peculiarities under the planning consideration of megalopolises as a whole, mega-corridors and even conurbations are not of primary importance for determining the development strategy of intra-urban polycentrism from a spatial point of view. At the same time, the polycentric features of metropolitan areas with one dominant city would already significantly affect the polycentric development of the main city and its satellites.

It seems that it would be more correct to consider metropolitan areas, rather than just cities within their administrative boundaries, as the largest urban systems to experience manageable spatial polycentralization. This allows us to focus further research attention not only on the continuous urbanized territory of the main city, but also on satellite settlements involved in the daily exchange of labor and consumption with the main city. This concept is similar to the FUA (Functional Urban Areas) methodological approach, while managing European polycentrism (Antikainen, 2005).

Polycentric metropolitan area evolution model

The formation of a metropolitan area begins around one city with outpaced economic and population growth, which is determined by historical circumstances. (Figure 1, stages 0 and 1). As metropolitan areas form with a discrete or continuous nature, various forms of urban polycentricity may arise. These forms include polycentricity: within both the main and satellite cities (Figure 1, stage 2a, "discrete polycentric metropolitan area"); within the continuous urban area of the main city (Figure 1, stage 2b, "continuous polycentric metropolitan area"); with urban corridors connecting (sub-) centers of the main and satellite cities (Figure 1, stage 2c, "stellate polycentric metropolitan area").

At the highest level of development observed today, a composite polycentric metropolitan area may form, with both main and satellite cities comprising (sub-) centers of metropolitan significance, and even urban corridors between them (Figure 1, stage 3).

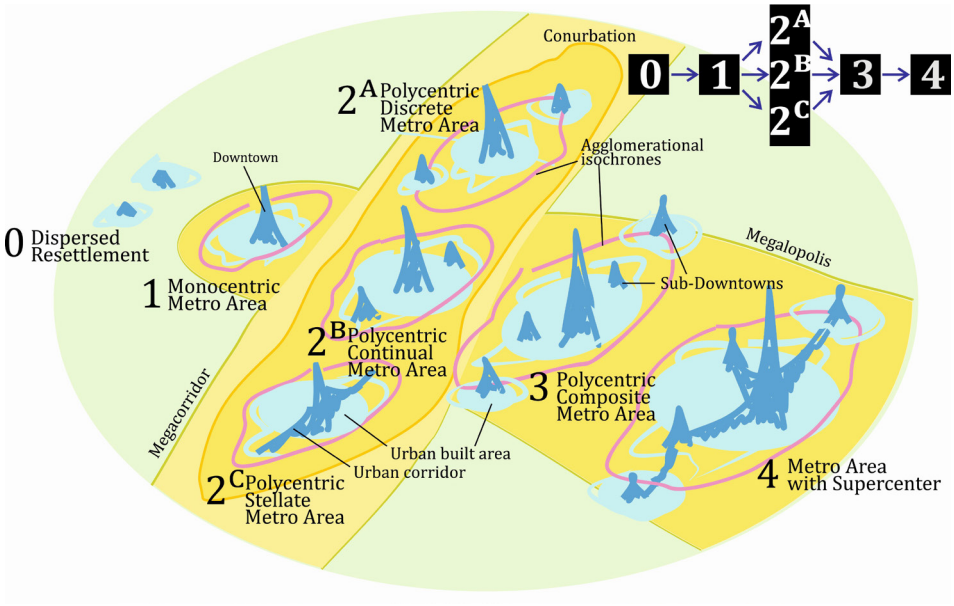

Figure 1. The stages of formation and evolution of a polycentric metropolitan area, in comparison with other urban systems under planning and management. The top-right scheme shows the prime options of evolution in stages

Hypothetically, at the highest level of development, a "supercenter" might form in a metropolitan area, if the literally morphological merging of urban centers and corridors lets a single lattice structure emergence (Zhukovsky and Pomorov, 2017) (Figure 1, stage 4).

