





# **spatium** No. 45, June 2021, Belgrade

#### 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**

Summer has launched itself upon us with such a fiery intensity in mainland Europe that it has interfered with my level of inspiration and originality. And so, at a time like this, I find refuge in poetry, while seeking beauty in 'small' yet meaningful things that may also find their way to the readership of this journal.

It is summer that brings to my mind the verses of nationally famous poet Desanka Maksimović, who happened to be the Serbian language teacher of a dear late colleague and friend of the Institute of Architecture and Urban & Spatial Planning of Serbia, Prof. Dr. Dobrivoje Tošković. He was a great urban and spatial planner, architect-designer and university professor, and we dedicate the cover page to him as we bid him a symbolic farewell in this issue of *Spatium*.

The summer is getting closer and closer; I can already sense it in my soul. Its golden hair is blooming in the ripe fields of yellow. - Desanka Maksimović, from the poem Bliži se, bliži leto (translated by the Editor)

In line with previous thoughts, among the contributions to issue No. 45 of Spatium we have papers dealing with tourism in the process of change, i.e. the smart tourism branding concept for cities in the "new normal era" and the phenomenon of "overtourism", examining the preparedness of cities that attract excessive numbers of tourists and the relationship between city dwellers and visitors. In another paper there is reconciliation between the present and past with the application of a reverse-engineering tool that helps guide the systematic analysis of architectural precedents. Further authors examine the spatial layout of modern apartments that still retain the spatial configuration of traditional houses, the importance of basic human needs and culture guiding the modifications of the physical environment, and the impact which spatial morphology and its properties have on the people's experience of it. Another topic presented in this issue of *Spatium* is a comparative analysis of the determinants of urban transport energy consumption between groups of cities, as one of the aspects of sustainability; a second aspect is tackled in the assessment of sustainable architecture's contribution to social equity, the aesthetic quality of the environment and the presentation of cultural values. The papers in No. 45 of Spatium present case-studies from all over the world: Indonesia, Vietnam, Algiers, and Turkey. They contribute to a better theoretical understanding of spatial and urban design and architectural issues, while simultaneously improving practice in the field.

Jasna Petrić Editor-in-Chief

# CITY TOURISM BRANDING RESILIENCE DURING THE COVID-19 PANDEMIC IN YOGYAKARTA, INDONESIA

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The New Normal Era needs future adaptation, in order to ensure cities still have competitiveness and resilience in the tourism sector during the pandemic. Therefore, this study aims to evaluate the implementation of the Smart Tourism Branding concept in Bantul city, Indonesia, during the COVID-19 pandemic. This is a quantitative study, using the random sampling method to obtain data from 230 respondents through a questionnaire, which was analyzed using the Statistical Package for the Social Sciences (SPSS). During the initial stage, a statistical test on each question's validity and reliability in the questionnaire was conducted, after which data analysis was carried out. Before performing multiple linear regression analysis, several assumptions were fulfilled, including data normality and multicollinearity. The results showed that the evaluation of smart tourism branding provides an overview of people's understanding and satisfaction level with regard to tourism during the COVID-19 pandemic. The Jelajah Bantul application, which is a smart tourism branding instrument, supports Bantul City's ability to compete in attracting tourists and investment globally. In addition, the city's tourism management and branding identity can be facilitated and strengthened when the synergy strategy of the community and city stakeholders is appropriately regulated.

Key words: smart branding, tourism, competitiveness, resilience, community perception.

## INTRODUCTION

Nowadays, cities are competing to become the global community's choice in investment, trade, tourism, and partnerships. In this shift in trend, a liveable, innovative, and sustainable residential environment is needed by cities, with the availability of comfortable, safe, healthy, and accessible public facilities for residents. Currently, the lifestyle of city residents and the future of cities are influenced by trends in information technology developments, since they are one of the solutions to the problems and challenges faced in a city. Indonesia has been in the process of building competitive smart cities in terms of planning, governance, information technology, and business development for the last three years. Information technology is needed in order to collect and analyze data useful for the government, community, and business actors. Building a smart city offers bureaucratic efficiency using information technology and also builds the community.

This study examines the implementation of smart tourism branding in Bantul City, Yogyakarta, Indonesia, in accordance with the New Normal era resulting from the COVID-19 pandemic. In March 2020, all tourist destinations in Yogyakarta were temporarily closed to visitors due to the emergence of the coronavirus. However, in October 2020, some destinations reopened and have received limited visitors by implementing health protocols. Therefore, in

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entering the New Normal era resulting from the COVID-19 pandemic, Bantul's smart city concept, especially its smart tourism branding, needs to be evaluated. Furthermore, cities need competitiveness and resilience for future adaptation of the concept. This study seeks to contribute to the novelty value of urban studies research in the new normal era.

## LITERATURE REVIEW

City branding is a strategic instrument used to publicize the competitive advantages, history, quality of place, lifestyle, culture, and capital accumulation of a city in a competitive environment (Langer, 2001; Morgan et al., 2002; Berci et al., 2002; Evans, 2003). Apart from giving competitive advantage, being a smart city also highlights its functional and non-functional qualities, such as appearance, history, cultural attractions, demographics, economics, governance, experience, and perception (Zhang et al., 2009). According to Lucarelli and Olof Berg (2011), city branding is the purposeful symbolic embodiment of all information connected to a city, in order to create surrounding associations. At the theoretical level, the concept of branding is typically developed in response to changes in the status and role of tourism in the global environment. City tourism branding competition and the latest developments show that successful city branding does not need to be limited to communication and marketing; instead, it needs to reach city planning, culture, trade, and investment (Herget et al., 2015).

The direct and indirect experiences people have with their city environment produce representations and perceptions. Therefore, there is a physical and symbolic city built in their minds. This relationship helps explain the differences in city forms, such as buildings, streets, parks, etc., containing diverse social, cultural, historical, and political meanings (Castillo-Villar, 2016). There are two main factors associated with the city branding process. Firstly, it is an instrument for socializing the city's identity, and secondly, it is an instrument for increasing the competitive capacity. Strong city competitiveness and identity are not paradoxical concepts. However, exploring the synergy and identity of cities opens up opportunities for sustainable development. Kavaratzis and Kalandides (2015) stated that there are two significant gaps in the understanding of brand formation. Firstly, it is unclear which types of elements are associated with place attachment, based on personal preferences. Secondly, it is not clear how these associations operate collectively and how they link with each other to form a brand.

Kavaratzis and Kalandides (2015) further stated that it is important to take a close look at the elements that constitute a place, and they address some of the tensions within that framework. They also reported that these ongoing and multiple place brand formation processes are similar and interconnected with the synthesizing method. This allows people to make sense of places, and it is a process of interactions between the associations. The perception of a city affects its attractiveness to tourists, foreign investors, and potential students. Currently, marketing experts are trying to brand or re-brand cities in order to create a community where people are willing to live that is attractive to visitors (Herget ., 2015; Young, 2012). Branding is a deliberate process of selecting and associating various attributes capable of adding value to the basic product or service (Knox and Bickerton, 2003). The worldwide competition between cities due to the increase in economic and cultural globalization has been a stimulus for the development of place branding techniques (Sameh et al., 2018). Several studies indicate that branding is one of the most important tools in city marketing. Therefore, when properly implemented, it helps to attract the target market and satisfy stakeholders, thereby increasing various aspects of city competitiveness (Purwanti and Genoveva, 2017). A place needs to be differentiated by means of its unique brand identity, assuming it is recognized as existing, and perceived in the minds of customers as possessing superior qualities, and consumed according to the place's objectives (Kavaratzis et al., 2005). Branding of cities contributes to urban development and serves as a tool to enhance their position. Sameh et al. (2018) stated that city branding is a central activity within city management, and one of the most debatable topics among marketers.

According to Kankhuni (2020), destination branding is executed by combining the efforts of the supply (destination) and demand (traveller) due to the successful outcomes achieved by both sides. A standard approach to city branding is typically associated with promoting competitive assets and often dictated by public-private partnerships without significant community involvement (Joo and Seo, 2018). This issue relating to place branding is a fairly new and dynamic development, which can be facilitated by a deeper understanding. Furthermore, this is obtained with the interaction of multiple stakeholders, in order to create value that brands a place, which is inextricably linked to place identity and a sense of place (Hereźniak, 2017).

The creation of a city brand is connected with a set of events aimed at forming a bright and large image that is able to accommodate all of the positive characteristics of the city, emphasizing uniqueness and authenticity, and making it attractive and memorable for tourists (Karakova et al., 2020). A city's image as a tourist destination includes a number of associations (memories), expectations, and other emotions. A strong brand is used to raise awareness of a place's existence (Uskokovic, 2020). At this stage of globalization, it is imperative to determine the urban selling point of a city's competitiveness, which gives a city its image by public design, so as to acquire the right identity based on a cultural understanding (Young, 2012). Cities tend to compete globally to attract tourism and investment. Therefore, city branding concepts and strategies are increasingly being adopted and applied to development.

City branding is the process of diversifying local tourist organizations, cultural and arts facilities, museums and historic preservation groups, as well as constructing a place for images, thus helping to develop tourist sites to attract consumers and investment in a particular local area (Jojic, 2018). According to Mohammadifar *et al.* (2018), city branding is a predictor variable for creating an ideal image that satisfies residents and significantly impacts the level of audience satisfaction, including that of tourists.

The transition from city marketing to branding is facilitated

by the extensive use and success of product branding and the recent and rapidly developed concept of corporate branding (Balmer, 2001; Balmer and Greyser, 2003). Gnoth (2002) reported that the power of tourism is a determinant of how the image of a country is perceived, with a theoretical approach in developing a leveraging model capable of facilitating the tourism experience brand across different industries. The synergy between public and private, when properly regulated, facilitates the management and maintenance of strategic areas of the city, reinforces the image and branding identity, and opens alternative ways of attracting new businesses, commercial investors, consumers, and tourists (Rossini and Nervino, 2019).

## **RESEARCH METHOD**

This is quantitative research with primary data randomly obtained from 230 respondents, using a questionnaire consisting of a list of questions on demographic data, responses, statements, and answers. Respondents to the questionnaire included city residents, via Google Form media. The questionnaire was divided into three parts. The first part contained the respondent's age and background identity, while the second and third contained their knowledge of smart tourism branding in Bantul and the Jelajah Bantul application. Respondents were required to complete the questionnaire by selecting and filling in the fields provided. Following this, multiple linear regression analysis was carried out to determine the respondents' characteristics, such as age, residence location, and their knowledge of smart branding and the Jelajah Bantul application. All data in this study were analyzed using the Statistical Package for the Social Sciences (SPSS). In the initial stage, a statistical test on each question's validity and reliability was conducted to determine their validity based on the value of  $r_{count} > r_{table}$  and Cronbach's alpha> 0.6. Before performing multiple linear regression analysis, several assumptions were fulfilled, such as data normality and multicollinearity.

#### **RESULTS AND ANALYSIS**

Bantul City is located in the Special Region of Yogyakarta, Indonesia, as shown in Figure 1. According to 2019 data obtained from the Central Bureau of Statistics, Bantul City is the second favorite tourist destination in Indonesia, after Bali Island.

According to the data from the Central Bureau of Statistics (2020), Bantul has a population of 951,344 and a density of 1,877 people/km<sup>2</sup>. Tourist attractions in this city are natural (Parangtritis beach, Depok beach, Parangkusumo dunes, Mangunan pine forest), cultural (traditional ceremonies), and artificial (handicraft centers) (Regional Development Planning Agency, 2015).



Figure 1. Bantul City, Yogyakarta, Indonesia (Source: Author, 2021)

The cumulative number of foreign tourist visits to Indonesia in 2019 was 13.62 million (2.85 percent increment), compared to 13.25 million visitors in 2018 (Central Bureau of Statistic, 2021). However, in 2020, the cumulative number of foreign tourist visits decreased by 72.35%, with a total of 3.72 million visits due to the Covid-19 pandemic. In



Figure 2. Potential map of Bantul city, Yogyakarta, Indonesia (Source: drawn by authors using Bantul Central Bureau of statistics data 2020)

order to facilitate the delivery of information on regional potential, the Bantul Smart City Master Plan, consisting of six dimensions, namely smart governance, branding, the economy, living, community, and the environment, was established in 2017. Smart branding is one of the dimensions in the Bantul City masterplan that aims to develop the competitiveness of superior commodities based on regional potential sustainably and build infrastructure and market tourism with a go-digital strategy, in the form of the Jelajah Bantul application (Starjogja information channel, 2020). This application contains information on various tourist destinations in Bantul City. Through this application, prospective tourists wanting to visit tourist destinations in Bantul are able to obtain prior information on location choices and types of tourist destinations, accommodation, culinary spots, and local transportation.

However, after running for three years, there has not yet been an evaluation to determine the extent of the community's understanding of the smart tourism branding, or any thoughts shared on tourism during the pandemic. Furthermore, there has been no evaluation of available applications and their contents that would respond to interest in tourism during the pandemic and understand the development of support facilities.

Therefore, in response to this lack, the community's opinions on smart tourism branding and the Jelajah Bantul application during the COVID-19 pandemic were collected through questionnaires, in which the respondents could share their opinions regarding:

- Smart tourism branding in Bantul, Yogyakarta;
- Tourism during the COVID-19 pandemic;
- The content expected to be available in the Jelajah Bantul application to help tourists during the COVID-19 pandemic; and
- Innovation in developing tourism support facilities.

The questionnaire was distributed to 300 respondents from various categories of age and educational background. A total of 230 respondents filled out the questionnaire. However, only 207 were analyzed because the remaining 23 had data errors due to incomplete answers and redundancy. The processing results are summarized in Table 1.

Table 1 shows that the questionnaire has a Cronbach's Alpha value above 0.6. This means that each question and answer item was reliable. The value of  $r_{count}$  for all questions and answers was greater than  $r_{table}$ . Therefore, it can be concluded that the results were valid and reliable, based on the results of statistical validity and reliability tests. The analysis process consisted of several unfulfilled assumptions, namely the community opinion on post-pandemic/New Normal touring, the expected applications and available content, especially to reveal tourism during the pandemic, and the level of understanding on the use of the application for developing tourism support facilities in Bantul.

The unfulfilled assumptions were the assumption of normality and multicollinearity for each component, thereby making it impossible to continue the regression analysis. Multiple linear regression analysis was only performed on variables that met several assumptions, as shown in Table 2.

Table 2 indicates the existence of a mutual relationship between the t-table and t-count. A significant value greater than each variable is obtained when the alpha value is 0.05, therefore, there is a relationship between the independent and dependent variables. Thus, it can be concluded that the respondents' characteristics, such as gender, higher (university), and secondary education levels (senior high school/equivalent/others), and an age of 15-29 or above 30 years do not influence the knowledge level of smart tourism branding. The residence location factor in Yogyakarta influenced the level of knowledge on smart tourism branding, since the questionnaire was also applied to respondents located outside Yogyakarta.

In the component regarding the understanding level of users of the Jelajah Bantul application, the significance value was greater than the alpha value (0.05), without any effect of gender, education, age or location of residence.

A descriptive analysis of the questionnaire is as follows:

• Knowledge of the Components of smart tourism branding

Respondents were given several statements to measure their understanding of the components of smart tourism branding, such as "I often visit tourist destinations", "Supporting factors for tourism such as transportation, accommodation, hotels, restaurants, souvenir places are in good condition", "There are supporting facilities at tourist destinations used for superior marketing products based on regional/local potential". The respondents' answers show that 62% were neutral, 27% agreed, 9% disagreed, 1% strongly agreed, and 1% strongly disagreed, as shown in Figure 3.



Figure 3. Community Knowledge on the Components of Smart Tourism Branding

#### • Opinions on tourism during the COVID-19 pandemic

On the community understanding of tourism during the COVID-19 pandemic, respondents provided several statements, such as "I still have fewer tourist activities, especially with general visitors that arrived due to the pandemic", "Touring after a pandemic is very necessary to refresh the mind", "Tour activities are allowed while implementing the health protocol". The respondents' Table 1. The Community Opinion on Smart Tourism Branding (Cronbach's Alpha, N = 207)

#### Opinions on Smart Tourism Branding ( $\alpha = .798$ )

Opinions on Smart Tourism Branding ( $\alpha = .798$ )						
Loften visit tourist destinations.						
When I visited tourist destinations, there were no obstacles.						
Loften visit natural tourist destinations.						
Anart from natural tourist destinations. Lyisited handicrafts culture arts and history tourism destinations.						
Supporting facilities such as transportation accommodation restaurants and sift shops are in good condition						
The Tourism Office properly conducts tourism management and marketing						
In each tourist destination there are marketing facilities for superior products based on regional /local notential						
There is signing on the road to tourist destinations						
Affordable admission prices						
There a various choice of tourist destinations						
Oninions on tourism during the COVID-19 nondomic ( $\alpha = 782$ )						
I have reduced my tourism activities, especially in crowded places.						
Tourism activities during a pandemic are needed to refresh the mind.						
The number of visitors to each tourist destination needs to be limited						
It is essential to choose a safe tourist destination because of the risk of contracting the COVID-19 virus and government regulations.						
Tourism activities are permitted in compliance with health protocols.						
Making a digital application to monitor visitors' numbers at each tourist destination in real-time is recommended.						
A digital application is needed to provide information on the COVID-19 zone in each tourist destination.						
Opinions about digital applications and content that supports tourism during the COVID-19 pandemic ( $\alpha$ = .929)						
The content on the home name are appendent to implementation of acquirity and alcost in the content deptiment deptiment of a second sec						
The content on the nome page presents the implementation of security and cleanliness at each tourist destination.						
I here is a zoning map on the spread of the virus in each tourist destination, and information on neath protocois.						
The app contains the number of COVID-19 cases in the local area, information on the availability of health facilities (hospitals), and recommended						
accommodation.						
There are COVID-19 news updates in areas where tourist destinations are located.						
There is added news regarding COVID-19 in real time.						
There is information on the number of visitors and health check standards at each tourist destination.						
There is a need for a digital application containing detailed tourism procedures in accordance with health protocols.						
The content includes updating information on visiting times and the number of visitors allowed, thereby enabling the community to manage their						
tourism time.						
There is content on accommodation facilities, local transport, maps, mileage, culinary spots, and tour guides.						
There is alternative information on other tourist destinations when the visitor capacity limit is reached.						
The opinion of Jelajah Bantul users about the application's innovation ( $\alpha$ = .967)						
I use the lelaiah Bantul application to choose tourist destinations.						
The left and application helps in providing access to tourist destinations.						
The lelajah Bantul application provides information on tourist destinations.						
The frequency of my visits to tourist destinations has increased after using the lelaiah Bantul application.						
The Jelajah Bartul application helps to provide recommendations on various fourist destinations						
There is a poor internet connection that needs to be improved						
I do not face any problems in using the application						
I am satisfied with the annication.						
Promotion needs to be carried out to educate the community on the use of the Jelajah Bantul application						
Content on the available touring schemes is needed (half-day one-day two-day tours).						
The oninion of the non-Jelaiah Bantul users about the application's innovation ( $\alpha = 824$ )						
The opinion of the holi jetajan bankar also stabult the application's innovation (u = 102+)						
I have never known or used the Jelajan Bantul application when choosing tourist destinations.						
Promotion needs to be performed to educate the community on the Jelajah Bantul application.						
It has impressive content for travel packages and events for families						
I need information regarding the COVID-19 distribution map, safe travel, and health protocols.						
I need information regarding accommodation and local transportation.						
I need culinary information.						
I need information on tourist destination places favored by the community.						
I need entrance ticket price information.						
I use information technology assistance, such as Google Maps and websites to locate tourist destinations.						
Luse the bein of travel guidebooks and information from friends that have visited the areas						

answers, showed that 68% agreed, 21% strongly agreed, 10% were neutral, and 1% disagreed. The option "strongly disagree" had no responses with regard to community opinion on post-pandemic tourism (Figure 4).

• Applications and content needed for post-COVID-19 pandemic tourism

In terms of the applications and content available

to support tourism during the COVID-19 pandemic, respondents provided several statements such as the need for "Zoning maps of the pandemic spread", "Information on health protocols", "Information related to alternative choices, when the destination has reached its visitor capacity", "Information on the number of visitors to a destination and standard health checks", "News updates on the pandemic, especially on the tourist destinations areas". Therefore, based on the respondents' answers, 50% agreed, 41% strongly agreed, and 9% were neutral (Figure 5).

• User understanding of the Jelajah Bantul application

Respondents provided various answers to questions associated with determining how well users of the Jelajah Bantul application understood it with regard

	Knowledge on the Components of Smart Tourism Branding in Bantul.		The level of understanding of the Jelajah Bantul application and its innovation (User of Jelajah Bantul application).			
	В	Sig	В	Sig		
Gender	.112	.870	-4.664	.484		
Higher Education Level	-1.001	.315	-5.261	.572		
Secondary Education Level	.986	.319	4.943	.585		
Aged 15-29 years	341	.626	-6.727	.329		
Aged >30 years	.359	.603	5.455	.452		
Inside Yogyakarta	1.586	.033	-2.209	.760		
Outside Yogyakarta	-1.575	.032	4.664	.623		

Table 2. Regression Analysis

#### Description:

 $\alpha$  (0.005) > p = Influencing; p = significance value



Figure 4. Community Opinions on Tourism during the COVID-19 Pandemic





to the development of tourism support facilities. The responses included "I use the Jelajah Bantul application to choose a tourist destination", "The frequency of my visits to tourist destinations has increased after using the Jelajah Bantul application", "I am currently satisfied with the Jelajah Bantul application", "I have not faced any problems when using the application". 50% of respondents were neutral, 36% agreed, and 7% strongly disagreed. Meanwhile, the option of "strongly agree" did not get any responses for this questionnaire component (Figure 6).



Figure 6. User understanding of the Jelajah Bantul application

• Non-user understanding of the Jelajah Bantul application.

In the questionnaire regarding how well users understand the Jelajah Bantul application in relation to the development of tourism support facilities, respondents provided several statements such as the need for "Information related to the zoning map of COVID-19 spread", "safe tourism", "a health protocol", "Information regarding accommodation and transportation", "Use of information technology such as Google Maps, tourist websites to identify tourist destinations". It was also said that "Promotion and marketing have to be performed to provide the community with knowledge regarding the Jelajah Bantul application". The respondents' answers, show that 73% agreed, 15% were neutral, 11% strongly agreed, and 1% disagreed (Figure 7).



Figure 7. Non-Users' Understanding of the Jelajah Bantul application

#### CONCLUSION

In conclusion, the respondents' characteristics, such as gender, higher and secondary education levels, and age (15-29 and above 30 years), did not influence the level of knowledge with regard to smart tourism branding. The residence location factor (living in or outside Yogyakarta) influenced the level of knowledge on smart tourism branding. Furthermore, most respondents were neutral towards the development of tourism support facilities. The majority of non-users of the Jelajah Bantul application agreed on the development of tourism support facilities.

In terms of the community understanding of tourism during the COVID-19 pandemic, the majority agreed to the implementation of a health protocol. Therefore, this evaluation of smart tourism branding in Bantul city has created an overview of the community understanding and satisfaction level with regard to tourism during the COVID-19 pandemic.

#### RECOMMENDATIONS

The community perception shows that Bantul needs to strengthen its unique tourism branding identity so that it possesses high competitiveness and resilience, which are considered superior qualities during the COVID-19 pandemic.

Smart tourism branding in Bantul is a strategic instrument used to publicize a competitive tourist advantage. Meanwhile, the Jelajah Bantul application is a vital tourism branding tool, used to attract the target market (tourists), satisfy stakeholders, and increase the city's competitiveness. As a smart tourism branding instrument, this application enables Bantul to compete globally in attracting tourists and tourism investment.

Therefore, the proper occurrence of a synergy strategy between the community and city stakeholders facilitates the management of tourism and strengthens the city's branding identity.

Tourism branding is expected to be safe, comfortable, and meet health protocols in order to be able to restore public trust. Forms of mass tourism involving large numbers of people are not in line with health protocols. Conversely, individualized tourism with a limited number of visitors is expected to consider environmental sustainability and prioritize health in order to be able to restore economic resilience. This branding is a sign of entering a New Normal.

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# CHANGING SOCIO-SPATIALITIES IN KADIKÖY, ISTANBUL: A CASE STUDY

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This study aims to reveal the relationship between the social structure and urban pattern in a specified urban area by means of the socio-spatial dialectic. To understand the circumstances behind this dichotomy, analyses were conducted on two intertwined subjects – social structure and morphology – as part of a case study of the historical core of the Kadıköy district in Istanbul, Turkey. Based on the findings, some inferences, depending on the predefined social and morphological components, are made about changing socio-spatialities in the given place by means of time-space-society relations. The results show that each socio-cultural group brought their own culture and adapted their physical environment according to their basic needs, and that culture has a restrictive and explanatory effect on the formation of space. In addition, population growth and the adaptive capacity of society to external forces demanding change in the urban space also turn out to unavoidably affect the development scheme of the morphological character of the area. *Key words*: socio-spatial change, urban morphology, spatial theory, Kadıköy, İstanbul.

## INTRODUCTION

Urban planning is based on shaping the built and natural environment, in other words, it is based on shaping a place (Bayer *et al.*, 2010). A place can be any point in the universe, from the micro level – a table – to the macro level – a planet (Gieryn, 2000). It allows people to differentiate between being *in* or *out*, reaching *there* or moving from *here*. However, when it is the case of space, it is the result of an individual or a group of individuals interrupting a certain place. After determining the land uses, a place turns into space where human activities and transactions take place.

For Batty (1993), cities were, at first, artefacts which were designed by human-beings, where complex systems originated, developed, and changed. Afterwards, the foci shifted to the urban form, which was regarded to be the vital factor affecting human behaviour. Although the initial

<sup>1</sup> Istanbul Technical University, Faculty of Architecture, Department of Urban and Regional Planning Harbiye Mah., Taşkışla Cad., No:2 34367 Şişli, İstanbul, Turkey ulubas@itu.edu.tr material for urban planning was taken as the physical being of the city, the social dynamics that are concurrently shaping it have only started to be taken into consideration within recent years (Caner and Bölen, 2013).

Edward T. Hall (1969), the founder of *proxemics* theory, defined people's use of space as an expression of culture. For him, spatial organization based on social relations is a fact of culture, and its pattern differs from culture to culture as people from different cultures perceive space differently. As a result, they experience space and act in it differently. Accordingly, making assumptions about shared human experience will cause misunderstandings related to the cultural dimensions of space and its relations (Low, 2003). For this reason, while working on space, the cultural context should be read by starting from its historical roots and continuing with its traces on space. Thus, the palimpsest characteristic of space serves as a tool for digging each layer of socio-spatial development/change.

As with Hall, Alexander also regarded space as being a repercussion of culture: "It is invented by culture, transmitted by culture, and merely anchored in space" (1979, p. 92). Supporting this, for Rapoport, "the effect of site is cultural rather than physical, since the ideal site depends on the goals,

ideals, and values of a people or period, and choice of the 'good' site – whether lake, river, mountain, or coast – depends on this cultural definition" (1969, pp. 29-30). Culture, which is the primary causal factor, has a restrictive and descriptive effect on the formation of space, as "the physical setting provides the possibilities among which choices are made through the taboos, customs, and traditional ways of the culture. Even when the physical possibilities are numerous, the actual choices may be severely limited by the cultural matrix; this limitation may be the most typical aspect of the dwellings and settlements of a culture" (Rapoport, 1969, p. 47). Secondary and modifying factors are listed as climate, use of materials and technology.

Following these, with Edward Soja, the paradigm shifted from space itself to spatiality: the genesis of the socio-spatial dialectic. He defined space as being a "given contextual thing", but went a step further, adding the new concept of social-based spatiality that means: man-made space of social organization and production (Soja, 1989). In other words, "social relations of production are both space-forming and space-contingent". The reciprocal relationship or the balance between space and the individual is, therefore, based on people modifying the spaces they live in, and in turn being modified by them (Soja, 1980). Soja (1989) states that space, in terms of physicality, is pre-given; however, the organization and the meaning of space are man-made, resulting from a series of produced "social translation, transformation and experience". For these reasons, he proposed the analysis of urban areas in terms of their historical background (Beauregard, 2011), whereby he put "space first as the primary discursive and explanatory focus" of social studies (cited in Soja, 2010). For Soja (1980, 2010), people are social, temporal and spatial, and in return, space is an evolving material product of human action.

Moving from Soja to Michel de Certeau (1984), space gains new dimensions and is defined as a combination of direction, velocity and time variables. Thus, it is the combination of mobility and place, whereby mobile elements intersect, and place is a combination of elements where there is an order/ rule defining a location according to the relative positions of these elements. Therefore, "space is a practiced place" which is an "instantaneous configuration of positions" based on its locality, which has a stable character.

For Alexander, what gives a place its character is the pattern of events taking place there. "Indeed, a culture always defines its pattern of events by referring to the names of the physical elements of space which are 'standard' in that culture" (1979, p. 71), which are actually inseparable. Each pattern of events is defined by the space itself. Therefore, to understand people's way of life, the elements of the space should first be investigated. Elements coming together fully construct the pattern, no matter the scale - whether building, neighbourhood or town. The general framework of these entities defines the pattern language of a place. This means that although each element has its own pattern, which may be different from the others, in the end together they formulate a general outline, the so-called language. Lively places are a result of life-generating deep patterns; therefore, it is important to find these out, as "the pattern in the space is, precisely, the precondition, the requirement,

which allows the pattern of events to happen" (1979, p. 92). Similar to Alexander, Marcuse (1993) defines this case as the *spatial pattern* whereby society is made of "relations of production, consumption, race, income, ethnicity or colour, gender, household composition, age and housing tenure", which are, hence, reflected in space.

With increasing importance given to socio-spatial processes that have helped us to understand the city, a transformation/ change in urban planning has appeared, from being designoriented to process-oriented, resulting in a search for the multi-dimensions of city space. Hence, space is no longer regarded as an independent variable (Abu-lughod, 1969), but it is assumed as having a direct link to society by means of social interactions.

Moving from this point of view, the aim of this study is to examine this close relationship between space and society in a particular place through morphological analysis, by referring to socio-spatiality. To begin with, different stages that have affected spatial theory are defined, and the changing emphasis in spatial theory is put forward to define the theoretical framework of the study. After that, the case-study area, the historical core of Kadıköy district in Istanbul, Turkey, is examined via its historical background, with the help of the socio-spatial dialectic. This study uses morphological analysis to define how this case area has changed physically in parallel with changes in society over time. As a result, some inferences are made depending on the predefined social and morphological components about changing socio-spatialities by means of time-space-society relations.

According to Alexander *et al.* "[p]eople need an identifiable spatial unit to belong to" (1977, p. 81). For Galster (2001, p. 2112), this spatial unit is the neighbourhood, and it is simply a "bundle of spatially based attributes associated with clusters of residences, sometimes in conjunction with other land uses", based on Lancaster's definition of "complex commodities as a multidimensional bundle comprised of simpler (albeit sometimes abstract) goods". The neighbourhood consists of structural, infrastructural, demographic, class status, tax/ public service package, environmental, proximity, political, social-interactive and sentimental characteristics (Galster, 2001). Alexander declares that these elements give a neighbourhood its character (1979). All in all, a neighbourhood can be defined as the interaction between human behaviour and geography (Lee, 1968). For these reasons, the scale of the study is defined as a neighbourhood, which is also the 'identifiable spatial unit' of the study. Additionally, as Alexander et al. (1977, p. 49) explain, "... different subcultures need their own activities, their own environments. But subcultures not only need to be concentrated in space to allow for the concentration of the necessary activities. They also need to be concentrated so that one subculture does not dilute the next: indeed, from this point of view they not only need to be internally concentrated - but also physically separated from one another". By this model of concentration and separation, it is easy to follow the footsteps of different socio-cultural groups in urban space simply by looking for their traces on the physical environment. Thus, another aim of the study is to reveal the traces of different groups in the case-study area, in order to show the two-sided relation of the poles in the socio-spatial dialectic.

