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The Walkability of Alvalade Neighbourhood for Young People: An Agent-based Model of Daily Commutes to School

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Abstract
The Alvalade neighbourhood in Lisbon, Portugal, was built in the mid-XX century as low-cost housing for workers, but it has become inhabited by the middle and upper classes. The neighbourhood is home to a large population of young people, including children and teenagers who attend the schools located in the area. We present an agent-based model which aims to investigate the walkability of the neighbourhood for these young people, focusing on the mobility patterns of children and teenagers as they navigate their daily routines of going to school. We simulate the pedestrian movement of these young people, considering factors such as the availability of sidewalks, crosswalks, distance to schools, and the presence of other amenities. Our research reveals the mobility patterns emerging in this area and compares them across the different schools in the area. These results inform both urban policies and interventions that promote safe and accessible routes to school.
Keywords: Urban Design; Walkability; Mobility; Agent-based model; Pedestrian movement; School accessibility.

1. Introduction

Alvalade occupies a central area of Lisbon, boasting numerous urban characteristics and a high quality of life. Recognized by the Laboratoire de Sociologie Urbaine Générative as one of the finest mid-20th-century residential complexes in Europe, Alvalade's significance is surprisingly underrepresented in the international professional literature (AA.VV., 1999). It embodies the ideal form of a Modern City, akin to the urban developments created by Haussmann in Paris or Cerdá in Barcelona (AA.VV., 1999). The Alvalade neighbourhood showcases various architectural styles within a well-designed urban environment, making it a noteworthy reference for architects involved in city planning and for residents of Lisbon.

The neighbourhood of Alvalade (Plan of the Zone to the South of Avenida Alferes Malheiro) was planned and designed by the architect João Guilherme Faria da Costa (1906-1971) between 1945 and 1947 (Howel, 1995, Terreno, 2013). Faria da Costa, who studied Urbanism at the Institut de Urbanisme de la Université de Paris, incorporated diverse influences into his design (Howel, 1995, Costa, 1998; Tostões, 2001). These influences include elements from traditional cities, from the English and American Garden City concepts, from the Modern Movement, as well as the urban expansions of Amsterdam (1915-1934) and the Siedlungs of Berlin (Howel, 1995, Tostões, 2001).

The origins of Alvalade trace back to the late 1930s when Lisbon faced a pressing need for housing and urban expansion (Costa, 1998). The planning for Alvalade began years before it received its name, originating in the Municipal Master Plan of Lisbon in 1938 (Tostões, 2001). In the same year, the Municipality of Lisbon developed the General Plan of Urbanization and Expansion, with the involvement of Duarte Pacheco (1900-1943), who served as the Minister of Public Works and the Mayor of Lisbon simultaneously.

The architect Étienne de Groër (1882-1974) also participated in the plan's development (Costa, 1998; Marat-Mendes et al., 2010). Étienne de Groër was a Polish-Russian urban planner who collaborated with architect Alfred Agache (1875-1959) on the Rio de Janeiro Plan. It arrives in Lisbon at the end of the 1930s by the hand of Duarte Pacheco to replace Agache when he was in Brazil. Étienne de Groër was interested in the concept of the city in the English garden city theory (Howel, 1995).

In 1938, a report containing an analysis programme provided by De Groër was published. This report was conducted by Emílio Abrantes, the municipal engineer, who employed extensive and innovative methods for the time. The report was so significant that it served as a methodology for subsequent plans (Brito et al., 2007).

The design of the Alvalade neighbourhood is rooted in the Urbanization Plan of the Zone South of Avenida Alferes Malheiro, which was regulated by Decree-Law No. 33921 on September 5, 1944. The plan was developed for the current Avenida do Brasil. The boundaries of Alvalade are defined by Avenida do Brasil (formerly Avenida Alferes Malheiro) to the north, Avenida Admiral Gago Coutinho to the east, the railway line to the south, and Campo Grande and Rua de Entrecampos to the west.

The Alvalade site, situated on the outskirts of the city, was selected as a strategic location for implementing and applying the principles of the Modern Movement (Brito, 1991). It was part of a larger initiative involving the expropriation of rural lands, providing an ideal opportunity for experimentation and practical implementation.