The development of polycentric metropolitan areas involves not one, but a system of centrifugal clusters known as "urban center systems" (Gutnov, 1984), which determine the spatial distribution of jobs (Nasri *et al.*, 2018). The business and social functions of these centers are at the same time moderately self-sufficient and interdependent (Gaĭkova and Kiselëva, 2019; Kwon and Seo, 2018). The manageable development of metropolitan areas should involve special attention being paid to "human capital", and not only to economic and industrial features (Li͡ubovnyĭ, 2015).

Problems of the manageable development of polycentric polarized urban areas

Western European authors note improvements in the common understanding of implementing the goals of polycentrism by authorities and developers (Schmitt *et al.*, 2015). However, the foundations and targets of the concept are still vague. It is unclear who should act in implementing polycentrism and to what extent and sequence, while considering the intricate realm of interactions between various public and state institutions at all levels of management (Granqvista *et al.*, 2019). The ideological influence of the party in power on municipal urban policies (Savini, 2013) can further limit the intersubjective understanding of the polycentrism concept goals and objectives.

Another important professional problem of a methodological nature in the field of study is the delimitation of metropolitan areas with unambiguous administrative boundaries. Various approaches already exist, many of which deal with the boundaries of metropolitan areas as unstable and changing, depending on the density of daily commuting (Monastyrskai͡a and Peslyak, 2017).

When determining the conventional metropolitan area boundaries, one can rely on stable isochrone dynamics, as isochrones combine all points of a populated area with the average time of transport movement to the selected community (sub-) center. Russian scientists propose to determine boundaries of metropolitan areas by 2-hour isochrones and to include such boundaries in urban master plans, reviewable every 10 to 12 years (Li͡ubovnyĭ, 2015). However, then the contaminant problem of the robust detachment of metropolitan areas as municipal units or even as mini-regions arises.

Other methodological problems include the technological capabilities for monitoring the emergence and development of subcenters (Taubenböck *et al.*, 2011), and inventing multilevel approaches to assess the changing spatial structure of metropolitan areas (Nasri and Zhang, 2018), in particular, the dynamics of isochrones.

The manageable development of polycentric polarization, either in the European Union or within other world regions, shows the low productivity, or even the counter-productivity of strategies undertaken to achieve the goals of polycentrism, to equalize the development pace and opportunities for various inhabited areas.

Until now, it has not been obvious enough that the European polycentricity concept has a positive effect on forming a more even distribution of public goods across regions or entire countries (Maly, 2016). Polycentrism at the national level does not affect the distribution of public services by region, especially the unique facilities of culture (to mention the unlikely possibility of sustaining a "theater in the village" (Rauhut *et al.*, 2018). However, there is some evidence that the polycentrism concept leads to a more even distribution of offices by regions (Chen *et al.*, 2019). The compatibility of the "Sustainable City" and "Affordable City" concepts is

problematic, while polycentrism involves financial cost in a paradigm of sustainable urban development (Pagliarin, 2013).

At the level of metropolitan areas, the implementation of the polycentrism concept can enhance the significance of the old capitals and main regional cities, while secondary cities, and even satellites, would not be among the societal and economic beneficiaries (Verkhovykh, 2018; Tosics and Berescu, 2011). According to the intermediate results of the modern European policy of polycentrism, it is not possible to find confirmation of comparable support levels for the development of first-tier and second-tier cities within metropolitan areas or regions (Cardoso and Meijers, 2017). Even the development of transport corridors between cities leads to an increase in resource flows towards the primary cities of metropolitan areas (Zhong *et al*., 2015). For instance, Russian scientists recognize as undesirable the concept of developing nationwide resettlement systems based only on 20 state-selected metropolitan areas, as this will cause a massive drain of financial, infrastructural and human resources from inhabited territories outside these metropolitan areas (Bokov, 2018; Lîubovnyĭ, 2015; Skryabin, 2019).

Thus, as first-tier cities exploit smaller second-tier ones, the latter need to develop their own competitive advantages, even pooling resources together with other satellites. However, areas with low-density and dispersed urban resettlement without any form of polarization remain problematic too, as there is no dominant city to consolidate investments and increase the pace of the inhabited territory's development as a whole (Cardoso and Meijers, 2017).