## DATA AND METHODOLOGY

In the nineteenth century, Kadıköy started becoming an important urban settlement with expanding territories. And today, it is one of the primary city centres in the Istanbul metropolitan region. The neighbourhoods of Caferağa, Osmanağa and Rasimpaşa, which make up the historical core of Kadıköy district, were specifically chosen for the research due to their palimpsest character of socio-spatial change. In addition, it is easy to track the process of change in society and space in Kadıköy through different periods of time, as it is documented in written and visual form. In this respect, the methodology mainly focuses on exploring the effect of social changes on the urban pattern, and it consists of three main parts (Figure 1).



Figure 1. Research framework

Firstly, data and information about the historical background of the selected site in terms of its social structure and morphological development were gathered by means of a literature review. For both factors, certain components were defined depending on which data type could be found and gathered continuously. With regard to social structure, population change, social diversity and income group were defined, whereas, for morphological development, these components were settlement pattern, street pattern and variation of land use. Then, the selected site was analysed under these two main topics. Changes in the social structure in terms of demographic and socio-economic factors were discovered in order to understand the social conjuncture of the selected site, in other words, the different archetypes within the society. Through the analysis of morphological development, changes in the physical structure of the selected site were determined by representing past and present situations. Finally, the selected site was evaluated based on the socio-spatial dialectic.

For the morphological analysis, first of all, visual data for the case-study area (Caferağa, Osmanağa, Rasimpaşa neighbourhoods) were gathered, namely, historical maps (1882 Map by C. Stolpe (Stolpe, 1882); 1906 Map by C. Goad (Goad, 1906a); 1922 Map by Société Anonyme Ottomane D'études et D'entrprises Urbaines (Société Anonyme Ottomane D'études et D'entrprises Urbaines, 1922); 1938 Map by J. Pervititch (Pervititch, 1938); 1965 Settlement Plan by Z. Teoman (Teoman, 1965)), aerial photographs (dated 1946, 1970 and 1982) (Istanbul Metropolitan Municipality, n.d.), and a 2007-dated base map. After that, historical maps and aerial photographs were screen digitized to create a common data type for analysing the urban pattern and its change through time. The 2007-dated base map was used to represent the current situation in the area as the urban pattern has not dramatically changed recently.

Using memory books (Aktunç, 2010; Gürpınar, 2009; Kavukçuoğlu, 2010, 2015) as primary sources, and then history books written on the area (Ekdal, 1997, 2004; Kütükçü, 2014; Türker, 2008), other books and research on Istanbul (Alus, 1995; Ayvazoğlu, 2011; Halıcı, 2008; Hızlan, 2011; Satan, 2012; Tuna, 2011), as well as webpages on the history of the area (Atılgan, n.d.; Biçer, 2013) and research on the urban renewal process (ÇEKÜL, 2014) as secondary sources, it was found that local names given to sub-regions have not changed over time. Thus, the district names in the 1938-dated original document by Pervititch are used.

Following this, detailed urban pattern analyses were made. For this, three sample areas were taken within the case area: (1) Mühürdar; (2) Osmanağa-Altıyol Bazaar; and (3) Bahariye-Kuşdili-Cevizlik (Figure 2). Comparisons between the sample areas and periods of time were made based on a 1906 map by C. Goad, a 1938 map by J. Pervititch, a 1982 aerial photograph and a 2007-dated base map. In order to systematize the data, three main layers of urban pattern (Kaya et al., 2013) were selected - buildings, plots and streets. By means of figure-ground map analysis, changes in the general layout of the sample areas were revealed. After that, axial lines were drawn from the middle of each road, taking into consideration the road geometries. If the angle of a road changed, a node was placed there, standing for the change in the road geometry. Hence, geometrical segments and nodes were extracted. Following this, predefined geometrical nodes which represent the junction points were combined with new axial lines to ensure the straight links between them. These are called *topological*  *segments* and *nodes*. Hence, if a road is broken into several geometrical segments, it is now represented as one line named as topological segment. Therefore, those preexisting geometrical nodes are removed, and the road geometry is simplified. Also, the general road pattern of the area was schematized with junctions (topological nodes) and axial lines (topological segments). These were used to analyse the morphological development of the sample areas in detail.

The reason behind choosing these sample areas is their differences in morphological character. Sample I exemplifies a typical grid pattern, whereas Sample II represents a loose grid pattern and Sample III represents an organic/cul-de-sac pattern. However, simply looking at these maps does not mean anything without knowing and understanding the social background. Therefore, it is important to go through history to reveal different layers that hosted different societies and resulted in a change in the urban pattern, and to make interpretations regarding this change.



Figure 2. Location of sample areas (prepared by using 1906 Map by C. Goad as base map) (Source: Goad, 1906b)

#### CASE STUDY: UNDERSTANDING SOCIO-SPATIAL CHANGES IN THE HISTORICAL CORE OF KADIKÖY, ISTANBUL

In order to understand the socio-spatial change in the historical core of Kadıköy, İstanbul in a comprehensive manner, the historical background of the selected site is delivered first. After that, the results of the morphological analyses are discussed so as to identify changes in the urban pattern with regard to the three sample areas with three distinct urban characteristics. To avoid certain repetitions, only morphological analyses and their specific links between the socio-cultural structure are referred to.

#### Historical background of the selected site

With the conquest of Constantinople, Halkedon came under the rule of the Ottoman Empire and was named after Kadı Köyü (Kadı Village, later on Kadıköy) (Kavukçuoğlu, 2010). In this period, Kadıköy was extremely popular with its summerhouses and excursion spots. Haydarpasa and Kuşdili Meadows were the most popular spots. Hence, it was not surprising to see big palaces with vineyards and Turkish gardens built in the region at that time (Ayvazoğlu, 2011; Ekdal, 1997; Kütükçü, 2014). These mansions, palaces and konaks (traditional Turkish mansion) belonged to those from a higher socio-economic class of senior managers, factory owners, naval officers, generals, etc. and even sultans (Ekdal, 1997). However, Kadıköy was still one of the most important agricultural production centres on the Anatolian side of Istanbul. Until the end of the 1700s, the historical core of Kadıköy housed Greeks and Turks, mainly involved in agricultural production and fishing, living in organically scattered single-family houses with gardens (Ayvazoğlu, 2011). With new investments being made, Kadıköy started developing and attracting people from different socio-economic backgrounds (rather than just high-income groups, elites, and families of the bureaucratic class that dominated the area until the nineteenth century) as well as those from different cultures. Starting with the nineteenth century, Armenians and Jews settled down in the area. Following the political reforms made in 1839, Levantines started entering commercial and daily activities, and they preferred living in Kadıköy (Hızlan, 2011). Not only economically, but also culturally, they brought their lifestyle to the region, with open-air theatres, promenade activities, and European art deco style houses/mansions with gardens (Kavukçuoğlu, 2010, 2015; Kütükçü, 2014). Moda (south of Kadıköy's historical city centre), from this time onwards, became the most important and attractive spot in Kadıköy (Kavukçuoğlu, 2015; Kütükçü, 2014). Similarly, Jews who moved to Yeldeğirmeni (north of Kadıköy's historical city centre) constructed a synagogue and started living in this neighbourhood. They adapted their way of living and culture to this particular place, resulting in the emergence of the first apartment quarter in Istanbul (including yahudhanes - three to four storey apartments specific to Jewish culture, where each family lives on a different storey of the same apartment, sharing the same kitchen and the toilet, mostly inhabited by low income groups) (ÇEKÜL, 2014). Not only Jews, but also Germans working on the construction of the railroad and Haydarpaşa port facility chose this area for living. Osmangazi Primary School is one of the buildings that was built by Germans in this period in Yeldeğirmeni (Kavukçuoğlu, 2010). As a result, the social structure underwent a dramatic change, as the character of the settlement turned from being Muslim and Greek to a more heterogeneous and cosmopolitan composition (Figure 3).

Traces of these cultures can be easily read from housing typologies (Figure 4) and the variety of religious buildings (Catholic and Protestant churches, mosques, a synagogue) that are specific and unique to a socio-cultural group, and have mainly been constructed to point out the centre of each socio-cultural group. Street life was vivid: women chatting in front of the doors, and children playing games on the streets.



Figure 3. Spatial differentiation in terms of socio-cultural groups by the end of the nineteenth century in Kadıköy (based on Kavukçuoğlu, 2010; drawn by the authors using Rojo's Man figure)



Figure 4. Examples of housing typologies from the selected site, which still exists today (a) an Armenian apartment – Demirciyan Apartment – in Yeldeğirmeni; (b) Greek houses in Caferağa; (c) a Jewish house in Yeldeğirmeni (source: Olgar, 2021); (d) a Levantine house in Moda; (e) a Turkish konak in Moda

With the growth in population, there was a great need for areas to host the new and modern urban life that was being demanded. So, big fires that occurred in 1855/6 and 1878 were turned into an opportunity to plan and rebuild

the area (Kütükçü, 2014). The historical core of Kadıköy that still exists today can be dated back to the 1880s, as the fires in 1856 and 1878 resulted in the very first systematized urbanization movement. This can be defined as the first dramatic change in the urban pattern, because the commercial area (Çarşı), which acted as the centre of the district, had to be planned again, and a gridiron pattern was selected as the best way to initialize this goal. Not only did the central area where the commercial activities are located change, but also, most of the natural (meadows, coastal line and beaches) and semi-natural areas (agricultural lands, vineyards and orchards) were turned into either semiurban or urban areas to house the increasing population; in addition, Kadıköy became a new city centre on the Anatolian side of Istanbul (Figure 5).

By the 1920s, with the impact of sea transport, which connected both sides of Istanbul, the coastal line between the port and the bazaar area kept developing so that beaches and orchards between these two important urban facilities were either turned into new housing or public areas. This movement can be regarded as the second breaking point for Kadıköy's socio-spatial change. The population kept increasing and the social structure was changing. In addition to Turks, Armenians, Greeks, Jews, and Levantines, Roman Catholics and Protestants, and Bulgarians were now living in this area (Akbulut, 1993, cited in Kütükçü, 2014, pp. 20-23). Kadıköy attracted the attention of the highly educated middle class and artists so that, depending on demand and force, the urbanization process gained pace. In this period, Kadıköy was regarded as a small European town with mansions, konaks with gardens, and coffeehouses where Turkish classical music was listened to (Kütükçü, 2014). During the Armistice Period, migration from Anatolia to Istanbul started, and ex-servicemen in particular moved into this area (Satan, 2012).

By the mid-1900s, the third dramatic wave of physical change appeared with the emergence of tremendous growth in the speed of constructing apartment blocks, either through demolishing the existing housing stock or through changing the type of land provision as a result of modernism. Following these, the area of plots and lots became smaller, supported by the development of new streets, in combination with the emergence of new public transport facilities and with the effect of changing technology from sea transport-based, railway-based or horse carriage-based transport to motorized transport used for travelling from residential spaces to working spaces. In other words, with the appearance of automobiles and increased car ownership for daily personal use, increasing inner/intracity mobility became a general trend. With the introduction of two important technological developments to residential units - electricity and telecommunications the speed of urbanization increased. Following these trends, more and more people from high income groups with a higher education moved to Kadıköy, especially towards the Moda and Caferağa regions (Kütükçü, 2014). Although the multicultural, multilingual, multi-religious structure changed context, cosmopolitan culture still had a continuing character. However, this change had repercussions within the urban pattern, as the old neighbourhood structure and

its features began to disappear, leaving in their place multistorey reinforced concrete buildings with a standardized urban pattern, called modern settlements of the new era.

As the old neighbourhood changed its physical structure with the impact of modernization, it also attracted new settlers who were potential workers in several economic activities. People migrated from Anatolia to Istanbul towards new urban areas that were under construction, to work either in construction or as doorkeepers. In addition, incidents in 1955 and 1964 resulted in Greeks being deported, thus causing a sudden change in the social conjuncture, which resulted in a big gap in trade/commercial and sociocultural activities (Kavukçuoğlu, 2010). These gaps were filled by migrants from Anatolia. The restaurants located in Kadıköy previously owned by Greeks became traditional or orientalist restaurants owned by the newcomers from Anatolia (Satan, 2012). With the implementation of the Law of Property Ownership in 1965, the speed of construction of apartment blocks gained pace. Mansions, konaks, and houses within gardens were replaced by newly built apartment blocks (Satan, 2012). The houses left as a result of the population exchange became derelict and empty, so that the region was more and more dilapidated, which was the case in the central areas of most big cities. Vacant areas were filled with apartment blocks, not leaving any open space for the inhabitants to spend their leisure time or for their children to play games.

By the 2000s, the historical core of Kadıköy had undergone another transformation movement that was triggered by large-scale urban transportation projects and several urban renewal projects, resulting in Kadıköy becoming a transitionary place for travellers and a lively region housing young white-collar workers, students both foreign and local, foreigners and professionals from different sectors (ÇEKÜL, 2014). Thus, the cultural composition of Kadıköy experienced a huge renewal.

## Understanding the change in urban pattern

Only by looking at the general view can it be derived that there has been almost no change where there are gridiron and loose grid patterns (Samples I and II) (Figures 7 and 8), but it is obvious that the organic/cul-de-sac pattern (Sample III) (Figure 9) turned into a loose grid pattern, especially after the 1980s. Based on the literature review, the reason why the gridiron pattern in Sample I and loose grid pattern in Sample II did not change over time is that they were the very first settlement locations in Kadıköy's historical city centre, and so they did not undergo a dramatic change because they were intentionally planned in the 1800s, and they kept the same characteristics from that time onwards. It is also not surprising to find out that these areas were adopted by the same socio-cultural groups for several decades until the period of population exchange, and so they did not change much either in their physical or social context. However, similar to other parts of Kadıköy, changes in the urban pattern that came after the 1960s were merely related to the increasing population, and in terms of housing typologies, based on the socio-economic structure of the inhabitants, and their income-based demands for housing, or the affordability of housing stock. Since then, the social diversity in terms of ethnicity and religion has become almost homogeneous, and divergence has been in the form of subcultures based on economic, educational, political, and social backgrounds.

From figure-ground schemes, it can easily be observed that the inner courtyards of building blocks have been decreasing over time. Gardens and orchards are being replaced by new buildings, parking lots or hard surfaces for the leisure facilities of gated communities and similar uses (especially in the case of Sample I and Sample III), because of the demand for housing, the increasing number of people and the changing way of living.



Figure 5. Change in the urban pattern in Kadıköy between 1882 and 2007

			URBANI 18	ISATION 50s 19	Modern 20s 19	INFORMATION ERA 80s 2000s	
SOCIAL STRUCTURE	SOCIAL DIVERSITY		GREEKS TURKS	ARMENIANS GERMANS GREEKS JEWS LEVANTINES TURKS	ARMENIANS BULGARIANS CATHOLIC LATIN AND PROTESTANTS GERMANS GREEKS JEWS LEVANTINES TURKS	ARMENIANS BULGARIANS CATHOLIC LATIN AND PROTESTANTS GREEKS JEWS LEVANTINES TURKS	ARMENIANS BULGARIANS CATHOLIC LATIN AND PROTESTANTS GREEKS JEWS LEVANTINES TURKS
			LOW MIDDLE HIGH	LOW MIDDLE HIGH	LOW MIDDLE HIGH	LOW MIDDLE HIGH	LOW MIDDLE HIGH
MORPHOLOGICAL DEVELOPMENT	URBAN PATTERN	BUILDINGS	HOUSING	HOUSING COMMERCIAL	HOUSING COMMERCIAL PUBLIC	HOUSING COMMERCIAL PUBLIC	HOUSING COMMERCIAL PUBLIC
	F		UNCLEAR	DEFINED	DEFINED	WELL-DEFINED	WELL-DEFINED
		STREETS	ORGANIC	ORGANIC LOOSE GRID GRIDIRON	ORGANIC LOOSE GRID GRIDIRON	ORGANIC LOOSE GRID GRIDIRON	LOOSE GRID GRIDIRON
	HOUSING TYPOLOGY		SINGLE FAMILY HOUSES KONAKS MANSIONS PALACES	SINGLE FAMILY HOUSES KONAKS MANSIONS PALACES YAHUDHANE	SINGLE FAMILY HOUSES KONAKS MANSIONS YAHUDHANE APARTMENTS	SINGLE FAMILY HOUSES KONAKS MANSIONS YAHUDHANE APARTMENTS	SINGLE FAMILY HOUSES KONAKS MANSIONS YAHUDHANE APARTMENTS

Figure 6. Summary of socio-spatial change in the historical core of Kadıköy



Figure 7. Sample I/ Mühürdar - Change in the urban pattern over a hundred years



Figure 8. Sample II/ Osmanağa-Altıyol Bazaar - Change in the urban pattern over a hundred years

In detail, it was calculated that, in 1938, the number of buildings in Sample I increased by 57.1%, however, this rate decreased suddenly to 13.2% in 1982 and then rose to 15.3% in 2007. As can be observed from Figure 7, the plot in the upper north-west side of the area was dominated by a group of buildings in 1906. By 1938, this group of buildings had disappeared, and the plot started to be filled by new attached housing units, which defined its outline because they were aligned with the plot's border, similar to the rest of the area. In 1982, this plot was divided into two by the construction of a new road and was filled up with new buildings following the same pattern of attached housing typology. However, as the borders of the existing plots were already well-defined, there was little space left for construction, explaining the sudden decrease after 1938.

Similarly in Sample III, the rate of increase in the number of buildings between 1906 and 1938 was 253.5% followed by an abrupt decrease to 6.8% for 1982 and then 11.4% for 2007. When examined in detail, in 1906, the area was dominated by scattered self-standing buildings. The borders of the plots were not defined by the buildings, but rather by the road network. In 1938, the plots in the north and southwestern parts of the area started to be defined by the newly constructed buildings (both attached and detached) and the road network started to become apparent in these areas. In 1982, although the increase in the number of buildings was 6.8%, most of the area was filled with attached buildings, revealing the road network and the plot geometries of the whole area. However, in contrast to Sample I, the reason behind this was related to the building floor ratios. Although the number of buildings did not increase dramatically, the

floor ratios of the buildings increased, and the plots were being filled. In 2007, most of the vacant land in private property was filled with new buildings.

In Sample II, the number of buildings increased by 59.7% between 1906 and 1938, but decreased by 62.6% by 1982 and only increased by 13.4% by 2007. The main reason behind this was similar to the case in Sample II, since between 1906 and 1938, plots were rapidly being filled with new buildings, though by 1982 the floor ratios of these buildings were getting larger and they were replacing the previous buildings. The pattern was almost the same until 2007, but new buildings had been added by this time. It can also be seen that the dominant housing typology was again attached buildings. In the case of Sample II, the distinguishing ratios of the floor areas of the buildings were related to the land use, as these buildings were used for commercial and service activities.

In general, it can be inferred that in residential areas like Sample I and Sample III, the plot sizes became smaller and the number of buildings per plot kept increasing. However, in commercial areas like in Sample II, the trend was the opposite. When compared in terms of the change in social structure, in Sample I, where the relatives of the former residents continue living, it is possible to follow the same pattern of building blocks, because mansions, palaces and *konaks* were directly replaced by apartment blocks. On the other hand, for Sample III, the case is quite different. This area is more of an example of rural-to-urban transformation because of the need for new housing stock. Finally, in the case of Sample II, it can be easily concluded that the main reason behind the change in building blocks



Figure 9. Sample III/Bahariye-Kuşdili-Cevizlik - Change in the urban pattern over a hundred years

is its location being close to the historical bazaar, and the influx of commercial activities replacing housing - and the social structure - in this transitionary place. Thus, in terms of change in the variation of land use, it can be concluded that Sample I and Sample III show a consistent character of being a residential area dominated by housing units from the 1900s to the present. However, it is also possible to see mixed land use (working areas mainly commercial areas and service sector) in these areas as a result of the increasing population. In contrast to Sample I and Sample III, Sample II represents a different process of change in the variation of land use. The area was first a residential area then it became a mixed-use area with the development and the dominance of the commercial centre (Carşı). And finally, it turned into a commercial area as a part of the sprawl of the commercial centre into adjacent areas.

In terms of street pattern, it can be seen that the road network in Sample I and Sample II did not change dramatically, but in Sample III cul-de-sacs merged with the main roads and new roads were added to the existing road network. The street pattern became more orthogonal, enabling certain speed levels for motorized transport within the neighbourhoods. It is obvious that this was the start of a new period. In general, in Sample I, almost no change in the general layout of the street pattern can be observed. The differences between the number of geometrical and topological segments, and geometrical and topological nodes are very low for all time periods. In 1938, this difference decreased by 50% (for both), and surprisingly, it multiplied by three in 1982. As seen in Figure 7 in detail, the road on the western outskirts of the area in a northsouth direction was developed to make it straighter. Apart from this, the general layout of the area was kept constant. However, in 1982, a sudden change in the layout of the road network can be observed. New road segments were added to the upper north-western plot and the geometry of the roads changed, explaining the increase by 300% for 1982. In 2007, the difference between the geometrical and topological segments increased by only a third, which represents the street pattern in its most recent form. In general, the number of geometrical nodes increased by thirteen units between 1906 and 2007, and the number of topological nodes increased by nine units, parallel with the development of road geometry and additional roads. The difference between geometrical and topological nodes which is equal to four units - also shows a slight change in street pattern from 1906 to 2007.



Figure 10: Comparison of the changes in the parameters of selected urban patterns ((a) Sample I; (b) Sample II; (c) Sample III)

For Sample II, the scheme for developing a street pattern is different to that of Sample I. By looking at Figure 8, it can be seen that the area did not undergo a dramatic change in terms of the general layout of the street pattern. However, a detailed examination shows that the road geometries and the connections with the surrounding areas changed from 1906 to 2007. For 1906 and 1938, the difference between the number of geometrical and topological segments was fifteen units, though the increase in the number of geometrical and topological segments was only two units. In 1982, the number of geometrical segments decreased by five units, but the number of topological segments was the same as in 1938. Finally, in 2007, both the number of geometrical and topological segments decreased by one unit, and the difference between them was ten units. On the other hand, the number of geometrical nodes decreased by thirteen units though the number of topological nodes in 1906 and 2007 was the same. This shows that the junctions were kept constant, but instead the road geometries were developed.

Lastly, in the case of Sample III, following the development of the area, the street pattern also changed dramatically between the years 1906 and 1938. The number of geometrical segments increased by 84.6%, and the difference between the geometrical and topological segments increased from twenty-three to thirty-seven. Although the general layout of the road network changed, the number of geometrical segments only increased by 12.5% between 1938 and 1982, and 3.7% from 1982 to 2007. However, when the difference between the geometrical and topological segments is examined, the results show that the difference between them is forty-five units in 2007, which is the highest number reached. In terms of the number of geometrical nodes, it can be concluded that the number almost doubled from 1906 to 2007, but the number of topological nodes increased by 76%.

All in all, the results show that the difference between geometrical and topological segments also indicates a difference between the street patterns, in other words the spatial typologies. In the case of Sample I, which is a typical gridiron pattern, the difference is very small, however, when it becomes a loose grid pattern, as in Sample II, this difference starts to increase and it reaches its peak when the area shows a development from an organic/cul-de-sac pattern to a loose grid, like in Sample III.

## DISCUSSION AND CONCLUSION

Changing socio-spatialities and understanding the circumstances behind them reveal important aspects of urban development. Hence, it is quintessential to look for the relationship between social structure and morphology. To do so, an evaluation of socio-spatial changes in the selected site was made by giving references to these two aspects. A critical research limitation was that specific information about ethnicity or religion along with the socio-economic

structure was not available as statistical records or kept as systematic data recordings. Therefore, this problem had to be remedied to a great extent using primary and secondary sources.

The research findings show a direct relationship between social structure and morphology as supposed by the sociospatial dialectic. It can be easily seen that each socio-cultural group brought their own culture and adapted their physical environment according to their basic needs. When observed in detail, Levantines and Jews in particular created their own visually and physically distinguishable territories as a part of a concentration and separation model. On the other hand, Turks, Greeks and Armenians were living together without showing any specific concentration and separation patterns. Levantine and Jewish settlements were also distinct with their gridiron plan. Armenians, Greeks, and Turks lived in a more organically developed physical environment. However, in terms of the architectural style of buildings and housing, each group did carry its own unique style that made it easy to distinguish between them.

Population growth can be taken as another important factor with regard to changes in the urban pattern. With the increase in population, urban plots got denser, losing green areas to high-rise apartment blocks that hosted more and more people. Modernism, motorization, and the emergence of new areas of work can also be listed as major external factors of change in urban patterns. The variation of land use diverged because of new working spaces for the commercial and service sectors. Parallel to these, road geometries changed explicitly, especially from an organic to a loose grid pattern, enabling more access and connection in-between urban areas.

This overall change resulted in the need to adapt the manner of the society to the new circumstances. High-income groups were among those who could adapt to these changes much more quickly and easily and continue holding the place they owned within the urban space. However, for low-income groups, this process was not that easy, so they tried to adapt their living culture to the area. Therefore, they were regarded as a factor of change in the selected site as both a social and physical entity.

Discussions on the definition of space made in recent years reveals the fact that the issue of culture has become increasingly prominent. It is believed that culture has a great influence on the (re)formation and characterization of space. Depending on the values of the people, culture plays a critical role in the change of space and it has a restrictive and explanatory effect on the formation of space. As seen from the case study, change in the socio-demographic and cultural structure is the dominant reason for the change in a neighbourhood's character, spatial features and morphological structure. Though the cultural structure changes, it continues to be *space-forming* and *spacecontingent*.

The interaction of individuals with each other, the periodic features in the historical process and their interaction with space have highlighted the socio-spatiality concept, which underlines the importance of space that is developed through the actions of individuals and communities. Factors such as

meaning, mobility and the need for space that individuals place on the space are important in terms of understanding the concept of socio-spatiality. These elements are closely related to social, economic, demographic, and cultural change, which are important indicators of social change and which deeply affect the urban space and urban pattern. Although it has not been tested in this study, new generations' changing *values*, *lifestyles*, and *individual preferences to communicate with each other* will be increasingly effective in changing the urban space and urban pattern in the near future.

According to the socio-spatial dialectic, a social entity creates its own physical entity, and in return, the created physical entity influences the social entity, constructing a two-sided pendulum. The dominating character of social structure upon (urban) space is inevitable, as space is nothing without the meaning, or role, assigned to it by people. On the other hand, (urban) space is regarded as a *modifier* of one's social entity in return. Though the socio-cultural background is changing, space is still being reused and refunctioned according to new social systems. This variety nourishes the socio-spatial dialectic and makes it valuable to investigate.

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# A LANGUAGE-DRIVEN REVERSE-ENGINEERING TOOL FOR THE ANALYSIS OF ARCHITECTURAL PRECEDENTS: A PALLADIAN CASE STUDY

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The analysis of precedents represents a significant point of departure for design processing. By applying a language/ design analogy, this research introduces a reverse-engineering tool that helps guide the systematic analysis of architectural precedents. The visual tool consists of four main layers: the morphological, the semantic, the semiotic, and the pragmatic. To test the tool's applicability, a prominent precedent from the Palladian designs is analyzed as a case study. By developing the tool and demonstrating its applicability for the analysis of the underlying regulatory and formative principles of the Palladian design, this paper aims to contribute to the knowledge of architectural design by introducing an analytical tool for decoding and externalizing the design language. This tool can be added to the existing toolbox of designers, and it can help reveal new insights into the multi-layered compositional language of precedents and their underlying architectonics. The findings related to the tool's applicability and the compositional language of the Palladian design and its associative meanings and connotations are explained, discussed and illustrated by diagrams.

Key words: Visual Language, Morphogenesis, Geometric Language, Space Syntax, Design Morphology.

# INTRODUCTION

Representing a cornerstone of the pre-design processing stage, precedents are vital sources for extracting retrospective knowledge and developing prospective inspiration. Decoding the designs of precedents in order to deduce their underlying principles, structures, and design methods is a well-established strategy in processing engineering designs. in addressing this strategy, three principal axes collectively form the point of departure of this research.

The first axis is represented by an interdisciplinary incorporation of the reverse-engineering approach into architectural design, in order to generate a tool that can help decode the principles of architectural compositions and their associative designing techniques.

The second axis emphasizes the significance of precedentbased design as a structured design methodology. Emergent

<sup>1</sup> P. O. Box 66833, beilouti@psu.edu.sa designs can be derived based on studying similar precedents and customizing them to fit new requirements and contexts.

The third axis is represented by the view of architectural composition as a visual language. Within the Language-Driven Approach (LDA), devising a Domain-Specific Language (DSL) seems promising in crafting a clear methodology for a designated domain (Mauw et al., 2004). Although the generation of DSL is more common in computer applications, this paper follows an LDA to contribute a visual language within the DSL of architectural design. The presented tool, which is referred to as a Visual Design Language (VDL) tool, is rooted in formal techniques, and is structured to demonstrate a holistic system of definite ingredients and a clear process. The VDL is portrayed as four layers of a visual language, with multiple sub-layers within each one. Loaded with meanings and signs, this language represents more than a superficial structure of aesthetic compositions.

This research intertwines the three above-mentioned axes in a reverse-engineering-oriented language-driven tool for the critical compositional reading of architectural precedents. The inter-disciplinary amalgamation underlying the tool aims to contribute to knowledge in the areas of precedentbased design, critical analytical studies in the morphology of the built form, the cross-disciplinary incorporation of the reverse-engineering approach in architectural analysis, and the derivative and analytical tools of architectural design management. Notably, the tool is not meant to be restrictive or inclusive. In contrast, it is designed to function as a guide to informing the analysis of building designs and explaining their constituents and aggregation patterns.

The scope of this work lies within the view of language as a syntactic and semantic structure, rather than a human activity (Losonsky, 2006). It is designed to analyze architectural compositions, but it can be extended for other design products in order to explain their implicit structures and methods of production.

## **RESEARCH DESIGN**

Within the scope of architectural morphological analysis, a tool based on an analogy between design and language is presented and discussed here. The VDL tool is developed and devised to function as a reverse-engineering tool that guides the analysis of precedents and, consequently, informs future design synthesis. Thus, the tool has both analytical and synthetic powers. However, the emphasis in this paper is on the analytical aspect to help understand existing building designs. The concept underlying the development of the tool is based on the application of deductive reasoning in order to disassemble a design precedent and analyze its functional components, compositional structures, and design architectonics. This is assumed to be followed by applying inductive reasoning for the synthesis of new forms by combining the components of the various layers to fulfil the new design requirements.

The ontological assumption underlying this research is that knowledge about building design is implicit in its spatial organization and formalistic configurations. The epistemological assumption is that knowledge about precedent design is developed by devising logical and abstract theoretical constructs that are deduced from the dismantling of precedent structures. The reverseengineering technique represents one of these constructs, applying logical abstraction, as well as deductive reasoning, for design analysis, and abductive and inductive reasoning in the application of the forward-engineering approach for the derivation of similar designs.

The methodological assumption is that architectural compositions convey a formal language, with a structure similar to that of natural languages. Using analogical reasoning, architectural composition can be viewed as a system that consists of a set of vocabulary elements (with semantics and semiotics associations), and syntax grammars that can be context-free or context-sensitive (e.g., Natapov *et al.*, 2016). The methodological tools used in the structured analysis of compositional languages in architecture are limited (e.g., Eilouti, 2020a; García-Salgado, 2008). This research is designed to contribute to systematic analysis of architectural products.

It presents a tool that can help in praxis, but which functions

more efficiently in educational applications, whereby learners need to understand the multiple dimensions of architectural design.

In addition to the above-mentioned assumptions, this study is based on three major premises. The first is the significance of the investigation of prominent architectural precedents as a reservoir of knowledge. The second is the importance of morphological studies for understanding the stylistic classifications and variations of the built forms. The third is the crucial role of analysis or reverse-engineering for synthesis or forward-engineering in building design. In regards to the first premise, Palladio's works form a significant source of information for understanding the derivation of his designs, the influence of Palladian design on subsequent architectural artifacts, and Renaissance style aesthetics, characteristics, and design principles.