The emergence of Alvalade took place within the framework of the consolidation regime of the Estado Novo and the urban expansion policies spearheaded by Duarte Pacheco, the city's planner. Between 1947 and 1957, the construction of "rent-controlled housing" played a pivotal role in fostering the development and expansion of the Alvalade neighbourhood (Brito, 1991).

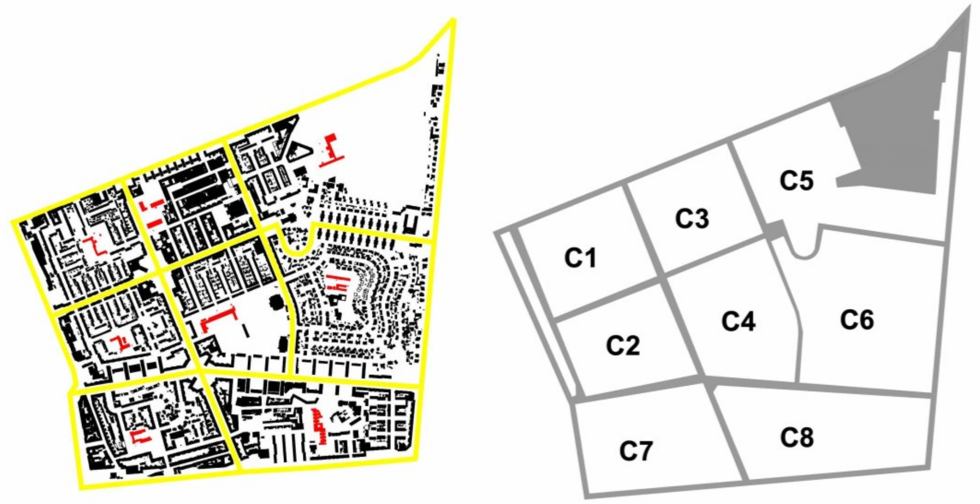

Figure 1. a) plan of the Alvalade; schools highlighted as the centre of each cell.
b) division of Alvalade in 8 cells.

Duarte Pacheco had an entrepreneurial attitude. He was responsible for the vast program of expropriation of land that allowed the urbanization of the neighbourhood of Alvalade, through the municipalization of the land from 1945 (Costa, 1998). The Alvalade plan has 230 hectares of which 218 hectares result from expropriation actions. Of the total space, 33 hectares were allocated to free spaces (Costa, 1998).

The new neighbourhood of Alvalade was intended to house a population of 45,000 inhabitants (12,000 dwellings) (Costa, 1998) - decentralizing the equipment and services located essentially in the Baixa Pombalina (city centre) and seeking to solve the problems of housing.

Figure 1a) and Figure 1b) show how the neighbourhood was structured in eight cells, each cell considering the maximum limit of 500 meters away from the housing to the school located on its premises. Each cell has a different urban morphology, with some being more permeable than others.

The models of urban design, whose concepts emerged innovatively in twentieth-century Europe, were methodically tested in Alvalade, reconciling the coexistence of tradition and the Modern Movement. In Alvalade a synthesis of different influences of the traditional city and the Modern Movement was carried out. We can still identify today the various urban concepts coming from these different models of the city (Costa, 1998). This neighbourhood functioned as an experimental laboratory of housing solutions.

The Plan of Alvalade, being innovative, shows in its structure concepts and influences that marked the first decades of the twentieth century. the neighbourhood is organized in eight cells designed from the intersection of the pre-existing paths and those that delimit it.

The cells are neighbourhood units [concept created by the American sociologist and urbanist Clarence Arthur Perry (1929)] structured from the central element the school (Costa, 1998). According to Perry's principle, the perimeter of the neighbourhood unit is obtained by a circumference with a radius of 500m (the maximum distance a child would walk to school). The urban complex provided for the coexistence of housing of various social categories, supported by equipment (schools, markets, civic centres, sports parks, and small industry).

The connections between home and school are facilitated by the existence of pedestrian footpaths that cross the backyards of the housing blocks. The neighbourhood is designed with several types of blocks, where the public places were thought to be large common outdoor spaces for the enjoyment of the populations. This urban core emerges as something never experienced in the panorama of social neighbourhoods of official promotion. This new neighbourhood allowed the establishment of a diversified and multifunctional social fabric (Alegre, 2004).