Attempts to manage the development of metropolitan areas have an ambiguous effect on satellite urban centers and on satellite towns as a whole. To compare in terms of possible development rate, even more centralized and directive Chinese policies include paying primary attention to developing free economic zones. This leads to the strong prevalence of morphological polycentricity over what is functional, and very significant dominance of primary cities over outside-inhabited areas (Mu and Yeh, 2016).

The development of Chinese urban polycentrism was peculiar because developers bought cheaper land in the suburbs and began new building campaigns since they were more profitable in comparison with development or redevelopment in the existing (sub-) centers, even with the already provided urban infrastructure. As a result, large-scale alternative centers or areas with other functional purposes have arisen very quickly, but the environmental, functional and informational ties with the rest of the city and with the old centers have not matured as quickly.

A.V. Bokov mentions the same kind of practices among Russian planning authorities that are still widespread, whereby the view of "what ought to be built" takes priority over providing opportunities for commuting and the functional exchange between built areas (Bokov, 2018). Thus, examples of ghost developments in Soviet Tobol'sk (Tumanik, 2014) and even the ghost towns of Ordos and Tianducheng (Pomorov and Zhukovsky, 2019) confirm the desirability of analyzing and planning potential functional exchange between the centers in a developing polycentric metropolitan area (Wenze *et al*., 2019; Liu *et al*., 2016).

We should not overestimate planning itself as having a dominant influence on the process of polycentralization, because the spontaneous formation of new metropolitan (sub-) centers also takes place (Bontje, 2007; Olsvold, 2018). This fact supports the vision of the essence of urban planning as "influence" rather than "ruling" (Shubenkov, 2017; Shubenkov and Shubenkova, 2018). For instance, municipalities should be set up for equal and productive interaction with top urban developers, whose plans for erecting commercial real estate by all legal means is an indispensable factor of urban planning (Pomorov and Zhukovsky, 2016b).

Ways to solve the problems of satellite cities developing within metropolitan areas

The centers of satellite cities in metropolitan areas are subcenters of a discrete polycentric urban area. Consequently, the satellite cities' development level and their exchange context will affect the development of their centers. Regional authorities and municipalities can partially solve the main problem of an unbalanced exchange between first-tier and second-tier cities in favor of the former by taking the measures below:

- The search for the real competitive advantages of satellites within metropolitan areas, which can be expressed in terms of their proximity to large natural areas, the provision of specialized and innovative services and infrastructure like university campuses, tourism and medical camps and motels (Bokov, 2018; Tzaninis, 2015);
- Promoting the lifestyle in small satellite towns to erase the inherited socialist mental perception of a large city as obviously more attractive than a small one (Bokov, 2018);
- Investing in the development of second-tier metropolitan areas of smaller regional cities (Bokov, 2018; Lîubovnyĭ, 2015; Skryabin, 2019), bearing in mind that they would never develop as rapidly as the old first-tier metropolitan areas (Mazaev, 2019b); and
- Detailing the municipal guidance of urban planning by differentiating the indicators and standards imputed to be reached by large cities, small towns, suburbs, and villages. Target indicators cannot be unjustifiably equal for different settlement types (Bokov, 2018).

HOW DOES POLYCENTRALIZATION AFFECT A METROPOLITAN AREA AT THE INTRA-URBAN SPATIAL LEVEL?

Density, speed, features of traffic

The effect of spatial polycentricity and compactness on traffic congestion is ambiguous: in some cases negative, in others positive (Li *et al*., 2019). A variety of local facilities and businesses reduces the volume of forced trips (Duarte and Fernández, 2017).

For the largest cities, polycentrism is effective: it reduces the total level of traffic congestion (Li *et al*., 2019). However, a relatively excessive number of alternative centers can lead to "chaotic" traffic in the city and an increase in traffic congestion (Pomorov and Zhukovsky, 2016a).