Regarding the second premise, this study is based on a visual analysis of building morphology, namely, a mathematical deductive study of the design component ratios and metrics, and a review of the potential semantic, semiotic and pragmatic forces and influences on the Palladian designs.

The third premise attempts to apply an approach that is successfully implemented in several engineering disciplines in architecture. This reverse-engineering tool can add a new visual tool to the toolbox of designers, which can be used to analyze and synthesize visual compositions in the early phases of their design. This interdisciplinary extrapolation can enhance the precedent-based design methodology in architecture.

In terms of applicability, the compositional analysis method can be a powerful explorative, informative, and intellectual exercise in recycling knowledge and development. It also forms a basis for a comparative analysis between various building designs. Examples of these include a critical study of modern architecture (Frampton and Simone, 2015), a provocative reading of Palladio's plans (Eisenman and Roman, 2015), a formalistic analysis of Palladio's palazzo facades (Eilouti, 2008), and comparative analytical studies of the design schemes of Palladio and Sinan buildings (Eilouti, 2012, 2017). This area of scholarly comparative critical analysis of architectural designs can benefit from the tool introduced in this paper, because of the multiple applications of its structure on various buildings that share a typology or a style, and it can subsequently compare their designs layer-by-layer to reveal their commonalities and differences.

To demonstrate the VDL tool, its testing scope covers the analysis of the morphology and associative meanings, messages, and contextual aspects of the Palladian design. Notably, this paper's primary concern is the visual study of the designated precedent rather than the cultural or social factors – despite their significance – that may have affected its design.

# THE THEORETICAL BACKGROUND OF THE VDL TOOL'S DEVELOPMENT

This section includes three components that have been used to develop the precedent analysis tool. These are

the precedent-based design, reverse engineering, and the language of architecture.

# **Precedent-Based Design**

This method is based on adapting an existing design to fit a designated similar problem within its context. The customization of an already solved problem, in order to derive new solutions, can save the time and effort of understanding the fundamental elements of the given design problem. Studying the designs of architectural precedents can be significantly informative for practitioners, learners, and educators in the area of systematic design programming and processing (e.g., Clark and Pause, 2012; Eilouti, 2009). Such a study can help designers externalize the implicit design principles and the style derivation tectonics, which are typically ambiguous in architectural presentations. In education, a critical analysis of buildings that share a typology or a style with the problem at hand represents an intellectual exercise and an evaluative and formative pedagogical experience for learners and educators. Applying a deductive reasoning approach helps to conclude the rules of composition, derivation methods and morphosis techniques out of pictorial representations. In practice, an explicit system of designing may provide a clear point of departure for generating designs and assigning the styles of spatial organizations. Examples of translating the deductive analysis of designs into an inductive form of generating methods include precedent-based instruction studies (Akin, 2002) and the example-based design processing method (Sio and Kotovsky, 2015).

This research applies a morphology-oriented model to decoding precedent designs. Many scholarly works are concerned with the morphological analysis of the built form in architectural literature. Examples of these include a critical analysis of modern architecture (Frampton and Simone, 2015), a provocative study of Palladio's plans (Eisenman and Roman, 2015), and a comparative analysis of the design schemes of Palladio and Sinan in their sacred buildings (Eilouti, 2017). In addition, there are related studies about precedent-based design paradigms, such as developing new approaches that recycle knowledge from precedent-based solutions to problems (Agarwal and Poovaiah, 2015; Eilouti, 2009).

# **Reverse Engineering**

Reverse-engineering is a top-down case-based approach to design. It is the process of extracting knowledge from an existing human-made product and reproducing a new product similar to the original or inspired by it, based on the extracted knowledge (Eilam, 2005). Resulting knowledge from the reverse-engineering processes can be applied in a subsequent bottom-up forward-engineering approach to the design of similar products. Hence, reverse engineering functions as a systematic analytical tool and a technique of problem-solving that informs a subsequent synthesis of design products. It has applications in many fields, such as bio-medicine, chemistry, mechanical and civil engineering, computer programming and manufacturing, as well as industrial applications (e.g., Ali et al., 2014; Chikofsky and Cross, 1990; Varady et al., 1997; Warden, 1992). Although indirectly implemented in case analysis, its applications in architecture are still under-represented.

# The Language of Architecture

Allegorically, formal languages and natural languages converge in multiple aspects of their structures. The notion of architectural composition as a visual language is not new and is still debatable (e.g., Salingaros, 2006; Summerson, 1966). Throughout history, the application of the visual language lens to viewing architectural design has evolved through multiple versions, with each emphasizing various combinations of the syntax, morphology, signs, behavior patterns, and/or symbolic layers of its configuration. Several of these transcend the typical prosaic dimensions to include high-order poetic and trope-loaded dimensions (Simitch and Warke, 2014). Most of these versions agree that architectural form communicates meanings such as welcoming, defensiveness, protection, uplifting, hierarchy, sacredness, connection, order, chaos, and flow. They also agree that buildings have a purpose beyond pragmatic sheltering and functioning as machines for living or working. In most versions, architectural form is viewed as a complex order of language that merges high levels of abstraction with pragmatic levels of materialization. The primary substances of its expression include shapes, forms, spaces, masses, surfaces, colors, textures, and construction materials.

The language of architecture can be positioned at the intersection of visual languages (e.g., Bermúdez, 2003; Breen, 2019; Kiroff, 2002), natural languages, and the composition of designs (Norberg-Schulz, 2000; Remizova, 2016; Simitch and Warke, 2014, Tayyebi and Demir, 2019). In the area where visual and verbal languages intersect, the generation of complex structures out of primitive elements and syntactic rules is described by Chomsky's generative grammars (Chomsky, 1965; Gandelzonas, 1983). Peter Eisenman introduced a series of residential designs that he called 'cardboard architecture', in which he embodied what he referred to as 'deep structure' to explore the concept of 'visual syntax'. The premise of this approach stemmed from Eisenman's interest in language structure and semiotics. In Eisenman's architecture, the design process is synchronized with the process of researching formal structures and fractal geometric shapes (Eisenman, 1983; Gandelzonas, 1983). Similarly, Eisenman and Roman (2015) graphically analyzed 20 Palladian villas and illustrated the evolution of emergent villas similar to the classical precedents. Moreover, Simitch and Warke (2014) proposed a language of architecture that provides a system that conveys meanings. However, this language's traits are comparable to a "thick" poetic language (Simitch and Warke, 2014).

Notably, this research is aware of the developments in the fields of linguistics and biolinguistics. However, these extended horizons are out of the scope of this study. Furthermore, the exact syntactic rules of generating form, as addressed by generative shape grammars (e.g., Eilouti, 2019), are also out of this paper's scope.

# A REVERSE-ENGINEERING VDL TOOL FOR DECODING THE DESIGN OF ARCHITECTURAL PRECEDENTS

While the formulation of a language system helps codify a large number of visual compositions in succinct structures, a system that dismantles these compositions can help to decodify them in order to understand their lexical and tectonic principles. To help decipher the compositional structure underlying a given building design, this section introduces a tool that helps in the analytic phase of processing architectural design. Structured tools for design analysis are still limited. The tool developed in this section aims to contribute a figurative and operative addition to a designer's toolbox. The tool aims to help decrypt the design configurations of architectural precedents and guide the analysis and comparison of various designs. Moreover, the tool can be applied to guiding the synthesis of future similar products. However, this forward-engineering application is out of the scope of this research.

The tool consists of five concentric circles that move from the general levels outwards into the more specific sub-levels (Figure 1). The circular structure is divided into four major geometric sectors. Based on a composition/language analogy (e.g., Bauer 2003; Harrison 1978), these sectors represent the morphological, sematic, semiotic, and pragmatic layers of a design language. The first sector is concerned with the form and appearance of a given building. Its structure consists of four segments, each of which highlights one aspect of the compositional language of architectural products. It consists of morpho-lexical, morpho-syntactic, morpho-metric, and morpho-graphic layers. While the first emphasizes the geometric and spatial vocabulary elements of a compositional language, the second is mainly concerned with the rules and methods of assembling vocabulary. The third is concerned with the measurements and proportional systems underlying the aggregation of form. The fourth is mainly concerned with the graphic representation of some of the systems used in the second and third layers.



Figure 1. The language-based reverse engineering VDL analytic tool

The second sector of the circular model transcends the boundaries of formalistic manifestation in an attempt to explore the meanings underlying the superficial appearance of buildings. The semantic layer explores the meanings associated with aesthetics, performance and impacts of compositions on users and viewers.

The focus of the third sector is on the messages and signs sent directly or indirectly by architectural compositions. It is concerned with the concept behind a design and the symbolic connotations it is loaded with. While the previous three sectors deal with the built form as a context-free product, the fourth emphasizes the form as a context-sensitive entity. The pragmatic segment investigates the location influences, the context-related aspects and the functional considerations of a design. Following is a furtherdetailed discussion of these four sectors.

# The Morphological Layer

As illustrated in Figure 1, the VDL tool consists of four layers. The first emphasizes the form-related aspects of architectural compositions, with a focus on the visual composition and both its ingredients and aggregation configurations (e.g., Niezabitowski, 2018). The morphological layer, in turn, comprises four major sets of classes. These are:

- **The morpho-lexical class**. It consists of the fundamental vocabulary elements of a compositional language, including two-dimensional shapes, planes and surfaces, and three-dimensional forms, masses and spaces.
- The morpho-syntactic class. It focuses on how the primary vocabulary components are synthesized. It can be classified, in turn, into two subcategories of attributes related to form, that is, the eidonomy and the layout anatomy. The former is concerned with the external characteristics, whereas the latter focuses on the internal relationships of the vocabulary-related components, such as their proximity and enclosure attributes. This class highlights features such as the topology, regulatory lines, organizational devices such as infrastructure, datums and grids (Simitch and Warke, 2014), zone clustering, spatial organization schemes, compartmentalization, layering and symmetry.
- The morpho-metric class. It consists of the numerical assignment to the parametric schematic planning schemes of a given design. It includes proportional systems, measurements, and the dominant scales. While the previous classes are concerned with the qualitative attributes of design, this class applies basic mathematics to interpret the quantitative aspects.
- The morpho-graphic representation. This set translates the mathematical relationships between space lexicons and the topological proximity relations of space syntax into an arithmo-geometric graphic representation. It also includes graphic representations such as the Nine-Square Grid (9SG), Pythagoras tree and the fractal chart of recurrent ratios. The 9SG is an abstract diagrammatic tool that is used in architectural planning and design to organize major zones and determine their topological relationships. It takes the form of a three-column by three-row matrix. It typically dictates topology and assigns order to the various elements it regulates. Eisenman (1999) proposes that the diagram's pedigree developed in the form of the nine-square problem as an antidote to the bubble diagramming of Bauhaus functionalism. In terms of its functionality, the 9SG can be viewed as an operative, derivative, figurative, and representative tool. In the first sense, it functions as an organizational tool that relates elements of design in space. In the second, it functions as a generative tool that helps derive new designs by

proposing a layout configuration. In the third sense, it dictates the rudimentary shape of the final composition. In the fourth, the 9SG functions as a pictorial abstraction of spatial organizations, where squares represent spaces and lines represent walls or space limits. Every line in this representation suggests a delimitation or demarcation of space that can be translated into separation, union, subtraction, or addition of masses. In terms of its semantics, the 9SG represents forces, themes, scenarios and historical connotations. Addressing the semantics of 9SG, Somol (1998) proposes that the beauty of the 9SG lies in its abstraction and immateriality, whereby it transcends function, site, client, body, and scale. The architectural literature is rich with research about the 9SG (e.g., Eisenman, 1999; Hedjuk, 1985; Kalfazade, 2009; Wittkower, 1971). Furthermore, some examples compare architectural precedents using the 9SG. For example, in the essay Mathematics of the Ideal Villa, Rowe (1977) compares Andrea Palladio's Villa Malcontenta and Le Corbusier's Villa á Garches using abstract diagrams that are analogous to the 9SG layout. Similarly, Rudolf Wittkower in his book Architectural Principles in the Age of Humanism (1971) analyzes Palladio's villa designs and their geometric languages in the context of 9SG. As a result of this analysis, Wittkower concludes that the geometrical pattern of the Palladian villas is the 9SG (Wittkower, 1971).

# The Semantic Layer

The second sector in the VDL tool emphasizes the semantic implications of a design in terms of the meanings assigned to its vocabulary elements, as well as those associated with its space syntax. Hence, the main concern of this layer is the set of connotations that includes, but is not limited to, meanings that can be categorized into three classes:

## Aesthetics-related meanings

- *Balance*, which is mostly expressed by symmetry in classical designs. This is also related to another aesthetic value, that is, order. In product design, order can be achieved by a regulatory grid, shape repetition and datum line.
- *Contrast*, which can take the form of a juxtaposition of void and solid, addition and subtraction, and/or the combination of simplicity and complexity in a given composition.
- *Rhythm*, which is associated with the harmony of recurrent elements. Rhythm can be constant, alternate, ascending or descending. Depending on which rhythm is adopted in a composition, a meaning related to monotony, variety, growth or decline is conveyed.
- *Style* of a composition can express a statement about a design's formalistic membership or temporal/ geographic reference.

#### Impression-related meanings

- *Unity* vs. fragmentation. A composition may provoke a feeling of consistency and unity or, otherwise, a feeling of duality, multiplicity, chaos or fragmentation.
- The *monumental* scale exaggerates some elements or dimensions, in order to convey the importance or

grandeur of particular components.

• The social or cultural *status* of a building's owner may be conveyed by means of the design syntax.

#### Performance-related meanings

When a group of spaces is clustered, its configuration helps impact its users and viewers with experiences such as:

- *Flow* of vocabulary elements. This includes flow of the spatial organization, of light or sound throughout the building, and of visual continuity among spaces.
- **Way-finding** to, around and inside a building. This is related to ease of accessibility, smooth circulation, and use of reference points that are easy to distinguish and remember while moving in a building.

#### **The Semiotic Layer**

This sector expresses the messages and signs sent by a building to its viewers. It can be considered similar to a human body language. It addresses the symbolic and conceptual aspects of a design. Symbolism may employ the geometry, directionality, occurrence and spirituality of spaces. For example, a dome is a geometric solid that is associated with temples and can be employed to signify the universe or heaven, and to convey a message about the sacredness of the building at hand. Similarly, the verticality of a dominant object in a composition may signify connectivity between earth and sky. Furthermore, repeating components with a particular number may represent a specific reference, person or era. Similarly, the employment of a *flow* of natural light and a visual connectivity may symbolize spirituality. In addition, the semiotics of a design may be represented by a concept or a designer's philosophy, which may be conveyed by the articulation and configuration of a form (Eilouti, 2018a, 2018b).

## The Pragmatic Layer

This sector represents the pragmatic layer, which addresses the contextual fitting of a design within its direct and indirect environments. This layer includes the site considerations, as well as the urban and environmental contexts of a building. The pragmatic layer also includes the functional considerations of a design. Function assigns a meaning and a purpose to space clusters, which helps to transform them from artistic sculptures into usable and livable structures. Such a dimension is related to how the end users of a building are expected to behave when using it. It includes attributes that make a space usable and issues related to its accessibility, circulation and place-making (Eilouti, 2020).

#### THE CASE STUDY

The architectural library is rich with publications related to Palladio's designs and his influence on architecture throughout the ages. Examples of these include Rowe's book on the proportional system and numerical aspects of Palladio's villa designs (Rowe, 1977), Wittkower's study of the principles of Palladio's architecture (Wittkower, 1971), Eisenman and Roman's research on Palladio's works (2015), Hersey and Freeman's possible Palladian villas (1992), Stiny and Mitchell's study of The Palladian Grammar (1978), Beltramini's studies of Palladio's works (2009), and Mitrovic's (2004) analysis of Palladio's designs. Despite the copiousness of the studies about Palladio designs (e.g., Ackerman, 1967; Constant, 1993; Murray, 1971), the area of structured analysis that systematically examines the multi-dimensionality of his design language is still under-represented.

One of Palladio's most influential works was selected to represent his designs. Following is a discussion of its structure.

## San Giorgio Maggiore

Skillfully articulated with characteristics of Renaissance architecture, the church of San Giorgio Maggiore was designed by Palladio and built in 1566 on an island of the same name in Venice, Italy. The concept underlying its design is based on an analogy with the Temple of Augustus. Interestingly, this concept applies a precedent-based design methodology. The main façade facing the water lagoon represents a superimposition of two Roman façades. The larger is recessed and consists of a wide pediment, and an architrave that is clearly supported by pilasters and extends over the nave and two lateral aisles. The smaller façade is projected and consists of a narrower and higher pediment that extends over the nave and is superimposed on top of the previous facade, with a giant order of four engaged columns that are raised on high pedestals. On either side of the central portal are statues of the religious figures to whom the church was dedicated. The portico includes massive engaged columns and pilasters on plain external white-surfaced walls. The internal layout combines a long Basilican nave with a cruciform plan that complements the nave with transepts. The interior of the church is bathed in light from the windows and clerestory openings. This effect is enhanced by the majestic Diocletian windows that channels natural light into the portico, arches and apses. The interior is decorated with paintings that are placed on either side of the presbytery, where they can be seen from the altar rail. A key measurement unit of the façade of the San Giorgio Maggiore church is the diameter of the large column at its base. It is the key element of the proportional system applied to this design. For example, the ratio of the diameter of the major order columns to their height is 1:15, which is the proper proportion for a Corinthian column as laid out in the MIT Press English edition of Palladio's Four Books of Architecture (1997). In addition, the distance between the columns surrounding the portico is twice the diameter measurement.

## THE VDL of San Giorgio Maggiore

The VDL tool introduced and described in the previous sections will be applied on the church of San Giorgio Maggiore in this section to decode the various layers of its compositional language.

## The morphological analysis

This section is concerned with the shapes, spaces and forms of the church in their individual and aggregational representations on the internal and external levels. It presents a reification of the four sub-layers of the lexical, syntactic, metric and graphic interpretations of the pictorial analytic tool (Table 1).

## The morpho-lexical analysis

In reference to the ground floor plan of the San Giorgio Maggiore church, the main 2D lexemes are squares,

rectangles, circles, and semi-circles. The lexical components are repeated with various scales and proportions. Regarding the treatment of the main façade, the basic vocabulary elements consist of rectangles, circles, sectors, semicircles and triangles. The three-dimensional blocks include the parallelepiped, cube, cylinder, cone, pyramid and hemisphere masses (Table 1). In addition, extruded meshes and nonuniform solids in the art statues are used as a supplementary ornamentation to the main masses.

#### The morpho-syntactic analysis

In terms of the syntax of San Giorgio Maggiore church, the formal lexemes were subject to multiple transformational operations. These include scaling, stretching, mirroring along orthogonal axes, transmission, and rotation.

Adjacency of blocks is the main topological relationship. There are no intersections or overlaps between the plan units. The main clustering and enclosure techniques are based on the mirroring of masses around a major axis in a linear scheme. The dominant modelling technique is the extrusion of planes, rotation of cross-sections in the domes and columns, and application of an additive approach for mass clustering. The latter can be seen in the porticos and the semi-cylindrical masses surrounding the main nave mass. The articulation of the plan suggests that the spatial planning technique underlying its structure is based on a clear manipulation of an orthogonal grid, and an apparent implementation of a parametric 9SG scheme. The highly abstracted schematic representation of the church floor plan reflects a structure that combines at least two sets of superimposed 9SG layouts. The first is used in the peripheral eight-corner squared spaces surrounding the introductory nave. The second is applied to the domed space and its surrounding four squares and four rectangles. The latter 9SG overlaps with the previous one and is applied to emphasize the major griddriven regulatory scheme in the composition (Figure 2). In the main facade treatment, Palladio's solution to the problem of the differences in heights of the central nave and the side aisles of the church was based on incorporating the actual pitch of the two roofs rather than merely concealing any of them. He skillfully integrated the two pediments that cover the two pitched roofs aesthetically and structurally. The main façade combines two types of columns: engaged columns and pilasters. Although the same two column forms are used both inside and outside the church, they are configured differently. Externally, on the main façade, the colossal components are all engaged columns, whereas the colossal elements in the interior are both engaged columns and pilasters. The orders of the exterior, as well as the interior, columns of San Giorgio Maggiore are used in two sizes and types. These are the Composite order in the large columns and the Corinthian order in the small ones. Externally and internally, ornamentation is not used in the surface treatment, with the exception of detailing the column capitals.

The church's composition displays duality between the language used in the front façade manipulation and that used in the other façades.

#### The morpho-metric analysis

A ratio of 1:1 is used in the central circle and the main squares



Figure 2. Nine-square grid abstraction of the San Giorgio Maggiore planning scheme

in the side aisles of the church. This ratio is also used to relate the main nave and transepts. As illustrated in Figure 3, the main proportional ratios used in relating the elements of this plan are: 1:1 in the squares and circles, 1:2 in the semicircles and in the introductory nave, 3:5 in the back space and 1:3 in the repeated three lateral cells. The proportion of 1:  $\sqrt{3}$  is used in the largest rectangle containing the nave and aisles (shown in dashed green lines). In addition, the dual scale of the orders is used in the main façade. In using a dual-scale for the orders, Palladio followed Alberti's guidelines for the configuration of the colossal columns (e.g., Santa Maria Novella and Sant' Andrea).





## The morpho-graphic analysis

The proportional system applied to the ground floor plan is illustrated by an arithmo-geometric representation that uses basic regular equilateral convex polygons to illustrate the major proportions, which are repeated in the plan (Table 1). The set of polygons that represents the proportional system of the church comprises regular tetragons and hexagons. The rudimentary unit in this representation is a square with a one-unit measurement for each side. With a hexagon constructed on one of the edges of the basic square, the length of its shorter diagonal demonstrates another ratio, that is  $1: \sqrt{3}$ . This ratio is used in the rectangle enclosing the central nave and aisle space. The length of the longer diagonal demonstrates a ratio of 1:2, which relates the lengths of the semi-circular shapes to their radii. The diagonal length of  $\sqrt{3}$  is used to construct another hexagon. The shorter diagonal chord of this latter hexagon represents another ratio that is applied in the side aisles of the church.

#### The semantic interpretation

The meanings that may be concluded from the internal and external spatial structures of the church include:

- The *monumental scale* that expresses significance and grandeur. It is represented in the central axial nave spaces, main dome, and elevated portico. It is also apparent in the platform above which the whole church is raised.
- *Balance*: The spaces are symmetrically arranged along the main axis to represent order, control, stability, balance and power.
- *Contrast*: This is demonstrated by the juxtaposition of the verticality and horizontality, void and solid forms, addition and subtraction, simplicity and complexity, and rectilinear and curvilinear geometric articulations, which are all balanced and contrasted in the overall design scheme. Furthermore, the contrast components of soft and sharp geometry, and sea and land contexts imply the duality of the worlds of sacred and secular, and this life and the afterlife.
- **Order:** The vocabulary elements of the church design are organized together in a highly-ordered configuration. This is demonstrated by the application of the regulatory 9SG, and by the ascending rhythm when moving from the main entrance towards the rear altar and choir halls.

The semantic elements are illustrated in Table 2, where it can be seen that some design features contribute to both semantics and semiotics, such as order, balance and fluent light and movement. The distribution of natural light is echoed by the acoustic distribution. To solve the visual and acoustic flow throughout the spaces, San Giorgio Maggiore has several features that enhance the worshippers' ability to see and hear the services from the nave.

These include the placement of the monks' choir behind the altar to assure the laity the unobstructed view and sound of the high altar, the use of a screen of columns and arches to form a background to the altar, the elevation of the altar to increase its visibility from the entrance, and the placement of a barrel vault over the nave to make the prayer more audible. In addition, to further emphasize the flow of the light effect and to provide optimum natural lighting for viewing processions and rites, a set of clerestory thermal windows was placed in the bases of the barrel vaults over the nave and transept arms.

## The pragmatic factors

The church's seaside location signifies its prominence as an iconic landmark that attracts the attention of viewers from other islands. The composition's reflection on water adds to the majestic character of the church and duplicates its effect. The balanced combination of verticality and horizontality simulates the calm nature of the surrounding water body (Table 3). Pragmatic analysis reveals a non-harmonious response to the site and context, as well as a lack of connectivity between the building and its surrounding

Layer	Aspect	Application	Layer	Aspect	Application	Layer	Aspect	Application
Morpholexical	Two-Dimensional	O∆d	Morphosyntactic- Eidonomy	Massing		Morphometric	Scale	
	Three-Dimensional			Enclosure	Open Enclosure		Proportion	
Morphosyntactic-Anatomy	Space syntax			Facade		Morphographic	Arithmo-graphic	
	Spatial Organization			Openings				The ratio of the diameter of the major order columns to their height is 1:15, which is the proper proportion for a Corinthian column (the Corinthian order is the slenderest). Column ratio 1-1/6
	Interior Design			Surface Treatment			9 Square Grid	

Table 1. The morphological analysis of San Giorgio Maggiore

environment. In terms of function, the method of clustering the main spaces together achieves the main purpose of the building, that is, hosting mass prayers and facilitating wayfinding, accessibility, circulation and comfortable praying. The church is easily accessible with clear way-finding routes. The most intensive movement areas are centered around the major axis of symmetry, as it directly connects the indoor and outdoor spaces. From the main entrance, it is possible to see the whole altar space. All spaces are visually and topologically well-connected and well-lit.

## The semiotic aspects of the church

Externally, the main messages sent by the massive articulation of the church are related to the accentuation of its sacred identity. These messages are further emphasized by the massive central dome, and the majestic front facade. Internally, the exaggerated heights of the central nave, the divine flow of natural light, and the employment of a dome that symbolizes heaven are all employed to emphasize the spirituality of the building. In addition, the verticality of



Table 2. The semantic features of San Giorgio Maggiore

Table 3. Pragmatic features of San Giorgio Maggiore


the bell tower symbolizes connectivity between earth and sky and highlights the divine character of the building. The dominant character of the spaces is introvertive, as it channels the users' attraction into the altar space. The major semiotic features of the church are illustrated in Table 4. The four layers of the tool have been applied to the church to reveal various aspects of its design structure. The isolation of each layer to understand its associative properties and design features helps organize the analysis process and reveal new attributes of the design structure. Moreover,

Table 4. Semiotic features of San Giorgio Maggiore

Layer	Aspect	Application
Symbolism	Geometry	https://sketchfab.com/3d-models/san-giorgio-maggiore- 3a980b23c4f54ab6a48168418025e72e
	Directionality	
	Number	
	Spirituality	https://www.akg-images.com/archive/-2UMEBMY20AVN0.html
Concept	Analogy Pantheon, Rome, Italy	http://www.greatbuildings.com/cgi-bin/gbi.cgi/Pantheon.html/ cid_1349932.jpg

the structuredness of the pictorial VDL tool facilitates the systematic visual reading of the precedent and helps guide the process of its incremental analysis. Inferences from the analysis can help synthesize other designs and emphasize new features to add deeper meanings to their manifestation. This derivative dimension of the tool can be addressed and discussed in a future extension of this research.

### CONCLUSION

Architectural precedents represent a rich reservoir of knowledge. The structured analysis of precedents is an intellectual exercise, a technique for forming knowledge, and a major component of the pre-design programming of architectural design. It also forms a basis for precedent-based design methodology. To help decipher the compositional language underlying precedent designs, a systematic pictorial VDL tool is presented. The tool is based on an analogy between architectural compositions and natural languages. It is designed to guide the reverse engineering process of decomposing the design of a precedent in order to isolate each layer and reveal its constituents and their relations and impacts on the resultant configuration. The tool consists of four major layers that are associated with multiple, more specific, sub-levels. The primary layers represent the morphological, sematic, semiotic, and pragmatic layers of the design language.

The analytical reverse-engineering VDL tool, as developed and applied in this paper, seems to facilitate the structured analysis of architectural precedents and highlight some of the implicit features.

To demonstrate the applicability of the VDL tool, a prominent Palladian precedent is selected. The San Giorgio Maggiore church, which represents the religious typology, is selected as a case study of the tool because of its rich syntactic and semantic composition. Applying the tool, the Palladian precedent is critically analyzed to conclude the principles underlying its compositional structure in terms of its morpholexical, morphosyntactic, morphometric, morphographic, semantic, semiotic and pragmatic configurations.

On the morpholexical level, the basic elements of the geometric vocabulary include the rudimentary twodimensional shapes of squares, rectangles, circles, semicircles and triangles, and the basic three-dimensional volumes of parallelepiped, cones, cylinders, pyramids and hemispheres.

On the morphosyntactic level, multiple transformational operations such as scaling, transition, rotation, and mirroring were used. Within this level, a parametric version of the 9SG can be found in the regulatory scheme of the plan. However, this resemblance between the nine-square grid and the precedent's layout does not necessarily suggest that Palladio applied this tool in his planning scheme.

On the morphometric level, the proportions of 1:1, 1:2, 3:5, 7:20 and 1:  $\sqrt{3}$  were repeated to order the numeric relationships between the design elements. These ratios exhibit proportions that are close to the golden section.

On the arithmo-geometric level, the proportional system is

represented as regular polygons and as a parametric 9SG. In this regard, the morphographic representation in the church applies a regular tetragon and hexagon as a proportion representation.

The semantic layer was expressed in the dramatic application of monumentality, verticality, directionality and ascending rhythm in the church. The monumental scale, balance of masses, contrast of features, order of configuration and flow of spatial organization all manifest the building's significance and status. The church's composition displays duality between the language used in the front façade manipulation and that used in the other façades.

The pragmatic analysis reveals a non-harmonious response to the site and context, as well as a lack of connectivity between the building and its surrounding environment. However, harmony between the building and its site appears stronger in the main façade of the church, which amplifies the interface between the sea and land in its design to attract viewers from a distance away. Despite the emphasis of the land-sea interface, the formal appearance of the facade still contrasts with the spontaneous character of the sea. In terms of function, the way spaces fulfil their expected purpose is apparent in the church. The semiotic aspects highlight the messages sent by the design about its concepts, symbolism of the masses, and expression of power and control. In addition, the verticality of the tower and nave sends messages about the connectivity of earth and sky through praying. The divine character and expression of spirituality exist in the spatial and visual flow of the design. In addition, the employment of a number of building blocks is clear in the design. The duplication of elements is dominant in the church because of its perfect symmetry, and the number three is repeated as a result of religious references.

The VDL tool seems to successfully function as effective guidance for the systematic analysis of architectural precedents, and as a reminder to explore new dimensions in the design process. However, the tool requires more applications to discover its limitations and develop its structure to explain more recent typologies and styles.

The VDL tool has potential as a synthetic tool that helps re-assemble the knowledge extracted from the analysis to produce emergent designs using a precedent-based design/ forward-engineering methods. However, derivative power was not addressed in this paper. Development of this power represents a future extension of the research.

Another extension is to compare the secular and sacred designs of Palladio, in order to conclude their design structures and discover their commonalities and differences, and externalize the detailed generative rules of their compositions and architectonics. In terms of the methodological aspects and mechanisms, the analytical tool can be developed to cover more layers of design language, such as the addition of the phonetic layer and its counterpart of kinetics in architecture.

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# SPATIAL CONFIGURATION OF TRADITIONAL HOUSES AND APARTMENT UNIT PLANS IN HO CHI MINH CITY, **VIETNAM: A COMPARATIVE STUDY**

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The study aims to investigate the effects of the spatial configuration of traditional Vietnamese houses on the design of apartment buildings in Ho Chi Minh (HCM) City, Vietnam. To achieve the objective, the following approaches were implemented. Firstly, the transformation of the socio-economic structure in HCM City, which is a primary factor affecting the development of apartment buildings was examined. Secondly, the well-known space syntax method for analyzing the spatial structure plan was outlined. Thirdly, a survey of traditional houses and apartment buildings from 1960 to 2010 was conducted. Among the various traditional house styles, the Hue traditional garden house, which has primary effects on the modern housing design in HCM City, was selected as a representative sample to compare with apartment units. Lastly, the space syntax method was employed to analyze the spatial structure of the sample of traditional houses and apartment units. The effects of the Hue traditional house's spatial configuration on apartment buildings were analyzed. The result shows that the spatial configuration of modern apartment buildings and traditional houses have similar characteristics, including having an adaptable natural environment, and they both reflect Vietnamese culture and society. The findings can be applied when predicting development trends for the unit plans of modern apartments in HCM City, Vietnam.