Figure 2. Diagram of the Alvalade borough public circulation spaces with the school's areas in green.

Recent research has been proposing new city models aimed at solving the problems caused by long-distance urbanism. Building safer, resilient, inclusive, and sustainable cities, as specified in the United Nations "Sustainable Development Goal" forces us to think about new urban planning models that must adapt to these trends to ensure a sustainable and safe urban future.

In this context, one of the most publicized concepts in urban planning is, as we have already mentioned, the "City of 15 Minutes" (Allam et al., 2022; Moreno et al., 2021; Khavarian-Garmsir et al., 2023). This concept is grounded in proximity, for such an urban neighbourhood is planned to accommodate an ideal density that gives access to basic essential services in 15 minutes on foot or by bicycle (Allam et al., 2022; Moreno et al., 2021). The concept envisages that within that 15-minute radius, residents will be able to have a better quality of life, as they will have to travel less to access basic services such as public spaces, culture, and work. They will then have more time and opportunities to interact with other members of the community and to perform other social functions, which are increasingly important, but which have been missing as a central function of contemporary urban planning models (Allam et al., 2022; Moreno et al., 2021, Aziz Amen, 2017; Aziz Amen & Nia, 2018; Amen & Kuzovic, 2018; Amen & Nia, 2021).

It has been argued that the current concept of the "15 Minute City" is very identical to another urban model from the early 20th century - Clarence Perry's 1929 proposal which had a huge influence on the evolution of the Modern City form (Pozoukidou & Chatziyiannaki, 2021). Perry proposed a set of functional principles for the design of the neighbourhood that included the existence of a hierarchical structure with amenities, services, green areas, public space, and residential areas, located in a ¼ mile radius (Perry, 1929).

Recent political campaigns in an urban context proposed the 15-minute city as a central concept. In the 15-minute city, most daily needs should be attended to on foot or by bicycle. These 15-minute cities would be constituted by a series of 5-minute boroughs also known as complete communities or walkable neighbourhoods (Allam et al., 2022; Moreno et al., 2021, Amen, 2021; Aziz Amen, 2022; Amen et al., 2023; Amen & Nia, 2020). This highlights the relevance of the approach taken here to explore the Alvalade neighbourhood in Lisbon. It was initially designed as a working-class neighbourhood constituted of 8 cells occupying approximately 230 hectares. The premise for each cell was that a maximum distance of 500m was a threshold for the distance to the cell's school. The map of the area is seen in Figure 2 with the area occupied by schools highlighted in green.

The idea of an urban environment providing quality-of-life expectations to its inhabitants has come a long way. From the ideas of the garden city to the 15-minute city, all these urban planning proposals aim (at least in the kindness of intent) to provide its citizens with what the authors consider a better way of living in the city. The recent 15-minute city offers a perspective where the chrono-urbanism takes centre stage and where boroughs are further divided into 5-minute communities where motion would be exclusively achieved by walking.

The simulation of the neighbourhood via an Agent-Based Model allows for the construction of a playground where many possible factors can be turned on and off, and their relative impacts on walkability are studied (if not in a quantitative manner, at least in qualitative terms). In this paper, we present a NetLogo Agent-Based Model of the borough of Alvalade in Lisbon, Portugal, where we explore the characteristics influencing the behaviour of pedestrians (namely children) in the context of going to or returning from school (Wilensky, 1999).

The main parts of the paper are outlined as follows. Following the introduction, the methodological approaches used in this work are presented. It is followed by the presentation of the results and in the concluding section they are discussed in light 15-minute paradigm discussed earlier.

2. Methodological Approach. Problem Formalization

The central focus of this project is understanding the movements of pedestrians within residential neighbourhoods. We want to gain insights into how the built environment in Alvalade accommodates the movement of children in their daily routines and determine the average time/distance it takes a child to go from each location of the neighbourhood to their respective central schools. Understanding their movement, allows us to characterize the neighbourhood in the face of the urban theories of the past.