Polycentralization contributes to the development of diversity in the choice of transport (Nasri *et al*., 2018). The emergence of additional (sub-) centers contributes to an increase in traffic flows, and the introduction of new transport communications leads to an increase in the total amount of intra-urban vehicles (Saprykina *et al*., 2019). A local increase in the level of education and income among the residents of a region (neighborhood) increases their mobility, and hence, the amount they commute (Shubenkov, 2017; Solis *et al*., 2019).

Distances and travel times

In Denmark, under the implementation of the polycentrism concept, travel distances decreased and the intensity of trips at the inter-urban level increased, while the latter decreased at the intra-urban level (Grunfelder *et al.*, 2015). In Luxembourg, the transport accessibility of public facilities increased by 9% after the transfer of some services from centers to subcenters (Decoville and Klein, 2020).

The local jobs-housing balance significantly affects the average movement time of transport in the city (Lin *et al*., 2019; Trujillo and Muñiz, 2014). This feature indirectly justifies the observed existence of a hybrid city model with many "non-centers" in addition to subcenters.

City economic performance

According to some reports, the consolidation of subcenters increases the economic efficiency of the city as a whole (Yingcheng, 2020). Subcenters create small positive extremes on a graph showing the relation between a decrease in land prices and the distance from the main center, but the global trend of decreasing prices is not affected (Huang *et al.*, 2018; Lang, 2003). Polycentric cities experience less property segregation than monocentric cities (Garcia-López and Moreno-Monroy, 2018).

FACTORS AFFECTING THE DEVELOPMENT OF POLYCENTRIC METROPOLITAN AREAS

One of the main factors contributing to the polycentralization of metropolitan areas is the development of a general transport infrastructure (Li *et al*., 2018; Li͡apunova and Platonova, 2017).

The introduction of advanced transportation allows the isochrones in the metropolitan area to expand to 1.5…2 hours, with the longest possible daily trips of 100 or more kilometers (Krasheninnikov, 2016). This effect also takes place within mega-corridor resettlement systems (Tolmachëva and Anti͡ufeeva, 2019).

Clear transport communications should be provided between the centers, since the level of social attractiveness of the center depends on its connectedness with other centers and the "buffer" areas: residential, industrial and reserved natural milieus (Liu *et al*., 2019; Sarkar *et al.*, 2018; Wenze *et al*., 2019). However, authorities should pay attention not only to the major transportation links between centers, but also to more even development of the transport infrastructure throughout the city, as well as within the "buffer" areas (Sarkar *et al*., 2018). Thus, transport must be accessible from both centers and "non-centers" throughout the metropolitan area (Li͡apunova and Platonova, 2017).

The development of transport infrastructure should correlate with planning new centers and monitoring their development, since underestimating the scale and pace of the spontaneous consolidation of unplanned "invisible" subcenters can lead to an increase in traffic congestion (Li͡apunova and Platonova, 2017; Sorensen, 2001) and gentrification throughout the city (Yang *et al*., 2015; Zhukovsky, 2018).

Subcenters are more likely to appear or remain when the time spent on various trips, the financial costs of traveling downtown and the purchase of land are less than staying downtown; the income associated with the local agglomeration effect would also cover the re-location costs (Harris and Ullman, 1945; Li͡apunova and Platonova, 2017). At the same time, the availability of the Internet improves the economic efficiency of a polycentric city (Zhang *et al*., 2017), although it also causes a decrease in the importance of traditional public urban spaces (Kuznetsova, 2013).

The development of information and telecommunication technologies affects the traffic in the city (Aguilera and Boutueil, 2018), reducing the need for mandatory clustering of public and business facilities literally within a neighborhood or block. This may explain the growing number of "non-central" areas of business activity and consumption (Krehl and Siedentop, 2018).

The compactness and continuity of urban areas (Dewita, 2018; Li *et al*., 2018) and the high density of urban development (Li and Liu, 2018) positively affect the usefulness of polycentralization to accomplish the aims of sustainable ecological development in the metropolitan area (Moiseev, 2017) and the creation of a more just urban structure in terms of the accessibility of the centers.