Key words: Spatial Configuration, apartment unit plan, traditional house's spatial configuration, space syntax.

### **INTRODUCTION**

Vietnam, located on the eastern margin of Southeast Asia, has an *S* shape, with 3/4 of its coastal length (3,260 km) on the East Sea. Ho Chi Minh (HCM) and Ha Noi, the capital, are two megacities, which are the economic and financial centers of the country, and Ha Noi has a history of more than 1000 years. Vietnam is divided into three main regions based on geography, the Northern, the Central, and the Southern regions. It is known that Ha Noi, Hue, and HCM are the financial centers of the Northern, Central, and Southern regions, respectively. Due to differences in their geography and the formation of each region, the socio-

economic characteristics are slightly different. This has led to differences in housing styles over time, especially with regard to traditional Vietnamese houses.

According to Ha (2002), the characteristics of traditional Vietnamese housing can also be divided into three groups based on geography. Traditional houses in the North built in the 16th and 17th centuries were spacious with two roofs, a symmetrical layout, and an odd number of compartments (e.g., 3, 5, or 7 compartments). Meanwhile, traditional houses in the Central and Southern regions built in the 19th and 20th centuries had similar features to each other. These houses were constructed using a form of four gable roofs, and they were about 1.5 times larger than those in the North. Moreover, the spatial configuration of houses was divided into the main house and the sub-house. The main house was designed with a symmetrical layout using

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5-7 compartments, and the sub-house was built with 3-5 compartments. All traditional houses (for all three regions) were built using a brick basement, a wooden structure, and tiled roofs.

Nowadays, traditional houses exist on the urban fringes, but hardly any of them are newly constructed. Meanwhile, condominiums have become popular accommodation in megacities (e.g., HCM City) since they can save construction land and provide a large amount of housing. In HCM City, the population has significantly increased from 4.6-8.5 million people between 1995 and 2016 (Truong *et al.*, 2017). This has resulted in a high demand for newly constructed housing, especially high-rise apartments. Moreover, multifunctional buildings (for entertainment, enjoyment, and even work) are also required in order to satisfy the needs of residents. Thus, condominiums have grown up at various locations in city centers. The new apartment designs emphasize a spatial configuration to be in harmony with the natural environment.

Traditional houses built 200 years ago are still being used and maintained, since they are associated with the cultural traditions and national identity of Vietnam. The advanced features of traditional houses can be utilized for the design of modern apartments. Le and Park (2011) studied the ecological features of traditional Vietnamese houses that can be applied to contemporary high-rise buildings. However, the study focused only on houses in the North of Vietnam. Truong (2014) analyzed the physical characteristics of architectural forms and the spatial organization of apartments recently built in HCM City. Nguyen and Dewancker (2017) investigated the relationship between the planning of traditional Vietnamese tube houses and contemporary houses. However, a survey on the influence of the spatial configuration of traditional houses on the design of apartment units in the economic-financial center of HCM City has not been conducted so far.

This study presents an investigation into the changes in the spatial configuration of apartment building design in HCM City from 1960 to 2010. By utilizing previous survey research on traditional house design (Nguyen and Kobayashi, 2014; Nguyen, 2013; Ha, 2002; Pham *et al.*, 2019), the influence of the spatial configuration of traditional houses on apartment building design is presented, based on the space syntax theory.

# TRANSFORMATION OF THE SOCIO-ECONOMIC STRUCTURE OF HO CHI MINH CITY

HCM City, located in the South of Vietnam along the Saigon River, is known as the largest and most prosperous city in Vietnam due to its historical richness and variety of religions and cultures. Since HCM city is positioned at an important location, it is favorable for city development from various aspects, including economics, transportation, and culture. According to the World Bank (2016), HCM's population is about 10 million of whom 2.95 million (29.5% of the population) live in rented houses. In particular, 2.33 million people (23.3% of the population) live in rooms of less than 10m<sup>2</sup>. Meanwhile, the average area of housing should be 30m<sup>2</sup> per capita. Thus, housing construction is estimated to grow rapidly in the near future, especially for apartment units, due to limited construction land being available. This section briefly introduces changes in the apartment typology in different periods of HCM City's development, emphasizing the transformation of the socio-economic effects on the apartment typology. The economic periods of HCM City can be classified into before Vietnam's reunification, from reunification to "Doi moi" policy, and after "Doi Moi" policy.

### Before Vietnam's reunification, 1975

Before 1975, Vietnam experienced political changes on its territory, and HCM City was known as Saigon. From 1945-1975, Saigon was under French and American rule. This was the first context for the formation of a colonial economy in Southern Vietnam. Saigon's economy rapidly developed under the colonial governments. Transportation systems connecting Saigon to the West and East parts of the territory were constructed to induce favorable conditions for economic development. During the Vietnam wars (against the French and the US), due to the war-torn countryside, people (so-called refugees) from rural areas sought housing in big cities (mostly in Saigon), thus creating demand for the development of apartments. Some of the large apartments, such as Khanh Hoi and Bac Hai apartments, were constructed not only for refugees, but also residents in the city. Managers and constructors introduced many options to satisfy customers' needs, with a cost of 15,500-35,000 VND (about 25-45\$ in 1974). However, the price of apartments was relatively higher than the affordability of the poor in Saigon. After 1973, when the USA cut economic support for the South of Vietnam, Saigon's economy experienced a significant crisis. After Saigon fell in 1975, Americans, other foreigners, and a large number of Vietnamese evacuated the city (Zhou and Bankston III, 2000). This led to an insignificant increase in the housing market in this period.

### From reunification to "Doi Moi" policy, 1975-1986

Northern and Southern Vietnam were reunified in 1975, and the country became The Socialist Republic of Vietnam. After the wars, Vietnam embarked on rebuilding the nation despite numerous difficulties and hardships. In order to build the new-born socialist country, the Vietnamese government launched many plans to push the growth of agriculture and industry. The period was divided into two phases 1976-1980 and 1981-1985 (5 years for each stage). The government managed most aspects of politics, the economy, and even socialist housing systems (MOC, 2020). For example, civil servants and workers, especially those who worked for the government, were provided with apartments or housing, and even food. However, because of inappropriate socioeconomic development policies, Vietnam's economy faced unexpected stagnation and hyperinflation (Vuong, 2004). Housing in HCM city was operated under the subsidy policy. The state not only constructed housing, but also supplied housing to citizens, which was all part of the national fiveyear plan (1975-1986). As a result, the quantity and quality of housing were not considerably increased (Duong, 2003).

### After "Doi Moi" policy, 1986

In 1986, the state of Vietnam imitated "Doi Moi" (renewal) policy to take the country out of the socio-economic

crisis. The economy shifted from being highly centralized to becoming a market economy. The state started to call for foreign investors and promote the many economic sectors, in which private sector investment in the housing market, transportation system and energy projects was especially encouraged. Moreover, the government stopped providing housing (Coit, 1998) and instead supported the marketization of the housing system from 1986. Foreign construction companies and domestic private entrepreneurs had a crucial role in planning and carrying out actual housing production under state supervision.

Up to 1990, a lot of high-quality housing was constructed, especially near the center of HCM City. Housing areas and the living infrastructure were progressively improved to satisfy residents' needs (Waibe *et al.*, 2007). Specifically, the average floor area per habitant was increased from 7.5m<sup>2</sup> (in 1991) to 10.27 m<sup>2</sup> (in 2000). According to Huynh (2015), housing construction projects after 2000 were known as being most successful when the Doi Moi policy was applied, which pushed socio-economic development. Most of the construction projects in the center of HCM City were apartment buildings due to limited construction land. Designers mostly focused on spatial configurations and technical requirements in order to satisfy economics and aesthetics.

### SPACE SYNTAX METHOD

The space syntax method can be applied to analyze the properties of each space in a dwelling (Hillier and Hanson, 1989). It can also be used to evaluate the spatial configuration and to assess formative processes and social meaning. Thus, it is a helpful tool for assessing meaningful information about architectural spaces. For example, Figure 1 shows two possible relations between spaces A and B and outside space C. In Figure 1a, spaces A and B are directly connected to space C. Meanwhile, Figure 1b shows only space A connected to space C, so it is necessary to go through space A to space B if starting from space C. This indicates that the relationship between A and B is changed if space C is considered (Hillier *et al.*, 1987).



Figure 1. a) and b) two possible relations between spaces A and B and the outside, space C; c) and d) corresponding justified graphs; c)- Connecting space directly to the root space minimum depth: Symmetric system; d)- The linear sequence of the maximum depth of a space: Asymmetric system. (Source: Hillier et al., 1987) The convex space and justified graph (J-graph) are analyzed to examine spatial layouts. When a planning scheme is converted into a J-graph, the total depth (TD), mean depth (MD), relative asymmetry (RA), and real relative asymmetry (RRA) are calculated to show the spatial relationship between two rooms in a building. The convex space shows the adjacency relationships between spaces. It helps to reduce the spatial complexity of a layout to the fewest spaces. The planning scheme shows that the largest convex space is drawn by the boundary, followed by the next largest, and so on until all the space in the house is occupied. Based on the convex space, a J-graph might be drawn to show spatial relationships between adjacent spaces in the layout of a house. The J-graph is presented as a diagram from one space (root) to all of the others. Each unit space in the house is represented by a node (0), and each unit space is connected by a line. The J-graph might be deep or shallow, depending on the planning scheme. Moreover, the spatial relationships may be formed as branching trees or looping rings.

The total depth TD is calculated based on the J-graph by counting the number of nodes at each depth level and multiplying this number by their depth level. Summing these values provides the TD. Next, MD is the mean depth of a mode in the graph determined using Eq. [1]. The MD results allow for the calculation of relative asymmetry (RA) and real relative asymmetry (RRA), as shown in Eqs. [1]-[4]. The RA values range between 0-1(Hillier and Hanson, 1989). A low RA value for space indicates its strong integration with the system, while a high value suggests segregation from the system. The RRA values proposed in the study to make a comparison between different depth values are related to mutual depth (Hillier and Hanson, 1989). When the RRA is calculated for each space, the integration value (IV) is calculated, as shown in [4]. A high IV shows that space integrates very strikingly with the system, thus suggesting a public space. In contrast, the space is more private when the IV value is close to 0 (Ortega-Andeane et al., 2005).

$$MD = TD/(k-1)$$
 [1]

This study used the J-graph to analyze the spatial configuration in apartment buildings and traditional housing in order to illustrate the relationships between the spaces through the integration value for each area. From that, a particular space was compared in terms of the depth of the node in the whole system. The planning scheme of a typical traditional house is shown in Table 1. The spatial configuration is separated into two principal parts, including the main house and the sub-house. The main house consists of a living room, a prayer area and bedrooms, and the subspace includes a kitchen, storage, and a toilet. Three primary spaces in the house, including the living room, bedroom, and kitchen, were selected for the calculation. The spatial structure of the house was redrawn to develop a J-graph and calculate the properties of each space, as seen in Table 1. In Step 1, the selected spatial configurations were named with numerals, and the convex

analysis map was drawn. In Step 2, the J-graph was drawn. In Step 3, the values of the terminologies were calculated using Eqs [1]-[4] for the three spaces (living room, bedroom, and kitchen), which were selected as representative spaces for analyzing the properties of the space.

traditional houses contains a profound historical-cultural message. Previous research (Ly, 2012; Le and Park, 2011) evidenced that traditional houses are appropriate for local natural conditions because open spatial structures were commonly used to satisfy Vietnam's lifestyle and culture.





# SURVEY ON TRADITIONAL HOUSE AND APARTMENT BUILDINGS

### **Traditional Vietnamese houses**

The traditional Vietnamese house plays a vital role in the formation of the Vietnamese architectural identity. Under the development of high-rise housing typology in urban areas, many traditional garden houses in rural areas have also been preserved and developed. According to Ha (2002), the architectural forms of traditional houses have been built to adapt to the surrounding climate conditions for many years. Studying the characteristics of traditional houses yields precious solutions with regard to the natural environment. Moreover, the spatial configuration of Hence, the characteristics should be researched, preserved, and utilized as a criterion for the design of modern housing.

In Vietnam, the oldest houses can be found in Hue City, which was built approximately 200 years ago. According to Nguyen, the traditional house has unique characteristics that can be utilized for modern house designs. Table 2 shows an architectural form of a traditional house adapted from Nguyen (2007). In the study, the spatial configuration of house plans was analyzed, as detailed in Table 2. The house layout consists of the main house, sub-house, surrounding garden, and other components. The main house was commonly designed with one floor, a wooden-structure for carrying loads, and clay tiles for the roof. The spatial structure of the main house contains





a living room, a prayer room, and bedrooms. In traditional Vietnamese houses, the living room is a flexible space that can serve as a guest room, a sitting room, a dining room, or even a bedroom. Service spaces, such as the kitchen and storage, are located in the sub-houses, which are separated from the main house. The bathroom and the toilet are typically situated to the rear of the outhouse.

### Apartment building typology in HCM City

To analyze the features of apartment buildings, 50 apartments built from 1960 to 2010 were surveyed at various locations in HCM City. The apartments can be classified into 12-types of apartment unit plans based on the construction period and socio-economic transformation in HCM city, corresponding to three periods (1960-1986, 1986-2000, and 2000-2010). The number of apartments surveyed for each period is as follows: 10 units for 1960-1986, 15 units for 1986-2000, and 25 units between 2000 and 2010.

From 1960 to 1986, apartment building typology appeared in HCM City (former name: Saigon City) in the early 1960s to meet the American and French armies' housing needs during the wars. After 1975, Saigon City became chaotic and most apartments were run down and degraded. The initial form of apartment buildings was a simple linear block with mostly horizontal access. The apartment buildings were designed with 3-5 floors, and a single-loaded corridor or doubleloaded corridor type. The typical floor plan, with an area of 20-30m<sup>2</sup> per household, had three primary areas, including the kitchen, toilet, and common space for multi-function.

From 1986-2000, the Vietnamese government started to reform the economy by means of the "Doi Moi" policy (Forbes, 1995). The urban population increased along with economic growth, thus enabling development of the housing market in megacities like HCM City. Some researchers (Mizuno et al., 2000) have pointed out that there will be approximately 46 million people in urban cities by 2025. It can be a great challenge to supply housing when there is a high population density. Moreover, it was estimated that the average number of housing units built from 1999 to 2009 was 273,500 units per year in Vietnam, most of which were high-rise apartment typologies (Un-Habitat, 2014). Because most new housing was built for migrants, civil servants, or people with a low-income, the service area in apartment units was small, about 30 m<sup>2</sup> (in 1999), which was adapted in order to meet fundamental living needs. In addition, in order to satisfy a number of high-income residents, some apartments were accessed from communal halls, which were connected to an elevator and stair core, and were relatively high (10-20 floors), with floor plan areas of about 40 m<sup>2</sup> for one-bedroom units or 60 m<sup>2</sup> for two-bedroom units.

Since 2000, high-rise apartment buildings (over 25 floors) have appeared more frequently in the form of tower blocks, as seen in Figure 2 and Table 3. These housing typologies are designed using international standards for a new living style that has gradually become the common form of dwelling in megacities (e.g., HCM City and Hanoi). Specifically, apartment floor plans commonly include two bedrooms or three bedrooms. The penthouse (a luxury apartment type) is positioned on the highest floor of the building, and it is designed to be a four-bedroom type, as seen in Figure 2 and

Table 3. As observed in Table 3, the spatial configuration in this period has been designed to satisfy not only basic living needs, but also relaxation and entertainment.

Twelve typical apartment layouts selected for the analysis include three units for 1960-1986, four units for 1986-2000, and five units for 2000-2010, as seen in Figure 2. The 12 layouts can be classified into one-bedroomed, two-bedroomed, three-bedroomed, and penthouses. It is noted that some apartment floor plan layouts built before 1975 did not have a bedroom, and the multi-functional area was utilized as a bedroom.

## RESULTS

# Results of the space syntax analysis of traditional houses

To identify the general characteristics of the Hue traditional garden house's spatial configuration, the spatial layout of four traditional houses in Table 2 was analyzed using space syntax. By applying the calculation steps in Section 3, the J-graphs of four houses were plotted in Figure 3, and the IV index for the three main spaces (living room, bedroom and kitchen) was calculated. The result showed three remarkable features of Hue traditional houses, as follows:

- Firstly, the general layout is separated exactly into two parts, made up of the main house and an auxiliary house, as seen in Figure 3. The main house consists of social and living functions, such as the living room, prayer area, and bedrooms. The main house's spatial structure has a long corridor located in the front area. The corridor plays a role as a buffer space that is a transition to the living room and worship area. The bedrooms are always located behind the living room, and there is just one entryway to ensure the homeowner's privacy. The auxiliary house, located next to the main house's right side, contains service spaces for living, such as a kitchen, storage, and a sanitary area. The auxiliary house entrance is separate from the main house;
- Secondly, based on the J-graphs in Figure 3, the diagram links four external spaces, including the courtyard, kitchen, pantry, and toilet, establishing a topology of these spaces, and they are completely separated from the main house. These spaces can be categorized as utility spaces that serve necessary living activities (e.g., cooking and farming). This linking is a genotype existing in traditional houses, thereby revealing the residents' lifestyles; and
- Thirdly, one primary genotype existing in four traditional houses was found through the integration value (IV), as shown in Figure 3. The IV of the living room differs within the floor plan of each house. Moreover, the IV of the living room is the highest of the spaces in the same system (also in Figure 3). From that, it can be concluded that the public and flexible features of the living room are the most important aspects for understanding the residents' lifestyles in a particular period. The IV of the living room has a high value by positively integrating into the system. In contrast, the kitchen and bedrooms have a lower integration value. They can be seen as private spaces.



Figure 2. Floor plan of 12 apartment buildings

Construction	Construction Before 1975			After 2000			
period	Belore 1975	Alter 1960	2005	2010	2015		
Apartment block planning							
Apartment name	Vinh Hoi	Xom Cai	Sky Garden	Topaz	City Garden		
Size of units(m <sup>2</sup> )	35	48-56	54-65	64-66	70-200		
Location	Central area	City fringe	City fringe	City fringe	City fringe		
Block typology	Linear block	Linear block with courtyard	U-shaped block	Grouped block	Wave towers		
Access way to units	Double loaded corridor access	Cluster corridor access	Hall access	Combined type	Hall access		
Number of storeys	4	4	26	26	28		
Number of units per block	28	20	6	10	16		
	Main House   Sub-House						

### Table 3. Changes in apartment building typology in HCM city



Figure 3. J-Graph with the entrance as the root note for traditional houses

# Results of the space syntax analysis of apartment unit plans

The J-graph and IV were used to determine the features of the traditional house that were utilized for the design of architectural apartment buildings. First, the 12 layouts of apartment buildings representing the common properties of apartments were analyzed by converting them into a J-graph, as seen in Figure 4. Then, the IV was calculated for the three main spaces (living room, bedroom and kitchen) in the apartments to show their properties. The characteristics of the apartment buildings in three periods (from 1960 to 2010) are detailed, as follows:

### Apartment units from 1960 to 1986

The apartments constructed before 1975 have the smallest area out of the three periods. The spatial configuration was arranged like a railroad without a hallway, and the rooms were positioned next to each other. Based on the convex map and J-graph, as illustrated in Figure 4, two main features of the spatial configuration of these apartments were identified. First, there is no bedroom. Instead, a large space is useable for different purposes, for example as a living room, dining room, workspace or for sleeping. Second, the main entrance is directly connected to the living room or kitchen without any directional space or subspace, as illustrated in the J-graph in Figure 4. It is noted that there were just a few partitions between the spaces. A flexible common space can be used for family members. In general, the spatial configuration in the period only serves the same basic needs, such as eating and sleeping. The apartment model was strongly associated with the socio-economic situation during the wars, that is, the socio-economy faced many difficulties. Moreover, the IV values for the three main spaces, namely the living room, bedroom, and kitchen, are slightly different, thus indicating a reduction of privacy in the space.

### Aparment units from 1986 to 2000

After 1986, the construction of apartment buildings developed with various types. Most apartment building styles referred to the patterns of developed countries (such as China, Korea). The private space in apartment unit layouts can be especially noticed. Figure 4 shows two different zones



Figure 4. Comparison of traditional houses and apartment unit plans

in the apartment floor plan layout, including a residential area and a service area. Specifically, the kitchen is completely separated from the main branch of the system, and the living room is at the center of the apartment's spatial structure. The bedrooms are connected by transitive space accessible from the living room or staircase. Moreover, the area of apartments from this period is greater than that of those built before 1975. The other features can be listed as more than two bedrooms, toilets, and several balconies or loggias.

As illustrated in Figure 5, interestingly, the living rooms in "73 Cao Thang" apartment and "Thuan Kieu" Plaza have the first and second highest integration values of those built at that time. The increase of integration value points out that a space is located at the center of the spatial configuration of the apartments, like a permeable space. It plays a crucial role in connecting the functional space within the housing units. Furthermore, according to homeowners, the living room has multiple functions, for example, as a reception

room, a dining room, and a relaxation area. Thus, the design of apartment buildings focused more on quality of life, that is, more privacy and space for family members.

### Apartment units built between 2000 and 2010

Apartments built between 2000 and 2010 were subject to enormous changes in the spatial structure. The number of functional spaces and the size of each unit increased to ensure spiritual life. Based on the J-graph in Figure 4, there are three essential features of the apartment floor plan. Firstly, the spatial configuration is separately divided into two zones, including a flexible residential zone (bedroom, living room) and an auxiliary zone (a kitchen, pantry, toilets, and balcony or loggia). In particular, the residential zone is divided into static and dynamic groups. Figure 4 shows that the static zone consists of a bedroom and a personal room directly connected to the service area through a transition space. These spaces are located on the corner or middle of the apartment, and they occupy the deepest place inside it to ensure privacy. Meanwhile, the dynamic zone, made up of the living room, dining room and service areas (e.g., kitchen, laundry, and storage), is usually located near the entrance. Secondly, these apartments have more than two space transitions, situated at the entrance or in the intermediate space connecting the static and dynamic zones, as seen in Figure 4. Thirdly, the most striking finding from the J-graph is a connection between the guest room and outside spaces through the balcony or loggia. The living room was also designed with a loggia or a balcony. The change is the most significant in an apartment building in this period.

For apartment buildings constructed since 2010, Figure 5 shows that the living room has the highest index of integration value, thus indicating that the living room is a public and flexible space. In some cases, the integration values of the living room are equal to that of the kitchen (Figure 5). It indicates that the role of the kitchen has been changed in modern society. In other words, the kitchen is no longer a domestic space, as in previous apartments (Figure 4). Moreover, in some apartments (H.A. Thanh Binh, City Garden), the kitchen has been placed next to the loggia for ventilation, and is directly connected to the dining room or living room. The kitchen can also be designed inside the living room or dining room without a partition, to form a circular layout type. It is noted that prior to this, apartments had a rail layout.

Moreover, Figure 5 reveals the lowest integration value of bedrooms in a partment buildings. The low IV values show that the privacy properties of the bedroom are still maintained, although socio-economic conditions have changed. Since 2010, luxury apartment units have been constructed rapidly due to economic development and an increasing standard of living. Economic growth has led to changes in society and in human behavior. However, these apartments still own the original features, that is, open space to connect the human and surrounding environment. The spatial configuration shows that the apartment has more than three bedrooms (an increase in space) and a connection between the inner space and natural environment via a large terrace and balcony (an increase in the quality of space). These spaces were designed as duplexes, with some apartment buildings even having additional swimming pools.

### DISCUSSION

By applying the space-syntax method to analyze apartment buildings, five characteristics of housing can be summarized, as shown in Table 4. First, the areas of apartment buildings have increased (1960 to 2000), and the maximum size is found in apartment buildings built after 2010. Second, the height of apartment buildings has also increased, with a height of more than 20 stories for apartments constructed after 2000. Thirdly, the space typology has changed over time, from a railroad layout (before 1975), a wing layout (1986-2000), and a circular layout (2000-2010). The increase in the height of apartments and their shape indicate the development of the economy and advances in construction technology. Fourthly, since 2010, there have been service areas (e.g., green space and swimming pool) in high-rise apartment buildings. Lastly, the spatial configuration of modern apartments (since 2000) has been strongly affected by traditional house styles, as seen in Table 4.

By comparing the features of traditional houses and apartment unit plans, three main features regarding the spatial configurations of apartment units can be summarized. Firstly, the spatial configurations of most apartments in the first period (1960-1986) differed from those of traditional houses. Their lack of spatial division based on function is remarkably different from traditional houses. Compared to traditional houses, the living room area in apartments was



Figure 5. Integration values calculated for apartment buildings

large during that period, also serving as a dining, worship, or study room. This space could be changed to adapt to each household's daily life. on the development of the socio-economy, from the railroad layout (before 1975), wing layout (1986-2000), and circular layout (2000-2010). In particular, the result

Table 4. Summarized characteristics of traditional houses and apartment buildings

Туре	Hue traditional garden	Apartment buildings			
	house	Before 1975	After 1986	After 2000	
1. Size of units	>100	30-50	50-60	60-200	
2. Number of stories	1	3-4	10-20	>20	
3.Typology of space	L-shaped layout	Railroad layout	Wing layout	Circular layout	
4. Functions	Dwelling+ Production	Dwelling	Dwelling	Dwelling+ many service spaces	
5. Spatial arrangement	Strong division	Lack division	Strong division	Strong division	
5.1. Living room	Flexible space	Flexible space	Flexible space	Flexible space	
5.2. Bedroom	Privacy space	Common space	Privacy space	Privacy space	
5.3. Kitchen	Close space	Common space	Open half-space	Open space	

Secondly, the spatial structure of apartment units built after 1986 was slightly affected by the traditional house style. Specifically, the kitchen and toilet (cluster space) were located at the entrances, and the IV value of the living room (using a J-graph) was higher than the other spaces, as seen in Figure 5. The high IV value indicates that the living room is a community area for the family. Thirdly, the spatial configuration of apartment units built since 2000 has definitely been affected by traditional house styles. Three essential features can be listed: (1) a strong division of the spatial structure, (2) separation of the residential space into dynamic and static, and (3) connection with the natural environment. In contrast, the role of the kitchen has a significant difference, that is, the living room, dining area and the kitchen are connected directly.

## **CONCLUDING REMARKS**

In this study, the effects of the spatial configuration of the traditional Vietnamese house on apartment buildings design in HCM city were investigated. Firstly, the development of the socio-economic structure in HCM City from 1960 to 2010 was briefly described. Secondly, the space syntax method for analyzing the spatial plan of the structure was outlined. Thirdly, traditional houses and apartment buildings between 1960 and 2010 were surveyed. Lastly, the space syntax method was applied in order to analyze the spatial structure of a number of traditional houses and apartment units. The effects of the spatial configuration of the Hue traditional house on apartment buildings were examined.

From the analysis, the remarkable features of the apartment buildings can be listed as follows:

- The spatial configuration of modern apartment buildings is similar to the features of the traditional house, including harmonization with nature and Vietnamese socio-cultural adaptation, which merits further investigation in terms of the application of the modern apartment design;
- The spatial layout of apartments has changed based

shows that the circular layout is strongly separated into two zones (static and dynamic);

- The appearance of flexible functional spaces (living room, dining room, and sitting room) is a focus of the design in modern apartments; and
- The kitchen in modern apartments is located close to the entrance or the living room, thus reducing the privacy of the space. Meanwhile, the kitchen in traditional houses is separated from the main house.

The results indicate that the spatial layout of the modern apartment has still retained the Vietnamese traditional house's spatial configuration. The findings provide useful information for the designs of modern apartment buildings in megacities. However, the present study has limitations because the analysis of the spatial configuration of apartment buildings was qualitative. Future study can focus on the design of a sample apartment planning unit, which takes into consideration the characteristics of traditional Vietnamese houses.

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# URBAN TRANSPORT IN WORLD METROPOLISES: A COMPARATIVE ANALYSIS AND KEY FEATURES OF ENERGY CONSUMPTION

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Most theoretical and empirical research on the subject of urban transport energy consumption has addressed the role of urban form and urban spatial structure (primarily population density and degree of centralisation), city size (population and/or area), the level of economic development, transport patterns, and transportation infrastructure. Our analysis encompasses a wide range of socio-economic, spatial, transport and infrastructure indicators, as well as energy efficiency and energy consumption indicators in a sample of 35 world cities, covering the period from 1960 to 2005. Comparative analysis indicates there are significant differences regarding the determinants of urban transport energy consumption, especially between the US and Australian automobile-dependent cities, on the one hand, and the wealthy Asian metropolises, on the other. Despite some recent positive trends (a decline in automobile vehicle-kilometres and reduction in urban transport energy consumption), a large number of cities in the developed world still rely predominantly on cars, while sustainable modes of urban transport play an almost negligible role. Due to trends of urbanization, demographic growth and a rise in living standards, the main focus of attention has shifted to metropolises in developing countries. In the long run, the urban form itself is particularly significant, not only because it critically influences transport demand, but also because of its inertness.

Key words: urban transport, world metropolises, energy consumption, comparative analysis, urban planning.

### INTRODUCTION

It is expected that by the middle of this century the intensified process of urbanization will lead to two-thirds of the world's population living in cities (United Nations Department of Economic and Social Affairs Population Division, 2015). The number of cities populated with more than one million inhabitants is growing steadily (especially in developing countries): while in 1950 there were only 75 such cities, now there are 548. The number of cities with more than 10 million inhabitants has doubled since 1995, and today there are as many as 33; by 2030 there will be 43, and these will be located mainly in developing countries (United Nations Department of Economic and Social Affairs Population Division, 2018).

Urbanization, accompanied by a demographic explosion, is also causing a dramatic increase in the consumption of resources and energy, as well as emissions of local and regional pollutants and  $CO_2$ . Cities account for 70% of

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In the context of accelerated urbanization trends and growing environmental problems, urban transport is gaining importance. Not only does urban transport energy consumption represent a very significant part of the total city-level energy consumption, but forecasts suggest that in the future, urban transport  $CO_2$  emissions from fossil fuel combustion will record the highest growth rate (International Energy Agency, 2009; UN-Habitat, 2011), as well as the transport sector itself globally (International Energy Agency, 2018).

The literature in this field is rich in studies and research that have sought to explain the relationship between urban form and urban travel characteristics (Acker, 2021; Ewing and Cervero, 2010; Leck, 2006; Milakis *et al.*, 2015; Næss, 2012; Næss *et al.*, 2019; Stead and Marshall, 2001; Stevens, 2017).

The main conclusion is that the characteristics of urban form have a very significant impact on transport patterns in cities and, consequently, on the environmental effects of urban transport.

Many factors influence urban transport energy consumption (Creutzig *et al.*, 2015). Most theoretical and empirical research has addressed the role of urban form and urban spatial structure (primarily population density and degree of centralisation) (Clark, 2013; Karathodorou *et al.*, 2010; Kenworthy and Laube, 1999; Li *et al.*, 2018; Liddle, 2013; Newman and Kenworthy, 1999; Rickaby, 1991; Zhao *et al.*, 2017), city size (population and/or area) (Banister, 1992; Li *et al.*, 2018; Shim *et al.*, 2006), the level of economic development (Choi, 2013; Kenworthy, 2003; Wu *et al.*, 2016), transport patterns and transportation infrastructure (Bongardt *et al.*, 2013; Hu *et al.*, 2010; Lin and Du, 2017; Vuchic, 2007).

The aim of this paper is to make a detailed analysis of the complex relationships that exist between the various elements of urban form, socio-economic factors and urban transport on the one hand, and energy consumption on the other, and also to examine the experiences of world metropolises characterized by different types of spatial development. Following this, the general policy implications that arise from this analysis will be highlighted.

### MATERIALS AND METHODS

Our analysis encompasses a wide range of economic, spatial, transport and infrastructure indicators, as well as energy efficiency and energy consumption indicators (Table 1) in a sample of 35 world cities, and it covers a period of four and a half decades, more precisely from 1960 to 2005.

The main sources of data used in this paper are as follows:

- data for 1960, 1970, 1980, and 1990 were taken and partially calculated from studies by Kenworthy and Newman (1989) and Kenworthy *et al.* (1999);
- 1995 data were taken and partially calculated from a study by Kenworthy and Laube (2001); and
- 2005 data were calculated from three sources: Newman and Kenworthy (2015), Kenworthy (2013) and McIntosh *et al.* (2014).

Comparative urban and transport data are not very often readily available. Some apparent limitations arise from difficulty with respect to the collection of different kinds of urban data, since they are often out of date. Still, this is not a major shortcoming in its usefulness. While it is important to have a more current perspective, the relative position between cities concerning many characteristics does not radically change over a ten-years period. Furthermore, these kinds of standardised data variables are most valuable and useful to "researchers and policy makers in coming to terms with the vast differences that exist between cities in basic patterns of land use, transportation and energy use" (Kenworthy *et al.*, 1999).

One of the most valuable aspects of the data used in our analysis is its broad comparative perspective, which is not quite so dependent on absolutely current data. This set of data is unique "as there is nowhere else that one can find such a time series of data to work with which has been developed using the same definitions and methods" (McIntosh *et al.*, 2014) spanning more than four decades.

Also, for the purpose of our analysis, the period 1960-1990 is of greatest significance, considering that the most important changes took place in many cities at that time which affected their urban form, transport patterns and energy consumption.

Economic indicator	Metropolitan GDP per capita
Spatial indicators	Urban density
	Urban job density
	Proportion of jobs in CBD
Infrastructure indicators	Length of road per person
	Parking spaces per 1,000 CBD jobs
Private transport	Passenger cars per 1,000 persons
indicators	Passenger car passenger kilometres per person
Public transport indicators	Total public transport passenger kilometres per person
	Total public transport vehicle kilometres of service per person
	Rail systems vehicle kilometres of service per person
	Total public transport vehicle kilometres of service per urban hectare
	Share of public transport in total motorised passenger kilometres
Energy efficiency indicators	Energy consumption per public transport passenger kilometre
	Energy consumption per bus passenger kilometre
	Energy consumption per private passenger kilometre
Energy consumption indicators	Private passenger transport energy consumption per person
	Public transport energy consumption per person
	Total transport energy consumption per person

Table 1. List of indicators used in analysis

In addition to the data included in our analysis, data for 2001 and 2012, published by the UITP (International Association of Public Transport), were considered but were not taken into account. There are two reasons for this. First, after a thorough analysis of key indicators, it was found that the methodology by which the data were collected was significantly different from that of the Newman and Kenworthy studies. Second, the quality of the data itself is questionable because of the large, illogical discrepancies between the 2001 and 2012 data for the same observation units.

On the other hand, the data provided by Newman and Kenworthy in their studies are highly precise and

comparable and are used by many researchers in this field (Karathodorou *et al.*, 2010; Lefèvre, 2010; Liddle, 2013; Liddle, 2015). Therefore, from the point of view of our analysis, the selected data set, although somewhat outdated, is arguably the highest-quality available cross-national, city-based data.

Although the mentioned studies individually contain data on a large number of world cities, time series are only available for a small group of cities for all six selected years. However, even for cities in this group, there are certain methodological discrepancies between the key indicators in different years. For many cities, it was simply not possible to make a quality time series, given that the methodology of statistical coverage within national censuses had changed at some point.

Our sample, therefore, includes only cities whose indicators are available and completely comparable throughout the time period of the analysis (Table 2). For many metropolises of developing countries, precise data for the period before 1990 are not available due to the lack of official statistics. rest of the territory. Therefore, this indicator was calculated based on the realistic assumption that the total share of the metropolitan GDP as part of the total national GDP did not change significantly compared to 1990. After obtaining the GDP calculated in this way, we used the relevant population of the city to obtain the metropolitan GDP per capita for the 1960s, 1970s and 1980s. Based on data in Kenworthy's paper (2013), we calculated the 2005 GDP per capita. For the purpose of the exchange rate conversion, official IMF data were used (International Monetary Fund).

### RESULTS

The comparative analysis indicates that there are significant differences in spatial and transport parameters, as well as energy consumption, in the urban transport of world cities.

Urban densities and job densities are significantly lower in cities in the US, Australia, and Canada than other cities in our sample. The US and Australian cities have an average of about 10 times lower densities than the wealthy cities of Asia and the metropolises of developing countries (Table 3). Western

USA	Western Europe	Australia	Canada	Asia (wealthy)	Developing countries
Chicago	Brussels	Brisbane	Calgary	Hong Kong	Bangkok
Denver	Copenhagen	Melbourne	Montreal	Singapore	Jakarta
Houston	Frankfurt	Perth	Ottawa	Токуо	Kuala Lumpur
Los Angeles	Hamburg	Sydney	Vancouver		Manila
New York	London				Seoul
Phoenix	Munich				Surabaya
San Diego	Paris				
San Francisco	Vienna				
Washington	Zurich				

Table 2. World cities included in analysis

The urban area data in this paper refer to the neturbanized area of the metropolitan area, which covers only a continuously built-up area within the city (following the methodology in Kenworthy *et al.* (1999)). In this way, the comparability of spatial indicators between different world cities is achieved. Accordingly, the population density and the job density calculated in relation to the net-urbanized area are referred to as the urban population density and urban job density.

In addition to the summary indicator, public transport data were broken down into bus and rail systems (where it was feasible to do so), which is very important, given the significant differences in the main characteristics of these modes of urban transport. Rail systems here include trams, light rail systems, subways and suburban rail.

As data for the metropolitan GDP per capita prior to 1990 are not known, we had to resort to their most accurate approximation. The use of national GDP per capita for these purposes (a method often used) would lead to major deviations from the real value, given that these cities/regions are, as a rule, economically much more developed than the

European cities are located somewhere in the middle, with about 5,000 inhabitants/km<sup>2</sup>. Although their urban density declined by about 30% over the observed period, this can be explained by the intensification of peri-urban development as well as by general trends in population decline. Obviously, the activity density (jobs and persons) in wealthy Asian cities, cities in developing countries and those in the metropolises of Western Europe is extremely compatible with highcapacity transit systems. On the other hand, higher densities have the effect of reducing the overall transport demand in the city.

During the period analyzed, in almost all world cities, the relative share of jobs in CBDs (central business districts) declined, and many of them that had prevalent monocentric characteristics started to develop polycentric or even dispersed employment patterns. Job centralization is most prevalent in Western European cities (about 19%), Canadian cities (17.5%) and metropolises in developing countries (about 16%) (Table 3).

Cities in the US, Canada and Australia are characterized by the highest values of private urban transport infrastructure indicators: the length of urban roads per capita and number of parking spaces in CBDs (Table 4). The length of urban roads per capita in Australian cities is five times greater than that of wealthy Asian cities and even 10 times that of metropolises in developing countries. Numerous studies have revealed a positive link between the construction of new road infrastructure and the increased number and length of automobile travel (Cervero, 2002; Cervero and Hansen, 2002; ECMT, 1998; Goodwin, 1996). In addition, the construction of city roads reduces opportunities for walking and cycling (Litman, 2001).

The number of parking spaces per 1,000 jobs in CBDs in US cities is twice as high as in Western European cities, three

times that of the metropolises of developing countries and even five times higher than wealthy Asian cities. The availability of parking space in the central areas to a large degree determines the use of different modes of urban transport, especially when commuting.

The level of motorization has seen a huge growth in almost all world cities, in parallel with the increase in the standard of living. Cities in Australia and the US have an extremely high number of cars per 1,000 persons, namely 647 and 626 respectively. It is worrying that in the observed period the level of motorization has tripled in the cities of Western Europe and the cities of developing countries (1980-1995).

Table 3. Evolution of urban density, urban job density and proportion of jobs in CBD in world cities, 1960, 1970, 1980, 1990, 1995 and 2005 (Source: adapted according to Kenworthy et al., 1999; Kenworthy and Laube, 2001; Kenworthy and Newman, 1989; Newman and Kenworthy, 2015)

Cities	Year	Urban density (persons/ha)	Urban job density (jobs/ha)	Proportion of jobs in CBD (%)
USA	1960	17.2	8.0	16.34
	1970	16.7	7.5	13.66
	1980	14.5	7.4	12.03
	1990	15.0	8.5	10.30
	1995	15.9	8.0	9.49
	2005	16.2	-	8.80
Western Europe	1960	70.9	41.1	23.74
	1970	65.8	37.5	21.50
	1980	55.1	32.6	20.10
	1990	49.7	31.7	18.82
	1995	51.4	30.7	20.44
	2005	52.1	-	19.01
Australia	1960	19.5	7.4	26.35
	1970	15.2	6.6	21.93
	1980	13.7	5.5	16.60
	1990	13.0	5.4	13.70
	1995	13.3	5.7	13.33
	2005	14.0	-	13.17
Canada	1960	36.5	6.6	-
	1970	30.1	10.6	26.43
	1980	26.3	12.5	23.10
	1990	26.7	13.3	19.65
	1995	26.4	12.6	18.01
	2005	25.6	-	17.49
Asia (wealthy)	1960	95.1	-	-
	1970	166.8	80.6	29.70
	1980	149.3	71.0	19.40
	1990	152.8	87.5	17.80
	1995	167.2	84.0	12.33
	2005	-	-	-
Developing countries	1980	153.7	50.8	-
	1990	166.4	65.1	25.65
	1995	161.3	73.2	15.83

 Table 4. Evolution of metropolitan GDP per capita, infrastructure and mobility of private urban transport in world cities, 1960, 1970, 1980, 1990, 1995, and 2005

(Source: adapted according to Kenworthy, 2013; Kenworthy et al., 1999; Kenworthy and Laube, 2001; Kenworthy and Newman, 1989; Newman and Kenworthy, 2015 and the author's calculations)

Cities	Year	Metropolitan GDP per capita (in \$)	Length of road per person (m per capita)	Parking spaces per 1,000 CBD jobs	Passenger cars per 1,000 persons	Passenger car passenger kilometres per person (pkm per capita)
USA	1960	4,648	7.44	360.1	372.7	8,606
	1970	6,905	7.48	448.3	458.0	10,255
	1980	15,119	6.84	399.0	534.4	12,839
	1990	26,785	6.42	434.4	595.7	15,718
	1995	31,425	6.24	536.2	569.5	17,434
	2005	54,655	5.85	415.0	625.8	18,100
Western	1960	1,547	1.51	128.2	126.0	2,723
Europe	1970	3,535	1.73	155.2	243.5	4,480
	1980	17,018	2.22	187.6	333.6	5,677
	1990	32,285	2.42	218.7	398.0	6,648
	1995	40,532	2.57	202.7	405.9	6,444
	2005	51,551	2.48	226.4	402.8	6,628
Australia	1960	2,211	8.68	293.0	217.4	5,610
	1970	3,652	8.28	258.4	313.3	8,035
	1980	11,307	8.58	314.3	444.3	10,121
	1990	19,761	8.20	378.1	488.2	10,604
	1995	20,226	8.57	367.2	590.9	12,114
	2005	36,648	7.58	297.8	646.7	12,447
Canada	1960	3,638	4.90	-	270.3	-
	1970	5,134	4.90	453.2	357.5	-
	1980	13,159	6.47	360.2	454.5	8,326
	1990	23,216	5.38	385.5	531.3	9,589
	1995	21,167	5.57	427.9	545.9	9,102
	2005	38,603	5.58	355.6	531.5	9,046
Asia	1960	639	-	-	21.9	-
(wealthy)	1970	1,859	2.15	53.7	66.9	1,136
	1980	8,880	1.94	67.1	87.5	1,593
	1990	21,331	1.76	79.9	123.1	2,385
	1995	32,324	1.76	103.6	156.5	2,860
	2005	25,973	-	-	-	1,975
Developing	1980	-	0.58	-	47.5	1,495
countries	1990	2,861	0.72	192.3	102.4	1,640
	1995	5,538	0.85	166.1	158.3	3,016

Although the increase in passenger kilometres is not as pronounced as in 1960-1990, the automobile-dependent cities of the US, Australia and Canada continue to have comparatively greater private mobility than other metropolises. By comparison, this number is nine times higher in US cities (18,100 pkm per capita) than in the wealthy Asian metropolises (1,975 pkm per capita).

The supply of public transport is also significantly different among world cities. The largest supply per capita and urban hectares is in wealthy Asian cities, Western European cities and the metropolises of developing countries. However, while developed cities in Asia and Western Europe have a significant share of rail systems, in poor metropolises buses account for the largest volume of vehicle-kilometres per capita. Therefore, they also have the highest public transport mobility - especially wealthy Asian cities (3,786 pkm per capita) (Table 5).

A very significant long-term benefit of high-capacity transit

systems is that they direct urban development towards their corridors. This creates the necessary conditions to prevent the process of urban sprawl. Therefore, the development of transit systems must be closely linked to urban planning and transport policy (Lefèvre, 2010).

Different modes of urban transport have very different energy efficiency, expressed here in MJ per passenger kilometre. Due to its significantly higher capacity and load factor, public transport is a much lower energy consumer than automobiles (Table 6). This difference is most pronounced in wealthy Asian cities, where automobiles consume five times more energy per 1 passenger kilometre than public transport. This is, of course, a consequence of high-capacity rail systems and the extremely high load factor that characterizes these metropolises, which is strongly influenced by high urban densities. Following these, cities in Western Europe and developing countries have the lowest energy consumption of public transport.

 Table 5. Public transport supply and mobility, and the share of public urban transport in the total motorised pkm in world cities, 1960, 1970, 1980, 1990, 1995, and 2005

(Source: adapted according to (Kenworthy and Newman, 1989; Kenworthy et al. 1999; Kenworthy and Laube, 2001; McIntosh et al., 2014; Newman and Kenworthy, 2015)

Cities	Year	Total public transport vehicle km of service per person (vkm per capita)	Rail systems vehicle km of service per person (vkm per capita)	Total public transport vehicle km of service per urban hectare (vkm per ha)	Total public transport passenger km per person (pkm per capita)	Share of public transport in total motorised pkm (in %)
USA	1960	28.91	6.86	561	560	8.4
	1970	24.48	7.14	475	399	4.7
	1980	30.67	8.36	497	533	4.5
	1990	31.36	10.92	501	551	3.6
	1995	31.69	12.21	533	503	3.0
	2005	42.37	15.68	733	601	2.9
Western	1960	78.36	59.40	5,420	1,860	41.4
Europe	1970	73.33	50.81	4,540	1,538	26.8
	1980	78.39	53.04	4,158	1,665	23.4
	1990	91.60	62.27	4,354	1,937	23.1
	1995	99.87	67.94	5,103	1,834	22.4
	2005	119.34	80.96	6,274	2,290	23.8
Australia	1960	81.25	44.98	1,610	1,539	21.4
	1970	60.55	24.43	934	1,192	12.9
	1980	57.58	26.25	819	906	8.3
	1990	61.50	28.40	840	1014	8.9
	1995	57.36	29.05	789	966	7.6
	2005	58.94	30.18	856	1,075	8.1
Canada	1960	32.77	-	861	335	-
	1970	26.57	-	714	328	-
	1980	55.10	6.18	1,509	857	10.1
	1990	54.03	10.38	1,466	862	8.8
	1995	47.19	10.17	1,252	884	9.0
	2005	51.41	12.31	1,310	1,007	10.4
Asia	1960	-	27.40	-	-	-
(weatiny)	1970	-	33.10	-	3,483	77.9
	1980	102.47	26.73	16,295	3,217	67.0
	1990	114.57	39.57	19,475	4,020	64.1
	1995	117.28	42.33	21,803	4,141	61.5
	2005	-	-	-	3,786	43.5
Developing	1980	-	-	-	1,371	45.5
countries	1990	108.00	2.83	19,772	1,871	38.3
	1995	155.07	-	29,379	1,822	38.7

It is clear that public transport has the greatest potential for reducing the overall energy consumption of urban transport, since it can carry the largest number of passengers, while being several times more energy efficient than private transport.

The values of the spatial, economic, infrastructural and transport indicators analyzed here are reflected in the per capita energy consumption of urban transport (Table 7). Although in a slight decline after 1990, the energy consumption of US cities is still at a persistently high level

compared to other world metropolises - US cities consume three times as much energy in transport than Western European and over eight times as much as wealthy Asian cities. Behind them are cities in Australia and Canada. The largest share of energy consumption, of course, comes from consumption in private urban transport.

### DISCUSSION

In terms of urban transport energy consumption, US and Australian cities (and to a certain extent Canadian)

Table 6. Energy efficiency of private and public urban transport in world cities, 1960, 1970, 1980, 1990, 1995 and 2005 (Source: adapted according to Kenworthy et al., 1999; Kenworthy and Laube, 2001; Kenworthy and Newman, 1989; McIntosh et al., 2014; Newman and Kenworthy, 2015)

Cities	Year	Energy consumption per public transport passenger kilometre (MJ/pkm)	Energy consumption per bus passenger kilometre (MJ/pkm)	Energy consumption per private passenger kilometre (MJ/pkm)
USA	1960	1.45	1.48	4.90
	1970	1.91	2.02	5.16
	1980	1.91	2.13	4.76
	1990	1.91	2.43	3.66
	1995	2.19	2.79	3.16
	2005	2.14	-	2.84
Western Europe	1960	0.40	0.71	1.93
	1970	0.51	0.91	2.05
	1980	0.62	0.96	1.88
	1990	0.67	1.30	3.38
	1995	0.74	1.33	2.61
	2005	0.77	-	2.38
Australia	1960	1.06	1.04	2.70
	1970	0.79	1.19	2.76
	1980	0.99	1.53	2.86
	1990	1.02	1.74	2.90
	1995	0.99	1.77	2.55
	2005	0.97	-	2.89
Canada	1960	0.88	1.58	-
	1970	1.56	1.77	-
	1980	1.37	1.56	4.05
	1990	1.35	1.74	3.29
	1995	1.18	1.56	3.50
	2005	1.21	-	3.19
Asia (wealthy)	1960	-	-	-
	1970	0.33	0.64	3.63
	1980	0.49	0.74	2.91
	1990	0.43	0.84	3.02
	1995	0.46	0.78	3.14
	2005	0.70	-	3.62
Developing countries	1990	0.70	0.74	3.17
	1995	0.87	0.85	2.17

Cities	Year	Private passenger transport energy consumption per person (MJ per capita)	Public transport energy consumption per person (MJ per capita)	Total transport energy consumption per person (MJ per capita)
USA	1960	45,276	715	46,041
	1970	58,573	589	59,162
	1980	66,538	834	67,373
	1990	62,265	852	63,117
	1995	55,287	834	56,121
	2005	51,038	1,008	52,047
Western Europe	1960	9,884	756	10,744
	1970	14,129	826	15,035
	1980	17,162	1,013	18,241
	1990	24,974	1,241	26,216
	1995	16,650	1,300	17,951
	2005	15,288	1,720	17,008
Australia	1960	18,898	1,451	20,349
	1970	27,168	843	28,011
	1980	35,801	812	36,613
	1990	37,754	904	38,659
	1995	31,044	875	31,920
	2005	35,972	1035	37,008
Canada	1960	-	467	-
	1970	-	463	-
	1980	42,240	1,175	43,366
	1990	38,209	1,161	39,332
	1995	31,987	1,046	33,033
	2005	28,568	1,187	29,756
Asia (wealthy)	1960	-	-	-
	1970	8,641	907	9,772
	1980	11,180	1,137	12,318
	1990	13,915	1,396	15,311
	1995	8,306	1,722	10,028
	2005	6,077	2,691	8,768
Developing countries	1990	12,272	1,327	13,598
	1995	8,009	1,632	9,641

Table 7. The evolution of urban transport energy consumption in world cities, 1960, 1970, 1980, 1990, 1995 and 2005 (Source: adapted according to (Kenworthy et al., 1999; Kenworthy and Laube, 2001; Kenworthy and Newman, 1989; Newman and Kenworthy, 2015)

represent a rather specific, even extreme, type of development. Newman and Kenworthy have called such metropolises automobile-dependent cities (Kenworthy and Newman, 1989). Automobile dependency is largely a consequence of public policy, namely, transport and spatial planning measures that have consistently favored car use and encouraged spatial expansion. At the same time, it has been completely neglected that traffic problems, such as congestion, cannot be solved solely by the construction of new urban roads, which again stimulates even more rapid growth of private mobility and intensification of dispersed spatial development (Frederick, 2016; Geels *et al.*, 2012; Kakar and Prasad, 2020; Kasraian *et al.*, 2016; Kenworthy, 2017; Litman, 2004: Litman, 2007; OECD, 2018).

Although very diverse, Western European cities are significantly different from US and Australian automobiledependent cities. In contrast to their spatial development, which is largely the outcome of macroeconomic policy (see: Jovanović, 2005), the far more significant role of spatial planning is noticeable in the development of Western European cities. The ambitious post-war development plans for Paris and London, although completely different in terms of their success, best bear witness to this. Jovanovic (2008) summarizes that "precisely the European way of regulatory urban planning and the continued subsidization of public urban transport has significantly contributed to the development of European metropolises in a 'more sustainable' way...".

However, there are indications that in many metropolises of the developed world, characterized by automobile dependence, saturation has occurred, and that the trend of exponentially increasing private mobility has at least slowed, if not stopped, in recent years. Many studies indicate that the peak of car use was reached at the beginning of the 21st century, both nationally and in the cities themselves (Millard-Ball and Schipper, 2011; Newman and Kenworthy, 2011; Puentes and Tomer, 2008).

Newman and Kenworthy point out possible reasons for the decline in car use in cities: the effect of the so-called Zahavi's constant, revitalization of public transport, stopping the process of dispersed urban development, aging of urban populations, and higher fuel prices (Newman and Kenworthy, 2011). Due to the increasing traffic congestion in automobile-dependent cities, the influence of Zahavi's constant, i.e., limitations of the so-called travel time budget, are becoming increasingly apparent. Also, as there is an exponential link between car use and public transport (an increase in passenger kilometres by public transport per capita causes a dramatic decrease in passenger kilometres by car per capita), the revitalization of public transport has played a significant role in reducing automobile dependence in many developed cities (Newman and Kenworthy, 2015). This relationship is something that transport planners often tend to disregard.

In the same period, there are indications of a break in the usual positive link between economic growth and urban mobility. In most cities in the developed world, there has been a significant reduction in vehicle-kilometres by car per unit of real GDP (an average of 21%), which means that despite the strengthening of their economies, car use is reduced. In some cities there is even an absolute reduction in the distance traveled by car (Kenworthy, 2013).

However, despite all these positive trends (decline of automobile vehicle-kilometres and reduction of urban transport energy consumption), a large number of cities in the developed world still rely predominantly on cars, while sustainable modes of urban transport play an almost negligible role.

The wealthy Asian metropolises are the complete opposite of the US and Australia's automobile-dependent cities. Singapore, Hong Kong and Tokyo are the best examples of sustainable urban development and energy efficient cities (Leung *et al.*, 2018). A key feature of their development is the exceptional coordination of urban planning and transport strategies, as well as innovative solutions to transport problems (Diao, 2018; M. Jovanović, 2014; Wen *et al.*, 2019).

Furthermore, the wealthy Asian metropolises are among the most densely populated cities in the world (Table 3). These extremely high population densities are not merely the outcome of the process of urbanization, accelerated economic development and the natural limitations of spatial expansion, but rather they are largely the result of strategic spatial and transport planning. This has provided the high load factor of economically very efficient high-capacity public transport systems (Jovanović, 2009). At the same time, the exceptionally high load factor (often over 100%) has led to the high energy efficiency of public transport, expressed in energy consumption per passenger kilometre.

The planned development of the 'new towns' has left a great mark on the spatial development of these metropolises, which originated from Howard's 'garden city'. However, these 'new towns' have largely fulfilled the principle of selfsufficiency, which, with the coordinated development of rail transport, effectively reduced the need for car use and travel in general (Diao, 2018; Jovanović, 2009).

Also, these cities have a very restrictive car ownership and car use policy. In Hong Kong, for example, the motorization rate has been successfully limited by various fiscal measures that have raised car registration prices and costs. Singapore is considered to be the world's best example of implementing measures to limit the use of motor vehicles. The congestion pricing system was introduced in 1975 and was quite innovative - in the form of permits that vehicle owners had to buy in order to enter the central city area. The effects were visible very quickly. In just one year, the number of cars entering the central zone in the peak hour decreased from 43,000 to 11,000 (Seah, 1980), and the speed of vehicle movement doubled (Chin, 1996). The modal share of public transport in travel, which stood at 46% in the 1970s, jumped to 67% two decades later (GTZ, 2012). These measures were aided by fiscal instruments such as restricting car ownership, introduced in 1990 (Vehicle Quota System) (Barter, 2005). Potential buyers took part in auctions to obtain a license that allowed motor vehicle registration. In ten years, this system managed to reduce the annual growth rate of motorization from 4.2% to 2.8% (Timilsina and Dulal, 2010). Following Singapore's example, many cities, such as Hong Kong, London and Stockholm, have successfully introduced congestion charge systems.

Unlike the developed world metropolises, cities in developing countries are in the early stages of the urban development cycle. Their urban form is compact, and population densities are high (Table 3). A large number of them have pedestrian characteristics, so non-motorized modes of transport have a large share in the overall mobility. In such circumstances, the choice of transport strategy and the construction of transport infrastructure is of the utmost importance, as it can decisively determine the further course of urban development.

Although the motorization rate is low due to the low standard of living compared to the wealthier cities in the world, in parallel with economic development the number of cars and the length of travel itself is growing rapidly. Some forecasts suggest that, thanks to rapid economic development, the mobility of motorized transport in these countries will increase as much as four times by the middle of the 21st century (Schafer and Victor, 2000).

As the share of car use is still at a relatively low level, their energy consumption is significantly lower than other cities in the world. Nevertheless, current processes of dramatic demographic growth, rapid urbanization and economic development place these metropolises at the heart of the global agenda for sustainable urban development. Already today, the population of these metropolises is much greater than the population of cities in developed countries (United Nations Department of Economic and Social Affairs Population Division, 2018). However, their urban sustainability problems should not be viewed solely as a consequence of accelerated urbanization and a population explosion, but more as an unintended outcome of poor urban planning and governance (Rode and Burdett, 2011).

Regarding policy implications, the effects of various instruments on energy consumption in urban transport are very often analyzed within the ASIF methodology. They represent different aspects that can be influenced by urban and transport policy: activity (A), structure/modal share (S), energy intensity (I) and fuel type (F).

Throughout history, the emphasis has often been on the implementation of new transport technologies, as well as on the improvement of existing ones (Webb, 2019). These are measures that improve the efficiency of the vehicles themselves (mainly automobiles), the quality of fuel and the quality of road infrastructure. A well-known example is the implementation of increasingly stringent automobile standards in the United States since the 1960s, which significantly reduced the emission of local air pollutants per vehicle-kilometre traveled, but unfortunately not the emission of CO<sub>2</sub>. However, as there was a tremendous increase in mobility by private modes of transport in the same period, these effects were almost nullified (Jovanovic, 2012). The same can be expected with other technological innovations with regard to fuel or the vehicles themselves - if these improvements cause energy savings, they often lead to greater car use (a well-known Jevons paradox). Investigating this effect in road transport, one meta-analysis shows that the short-term reduction in expected benefits from technological improvements is 10-12%, and in the long-term as much as 26-29% (Dimitropoulos et al., 2018). Also, the positive effects on the environment of many new technologies are not so clear when the entire process of their production and consumption is taken into account. The use of an electric car, for example, which is based on energy obtained from non-renewable sources, is not effective from the point of view of sustainable urban development.

Most authors agree that measures affecting components I and F will, at least in the foreseeable future, have the least effect on reducing energy consumption and  $CO_2$  emissions in urban transport (Banister, 2011; Lefèvre, 2009; Næss and Vogel, 2012). The scope and outlook of new transport technologies are perhaps best illustrated by the fact that, despite high expectations, electric vehicles have failed to significantly replace the internal combustion engine - today, their total number in use is only 0.2% of the total passenger vehicles (OECD/IEA, 2017).

This is especially true for the metropolises of developing countries. Given their level of economic development and living standards, it cannot be expected that new technology, such as electric vehicles, will be widely available in the near future. It is estimated that, in relation to developed countries, the market penetration of new transport technology in developing countries lasts on average 10 years longer, e.g. since the launch of the electric car, it has taken more than four decades for it to reach a somewhat significant market share in the least developed countries (Assmann and Sieber, 2005).

Thus, although all components of the ASIF framework should be taken into account in order to reduce the energy consumption of urban transport, it is obvious that, especially in the metropolises of developing countries experiencing the greatest changes, the focus should be on reducing demand and changing the modal share in favor of walking, cycling and public transport.

It is obvious that the reduction of energy consumption in urban transport can be achieved by implementing various urban planning/land use and transport policy instruments (Banister, 2011; Bongardt *et al.*, 2010). Among these, measures that reduce the need for urban transport (reducing the total vehicle-kilometres or the total passenger kilometres) are the most significant, especially ones resulting in increasing urban densities. Urban planning arguably has a key role in achieving sustainable urban transport (Hickman *et al.*, 2013), as it affects the spatial distribution of activities and determines their proximity to urban residents (i.e., accessibility).

Future research should focus on identifying the determinants of urban transport energy consumption and their significance using econometric methods (i.e., panel analysis), in order to fully understand their effect. Finally, given the significant number of studies in this field with similar hypotheses, it would be very useful to conduct a meta-analysis.

### CONCLUSION

A comparative analysis of the urban transport energy consumption of world metropolises indicates that there are significant differences, especially between the US and Australia's automobile-dependent cities, on the one hand, and the wealthy Asian metropolises, on the other. Although due to numerous factors, the trend of increasing private mobility and energy consumption slowed down in the first decade of the 21st century, the modal share of public transport and other sustainable modes of urban transport is still underwhelming.

In the long run, the urban form itself is particularly significant, not only because it critically influences transport demand, but also because of its inertness. Therefore, a substantial decrease in urban transport energy consumption in the mature cities of the developed world, at least in the near future, is not likely due to the radical interventions and high economic costs it entails.

Global urban transport energy consumption will be greatly determined by the type of urban development that is prevalent in the 'young' cities of the developing world, especially those with a relatively low motorization rate and private mobility, as urban planning and transport policies are much more effective in these conditions.

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## **IMPACT OF OVERTOURISM ON URBAN LIFE**

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The unrestrained and constant inflow of tourists to some cities can provoke the discomfort of residents. The term 'overtourism' describes a condition in which the limits are exceeded to the point that regular everyday urban life suffers. The quantity of visitors and resulting crowds create burdens on the functioning of some city services, and they simultaneously result in a deterioration in the quality of sightseeing. This paper gives a review of the academic literature concerning this issue, especially studies concentrating on cruising and alternative short-term renting. Major complaints raised by locals on the negative impact of tourism are not only about overcrowding, but also include the serious social and economic questions of the endangerment of rights. In order to regulate and mitigate conflicts, preserve identity and allow decent urban life in all its aspects, city governments are forced to introduce some limitations and rules in the sphere of tourism, and also with regard to the real-estate market and urban planning. The level of measures and policies required depend on the type of problem, size of the city and dispersion of the attractions.

Key words: overtourism, urban impact, citizens, regulations, limitation.