ADDITIONAL FEATURES OF POST-SOCIALIST URBAN DEVELOPMENT THAT CAN AFFECT POLYCENTRALIZATION

Suburbanization and gentrification

Gentrification in post-socialist cities occurs in the inner built-up areas and inner suburbs (Drozda, 2019; Grabkowska, 2012; Sýkora, 1999), parallel with the reurbanization process (Šimon *et al*., 2015), including the "revival" of the historical inner cities in Eastern Europe under revitalization and diversification (Grabkowska, 2012). The municipal regulation of urban development itself may also lead to gentrification (Chelsea, 2006).

Although gentrification within Russian metropolitan areas has not been a rising trend so far, they are experiencing specific changes on their peripheries. For instance, rural residents tend to move to high-rise neighborhoods (microrayons) (Hochstenbach and Musterd, 2017; Ouředníček, 2007); and developers organize residential quarters and shopping centers on former brownfields (Verkhovykh, 2018). The residents of rural areas and suburbs also have a need for additional inter-settlement sub-downtowns on exit routes with a mix of uses representing trade, medicine and leisure (Filanova and Kruglova, 2019).

Thus, the initial post-suburbanization already develops before suburbanization has become significant: still a small percentage of households currently live in low-density suburban settlements (Brade, 2012). To note, in Polish cities post-suburbanization has already come quite a long way, as new linear sub-centers of business and public activity in the form of sub-downtowns have already formed along the outbound routes.

In Western countries, the establishment of new satellite towns is often accompanied by suburbanization, for instance in Almere near Amsterdam, the Netherlands (Boterman and Tzaninis, 2018). The factors leading to the displacement of citizens to the suburbs and satellites include improving the well-being of households, and the efficient branding of satellite cities by municipalities and developers (Tzaninis, 2016).

The reverse process, reurbanization, which is the return of the population from the suburbs to the main city, often leads to gentrification. In this phase, young families with a need for a "central urban" lifestyle with pedestrian accessibility to a mix of urban uses (Grabkowska, 2012), higher-income people and foreign immigrants (Ouředníček, 2007), Tzaninis, 2015) move downtown.

Administrative issues

There is a need for planning and monitoring the polycentralization of each specific metropolitan area, taking into account the priority ranking of urban areas in order to stimulate them with forming or developing additional subcenters or sub-downtowns (Zhukovsky, 2018).

However, the municipalities in post-socialist countries still have little authority and are limited in funding and sources of income. A number of researchers note that the decentralization and expansion of municipal powers and budgets for the implementation of many urban development programs is needed (Bokov, 2018; Vogler, 2020). It is not necessary to create a "supra-municipality", but to intensify cooperation in the urban zoning of municipal and regional authorities, where the regions should regulate the relatively equal development pace within metropolitan areas (Marques *et al*., 2019, Smol'i͡aninov, 2018).

Post-socialist urban planners need to search for new forms of administrating urban development more flexibly (Tosics and Berescu, 2011). In particular, this means the transition from direct general planning with long-range forecasting (20 to 25 years) to masterplans in which spatial development is projected with granularity at the level of districts and centers, for a medium term of 10 to 12 years (Li͡ubovnyĭ, 2015).

Another administrative problem in post-socialist countries that impedes the controlled development of polycentric metropolitan areas, as exemplified by Russia, is the lack of a legal concept of a metropolitan area in the state urban planning codes (Verkhovykh, 2018). It is possible to design metropolitan areas as separate entities of the state, which may require a reform of the administrative division of regions or the state as a whole (Smol'i͡aninov, 2018).

There is also no single subject of planning in metropolitan areas, even in conditions of cooperation between various urban municipalities (Verkhovykh, 2018). From this point of view, the formation of a supra-municipal planning institute would be advisable.