### **INTRODUCTION**

Competitiveness between urban centers in order to attract visitors and gain economic benefit has become a usual occurrence. Tourism has become tense over the past two decades; the need to visit and record own's presence in a tourist destination on social networks has become more important than to really explore and blend in with the surroundings. Beside global metropolises, which are the most popular tourist destinations and 'must see list' recommendations, many other cities have joined the club, trying to promote their unique image and identity, cultural potential and heritage, or their capacity for fun and leisure. In Europe, traditionally Paris, London, Barcelona, Rome and Prague are overcrowded by bustling tourist groups. Sea (or river) port cities, or those within reach of them, have been confronted with the massive cruising industry and the resulting rise in crowds. In pearls of architecture like Venice, Florence, Bruges, etc., the invasion of visitors is an everyday occurrence that has become intolerable, particularly in the peak of the tourist season (Figure 1). Sightseeing in an overcrowded ambience is not pleasant, and wandering around and being crushed in queues has no charm, making the general quality of visits very low. It seems that the content of historical city cores, with souvenir shops and restaurants, is sometimes more adjusted to the needs of visitors than to local citizens, including the prices. In the main streets, squares and various points of interest it is more common to hear different world languages than the local dialect. Local residents are leaving to live elsewhere, and whole areas are becoming only empty scenes of historical architecture. Outside of regular hotel capacities it is now possible to rent a private apartment during a visit, probably owned by residents who have left because of the crowds, prices and lack of city functions. 'Airbnb', as the most popular internet site and application, for some travelers is a much more convenient and cheaper way to plan their visit. All of the above-mentioned factors are the reason why the new term *overtourism* has appeared, which describes the loss of realistic boundaries, pushing capacity over the limits and finally degrading city districts in the sense of traditional urban life, in order to fulfill tourist demand. In 2019, some European cities were forced to announce the limitation of daily (or monthly/annual) numbers of tourists, with the goal of relieving the pressure on the urban tissue. In the COVID-19 pandemic, all city tourist destinations were

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deserted and the tourism industry, including accompanying sectors, underwent an enormous fall, but it is expected that everything will return to normal, and perhaps people will be eager to travel even more frequently after lockdown. This is the right moment to try to find new sustainable models for urban tourism. The paper is based on a review of academic literature concerning this issue, especially with regard to cruising and alternative short-term renting. It is structured in five sections, starting from a review of academic papers and various case studies, followed by the methodology used, an analysis of the negative effects of and major objections to tourism in popular city areas, including remarks made by residents, then a discussion on establishing limits according to urban capacity, with final conclusions. The scientific contribution of the paper is in its review of examples, with suggestions for resolving overtourism in the spheres of urban planning and management. There are research limitations regarding the present situation with the pandemic and limitations of travel all over the world, and also in comparisons between cities of different sizes, points of interest, and old and new attractions. The global problem of overtourism may have a completely different impact on different locations and citizens.

development of tourism (Pham et al., 2019).

When the impact of tourism on urban life is mentioned, even in academic papers, it is usually about positive economic gain for cities or as initiator of regeneration and reconstruction processes; and the impact of mass tourism on local citizens and social issues is limited to rare locations. Capocchi *et al.* give a comprehensive literature review about overtourism with an emphasis on its implications and future perspectives (Capocchi et al., 2019). They explain that "the growth of tourism has been accompanied by the concentration of tourist flows to specific areas, causing crowding and problems with carrying capacity, so in this context, the term 'overtourism' has begun to be used in the recent literature with particular regard to models of tourism development, some city destinations, and issues of sustainability". Dodds and Butler also researched the phenomenon of overtourism as "a new term for an old problem, namely, excessive numbers of tourists at a specific destination that can result in negative impacts of all types on the community involved" (Dodds and Butler, 2019). The attitude and feeling about overtourism is well observed and described by Minihane: "We first hear about these places



Figure 1. Face of overtourism – Toledo, Venice and Rome (Source: authors of the text, private photos)

## LITERATURE REVIEW

The term overtourism is new in the literature, describing an existing and well-known phenomenon. The problems caused in some destinations by the increasing growth of tourism have resulted in these issues being discussed in the literature since the early '70s (Capocchi et al., 2020; Milano et al., 2019). Even before massive tourist packages, in the late 19th century, some destinations on the Mediterranean (located on the coast and historical cities around France, Italy or Greece) were "overloaded" by wealthy people (aristocrats and bourgeoisie). There was a great interest in travelling to Egypt too, and visiting famous archeological sites. The increasing demand for mobility, leisure and unique experiences has been examined as a key factor in the growth of tourism, causing pressure on locations and dependence on tourism. "Tourismphobia" is another term describing the antagonistic relationship emerging between local residents and tourists. Pham et al. (2019) examine the perspective of local residents, focusing on their perceptions about the

when we're kids. Famous destinations full of wondrous architecture, spectacular scenery or ancient mysteries that fire our imaginations and fill us with yearning. We dream, we grow, we save up all our money and one day we finally get to visit - only to discover that everyone else is visiting at the same time." (Minihane, 2019). The economic impacts, significance, and benefits of cruising tourism have been researched by a number of authors, including Dwyer and Forsyth (Dwyer and Forsyth, 1998), and the topic of urban reconstruction and regeneration, especially in large projects for waterfronts, has been researched, among others, by McCarthy in the case study of Valletta (McCarthy, 2003). Very little has been written in academic literature concerning the impact of Airbnb in cities, but there are exceptions. Prior studies have noted the potential impact of Airbnb in neighborhoods, on the housing market and on the tourism sector. Sheppard and Udell consider the effect of Airbnb properties on house prices (Sheppard and Udell, 2016). Garcia-Ayllon gives insight into issues related to urban transformations as an indicator of unsustainability in the

mass tourism phenomenon, using three Airbnb case studies in Spain: Madrid, Barcelona and Palma de Mallorca (Garcia-Ayllon, 2018). Another study, which considers the situation in Malaga, describes the consequences of "touristification" in historic cities (Barrera-Fernández *et al.*, 2019). Arias Sans and Quaglieri Domínguez (2016) in their analysis of Barcelona state about the Airbnb company:

"Founded in 2008 in San Francisco, it has become a global phenomenon the growing popularity of which has been reported and boosted by the global media. The business press and economic columnists in particular celebrated it as 'the most prominent example of a huge new sharing economy'. Airbnb has been widely acknowledged for its contribution to this rising new economic paradigm and, more concretely, its capacity for quietly turning millions of people into part-time entrepreneurs. As its relevance and impacts at the local level grow, the debate also starts embracing the legal and social issues related to the application of the Airbnb model in the tourist field. Despite its popularity in the media and its significance in many destinations around the world, Airbnb is still a phenomenon barely considered in the tourism studies debate" (Arias Sans and Quaglieri Domínguez, 2016: 209).

Balampanidis *et al.* (2019) give an overview about informal urban regeneration in Athens and its effects on space and society:

"The effects of the Airbnb phenomenon are found to be both positive and negative, including – on the one hand – the partial upgrading and reuse of the existing building stock or the reactivation of the local economy and – on the other hand – processes of residential segregation, gentrification and 'touristification'" (Balampanidis *et al.*, 2019:1).

Koutsoumpos gives a historical overview of 25 blocks in Exarcheia in Athens that are well-known for their culture of resistance. Because of the influx of tourists considering this area to be a 'cool neighborhood' it has faced demand from foreign investors interested in short-term renting, resulting in higher rental prices and traditional bohemian residents and students leaving the area (Koutsoumpos, 2019). Ferreri and Sanyal investigate the case of Airbnb in London, where flats are run by third-party management companies and agents who let out hundreds of properties, instead of individuals. They examine the need for the city government to change existing regulations, in this case by deregulating short-term letting, which has implications for urban planning policy (Ferreri and Sanval, 2018). Lima attempts to understand the regional impact of Airbnb in Ireland (Lima, 2019), and Mermet examines the same 'syndrome' in Reykjavik (Mermet, 2017). Gurran and her coauthors, in two studies, raise questions about the necessity for an urban planning response to tourists 'moving in' with different spatial regulations and property rights, and they ask whether Airbnb rentals reduce the supply of permanent rental accommodations, focusing on Sydney (Gurran and Phibbs, 2017; Gurran et al., 2018). Wegmann and Jiao (2017) offer guiding principles for the local regulation of urban vacation rentals, based on empirical results from five US cities: Austin, Boston, Chicago, San Francisco, and Washington, DC. Lee makes a similar conclusion to Wegmann and Jiao about how Airbnb short-term rentals exacerbate Los

Angeles' affordable housing crisis:

"Airbnb likely reduces the affordable housing supply by distorting the housing market in two interconnected mechanisms. The first such mechanism is one of simple conversion: any housing unit that was previously occupied by a city resident, but is now listed on Airbnb year-round, is a unit that has been removed from the rental market and has essentially been added to Los Angeles' supply of hotel rooms. The second mechanism is 'hotelization'. So long as a property owner or leaseholder can rent out a room on Airbnb for cheaper than the price of a hotel room, while earning a substantial premium over the residential market or rent-controlled rent, there is an overpowering incentive to list each unit in a building on Airbnb rather than rent to Los Angeles residents, thereby creating 'cottage hotels'. This decreases the supply of housing and spurs displacement, gentrification, and segregation." (Lee, 2016:229).

The topic of gentrification is also processed in research by Yrigoy in the case-study of Palma old quarter in Mallorca, Spain (Yrigoy, 2016), then Jover and Díaz-Parra (Jover and Díaz-Parra, 2019, 2020) give an overview of Seville, even asking "Who is the City for?". Finally, Gotham, in a case study of New Orleans' Vieux Carre, argues about holiday rentals causing gentrification in the urban quarter (Gotham, 2005). The main question to ask is whether it is possible to overturn the situation to the sustainability level (Benner, 2019; Kuščer and Mihalič, 2019) and find a balance between the right to travel and residents' rights (Perkumienė and Pranskūnienė, 2019).

### METHODOLOGY

This paper investigates overtourism and its impact on urban life. It gives a significant and extensive review of the international literature, looking at issues that are part of the phenomenon, their main causes, and possible solutions. A discussion of the implications is provided in this review, mostly in two directions: what creates the negative effects? And what major complaints are raised by local residents? The findings are in the sphere of their practical implications, which contribute to an acknowledgement of the problem and help local governments and urban planning practitioners to identify prevalent and critical issues, as well as possible responses and appropriate actions.

### HOW IS IT POSSIBLE TO CREATE A NEGATIVE EFFECT BY MEANS OF A POSITIVE ATTITUDE?

While many cites, according to their strategy goals to present tourist potential and secure income, are making effort to promote themselves and trying to attract tourists, others are in the position of considering how to limit number of visitors and avoid overcrowding. City budgets and the tourism industry with their accompanying sectors are not complaining very much about the number of visitors, but citizens that inhabit the quarters of interest and do not participate directly in the share of revenue have serious complaints. There is no doubt that cities depend on tourism because it creates significant income, but balance should be achieved, keeping the traditional lifestyle in place. In the case of Airbnb and similar companies, those leasing to visitors and retailers have a benefit, and complaints originate from other residents in the neighborhood (Wegmann and Jiao, 2017).

In 2018, the Oxford English Dictionary added a new word 'overtourism' defined as 'an excessive number of visitors heading to famous locations, damaging the environment and having a detrimental impact on resident's lives'. Although the term is relatively recent, many of the problems involved have a long history, particularly in well-visited urban centers. In the literature review of academic papers, it was explained that this introduces a new term for an old problem (Capocchi et al., 2020). This appellation gives an opportunity to describe and analyze the causes of the process and list all possible disorders in the spatial, social or economic sector. In modern times it is not only a question of overcrowding, because overtourism also leads to the deep disturbance of ordinary, everyday life in particular city areas, and the dissatisfaction and protest of locals against visitors (Pham et al., 2019).

Complaints relating to the presence and impacts of tourists in Venice and the transformative effect of heavy visitation on certain destinations was noted in the mid-nineteenth century. Later, in the mid-20th century, negative resident reactions to excessive numbers of visitors to Niagara Falls were noted, because of the undesired physical changes and damage to natural and cultural resources, as well as general overcrowding. The conclusion was that the excessive growth of visitors led to overcrowding in areas where residents suffer the consequences of temporary and seasonal tourism peaks, which have enforced permanent changes to their lifestyles, access to amenities and general well-being (Dodds and Butler, 2019).

On the other hand, tourism has officially been declared as an 'industry', because revenue on a global level in 2019 reached \$ 1.478 billion USD (Figure 2). As a comparison, there is an estimation that this sector could lose at least \$ 1.2 trillion USD due to the coronavirus pandemic and lockdowns, with a warning that in the most pessimistic scenario, for a 12-month break in international tourism, the expected decline could be about \$ 3.3 trillion USD (data projected by the UN World Tourism Organization – UNWTO). This numbers shows that the scale and importance of the associated income is behind the idea to travel, visit, enjoy and expand one's experience.



Figure 2. Global international tourism revenue from 2010 to 2019, in billion US \$ (Source: https://www.statista.com/statistics/273123/ total-international-tourism-receipts/)

For those who travel it may be a joy, but for those who have to live with crowds of tourists it has become a nightmare.

What creates and increases overtourism today? An analysis of the modern factors that in combination lead to this phenomenon shows several key points:

- the growing world population has increased tourist numbers to the current levels of over a billion travelers a year; and of the 1.4 billion overseas trips, 45% (630 million) were city breaks (UNWTO, 2018);
- it is easier for more people to become tourists than ever before;
- some destinations have always been seen as attractive; others have grown in visibility over time; and
- the tourism industry has responded and expanded globally by making it feasible for tourists to travel to attractive places.

There are several important factors explaining the previously indicated key points, including rising incomes and more leisure time, then numerous tourist agencies and a wide offer of destinations, low-cost flights, cruising lines, the dissemination of online information with recommendations (Tripadvisor.com), social networks (Facebook, Instagram and similar with billions of followers), the influence of media and massive publicity, easy online booking (companies such as Booking.com, Expedia.com, Trivago.com, Agoda. com, Kayak.com, Otel.com, etc.), and short-term renting possibilities (Airbnb.com). In fact, it has become easy and affordable to choose a destination and make a reservation, because people have become aware of and informed about attractions and how to reach them.

Staying in a hotel is not the only option anymore. Urban social movements have for years been denouncing the negative impacts of short-term holiday rentals in the central areas of cities, calling for stronger regulation.

"According to Airbnb's poll, 96% of their guests want to live 'like a local' during their stay. The question arising at this point is: 'Which locals?'. Since short-term letting of private homes has become widespread, the nuisance caused by leisure uses of residential buildings, the loss of permanent population, the undermining of everyday life and the impact on the rental housing market have been the main claims against this practice" (Arias Sans and Quaglieri Domínguez, 2016:222).

For example, there were riots during the summer of 2014 in the Barceloneta district, the old beachfront neighborhood of Barcelona. The slogans were: "This isn't tourism, it's an invasion!", "Tourist flats displace families" and similar (Figure 3). A similar protest supporting the restriction of short-term renting and overcrowding was organized in 2015 in San Francisco, followed by locals in Dublin in 2018 asking to 'take back the city'. In 2019 in Athens, because of rising house prices in the Greek capital, protestors accused Airbnb of being a major contributor to the housing crisis.

### MAJOR OBJECTIONS AND REMARKS BY RESIDENTS

Have you ever experienced Venice by night? It looks like a ghost city. After tourist groups finish their 'attack', as early evening comes, visitors leave towards other scheduled



Figure 3. Riots in Barcelona and Dublin against short-term renting of residential buildings for touristic purposes (Source: left: https://barcelona-home.com/events-and-guide/event/ airbnb-pulls-1000-listings-barcelona/, right: https://www.aol.co.uk/news/2018/10/13/housing-protestersoccupy-airbnb-offices-in-dublin-protest/)

destinations or simply go to rest in one of the hotels outside the city, in nearby Mestre or Lido di Jesolo. Finally, Venice with its canals, squares, monuments, restaurants and Murano's glass shops becomes quiet once again. By the number of illuminated windows, it is possible to see how few people inhabit the dwellings. The beautiful daily facades turn into empty scenography. The locals have moved to other places that are much more comfortable for organizing their lives, far away from the frequent floods and the restrictions because of the specific form of the city and its heritage protection, to places that are less expensive and dense, not so crowed by tourists. Many other places, too, like Florence, Toledo, Oia on Santorini, etc., by day have their narrow streets filled with long queues of visitors who are following guides and taking photos. In the evening or early morning hours, there is time for locals or perhaps some rare lucky overnight tourists to enjoy tranquility. Several academic papers mentioned in the literature review have analyzed the less extreme impact of tourism on historical places, as major points of interest. Regardless of whether tourism makes some locations more livable and self-sustaining in terms of their economic and heritage preservation as well as simultaneously provoking regeneration, there should still be some limits in order to retain a certain level of quality and impression of the visit in order not to reach extremes (Barrera-Fernández et al., 2019).

"Those residents not involved in tourism, that is, not employed in or engaged commercially in tourism, often see or receive little direct benefit from tourism and the presence of tourists. They do often experience the congestion, inconvenience, disturbance and changes brought about by increasing numbers of tourists and greater tourism-related developments. To them, a reduction in tourist numbers, if not a total absence of tourists, would appear to be the only way to restore the quality and way of life before large-scale tourism was developed" (Dodds and Butler, 2019:524).

Complaints from local residents are varied, depending upon the kind of tourism, whether it is a few hours a day by tourists on a cruising field trip, a constant flow of tourists in a central zone, or as already mentioned, the rotation of strangers in short-term rental units inside popular residential areas. The scale goes from lifestyle disruption to serious social and economic questions:

- Crowds (Figure 4), constant daily flow of strangers in groups, stopping on the pavements to take selfies;
- Inappropriate behavior, not respecting heritage or

local customs, disturbing peaceful districts (Dodds and Butler, 2019);

- A change in the type of services offered in a neighborhood, and the unavailability of basic ones (Gurran *et al.*, 2018), for example, in central Bruges there are more than 70 chocolate shops, and who really needs them except tourists?; and
- Rising prices, especially rent, and related social changes, like gentrification (Cócola-Gant, 2016; Gotham, 2005; Yrigoy, 2016; Jover and Díaz-Parra, 2019, 2020).



Figure 4. Crowds of tourists in Paris and Lisbon (Source: authors of the text, private photos)

While hotels and standard travel packages were the only option, the level and ratio of visitors was tolerable. But with the introduction of cruising and alternative accommodation, the issue has become more significant and stressful. For example, the average cruise ship may have around 3,000 passengers on sea and ocean liners, and about 150 guests on river cruise ships. The largest cruise ships can embark around 5,500-6,000 passengers. Assuming that the majority of them plan to visit the ports that are on the itinerary, just for a scheduled one cruiser per day, it is quite a crush even for bigger urban centers, not to mention small historical places. Nevertheless, theoretically it is possible to predict routes, organize timetables, divide groups, establish quotas and limit dockings in order to avoid too much disturbance to ordinary life. Although they arrive in great numbers, these visitors are only present for a day, spending the night on the boat, and they are concentrated on particular points of interest. Easy access to rental units, staying all over city residential zones, and especially concentrating in popular areas is completely different, because it influences the urban habits of the locals, mixing with them and changing their everyday routine. It is not pleasant when residents do not know who is in their building and neighborhood, when owners or long-term tenants are leaving, or when strangers without any responsibility and decency, with the excuse that they are enjoying their holiday, harass locals with their noise or other inappropriate behavior. Some riots and protests by citizens have started after particular incidents, revealing much deeper problems. The greatest challenge comes when the level of interest for renting provokes modifications and transitions in the real estate market, affecting local businesses and public services, and thus emptying local neighborhoods by triggering evictions through social segregation and gentrification. Recognizing the problem of overtourism directs us to the logical question of whether

it is possible to reduce the impact on urban life by urban management and planning, by introducing sustainable and overall agreeable measures and rules that will benefit citizens and secure and maintain regular urban life, but simultaneously permit cultural dissemination and share global heritage with interested visitors.

# DISCUSSION ON ESTABLISHING LIMITS ACCORDING TO THE URBAN CAPACITY

"Tourism is like any other industry: it needs to be regulated and managed locally to prevent negative impacts," says Justin Francis (UK-based tour operator Responsible Travel, which has produced its own guide to the issue of overtourism) (Minihane, 2019).

In the past few years, the number of destinations raising the alarm because of overly high tourist crowds has steadily increased. Some cities have even been forced to establish limits and new rules in order to preserve heritage and avoid overcrowding. For example, the city of Rome has banned sitting on the Spanish stairs, and people can be fined € 250 for doing so. The city council has set up glass fence in front of the Fontana di Trevi, as an anti-tourist barrier to stop people sitting on the monument's wall and prevent them from stealing coins from the fountain (an estimated € 3,000 are thrown into the fountain each day, annually about €1.4 million; the money has been used to subsidize the city budget). Amsterdam has recently announced that the 'demotion' of tourism is to become part of city policy; the intent is not to make Amsterdam unattractive to tourists, but rather it will not be promoted to attract greater numbers of tourists (Dodds and Butler, 2019). In Bruges, each year about 8 million tourists visit its small historic center, with a resident population of just under 20,000. The vast majority of visitors are day-trippers, and many of them stay for less than three hours. Their numbers have swelled recently with the increasing popularity of cruises, landing at nearby Antwerp, Ostend and Zeebrugge. Bruges has managed with remarkable success, and has developed a blueprint for other distressed tourist cities. The city authorities, worried by the growing tourist invasion, introduced a "hotelstop" in 1996, which has limited the number of hotels in the historic center to just over 100. In 2002, they limited the number of second or holiday homes, in order to preserve the population of permanent residents. The city authorities also followed a strategy of concentrating tourists in the southwest of the city, with parking for buses and a railway station. Buses are only permitted into the city center if they are bringing visitors and their luggage to hotels. Cars are likewise discouraged by limiting parking and locating cheaper, long-stay car parks on the outskirts (Mason, 2018). The World Tourism Organization has proposed 11 strategies and measures to address the increase in visitor growth in cities, and 12 key policy recommendation for implementation, given in Table 1 (World Tourism Organization, 2018).

In the opinion of the authors of this paper, resolving the problem is possible only by applying a set of different measures as a part of one thoughtful strategy, combining legal and economic limitations, such as taxation, changes in the tourist sector promotion and spatial organization where possible (urban zoning and land use, better transport facilities). It is not desirable or possible to avoid tourism, but for those suffering from exaggerated levels of visitor flow, some kind of strategy or plan for moderation should be implemented.

The sustainability of tourism is usually connected with the preservation of natural and cultural goods, but in this case its purpose is to preserve traditional urban life in destinations that are under pressure from visitors. It is up to cities to set strategic goals and decide what kind and level of tourist visits are sustainable for a particular place and whether profit from this industry is a priority, or the quality of local urban life. Limiting the negative effects, but still keeping the benefit of arrivals is a question for serious analysis and balance. Seasonal peaks or visits throughout the year should be considered too, including for attractions and events that provoke crowding. Now is the moment when city authorities that face these issues have to consider them and make decisions about introducing single rules or sets of measures in the spheres of legislation and the economy, and even to reassess urban plans and relationship between contents and functions. In reality, it is not too complicated to review and adapt some regulations, particularly those concerning renting apartments and opening hostels in residential buildings, by proposing terms for the minimal technical preconditions, consent of neighbors, special taxes, limitation in the number of visitors or renting days per year, and similar measures concerning communal order. Possible limitations for cruising ports have already been mentioned. It is very difficult to change and adapt the urban matrix or influence land uses. The spatial aspect depends on numerous factors, including the type of problem, size of the city and dispersion of attractions; however, it is still possible to plan traffic and other connections between points of interest, including spaces for parking buses and drop-off spots, better public transport, pedestrian zones and cycling lanes, or allocating hotels and accommodation in peripheral areas, thus dispersing them to the surroundings. It is important to remember that tourist interest has provoked some revitalization and reconstruction projects in cities, which is a positive influence. Analogously, it is logical to expect some planning solutions, in order to better organize city capacities and satisfy both local needs and visitor curiosity. The team of experts who consider these aspects, besides urban planners, should include specialists in tourism, with a knowledge of local features and demands.

### CONCLUSIONS

Urban life is sometimes complicated in itself, because of spatial and time limitations, distances, crowds, insufficient infrastructure and organizational issues. It has become obvious that overtourism, as a product of modern times, infuses urban life and makes it more tense and stressed. Citizen associations and non-government organizations have pointed out that normal and regular life in some city areas has become impossible because of the influx of tourists. Some cities have been forced to introduce bans and penalties, others have decided to try by means of a strategic change of attitudes and conditions. After the current calm, owing to COVID-19 lockdowns, it is reasonable to expect a new boost after normalization and to be prepared to face old problems; however, it is even better to use this situation to reconsider some measures that will improve and resolve the relationship between city dwellers and visitors.

The literature review gives evidence of the process at different locations, emphasizing some major causes of overtourism, such as massive tour operator packages, the cruising industry and the new invention of renting apartments via applications. Different case studies have in common the negative effects on city residents, causing social and economic encumbrances, and raising questions about the quality of life, safety and accessibility to city contents.

There is spectrum of different measures and policies that may gain some upgrading and balance between the needs of citizens and demands of visitors. Besides new rules in communal order or taxation, some adaptations in urban planning and zoning, traffic organization and similar topics may be introduced. Every decision should be toward the relief and avoidance of negative effects, from overcrowding to more deep problems like their influence on the housing market, gentrification and the movement of businesses and services.

There are some guidelines for further scientific research about this topic, in the field of urban planning. It is necessary to create the subdivision of locations by urban characteristics (size, specific areas, popularity, sessional or annual interest, etc.) and observe the impact of overtourism (social, economic, functioning of urban system, safety, etc., as well as to link in a matrix with suggested measures on how to improve the state and avoid the displeasure of the residents and visitors. The measures should be drawn from different bases, including urban planning and design, transport organization, urban management, marketing, public and social services, legal acts and economic interventions. Because this is a long-term, living and changing process, it is crucial to observe, collect and analyze data, especially in case studies, and to create scenarios for the implementation of suggested measures and limitations, evaluate their effects and make a recommendation list, focusing on the main problem and possible solutions, in line with the expected results. Having a right to the city should include this topic wherever possible and necessary.

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# THE ARCHITECTURAL EXPERIENCE OF THE KASBAH OF ALGIERS: INSIGHTS FROM LE CORBUSIER'S EXPERIENCE AND NEUROARCHITECTURE

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This paper contributes to a deepening of the knowledge about how architectural experience can be described in neuro-phenomenological terms, through the development of a cognitive-phenomenological approach to examining architectural experience through text-based analysis. It aims to develop an assessment tool to produce knowledge about one's personal experience and perception of the built environment by exploring the impact of its spatial properties on an individual, taking as a case study Le Corbusier's experience of the Kasbah of Algiers. The results demonstrate that this city has the power to stir emotional engagement that arises from: a high cognitive-affective reaction towards the dynamic interactions between the curved contours of its streets; the harmony of its colours; the magnitude and vastness generated by its panoramic views towards the sea; its proportions in relation to the dimensions of the human body in different postures; the contrasts of the height, light, dimensions and ambiances; and the spatial navigation that favours the act of walking to discover the Kasbah and unveil its mysteries. These properties exist as complex networks of interconnected physical and atmospheric elements, and they involve integrated perception under the influence of previous knowledge, beliefs and aspirations to shape Le Corbusier's architectural experience of the Kasbah.

Key words: Le Corbusier; Kasbah of Algiers; spatial properties; architectural experience; content analysis.

#### **INTRODUCTION**

Le Corbusier is one of the most polemic and influential architects of the 20th century. His clearly evolved architecture, art and dogma have inspired many scholars to investigate his career in order to understand the influences behind it (Gerber, 1994, p. 377). His architecture evolved from purism and white cuboid forms in the 1920s, to more curved and sculptural forms after the 1930s, whereas, his urban-planning switched from *"Baroque-type grids with diagonals, symmetrical designs on cruciform or linear axes"* to *"juxtaposed nets style with different geometries for vehicles and pedestrians, often based on curvilinear, trigonometric and linear forms"* (Steyn, 2010, p. 118).

Le Corbusier's travel notes and sketches show how much traveling around the world impacted him as both an artist and an architect. His visits to countries such as Brazil, Argentina and Algeria appear to have influenced his perception of architecture, hence giving birth to his second architectural language, with expressive, plastic and liberated vocabulary (Sobin, 1994). His experience of North Africa, especially of the Kasbah of Algiers and the M'zab, made him appreciate the value of vernacular architectures (Steyn, 2014, p. 134). De Maisonseul, Le Corbusier's guide in Algeria, claimed "it seems clear that his journeys to Algiers were a key factor in the evolution of Le Corbusier's work, in what could be called its humanization. It is the man he became in Algiers, architecturally and plastically" (Bonillo, 2012). Le Corbusier visited Algiers for the first time in 1931; the city fascinated him while wandering through the maze of its narrow alleys and densely packed dwellings, he even described it as "the *most beautiful city in the world*" (Roy, 2001, p. 12).

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Many scholars have investigated the undeniable impact of the Kasbah of Algiers on Le Corbusier's works and philosophy. They emphasize that the architecture and the urbanism of this city had a deep decisive influence on a number of his design concepts and projects after 1930 (Steyn, 2010; Gerber, 1993). Embracing this hypothesis, in this paper we wonder what makes the Kasbah so appealing that it earned the praise of Le Corbusier. What properties shaped Le Corbusier's architectural experience of the city and engaged his sensibilities?

This paper suggests that an analysis of Le Corbusier's experience of the Kasbah of Algiers will lead to the identification of the atmospheric and physical spatial properties that had an impact on his experience there. It develops a qualitative cognitive-phenomenological approach in order to study the impact of the built environment on spatial experience, through a text-based, thematic content analysis using knowledge from cognitive neurosciences. Thus, writings from Le Corbusier about his experience of the Kasbah are analyzed in order to identify and discuss the spatial properties that shaped his experience of this city. The impact of the built environment of the Kasbah of Algiers is open to interpretation using discoveries from cognitive sciences.

In the following section, we introduce several discoveries in the cognitive study of architecture, and propose the application of these findings in the interpretation of Le Corbusier's experience of the built environment in the Kasbah of Algiers, with the aim of enriching our understanding of the reception of these encounters in general. densely packed high blank-walled houses, climbing the slope from the sea-side to the hill-top. It is considered one of the finest coastal sites on the Mediterranean Sea. The Kasbah still retains its architectural integrity: its features of the traditional urban design and architecture of North Algeria, as well as its aesthetic features and the original materials, have been preserved (UNESCO).

The Kasbah has an organic urban order. It developed gradually through a step-by-step generative process ruled by the interaction between the geometry of the built form, the site, and the residents' needs and culture (Benhamouch, 2003). The overall form shows repetition, translation and rotation of cubic units forming the dwellings, which flank the edges of the streets, hence drawing curvilinear boundary lines. Their gleaming white appearance gives an overall consistency in aesthetics, colour, tone and brightness to the city (Figure 1). All the urban facades are unadorned, deprived of ornamentation and covered with white lime, which contrasts with the brown wooden beams, and the heavily decorated doors. Dominance of the bright white colour, gives this city its famous nickname *The White City* (Gerber, 1993).

The streets are tortuous and interconnected (Figure 2); some are large and open, and some are as narrow as corridors while others are vaulted like cellars (Figure 6). As one moves upward to the Haute Kasbah, the streets become narrower and stepped to fit with the steep topography, and they cut through the urban fabric to improve the communication between the city's districts, called *houma* (Faidi, 2015, p. 11).



Figure 1. Dominance of the colour white. (Source: Authors)

#### THE KASBAH OF ALGIERS

Placed on the world heritage list in 1992, the Kasbah of Algiers is a unique kind of medina and an outstanding example of a historic Maghreb city of the 16th century. Built on the ruins of the ancient Phoenician city of *lkosim*, the Kasbah sits on a huge crescent bay on the Mediterranean, surrounded by abrupt slopes, with a maze of narrow winding alleys and

#### The Houses of the Kasbah

The Kasbah's houses belong to a Mediterranean architecture characterized by an exteriorization looking toward the sea, and introversion through its courtyards (Karabag and Fellahi, 2017). A typical Kasbah house is a well-proportioned and highly introverted three-story structure with a courtyard surrounded by rooms and an entrance space called a *sqifa*,

which is a space located directly after the entrance door, where male guests are received to prevent them from entering the interior spaces of the house, for reasons of privacy (Figure 3). The courtyard is the main source of daylight and fresh air in the house (Karabag and Fellahi, 2017).



Figure 2. Plan of the Kasbah illustrating the meandering maze of streets. (Source: Authors)



Figure 3. Principle of Sqifa (Source: Hadjiri, 1993)

The indoor space of the Kasbah's houses is totally the opposite of the outdoor space of the Kasbah. It is richly ornamented and coloured, the walls are covered with faience, and the wood used for the doors and the stairs is richly sculpted with floral and geometric motifs (Figure 4).

The Kasbah's houses are built following the site topography and some strict regulations established by the local government and by Islam; one of these rules instructs that every house should face the sea and have a roof terrace (Hadjri, 1993, p. 68). The terrace occupies the upper floor of the house. And it is open to the terraces of the neighbouring houses so that women can communicate easily. Each terrace, especially those on the top of the hill, offers a panoramic view over the whole city and over the Mediterranean Sea (Figure 5).

Many contrasts are at play in the Kasbah, alternating between openness and closure, light and shadow, and



Figure 4. : A Kasbah house interior (Dar Mustapha Pacha) (Source: Authors)



Figure 5. View from the terrace (Source: Authors)



Figure 6. Play of contrasts (Source: Authors)

different dimensions and heights. On the urban level, the most prominent examples of these contrasts can be seen in the dynamic change between large and open streets that suddenly or gradually become narrow and closed, and in the subtle play of light and darkness in them, when light is slightly filtered either by the entrances in the covered lanes, or the cantilevered corbels of houses extended over the street (Figure 6). At the house level, the strongest contrasts are encountered everywhere and characterized by the dynamic shift between different contrasts from one space to another, such as in the transition from the closed dark entrance room to the open and lit up courtyard, and from the dark closed staircase to the open terrace flooded with sunlight.

#### NEUROSCIENCE AND THE BUILT ENVIRONMENT

Rosenblum (2013, p. 69) emphasizes that our brain derives infinite meanings from the surrounding environment by merging diverse forms of our sensory perception. Over the last two decades, a growing body of research has been investigating the neural underpinnings of the relationship between the built environment and humans. Neuroaesthetics investigates one's response to aesthetics; neuroarchitecture investigates the impact of design features on one's perception of architecture, while cognitiveneuroscience studies the neural substrates of mental processes and psychology.

A literature review, grouping empirical and theoretical papers in the fields of neuroaesthetics, neuroarchitecture and cognitive neuroscience, unveiled six categories of identifiable spatial properties (morphological and atmospheric) affecting man cognitively and psychologically. These categories concerned, essentially, research about beauty and aesthetic judgment, approach avoidance decision making, spatial navigation and wayfinding, perception and emotions.

#### Curvilinear and sculptural forms

A great deal of psychological research and neuroimaging studies outline strong human preferences and sensitivities to curves in the built environment, especially in contrast to sharp or linear edges and contours (Paul and Christopher, 2009; Vartarian *et al.*, 2013; Banaei *et al.*, 2017). Curvilinear forms are perceived as aesthetically appealing and providing richer stimulation to neurons representing 3D surface shapes in the brain of the beholder (Balachandar, 2012). The perception of curves taps into the reward/ punishment system in the brain, and activates the anterior cingulate cortex (ACC), which is a region strongly responsive to the reward properties and emotional salience of objects (Vartarian *et al.*, 2013).

#### Magnitude and vastness

Perceived vastness generates the emotion of awe. Schopenhauer defines it as a powerful emotional experience involving both the feeling of being powerfully overwhelmed, humbled, or dislocated and the sense of being exalted, elevated, or elated (Vandenabeele, 2015). This emotion relates to physical size and other categories involving magnitude (Eberhard, 2009; Gallagher *et al.*, 2015). For instance, when looking at an open sky, or an open natural landscape, the spatial memory will evoke an embodied sense of space that helps to create, within the size parameter, the sense of awe (Navarretea *et al.*, 2017).

The experience of awe arises from a feeling of sublimity, which is a powerful aesthetic feeling that is different from

beauty. The experience of the sublime involves different neural mechanisms than that of beauty. It activates the inferior temporal cortex, the frontal gyrus and the posterior hippocampus, as well as the basal ganglia and most importantly, the cerebellum, which is associated with spatial cognition and the experience of extended space (Ishizu and Zeki, 2014). In contrast, the experience of beauty involves the medial orbito-frontal cortex (mOFC) and the anterior cingulate cortex (ACC) (Yeh *et al.*, 2015). The mOFC is activated in pleasant aesthetic experience related to visual beauty. The ACC is involved in regulating both emotional and cognitive processing; it also correlates with preference ratings (Lindal and Hartig, 2013).

#### Colours

Our psychological responses to colour are subconscious; however, our conscious responses to a specific colour are mainly related to the symbolism behind it (Brucker, 2013), and the recognition of specifically coloured objects does not add any cognitive operation to the recognition task (Bramão, 2010). Hence, responses to a specific colour are related to the beholder, and they initiate emotional responses aroused by feelings of the fulfilment and satisfaction of expectations, which are predisposed ideas or mental images related to one's beliefs, imagination, culture or knowledge. The emotional engagement in the perception of a specific colour involves both the amygdala, which facilitates attention through emotional integration (Phelps, 2006), and the right precuneus, related to consciousness, visuo-spatial imagery tasks and the subjective wellbeing that results from the experience of satisfaction. Moreover, colour harmony has a strong positive correlation with colour preference since it is reflected by the aesthetic value represented in the mOFC, which is related to aesthetic and visual beauty (Ikeda et al., 2015).

#### Embodiment and empathy for order and proportions

One of the main tasks of architecture is the creation of empathy (Mallgrave, 2013, 2015) and instilling the emotional potential in the physical environment to create sensibilities in humans, by the invocation of its *atmospheres*, which are a state of resonance between man and the built space (Pallasmaa, 2014).

At the neural level, the discovery of *canonical neurons* and *mirror neurons* holds implications for the experience of architecture. These neurons are essential to learning through observation and emulation. Hence, people can feel empathy for space by establishing an embodied simulation (Freedberg and Gallese, 2007), mapping the sensory representation of some architectural properties as form, proportions, rhythm, materials, light, temperature, and sounds onto the perceiver's brain. Freedberg and Gallese (2007) assert that proportions, as with many other spatial and architectural properties, can influence the aesthetic experience and appreciation of the built environment, through an empathic embodied simulation.

Embodiment responses to architectonic stimuli evoke in the observer distinct multisensory sensations linked to emotions and feelings, such as familiarity, intimacy, fear and safety. This mirrored mapping process links perception, action, memory and emotion by implicating the same neural structure involved in the unconscious modelling of our body in space (Stamatopoulou, 2018), so the experience of the built environment provides a richer and more complex constellation of active responses.

#### **Openness and enclosure**

Openness and enclosure are related to aesthetic judgment, permeability, approach/avoidance decisions, empathy and visual motion. Open and large spaces are judged more beautiful, pleasant, and inviting to enter than closed spaces. The aesthetic preference for openness is coupled with activation in the parietal and frontal structures located in the dorsal stream, which support visuo-spatial attention. Openness activates structures underlying perceived visual motion (Vartarian *et al.*, 2015). Navarretea and Witherspoon (2017) emphasize that smaller spaces speed up perceived time, while larger ones slow it down.

Closed spaces elicit exit decisions and activate the anterior midcingulate cortex (aMCC), a region with direct projections from the amygdala, which is involved in evaluating the significance of affective visual stimuli (Ikeda *et al.*, 2015).

#### Light

When light is used strategically in the built environment, it can enhance mental understanding and trigger a nerve response that increases sensory perceptions and wellbeing. Light affects different functions of the brain and regulates one's emotions and behaviours (Havelka, 2018). The light that falls on the retina is transmitted to the hypothalamus, an endocrine gland that controls circadian rhythms. This later regulates mental alertness and other aspects of wellbeing (Navarretea *et al.*, 2017), and when it is disrupted, it causes various mood swings. The circadian rhythm relies on blue light found in the outdoor environment (especially from the sky), in order to achieve optimum physiological and psychological performance (Navarretea *et al.*, 2017).

#### **Spatial navigation**

Spatial navigation is one of the most important functions for exploring and interacting with the environment. It is a multimodal function (involves different sensing modalities), which helps create a mental image of the encounters in visual cortical areas during perception (Lacey and Sathian, 2015). The quality of free exploration creates experiences that are less influenced by the paths taken, and it enhances the sense of place within a space (Sternberg, 2006). A sense of place is generated by spatial navigation, through empathy and the formation of memories about the functionality and aesthetics of a space.

The brain's navigation system involves place cells and grid cells, from the hippocampus and parahippocampal regions, activated by movement and location tasks. The hippocampus and the parahippocampal areas act as cognitive maps to create mental representation of the environment in the brain (Moffat, 2016). They are recognized as the key sites for consolidating long-term memories for storage (Stephenson, 2019). Neuroimaging studies show that the entorhinal cortex, the subiculum, and the dentate gyrus are also involved in spatial navigation (Jain *et al.*, 2017). The

brain's navigation system contains receptors that bind with the pleasure felt when we visually and physically seek and discover (Biederman and Vessel, 2006).

## LE CORBUSIER'S EXPERIENCE OF THE KASBAH OF ALGIERS

#### Methodology

This paper develops a qualitative methodology for studying the impact of the built environment on one's architectural experience, by combining thematic content analysis and knowledge from cognitive neuroscience. Using this methodology, the writings of Le Corbusier about his experience of the Kasbah are analyzed in order to identify and discuss the spatial properties of the Kasbah that shaped his experience of the city.

*Content analysis*, which has already been applied in many architectural and urban studies (Dagenais, 2007; Joanne, 2003), makes it possible to objectively analyze certain aspects of architecture related to spatial perception and representation, through an objective approximation of people's holistic sensory/emotional experience of a space. An architecture literature review based on neuroscience is used as a theoretical background for this analysis and for a discussion of the results about how the built environment of the Kasbah was perceived and experienced by Le Corbusier.

#### The content analysis

*Content analysis* is a six-step method (Bardin, 1977): 1) constitution of the study's corpus; 2) definition of the recording units; 3) analysis and coding of the units; 4) categorization; 5) calculation of the occurrences (facultative step); and 6) discussion of the results. The process of analysis consists of working and re-working the data that reveal any connections to the study questions. Once meaning units are coded, it is easier to identify the patterns in the codes and organize them in categories. The whole study ends with a discussion of the results and establishment of links between them and the questions and aims of the study.

#### Data collection

A content analysis was conducted on Le Corbusier's writings about the Kasbah. The writings were collected from different sources, including but not limited to: books – poesie sur Alger; postcards; and articles – L'Architecture vivante (1932), La ville radieuse (1933), and Le folklore est l'expression fleurie des traditions (1941).

#### Data analysis

The analysis was conducted by 4 different scholars, including the authors. Each, individually, read the corpus over 10 times and highlighted all the revealing passages in it. The analysis then proceeded by extracting words and phrases that reveal information about Le Corbusier's experience of the Kasbah, and organizing them into recording units, each expressing a response by Le Corbusier towards the built environment of the Kasbah. The recording units were coded. The codes, then, were grouped, analyzed and assigned to content categories established in the light of the literature review on neuroscience for architecture. Finally, the categories identified from the 4 analyses were discussed and organized into themes based on the questions, the aims and the theoretical background of this study.

Erlingsson and Brysiewicz (2017) emphasize that using many scholars to conduct an analysis together is actually a key element in qualitative analysis when striving to ensure trustworthiness and objectivity. Collaborating with others during analysis makes it easier to see variations in the data, thereby enhancing the quality and the rigor of the results.

#### Results

The results of the data analysis are presented in Table 2, while Table 1 gives an overview on how the analysis proceeded.

Table 3 reorganizes the previous results (Table 2) based on the relationship between spaces (outdoor/indoor), their properties and the frequency of the theme effects. The most frequent themes display strong emotional responses to the Kasbah's built environment. The effects of harmony (7 times), empathy (7 times) and contrast (5 times), respectively, are the most influential in Le Corbusier's experience of the Kasbah. They are followed by the effect of vastness and magnitude (4 times), the effect of spatial navigation (3 times), the effect of colours (2 times), and the effect of contours (1 time).

Acting together like a hierarchical complex system to shape Le Corbusier's experience of the Kasbah, each theme relates to others, reinforces them and gets reinforced by them at the same time. Hence, all the spatial properties are part of the city as a whole, and exist as complex networks of physical and atmospheric elements. For example, the emotional outcomes of bliss, calm and intimacy are related to the extended view towards the sea and the contrasts played dynamically

Table 1: Content analysis of some recording units collected from Le Corbusier's writings about the Kasbah

Recording units	space	Codes	Categories	Themes
Dominant horizontal here each house lends its roof to touch the clouds, Azure or stars (Gerber, 1993, p. 209)	The house	Extended view towards the horizon	Dominance via openness	The effect of magnitude and vastness
It is in consonance with nature because from the terrace of each dwellingone sees the sea. (Le Corbusier, 1941, p. 30)	The house	Open view on the sea	Consonance via openness	
Arab architecture is the most mathematical. (Gerber, 1994, p. 370)	The house	Fascinating mathematical dimensions	Proportions and dimensions	The effect of harmony and proportions
An Arab house is measured in accordance with the pace of the steps and the height of the shoulders. The courtyard and the rooms are dimensioned based on the measure of the step, and the heights are estimated according to the height of the head and the shoulders: columns with the height of the shoulders and passages within the level of the head. (Gerber, 1994, p. 370)	The house	Architecture and human scale	Proportions and dimensions	
Principles of the Moorish dwelling: contrast of various heights (Le Corbusier, 1933, p. 247)	The house	Contrast of heights	Contrast in the geometric shape	The effect of contrasts
and the so prodigiously architectural contrasts of low and high spaces (Le Corbusier, 1932, p. 7	The house	Contrast of heights	Contrast in the geometric shape	

#### DISCUSSION

The content analysis (Table 2) unveils seven themes representing the impact of the spatial properties that shaped le Corbusier's experience of the Kasbah. Some are related to the physical features of the built environment, and some are related to the atmospheric ambiances of the Kasbah. The themes are: the effect of contours; the effect of vastness and magnitude; the effect of colours; the effect of proportions and harmony, the effect of empathy; the effect of contrast; and the effect of spatial navigation. through smooth transitions in the space. Here, empathy, magnitude and contrast effects exist by themselves and are aroused by the panoramic view, the contrasts and the spatial organization, but they become more intense when interacting with each other, hence strengthening the formation of memories and the architectural experience of the Kasbah.

According to the content analysis in Table 3, indoor space displayed a frequency of 16 repetitions for 6/7 effects listed in Table 2, while outdoor space displayed a frequency of 9 repetitions for 5/7 theme effects. This suggests that the

indoor built environment (the architecture) left a greater impact on Le Corbusier's experience of the Kasbah than the outdoor space.

Within the indoor space, the terrace and courtyard had the greatest impact on Le Corbusier's architectural experience

of the Kasbah. *Terrace* is recorded 5 times within 2 theme effects, those of magnitude and vastness and empathy, while *courtyard* is recorded 3 times within 1 theme effect, that of empathy via positive emotions and beauty judgment.

Composed of a maze of narrow winding alleys, sometimes

Recording units	Space	Codes	Categories	Themes
A1	The city	Magnificent, compact and curved forms	Curvilinear contours	The effect of curvilinear contours
Total			1	
E1	The house	Extended view towards the horizon	Dominance via openness	The effect of magnitude and
C1	The house	Open view of the sea	Consonance via openness	vastness
C2	The house	Giant terrace staircase open to the sea	Dominance via size and openness	
G1	The house	Extended view towards the horizon	Dominance via openness	
Total			4	
С3	The city	Glittering white walls	Dominance of the colour white	The effect of colour
C4	The house	Mixture and harmonious contrast of colours	Harmony of colours	
Total			2	
C5	The city	Fascinating mathematical dimensions and proportions	Proportions and dimensions	The effect of harmony and proportions
F3	The house	Fascinating mathematical dimensions	Proportions and dimensions	
F4	The house	Architecture and human scale	Proportions and dimensions	
A2	The city	Fascinating mathematical dimensions and proportions	Proportions and dimensions	
A3	The house	Fascinating mathematical proportions and human architecture	Proportions and dimensions	
D1	The city	Imminent harmonious wholeness	Symphonic Harmony	
C6	The city	Imminent harmonious wholeness	Symphonic Harmony	
Total			7	
A4	The house	Embodied feeling of calm, intimacy, bliss, comfort and hospitality	Empathy via positive emotions	The effect of empathy
F1	The house	Embodied feeling of calm, intimacy, bliss, comfort and hospitality	Empathy via positive emotions	
E2	The house	Embodied feeling of calm, intimacy, bliss, comfort and hospitality	Empathy via positive emotions	
G2	The house	Attachment, happiness and the joy of living	Empathy via attachment	
C7	The house	Surprise, awe and beauty	Empathy via beauty and awe	
F2	The house	Tenderness and sensitivity to human needs	Human architecture	
C8	The city	Tenderness and sensitivity to human needs	Human architecture	
Total			7	
A5	The house	Contrast of heights	Contrast in the geometric shape	The effect of contrasts
B1	The house	Contrast of heights	Contrast in the geometric shape	
B2	The house	Contrast of ambiences light/ shadow	Contrast of ambiences	
E3	The city	Contrast of indoor/outdoor ambiences	Contrast of ambiences	
A6	The house	Contrast of indoor/outdoor ambiences	Contrast of ambiences	
Total			5	
E5	The house	Flexible transition and fascinating spatial discovery	Spatial Promenade	The effect of spatial navigation
E4	The house	appreciated spatial discovery though walking	Architecture of walking	
F5	The house	appreciated spatial discovery though walking	Architecture of walking	
Total			3	

#### Table 2. Content analysis results

vaulted like cellars, and bordered by densely packed high blank-walled houses, the spatial configuration of the outdoor space as a maze of enclosed space and a bare minimum of openness, generates the feeling of being in an indoor space, since it generates empathetic feelings of intimacy, protection and calm like those usually felt in indoor spaces. The same reasoning goes for indoor space that feels like outdoor space; its exteriorized spatial configuration through the courtyard and the terrace, and its open panoramic views towards the sky and the sea, generate an empathetic feeling of freedom and being connected to the world, as usually felt in outdoor spaces.

Le Corbusier's experience of the Kasbah is led by a number of factors such as his background as an architect in progression, his knowledge and expectations related to his previous *voyage de l'orient* and his predisposed ideas about the Muslim word and exotic cities. For instance, the psychological factor of Le Corbusier's expectations for a *white city* strengthened the aesthetic impact of the white colour of the walls in positively shaping his experience of the Kasbah.

### Insights on Le Corbusier's Experience of the Kasbah of Algiers

The harmony and the synergy between the site (topography, nature and climate), the life style (religion and culture), the

proportions and the desire for spatial quality and adaptation to the human scale are what shaped the architectural experience of Le Corbusier in the Kasbah of Algiers (Le Corbusier, 1941). Acting as a complex system of hierarchal and ordered elements that contribute to the formation and the harmony of wholeness, these elements are a small part of the numerous secrets behind the impactful architecture of the Kasbah. These elements, argues Gerber (1994), served as lessons for Le Corbusier to develop his second architectural language, especially with regard to proportions (human scale), spatial navigation (promenade and discovery) and empathy (humanization of architecture). *"L'architecture arabe nous donne un enseignement précieux [...] Je préfère l'enseignement de l'architecture arabe.<sup>2</sup>" (Le Corbusier, 1928-34, p. 24).* 

#### The effect of curvilinear contours

The great amount of curvature present in the Kasbah (especially in the outdoor space) was greatly appealing and fascinating to Le Corbusier. The resulting pleasure and the beauty judgment of the curvilinear forms and contours of the Kasbah are underpinned by the reward and positive emotions of joy and pleasantness. Using the words *magnificent body, supple-hipped* and *full-breasted*, Le Corbusier compared the Kasbah's forms and contours to the plasticity and the curves of women's bodies (Le Corbusier, 1933, p. 260). These forms may have influenced Le Corbusier's emotional response towards the Kasbah by

Spaces	Spatial properties/ elements		Theme effects	Frequency of effects
Outdoor environment (the city)	Forms and contours		The effect of curvilinear contours	1
	White walls		The effect of colour	1
	Human dimensions and Proportions		The effect of harmony and proportions	3
	Harmony of ratios			2
	Human sensitive architecture		The effect of empathy	1
	Contrasts		The effect of contrasts	1
			5 effects / 7 effects	Total 9
Indoor environment (the house)	Terrace	Open panoramic view on the sea and the sky	The effect of magnitude and vastness	3
		Size		1
	Harmony of colours		The effect of colour	1
	Human dimensions and proportions		The effect of harmony and proportions	2
	Terrace	Blissful, comfortable, calm and intimate atmosphere	The effect of empathy	2
	Courtyard	Beauty		1
	Human sensitive architecture			1
	Contrasts of heights		The effect of contrasts	2
	Contrasts of ambiences			1
	Spatial transition as a discovery		The effect of spatial navigation	1
	Architecture of walking and discovery			2
		6 effects / 7 effects	Total 16	

Table 3: Indoor and outdoor experience

activating the brain's circuit of aesthetic processing and stimulating a reward response within the anterior cingulate cortex through both emotional engagement and embodied imagination that relates the curves of the built environment to the curves of women's bodies.

#### The effect of magnitude and vastness

The synergy between the panoramic view from the terraces towards the horizon (connecting the blue of the sky with the blue of the sea) and the illusionary view of the gigantesque white stairs (formed by the gradation and imbrication of the terraces following the topography of the site) (Corbusier, 1941, p. 31) increases the perceived vastness and gives rise to a strong and memorable spatial experience of the sublime.

Le Corbusier did not actually used the word *awe* in his writings, however certain aspects of awe, as defined earlier, are still recognizable. In his description of the Kasbah, he highlighted the consonance between nature and the terraces that offer a dominant view open to the sky and the sea. Le Corbusier overwhelmingly described these terraces that drove him to the light as magic, dominant and touching the clouds, azure or stars (Gerber, 1993, p. 209). The vastness and grandeur offered by this view are behind this feeling of awe and the experience of the sublime, intimacy and bliss (Gerber, 1993, p. 266).

Moreover, built environments that offer panoramic views of natural elements are judged to be aesthetically attractive (Galindo and Hidalgo, 2005). Nature scenes have the ability to bring emotional and cognitive restoration (Jacobsen and Beudt, 2017; Havelka, 2018). In the Kasbah, the diversity and the great exposure to nature scenes increase its aesthetic appeal and positive architectural experience. Hence, the perceived vastness and magnitude, together with the restorative impact of nature, may have played an important role in shaping Le Corbusier's experience of the Kasbah.

#### The effect of colour

The dominance of the colour white in the Kasbah captivated Le Corbusier's attention and admiration as a result of a strong emotional engagement and appositive subjective wellbeing, which are related to his feelings of fulfilment and satisfaction upon encountering a spatial reality that was close to his expectations, aspirations and imaginations in relation to the exotic Muslim white city in general and the Kasbah in particular (Le Corbusier, 1941, p. 31).

The emotional engagement with the dominant white colour was a key factor in developing a sense of place in Le Corbusier's mind. In this case, the involvement of the circuit of aesthetic processing and the amygdala in the perception and evaluation of the colour white as a spatial quality is expected. Moreover, the harmony between the white of the walls and the blue of both the sky and the sea intensifies the aesthetic value of the Kasbah represented in Le Corbusier's mind, amplifying his emotional and aesthetic response towards this city.

#### The effect of empathy

A sense of place is generated by the spatial configurations and the atmospheric ambiances (spatial distribution, forms, proportions, nature, calm, freshness) of the Kasbah, which lead to the arousal of some embodied architectonic sensations (intimacy, bliss, containment, happiness and attachment) through an empathic projection caused by a strong emotional engagement towards the built environment encountered. These experiences became part of Le Corbusier's memories, which he took as architectural and urban planning lessons.

The dimensions in each space in the Kasbah are conceived according to the proportions of the human body, such as the height of the eyes in a sitting or standing position, the rhythm of one's steps, the length of the arms... etc. (Fig 7) (Karabag and Fellahi, 2017, Ravereau, 2007). Jean De Maisonseul, who was Le Corbusier's guide in the Kasbah, speculated that the idea of the Modulor was born in Algiers; he reported that Le Corbusier admirably described the Kasbah as a harmonious symphony (Le Corbusier, 1941, p. 30) and a mathematical city, where everything is calculated and measured according to the proportions of the human body (Gerber, 1994, p. 370). The perception of the mathematical dimensions in the architecture of the Kasbah and the observation of people being in this space triggered an embodied simulation of harmony in Le Corbusier's mind, ensured by canonical neurons and mirror neurons, leading to a beauty judgment regarding the richness of the stimulus and the poetic (mathematical) synergy between the human body proportions and the built space.

#### The effect of contrasts

In his texts, Le Corbusier pointed out different contrasts of sizes, heights, light and shadow, openness and closure, ornamented and unornamented, wideness and narrowness, etc. that contributed to the beauty and the comfort of the Kasbah's architecture (Le Corbusier, 1932, p. 7; Le Corbusier, 1933, p. 247). In fact, the subtle play of the contrasts between these elements, in both the indoor and outdoor spaces of the Kasbah, amplifies its aesthetic and sensory experience through a continuous switch of ambiances, causing continuous emotional regulations and shifts in the neural activities in the brain.

Since the play of light and volumes are decisive parameters in his works (Morel Journel, 2015), his sensibility towards the interaction and contrasts between the hardness of matter, the dimensions and heights of volumes and the lightness of light in the Kasbah is a crucial factor with regard to the architectural experience it offers. The alternation between light and shadows (darkness) through the meandering form of the alleys of varying widths, the salient cantilevered corbels of the houses covering parts of the streets, the transition from the entrance (dark) to the courtyard (immersed in daylight) to the rooms (dark), etc., create constantly changing ambience patterns of air, light and shadows during the day. These contrasts in the light settings intensify the selfregulating circadian rhythm, thus enhancing Le Corbusier's emotional response and beauty judgment about the Kasbah, and his empathetic sense of place.

Moreover, the atmospheric contrasts in the Kasbah also left a strong impression on Le Corbusier (Le Corbusier, 1941, p.31; Le Corbusier, 1933, p.230); they are observed in the transition between the indoor and the outdoor space, where the ambiances are so different, shifting from calm and minimalist atmospheres in the outdoor space to colourful, ornamented and dynamic atmospheres in the indoor space



Figure 7. Harmony, human scale and proportions in the houses of the Kasbah (Source: Ravereau, 2003)

(especially the courtyard).

#### Effect of spatial navigation

The Kasbah stirs rich emotional-sensory experiences, through the stimulation of different perceptual modalities caused by a multitude of harmoniously correlated spatial qualities located along a path of the promenade in indoor or outdoor spaces. The quality of free exploration granted by the Kasbah's complex maze-like street network, the ambulatory navigation in the houses (because of their disposition around a courtyard), and the connectivity between the houses through the terraces, make the pedestrian motion an important parameter for generating a sense of place. The process involved is the formation of long-term emotionalspatial memories by implicating place cells and grid cells in wayfinding, proprioception, and the formation of memory within the hippocampus and the amygdala.

The ambulatory nature of the Kasbah's houses engaged Le Corbusier in a lot of exploratory pedestrian movement (Le Corbusier, 1928-34, p. 24), which, under the influence of the other spatial properties, resulted in a continuous act of cementing and updating memories of striking and visually rich architectural experiences (Le Corbusier, 1928-34, p. 24). It is the order of all the above-mentioned spatial properties along a path which creates a pleasurable experience in the Kasbah through spatial navigation.

Although the above six effect themes do not exhaustively explain or capture the complexity and the diversity of Le Corbusier's architectural experience of the Kasbah of Algiers, they represent a useful starting point for investigating Le Corbusier's responses to the built environment of the Kasbah, based on his discourses and knowledge from cognitive sciences.

#### CONCLUSION

Inspired by a larger framework for developing a cognitive phenomenological approach which unites cognitive sciences, architecture and phenomenology in the analysis of an individual's architectural experience, this paper contributes to deepening the knowledge about how architectural experience can be described in neurophenomenological terms. It explores how the relationship between humans and architecture can be used to develop an assessment tool to produce knowledge about the impact of the built environment through a text-based analysis of the architectural experience.

The examination of Le Corbusier's experience of the Kasbah of Algiers, based on his writings, shows that this city has the power to generate emotional engagements. These engagements arise from: a high cognitive-affective reaction to the dynamic interaction between the curved contours of its maze of streets; the contrasts and harmony of the colours; the magnitude and vastness generated by its panoramic views; the proportions that follows the human body dimensions in different postures; the contrasts of height and light dimensions and ambiances; and the spatial navigation that favours the act of walking to discover the environment and unveil its mysteries.

The results also show that these properties are part of the city as a whole; they exist as complex networks of physical and atmospheric properties in perpetual interaction. This network experience recruits a number of cerebral activations that involve a variety of mechanisms regulating corporeal, emotional and cognitive responses, under the influence of the previous knowledge, beliefs and aspirations of Le Corbusier.

Analyzing historical architectures like the Kasbah can teach us something that contributes to enhancing the design of contemporary buildings and cities. The exploration of other people's experiences of the built environment of the Kasbah can reveal other properties that did not grasp Le Corbusier's attention, but they are part of the holistic experience of the city. Moreover, with support from phenomenology and neuroscience, as more established experimental frameworks in which architectural experience is studied in the real world and in real time, future studies can expand these results towards a deeper understanding of how the spatial morphology and its properties affect people's perception.

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## THE ROLE OF AESTHETICS IN BUILDING SUSTAINABILITY ASSESSMENT

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This theoretical study examines the role of aesthetics in the assessment frameworks of sustainable architecture. The article is organized into two main sections: a general literature review and the results. The results section encompasses an analysis of the place of aesthetic quality in the understanding of sustainable architecture, and an overview and discussion of the general sustainable building assessment frameworks and the main sustainable buildings certification systems (LEED, BREEAM, WELL, Living Building Challenge), identifying the existing and potential place of cultural sustainability and aesthetics in them. Finally, four architecture are presented. These theories are: sustainability aesthetics, genius loci, biophilia, and a regenerative approach. The conclusion was made that these approaches hold the potential for the breakthrough of aesthetic quality and uniqueness of sustainable architecture.

*Key words:* sustainability, sustainable architecture, sustainable building, sustainability assessment, aesthetics, sustainability aesthetics.