DISCUSSION

A survey on the manageable development of polycentric metropolitan areas in post-socialist countries revealed the following details:

- Urbanization in developed countries, as well as in the post-socialist region, will continue to develop as "super-urbanization", implying the formation of polarized resettlement systems, including polycentric ones.
- The aim of stimulating urban polycentrism within polarization is to equalize the development possibilities and the pace concerning differing populated areas; it is also to increase the distance and time availability of (sub-) centers. For example, the authorities at different levels implement the polycentrism concept in the European Union today.
- Planners and authorities should manage the development of polycentrism concerning not just the cities within administrative boundaries but also the metropolitan areas as a whole. Thus, the downtowns of satellite cities are the sub-downtowns of metropolitan areas.
- The evolution of large-scale urban systems towards polycentricity, such as megalopolises, corridors and conurbations, does not directly affect the spatial aspects of polycentralization at the level of metropolitan areas.
- Monocentric metropolitan areas can transform during their evolution into different types of polycentric areas: continual, discrete, with a stellate configuration of the center, and discrete-continual (composite) with the prospect of integrating a single lattice-like "supercenter".
- The main factors affecting the features of polycentralization of metropolitan areas are:

  a) Comprehensive development of an urban transport infrastructure;

  b) Compactness and continuity of the urban territory;

  c) Suburbanization and reurbanization with the possible dominance of one of these at a time; and

  d) Mass introduction of information and telecommunication technologies.

- The main issues concerning the manageable polycentric development of metropolitan areas in post-socialist countries are:

  a) Unequal development opportunities and pace between the first-tier and the second-tier cities, their centers and respective metropolitan areas;

  b) Use of a directive "morphological" approach to forming alternative centers of urban attraction as a simple large-scale development, without enough consideration given to the emerging functional links between such a development and the rest of the metropolitan area;

  c) The ambiguous interpretation of the goals and objectives of polycentrism by various participants in urban planning;

d) The complicated nature of the operational and legal delimitation of metropolitan areas as objects of planning and management;

e) Lack of a legal concept of a "metropolitan area" in regional urban planning;

f) Limited financial, regulatory and research capabilities of municipalities; and

g) Technological and methodological problems of developing scientifically based models for regularly monitoring the evolution of polycentric metropolitan areas.

- Hypothesizing, those who take part in the manageable development of polycentric metropolitan areas in post-socialist countries should apply the following to achieve better societal and economic urban performance according to goals of the polycentrism concept:

  a) Legal designation of "Metropolitan Areas" and "Sub-Centers" with additional "Sub-Downtown" concepts in urban planning practice;

  b) Implementation of scientifically based delimitation of metropolitan areas and (sub-) centers with regularly updated isochrones and other necessary boundaries;

  c) Introduction of scientific and legal definitions of the "Polycentric Metropolitan Area" concept;

  d) Expansion of measures undertaken to make satellite cities and the main city rim more competitive and attractive;

  e) More differentiation of development goals (containment, expansion, stabilization) concerning various settlements and (sub-) centers in a polycentric metropolitan area, including attention to districts requiring urban renewal;

  f) Regular monitoring of suburbanization, reurbanization and gentrification processes within metropolitan areas;

  g) Regular monitoring of the efficiency of the metropolitan transport infrastructure according to the dynamics of changes in traffic volumes, average speed of movement, and the average time and distance of established pendulum migrations between (sub-) centers and residential zones;

  h) The introduction of more mathematical, graphic and analytical models to monitor the development of metropolitan areas, especially in provincial regions;

  i) Transition from a directive Soviet-style "general city plan" to a master plan of metropolitan areas with a medium-term prospect of planning aimed at neighborhood-scale urban areas, including the (sub-) centers;

  j) More even transport infrastructure development within and outside the (sub-) centers, also the introduction of advanced, flexible forms of public transport;

  k) Support for spatial consolidation of metropolitan areas through new development and revitalization practices; and

  l) Deepening further interdisciplinary research in relation to polycentric metropolitan areas in post-socialist countries, whilst providing the exchange of scientific and practical experience in the field.

CONCLUSION

Summarizing the above, a hypothesis has been put forward for a comprehensive strategy for the sustainable development of large polycentric metropolitan areas in post-socialist countries. This strategy should have, in theory, a robust interdisciplinary scientific approach, including urban concepts with spatial delimitations and monitoring. In practice, this strategy should not use a directive, but a differentiated approach to the development of real estate and transport, aimed at morphological and functional urban consolidation.

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