#### INTRODUCTION

Since the second half of the 20th century, sustainable development has emerged as an alternative to the predominant socio-economic development of humanity (Lozano, 2008). Buildings and built environments in general are a crucial part of the human habitat and make considerable social, economic, and environmental impact. Therefore, the building sector and architecture are given considerable attention in sustainability research and strategies. In this research *sustainable architecture* is considered as architecture that is fully based on the principles of sustainability, such as the pursuit of material and intangible prosperity, justice for present and future generations, justice within and between societies, protection and promotion of cultural and environmental biodiversity, precautious decision-making, and recognition of the interdependence

of phenomena (Throsby, 2002). Architectural sustainability must be programmed during the development phase of a project and occur throughout its life cycle; sustainable architecture must not only be sustainable, long-lasting and environmentally friendly, but also contextual, aesthetic and psychologically acceptable (Kamicaityte-Virbasiene and Grazuleviciute-Vileniske, 2011). Architectural quality is the aim of both architects and societies as a whole and includes such aspects as urban integrity, accessibility and mobility, respect for the environment and energy efficiency, quality of construction and well-being, innovation, aesthetics and image, as well as functionality and flexibility, costs etc. (European Commission, 2009). It is evident that the expression of a building and the *aesthetics of architecture* have constituted a fundamental part of architectural quality since antiquity (Stauskas, 2009). However, with the rise of environmental and energy saving concerns in the building sector, energy-related requirements are greatly increasing and becoming the main focus of designers and engineers. Meanwhile, some authors identify the negligence towards aesthetics, which is an integral part both of architectural

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sustainability and general architectural quality, in the design of sustainable buildings and their assessment (Wines, 2002; Heymann, 2012). With this in mind, the article focuses on the role of aesthetics in sustainable architecture. The aim of this study is to carry out theoretical research based on a literature analysis and to determine the importance of aesthetics in the definition of sustainable architecture, as well as to define the role of aesthetics in the existing sustainable architecture assessment frameworks. This study is organized according to the following framework: 1) a general literature overview in order to reveal the relevance of the research and the existing research gap related to building aesthetics and sustainability; 2) an analysis of the place of aesthetic quality in the understanding of sustainable architecture; 3) an analysis of the existing general sustainable architecture assessment frameworks and sustainable buildings certification systems (LEED, BREEAM, WELL, Living Building Challenge), including an analysis of current and potential places of cultural sustainability and the aesthetics in them; and 4) the identification and discussion of architectural theories relevant to the integration of aesthetic criteria in the assessment of sustainable architecture and balancing them with the existing environmental criteria. These theories include: biophilic design, focusing on the direct and indirect use of natural systems, processes, and materials in the design of the built environment (Kellert et al., 2008; Gillis and Gatersleben, 2015); sustainability aesthetics - the expression of underlying ecological attitude in design; sense of place (genius loci) - the intangible quality of a place, determining its distinctiveness and expressing it in the tangible qualities of the environment (Vecco, 2019); and regenerative design - a movement that strives towards harmonious humanenvironment co-evolution and the development of built environments as ecosystems (Dekay, 2012).

#### LITERATURE REVIEW

There are numerous definitions of the sustainability concept due to its wide and general character. There were already 70 different definitions of sustainable development recorded in the literature by 1992 (Lozano, 2008). A similar situation can be identified in the environmentally oriented architecture and construction sectors. Numerous definitions, such as green architecture, sustainable architecture, ecological architecture, green buildings etc. exist and are used interchangeably with one another (Wines, 2002; Berardi, 2013). This proliferation of terms reflects the imperative for sustainability in architecture (Lee, 2011) and the endorsement of this principle by the architectural community (Fox, 2000). According to Fox (2000, p. 5-6), the "1993 World Congress of the Union of International Architects declared that they would commit themselves individually and professionally to place environmental and social sustainability at the core of their practices and professional responsibilities".

The term "sustainable architecture" generally implies that such architecture is based on the paradigm and principles of sustainability in the social, cultural, economic and environmental spheres, and it definitely contributes to the implementation of sustainability goals. Increasing interest in the topic is revealed by a quantitative literature review using the keywords "sustainable architecture" in major scientific databases (Table 1). Since the 1980s the number of published papers on this theme has increased from several to hundreds and thousands. The field of engineering dominates in sustainable architecture research.

The literature review revealed two distinctive trends in research developments on sustainable architecture that relate to the theme of this study. The first trend is the analysis of architectural expression and aesthetics in the context of building sustainability. Researchers raise and try to answer questions such as: is there a distinctive aesthetic face of sustainable architecture? Does the sustainability paradigm influence architectural aesthetics and how? (Cucuzzella, 2015); what trends in sustainable architecture and the built environment can be distinguished? (Guy and Farmer, 2001; Wines, 2002; Sauerbruch and Hutton, 2011; Di Carlo, 2016); how can sustainability aesthetics be defined (Kagan, 2011) and experienced? (Dekay, 2012). The second relevant research trend relates to the development, analysis and comparison of building sustainability assessment frameworks, systems and tools. As these assessment approaches and tools are constantly developed and improved, the number of such studies is growing, several of which can be mentioned. Cole (1999) discusses the existing building sustainability assessment systems, the approaches towards the formulation of criteria and indicators, and the general building sustainability assessment frameworks. Todd et al. (2001) present a comparison of building sustainability assessment tools. Al Waer and Sibley (2005) present an overview of building sustainability assessment methods and trends. Poveda and Lipsett (2011) provide a comprehensive assessment of existing approaches, strategies, models, appraisals, and methodologies in this field. The general literature review revealed the gap between the research trends in sustainable architecture mentioned above, and the gap between aesthetics and sustainability assessment. Thus, the following research questions can be asked:

- Is aesthetic quality a part of sustainable architecture?
- What role does aesthetics play in building sustainability assessment frameworks?
- What are the possibilities of including the aesthetic dimension in building sustainability assessment?

#### RESULTS

## The place of aesthetic quality in the understanding of sustainable architecture

The notion of sustainability is expanding beyond the triad of social-economic-environmental factors (Berardi, 2013) and the cultural dimension of sustainability is emerging in research and international documents (United Cities and Local Governments, 2010; Moldavanova, 2014; Meireis and Rippl, 2019). The emerging cultural dimension of sustainability introduces such themes as aesthetics and artistic qualities into the frame of discussion based on sustainable architecture. For example, Berardi (2013) underlines that cultural perception and inspiration are integral aspects of sustainable buildings. Accordingly, such buildings should increase "social equity, aesthetics

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Scopus database search						
Total number of sou	Irces: / 382	1	1	1	[	
Years	Number of sources	Main keywords	Dominant author	Dominant field	Dominant country	Dominant source
1983 - 1987	6	Architecture (3)	Levine, R.S. (2)	Engineering (6)	-	Wescon Conference Record
1988 - 1992	5	Architecture (2)	Glass, C.J. (1)	Engineering (3)	USA (3)	Journal of Architectural Education
1993 - 1997	31	Architecture (7)	Wu, J.S. (2)	Engineering (16)	UK (5)	Corporate Environmental Strategy
1998 - 2002	109	Sustainable development (43)	Farmer, G. (2)	Engineering (61)	USA (26)	Places
2003 - 2007	697	Sustainable development (381)	De Weck, 0. (6)	Engineering (452)	USA (208)	International Journal of Engineering Education
2008 - 2012	1746	Sustainable development (899)	Zeiler, W. (9)	Engineering (900)	USA (345)	World Applied Sciences Journal
2013 - 2017	2688	Sustainable development (1279)	Mileto, C. (14)	Engineering (1666)	USA (370)	Xi'an Jianzhu Keji Daxue Xuebao/ Journal of Xi'an University of Architecture and Technology
2018 - 2021	2102	Sustainable development (858)	García-Soriano, L. (7)	Engineering (1067)	USA (218)	Journal of Materials Science and Technology
Web of Science database search						
Total number of sources: 4358						
Years	Number of sources	Main keywords	Dominant author	Dominant field	Dominant country	Dominant source
1990 - 1994	13	Architecture (5)	Blake J. (1)	Architecture (5)	USA (4)	Architecture
1995 - 1999	52	Energy fuels (22)	Jain K. (2)	Energy fuels (22)	USA (13)	Journal Of Urban Technology
2000 - 2004	117	Architecture (32)	Oktay D. (3)	Engineering (45)	USA (24)	Energy And Buildings
2005 - 2009	346	Architecture (97)	Lehmann S. (5)	Environmental studies (108)	USA (74)	Journal Of Green Building
2010 - 2014	1090	Architecture (245)	Gambardella C. (18)	Engineering (451)	China (162)	Applied Energy
2015 - 2019	2294	Green sustainable science technology (416)	Gambardella C. (12)	Engineering (681)	USA (258)	Scientific Reports
2020 - 2021	446	Green sustainable science technology (135)	Kim Y. (5)	Science technology other topics (156)	China (73)	International Journal Of Engineering And Geosciences

Table 1. Quantitative literature overview using keywords "sustainable architecture" in the Scopus and Web of Science databases

improvements, and preservation of cultural values" (Berardi, 2013, p. 76), along with other aspects. The sustainability framework developed by Musacchio (2011), which is applicable to landscapes as well as architecture, contains factors related to: the environment, economics, equity, aesthetics, experience, and ethics. Thus, it also reflects the complexity of sustainable architecture and the presence of

both tangible and objective, and intangible and subjective dimensions in it, such as aesthetics and a sense of place.

However, some researchers have noticed biases in the approaches towards sustainable buildings, such as an overly eco-centred approach, managerialism and technoctaric control (Berardi, 2013). Indeed, with multiple regulations and certification systems, construction is increasingly viewed as a process and the focus is on the life cycle of the building (Sauerbruch and Hutton, 2011). On one hand, it is helpful to better understand and manage the environmental and other impacts; on the other hand, less tangible and more subjective aspects, such as a sense of place, aesthetics and artistic quality can be lost in such a broad and managerial approach.

According to some researchers, a certain level of sustainability appears to be inevitable in the architectural and building fields as a matter of professional commitment as well as of governing policies (Fox, 2000; Jauslin, 2011). Accordingly, all architecture could become sustainable. Thus, it is worth looking at the understanding of general architectural quality and what role sustainability plays in it. The criteria that determine architectural quality have been under consideration since antiquity's Vitruvius triad (Stauskas, 2009). Stauskas distinguished the functional and cultural contents, form, environment and technicaleconomical aspects as determinants of architectural quality. Sets of architectural quality criteria are presented in national and international regulations as well. For example, the guidelines to the architectural policy of the European Commission (European Commission, 2009, p. 4-7) distinguish urban integration, accessibility and mobility, respect for the environment and energy efficiency, quality of construction and well-being, innovation, aesthetic aspect and image, functionality, modularity and flexibility, costs, and cohesion as the common thread, in this particular case meaning "the establishment of a symbolic common thread linking all the buildings and building clusters occupied by the Commission". Similar criteria are, for example, distinguished in the Lithuanian Law of Architecture (Lietuvos Respublikos Seimas, 2017) (Table 2).

environmental aspects. In order to better understand the role of aesthetics in building sustainability and the potential of the sustainable architecture movement to influence the aesthetic expression of buildings (Heymann, 2012), the existing building sustainability assessment frameworks are analyzed in the following sub-section.

## The potential place of aesthetics in the assessment frameworks of sustainable architecture

In a further analysis of the links between the sustainability and aesthetics of architecture, it is worth examining the frameworks of general sustainable architectural analysis and sustainable building certification systems, which are gaining increasing importance due to the growing number of societal challenges and the impact of sustainable architecture.

Several general models – the general building sustainability analysis framework by Cole (1999), the HalStar sustainability assessment model (Pearce *et al.*, 2012) based on five capitals, and the VERSUS model based on the qualities of vernacular architecture (Guillaud *et al.*, 2014) were selected for analysis. These models go beyond the basic Bruntland model of three overlapping dimensions (Lozano, 2008) and they target the built environment. The selected models are rather diverse and thus reflect the spectrum of understanding of building sustainability.

The general building sustainability analysis framework by Cole (1999) encompasses sustainability criteria, which are subdivided into two categories - human (indoor environmental quality, maintenance, prosperity, cultural heritage integration, etc.) and environmental (resource use, ecological loadings etc.). Bearing in mind the concept of

Table 2. Architectural quality criteria in regulatory documents (European Commission, 2009; Lietuvos Respublikos Seimas, 2017) and their analysis
according to sustainability dimensions

Lithuanian law of architecture (2017)	Guide to the European Commission's architectural policy (2009)	Sustainability dimensions*
Urban integrity	Urban integration	
Accessibility using universal design	Accessibility and mobility	
Correspondence to sustainability principle	Respect for the environment and energy efficiency	
Quality, ergonomics and durability of the built environment	Quality of construction and well-being	
Innovativeness	Innovation	
Coherent architectural idea	Clarity of purpose and comprehensibility of buildings	
	Cohesion: a common thread	
Aesthetics	Aesthetic aspect and image	
Functional structure of the building	Functionality, modularity and flexibility	
Economic rationality	Costs	
Preservation of immovable cultural heritage		
	1	7 10 6 2
Sustainability* Cultural Social Economic Environm	ental	

An analysis of architectural quality criteria according to sustainability dimensions (Table 2) reveals that these criteria encompass all four dimensions, although human dimensions (cultural, social, economic) clearly dominate over the environmental dimension. The analysis reveals the mutual integration process: the cultural dimension (including aesthetics and the sense of place) is increasingly becoming a part of the concept of sustainable architecture and sustainable building. Meanwhile, the understanding of architectural quality increasingly encompasses any building as a process with a life-cycle, the framework encompasses the dimension of time. According to Al Waer and Sibley (2005), "time scale is one of the most important factors in assessing sustainable development due to the changing nature of the performance criteria and the appearance of new ones over a period of time". The model demonstrates the possible different scales of sustainability assessment, ranging from the building materials up to the global scale. "Scale is obviously the critical dimension in relation to building environmental performance within the context of sustainability, architecture and urban planning" (Al Waer and Sibley, 2005). This framework demonstrates the potential of integrating aesthetics as one of the human criteria (Figure 1) into building sustainability assessment. The different scales represented by the model make it possible to consider the aesthetics in the neighborhood and cityscape contexts as well.





The HalStar sustainability assessment model was developed by the English engineering firm Halcrow. The company's goal is to encourage people to lead an increasingly sustainable lifestyle by trying to look at the problem from all possible perspectives: from small-scale to massive projects. The significant development of the company's infrastructure has also led to the development of theoretical models to address sustainability issues. This model demonstrates sustainability as the balance between five dimensions or capitals - natural, social, human, manufactured and financial. This model considers the life cycle of the project under evaluation and includes the dimension of time by identifying short-term, medium-term, and long-term time-frames (Pearce et al., 2012). Moreover, similar to the model by Cole (1999), this model contains scale: global, regional, local, and client. Although this model does not explicitly distinguish the cultural dimension or aesthetics in particular, it includes some culturally and aesthetically oriented factors, such as cultural heritage, happiness and motivation, quality and innovation. These factors are dispersed in the following fields: social, human, and manufactured capital.

The VERSUS model for the analysis and assessment of sustainable architecture was developed by partner institutions from Portugal, Spain, Italy, and France, with the support of the Culture Programme of the European Union. This model was based on "the identification of strategies and principles within vernacular heritage, in order to define a conceptual approach for sustainable architectural design" (Guillaud et al., 2014). The model has three sustainability dimensions - environmental, sociocultural, and socio-economic. The environmental dimension encompasses five criteria or principles: to respect nature, to be appropriately situated, to reduce pollution and waste materials, to contribute to the quality of health, and to reduce the effects of natural hazards. The socio-cultural dimension encompasses the following criteria: to protect the cultural landscape, to transfer construction cultures, to enhance creativity, to recognize intangible values, and to encourage social cohesion. The criteria of the socio-economic dimension are: to save resources, to extend the lifetime of buildings, to optimize construction efforts, to promote local activities, and to support autonomy. It is evident that the VERSUS model has a strongly expressed cultural dimension acknowledging the importance of the sustainability of preserving cultural heritage, and such intangible factors as collective memory, cultural identity, sacredness, history and mythology. Respect for the cultural landscape (cityscape) might include some aesthetic considerations; meanwhile the creativity criterion explicitly mentions beauty (Guillaud et al., 2014).

In order to understand better the potential to include aesthetics in building sustainability analysis, it is worth looking at actual building sustainability certification systems, which are practical undertakings in evaluation and decision making (Poveda and Lipsett, 2011). This overview of popular certification systems was prompted by the claim of some researchers that these tools are discouraging, or at least do not encourage aesthetic experiments and innovations in the field of sustainable architecture. For example, Heymann (2012) notes that the LEED certification system "serves to uphold a pre-existing aesthetic; or, perhaps better, does not serve substantially or directly to take an existing aesthetic ideal apart". According to Sauerbruch and Hutton (2011), the existing certification systems focus heavily on technical and quantifiable aspects, and such aspects as beauty and aesthetics are viewed skeptically in circles linked with sustainable building certification.

The most popular certification systems - LEED, BREAAM, WELL - and the Living Building Challenge were selected for the overview (Tables 3 to 6). LEED Interior Design + Construction (U.S. Green Building Council, 2020) appears to balance the social, economic, and environmental sustainability dimensions. However, environmental concerns are predominant in this system (Table 3). The only sub-criterion, quality, and the criterion innovation can be attributed to the cultural sphere. Some sub-criteria targeted at environmental and economic dimensions can have potential synergistic effects on the aesthetic expression of buildings: sensitive land protection, reduced parking footprint, protected or restored habitat, open space, rainwater management, heat island reduction, renewable energy, daylight etc. For example, the rainwater management requirement can encourage the creation of rain gardens or permeable surfaces on a site with particular ecological aesthetics, and daylight requirements can influence architectural form and the character of interiors etc. It is possible to summarize that the LEED certification system can influence the aesthetic expression of architecture, although it is possible to agree with D. Heymann (2012) that this system does not encourage aesthetic and cultural breakthrough in sustainable architecture.

This study identified the dominance of environmental and economic concerns over social and cultural ones in BREEAM International New Construction 2016 technical standards (BREEAM, 2016) (Table 4). Only the sub-criterion innovation can be clearly attributed to the cultural sphere. Some sub-criteria targeted at the environmental and economic dimensions can have a potential synergistic effect on the aesthetic expression of buildings: visual comfort, life cycle impacts, designing for durability and resilience, adaptation to climate change, and enhancing site ecology. For example, adaptation to climate change and site ecology enhancement can include creating vertical greenery with particular aesthetic impacts, etc. Only the sub-criterion visual comfort and the criterion innovation can be directly linked with architectural aesthetics. In summary, the BREEAM certification system is not targeted at the cultural dimension of sustainability, and sustainability aesthetics are not directly encouraged by it. However, it is neccessary to mention, that both LEED and BREEAM include innovation as a criterion, which is also considered as one of the general criteria of architectural quality, as demonstrated in the sub-section above. Thus, it can be expected that innovation can be expressed not only in technologies, but also in distinctive aesthetic language.









In comparison with the LEED and BREEAM systems, the WELL Building Standard version 2 (WELL, 2020) is basically socially oriented (Table 5). This system is oriented at the well-being of building occupants; however, the cultural dimension of sustainability is also omitted here. Only the criterion innovation and the sub-criterion nature and place can be linked with the cultural sphere and aesthetics. Some sub-criteria targeted at social, environmental and economic dimensions can have a potential synergistic effect on the aesthetic expression of buildings: visual lighting design, day light strategies, nature and place, restorative spaces, and enhanced access to nature. These sub-criteria can be directly linked with the biophilic design concept (Kellert et al., 2008), which is currently growing in popularity. It is peculiar that the WELL system, being clearly human-centered, does not include cultural and aesthetic aspects. However, the biophilic design-oriented criteria can evolve into a synergistic approach simultaneously targeting ecology, personal wellbeing, aesthetics and connections to place.

The Living Building Challenge 4.0 Standard (new construction) (Living Building Challenge, 2020) system is most successful at achieving a balance between the sustainability dimensions compared to the other systems analyzed in this paper (Table 6). The cultural dimension

here is reflected by the criteria place and beauty and the sub-criteria human scaled living, beauty & biophilia, and education & inspiration. It is possible to see clearly in this system that some material and wellness-related criteria can have a direct impact on the aesthetic expression of design: access to nature, responsible materials etc. This system underlines the importance of place, which is both a cultural and ecological concept. Moreover, the implementation of the beauty & biophilia sub-criterion can have synergistic positive effects on all the sustainability dimensions as mentioned above.

#### Architectural theories relevant to balancing the aesthetic and environmental criteria in the assessment of sustainable architecture

The integration of sustainability into architectural quality criteria, the rise in popularity of certification systems and the overall global sustainability agendas demonstrate that certain aspects of architectural sustainability are inevitable. However, the question still remains of how to avoid a merely techno-centrist or eco-centrist approach, and to balance the social, cultural, economic and environmental aspects of sustainable architecture. Moreover, some authors note the current lack of and need for a particular aesthetic language of





Table 6. Analysis of the Living Building Challenge building certification system according to sustainability dimensions. Criteria with aesthetic potential or impact are marked in green (Source: Living Building Challenge, 2020)



sustainability (Kagan, 2011; Heymann, 2012; Di Carlo, 2016). The lack of cultural criteria in sustainability certification systems and the emphasis of environmental and economic dimensions might be the causes of the slow development of sustainability aesthetics. Below we distinguish and discuss four architectural theories that hold the potential of balancing the human and environmental criteria and could potentially become a part of sustainable architecture assessment systems: sustainability aesthetics, spirit of place (*genius loci*), biophilic design, and a regenerative approach.

Sustainability aesthetics. The notion of sustainability aesthetics (Kagan, 2011) has evolved from the environmental movement and ecological art that started in the 1960s and 1970s. Such art relied on natural materials, natural and social processes, and creativity based on the mutual interaction of humans with nature and society. The humannature co-creation approach also emerged in landscape architecture in this period (McHarg, 1969). The results of ecological art were particularly complex, dynamic, open aesthetics based on sometimes radical environmental ethics. Several authors have defined what the term sustainability aesthetics actually means. According to Kagan (2011), it focuses on "relationships and processes and is based on a sensitive response to connecting structures at many levels". Kagan emphasizes the following qualities and features of sustainability aesthetics: reconciliation, complementarity of opposites (focusing on the visible diversity, complexity and differences and metastructure connecting the living world), openness to the creative power of chaos, unexpectedness of results, interest in "complex and dynamic life networks in the environment and the social, political and economic complexity of modern societies". It is evident that this aesthetics draws a lot from environmental art, which is more flexible than architecture or urbanism. However, it can be presumed that sustainability aesthetics reveals and emphasizes the intrinsic beauty of our connectedness to ecosystems and sustainable systems and holds potential for the built environment as well.

Shrivastava (2011), working in the field of sustainability research, notes that radical behavioral and organizational changes are necessary in order to achieve global sustainability. He states that this change first of all requires a change in human consciousness, "the emotional change in human-nature relationships". He urges us to employ the human capacity for art to achieve this transformation, and even bases this claim on the idea that arts serve the evolutionary functions of humanity. In this context the sustainability aesthetics of architecture can even stimulate the further development of harmonious human-nature relationships.

*Spirit of place (genius loci).* I. Brook (2000) identifies the sense of place or the so-called spirit of place, also known as *genius loci,* as an imperative for environmental ethics. This idea links the cultural and environmental realms in environmental ethics, which often tends to concentrate on the radical biocentric and ecocentric approaches. The VERSUS model discussed above also includes protection of the cultural landscape and recognition of intangible values as characteristics of sustainable architecture. The Living Building Challenge certification system includes the

criterion of place, WELL includes the sub-criterion nature and place. Place in its nature integrates both natural and cultural aspects. Thus, place and *genius loci* can become the drivers both for ethical, environmentally friendly construction and the aesthetics of sustainable architecture in a particular place. Genius loci, which is seen as intangible, and place which is mainly viewed as tangible, and their actual inseparability (Vecco, 2019), reveal that both spatial aspects and intangible ones matter for the sustainability of architecture. The importance of understanding the intangible dimension in the context of sustainability even transcends the question of architecture and is receiving the increasing attention of researchers (Grant, 2010; Vecco, 2019). Grant (2010), analyzing the potential of sustainability aesthetics, emphasizes the general necessity of replacing the current consumer culture with alternative value systems. Sustainability is often viewed as a behavioral problem (Grant, 2010; Shrivastava, 2011), which invites us to consider consumption and production from the psychological/ behavioral perspective. Grant (2010) supports the idea that "the problem of material overconsumption is rooted in the lack of skilled consumption" and presents a literature overview on less tangible and more sustainable forms of consumption, so-called "resource-light and resource-free activities", which "require a more cultivated mind" including increasing the role of artistic creation, fostering appreciation in daily life and general intellectual culture like reading a good book, listening to music or intelligent conversation, etc. Harper (2012) mentions anti-consumption or at least minimal consumption in the context of sustainability aesthetics. The empathetic involvement in a place, grasping its genius loci and sensitive architectural development, are forms of skilled sustainable consumption and production. Nevertheless, genius loci as an asset nowadays is often ignored (Petrusonis, 2018). Vecco (2019) proposes a threefold process: rethink, protect and transmit the place and its spirit. She asserts that this process needs to be circular and incremental, and the role of sustainable design and sustainable heritage preservation cannot be underestimated in this process.

*Biophilic design*. The biophilic design concept is an evolving environmental awareness and human well-being targeted design approach. It encourages the direct and indirect use of natural systems, processes, and materials in the design of the built environment (Kellert *et al.*, 2008; Gillis and Gatersleben, 2015). Biophilic design is based on the biophilia hypothesis, formulated in the 1980s by ecologist and sociologist Wilson (1984). This hypothesis maintains the "innate emotional affiliation of human beings to other living organisms" (Wilson, 1993).

Moreover, the physical and psychological well-being benefits of human-nature connections have been proven by numerous studies (Gillis and Gatersleben, 2015). The biophilic approach is increasingly integrated into building sustainability assessment. For example, the Living Building Challenge includes the sub-criterion of beauty and biophilia. The WELL system includes the sub-criteria nature and place, restorative spaces, and enhanced access to nature, all of which recall the biophilic approach, and all of these sub-criteria are placed under the criterion mind, focusing on human psychological well-being. However, it is necessary to note that biophilic design can enhance human well-being and create aesthetically pleasing restorative environments, and at the same time positively influence the ecology of a place. Moreover, DeGroff and McCall (2016) identify two trends of the biophilic approach: one oriented towards biological systems and the other incorporating traditional practices for forming ethnic environments. This makes it possible to create various biophilic designs in harmony with the *genius loci* of a place.

Regenerative approach. Currently, attitudes towards sustainability are developed within the context of restorative and regenerative movements in the field of sustainability (Brown et al., 2018), with reference to regeneration as a feature of natural systems. The aim of these approaches is no longer to sustain the *status quo*, but rather to move towards the restoration of the damage done by human activities. New concepts also strive towards the harmonious built environment as ecosystems (Dekay, 2012), as well as towards achieving the properties of natural systems in man-made products and environments. Berardi (2013) distinguishes the aspects of biological and regenerative approaches towards sustainable architecture, ranging from the behavior of building materials to the building-environment and building-society interaction in his literature review. The following are examples of a regenerative approach in practice: developing building materials that would function as biological nutrients circulating through the world's systems in cycles; and considering and creating a building as a "live system with dynamic flows with nature", as "an active entity which is designed to help a metabolism of human beings that regenerates the built environment within the natural capital". This perspective of buildings as ecosystems and living entities would make it possible to move beyond the currently trendy biomorphic formalism (Sauerbruch and Hutton, 2011), when nature becomes an inspiration solely for the building form, and achieves integrated humanenvironment benefits including recognizable aesthetic quality.

#### CONCLUSIONS

Sustainable architecture, according to its definition, should be based on the paradigm and principles of sustainability involving social, cultural, economic and environmental dimensions; it definitely contributes to the implementation of sustainability goals. The dimension of cultural sustainability should be strengthened within the fields of both sustainable architecture and general sustainability. This leads to the conclusion that sustainable architecture must contribute to social equity, aesthetic qualities of the environment and the preservation of cultural values. Therefore, aesthetics must be considered as an integral part of architectural sustainability.

Architectural quality in general is determined by such criteria as urban integrity, accessibility and mobility, respect for the environment and energy efficiency, quality of construction and well-being, innovation, aesthetic aspect and image, functionality, etc. (European Commission, 2009). An analysis of architectural quality criteria through the sustainability perspective revealed that architectural quality criteria encompass all four sustainability dimensions. However, a lack of attention given to the cultural aspects while developing sustainable architecture was noticed.

An overview of selected general sustainable architecture assessment models – general building sustainability analysis framework by Cole (1999), the HalStar sustainability assessment model (Pearce *et al.*, 2012) and the VERSUS model based on the qualities of vernacular architecture (Guillaud *et al.*, 2014) – demonstrated that these diverse models have room for cultural aspects and aesthetics, even if these aspects are not always explicitly identified.

Analysis of the most popular certification systems – LEED, BREAAM, WELL and Living Building Challenge – according to sustainability dimensions and a search for the possible integration of cultural aspects and aesthetics in building sustainability assessment revealed the general predominance of environmental and economic aspects. However, some promising possibilities for expanding the cultural dimension and including integrated, synergistic, aesthetic and environmental criteria based on the biophilic approach were distinguished.

This research has revealed a paradoxical situation: while cultural aspects and aesthetic expression are an integral part of the sustainable architecture concept, they are not so eagerly incorporated into sustainable building assessment approaches. The results of the research suggest that the lack of cultural criteria in sustainability certification systems and the emphasis on the environmental and economic dimensions might be the causes of the slow development of sustainability aesthetics, as identified by some researchers. Another problem identified by this study is the lack of balance between human and environmental criteria. Consequently, four categories that hold the potential for balancing human and environmental criteria and could potentially become a part of sustainable architecture assessment systems were distinguished: sustainability aesthetics, spirit of place (genius loci), biophilic design, and a regenerative approach. The research maintains that these approaches hold the potential for breakthrough in the aesthetic quality and uniqueness of sustainable architecture.

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#### **IN MEMORIAM**

#### Prof. Dr. Dobrivoje Tošković (1927-2021)

It has happened ...and shattered our expectations. We always believed that he would outlive us all: upright, well-groomed, active, always ready to discuss, even to write a new book or take part in a scientific gathering, with a narrative that would always sound clear and inspiring. Suddenly, there is a void, created by the departure into eternity of the great urban planner, spatial planner and architect-designer, Dobrivoje Tošković, professor, doctor of sciences, and a full member of the Academy of Engineering Sciences of Serbia. Born in the Serbian village of Draginac in 1927, he graduated from the University of Belgrade at the Faculty of Architecture, where he received his master's and doctoral degrees. He also studied in the Netherlands. He was lucky to learn Serbian with the famous Serbian poet Desanka Maksimović, so that until the end of his professional life he was clear and understandable to everyone in his written studies, plans, books, etc. And he was also enthusiastic and clear about the territories where he worked. Working in Tanzania, in charge of the Ruvuma Regional Plan, 8 general urban plans and numerous village plans, he experienced Tanzanian President Nyerere sending a private plane to pick him up. He worked on the urbanization of Libva and taught at the University of Helsinki, and in Iraq (Mosul). In Serbia, he was mainly engaged as a professor at the University of Belgrade at the Faculty of Geography (Department of Spatial Planning), and at the Institute of Architecture and Urban & Spatial Planning of Serbia. Of particular importance was his involvement in numerous urban plans for several cities in Serbia (Šabac, Valjevo, Ćuprija, Užice, and others).

The crown of his professional career was his work in Calcutta (today Kolkata), the largest city in India. Working for the large Serbian company "Ivan Milutinović", which had been engaged in draining Salt Lake near Calcutta in 1965/66, he was invited to participate in the international competition for the new town named Salt Lake City on the drained lake, on the outskirts of this huge agglomeration. After he won, he had the great opportunity to lead the development of the urban plan for this new town with 200,000 inhabitants, which is today called Bidhannagar, and to later work on projects and monitor the construction until everything was built. Prof. Tošković's plan was carried out in quite the opposite way to plans for similar new towns/cities by world greats such as Le Corbusier, Oscar Niemeyer and Consantinos Doxyadis. Today, the world's most famous architects, such as Jacques Herzog and Pierre de Meuron, classify Bidhannagar side by side with Chandigarh in India, Brasília in Brazil, and Rawalpindi in Pakistan, but they recognize it is completely different, more humane and of better quality in terms of the concept, based on the idea of a garden city. In an interview for The Economic Times, Prof. Tošković said: "Some of the main problems I faced at the start of my work were related to the socio-cultural context, how to plan a new town in a completely flat area, and how to avoid monotony in that area. I found that Indian people preferred to live in a house rather than in a high-rise building, but at the same time they liked grouping".

Thanks to this great undertaking, Prof. Tošković was awarded



the highest recognitions and charters in India. In addition to the plans, Prof. Tošković published a series of important books, articles and other texts that richly illuminate his urban ideology.

I was lucky to have worked closely with Prof. Tošković for over 30 years, and known him as a professional and academic of high professional integrity, but also as a man of the highest human qualities and steady principles. Never in conflict with his surroundings, he was appreciated and loved among his colleagues, students and everyone else who knew him. We sadly say goodbye to our Toshke, as was affectionately known.

Borislav Stojkov

#### **Instructions to Authors**

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