The study of pedestrian movement has been approached through various methodologies in previous research, particularly within the field of engineering. These methodologies can be broadly categorized into analytical models and simulations. Modelling efforts often draw upon metaphors and analogies from other disciplines, such as fluid dynamics or gas kinetics (Henderson, 1974; Helbing, 1998; Sampayo et al., 2009). Some strategies focus on maximizing entropy, utilizing multi-level dynamic networks, or employing stochastic processes to represent the model (Sugiki et al., 2021; Turker & Bingol, 2023; Wegener & Spiekermann, 2018).

In the simulation field, agent-based simulation has been extensively utilized to capture the behaviour of individual agents by following predetermined local rules of interaction, either with the environment or with other agents. Taking inspiration from physical phenomena, Helbing introduced a model based on the concept of social force (Helbing et al., 1995). This force serves as an internal driving factor for agents, influencing variables such as velocity and acceleration at each simulation timestep.

Another significant advancement has been the application of cellular automata (CA) models for pedestrian simulation (Batty, 2001). In CA models, the world is defined as a grid of individual cells (in 2D simulations), where each cell updates its state based on a set of rules typically dependent on the states of neighbouring cells. CAs have been employed in the study of pedestrian movement, including bidirectional movement in walkways (Blue et al., 2001). An alternative approach utilizes CA models with agents having long-range interactions through a floor field, which modifies the transition rules of each cell. This floor field undergoes diffusion and decay, drawing inspiration from the concept of chemotaxis, where biological entities respond to chemical substances in the environment (Burstedde et al., 2001).

3. Modelling approach

A decision was made to construct a computer-based simulation representing the Alvalade region. This simulation would serve as a valuable instrument for investigating the constructed surroundings, offering the ability to function as a guide for envisioning future design options and interventions.

The simulation was programmed in NetLogo (Wilensky, 1999), a platform for agent-based simulation focused on exploratory research. Figure 4 shows the interface of the platform with a viewport and controls. Procházka et al. have shown the use of the NetLogo platform for the modelling of pedestrian movement under three different modelling approaches: based on cellular automata, implementing a social force model, and using a network model of pedestrian movement (Procházka et al., 2015).

The utilized model incorporates ground images that serve as maps, representing the key elements of significance. These images, obtained from openstreetmap.org (2017), are in the form of 1024x1024 raster images. However, before their usage, a pre-processing stage is necessary to address potential inaccuracies within the GPS data. During this stage, some issues arise where certain urban features, such as footpaths and artificial barriers within them, either exist or are absent in the real world but are not accurately captured by GPS data. The authors have confirmed these discrepancies through on-site verification.

The loaded images serve as static elements within the environment, encompassing a variety of features such as roads, schools, buildings, crosswalks, and more. For this study, schools, streets, and pedestrian passages were specifically chosen. The cellular automaton (CA) technique employed in this research maps each location on the image to the distance from the nearest school. Each location, referred to as a patch in NetLogo's terminology, has the flexibility to contain any desired set of properties as specified by the researcher.

Figure 3. Locations of public schools in Alvalade corresponding to levels 1–4 (left), 5–9 (middle) and 10–12 (right)

As schools in the area depicted by Figure 2 encompass all levels of schooling (1–12) it was necessary to break down the study in age brackets. The public school system comprehends 3 main brackets, with different schools for each bracket: levels 1–4 (ages 6–9), levels 5–9 (ages 10–14), and levels 10–12 (ages 15-17). In this work, we only considered public schools, although there are some private schools in the area. This leads to 3 layers of analysis with a different set of schools. This is shown in Figure 3 where the public schools for each set of levels are shown.

4. Metrics

The cellular automaton (CA) algorithm calculates the time required to update the cells representing public circulation elements such as roads, pedestrian passages, and squares to reach the nearest school of interest. Each cell is updated based on its Moore neighbourhood, taking the maximum value of the time from its neighbouring cells, and adding one. This process creates a diffusion wave that represents the minimum effective travel time from the school areas. It can be likened to the breadth-first traversal algorithm on a tree.

By obtaining the final time value for each patch, we generate a density distribution of all the cells representing public circulation, which is then compared visually and numerically. These distances are scaled based on the average movement speed and the size of the cells within the area. In our model, the cell size is set to 2m, and the speed is assumed to be 1m/s (equivalent to traversing one cell in 2 seconds or a speed of 3.6km/h). This speed is chosen as a lower bound, as in real scenarios, children exhibit a range of speeds that can be modelled using distributions (David et al., 2005).

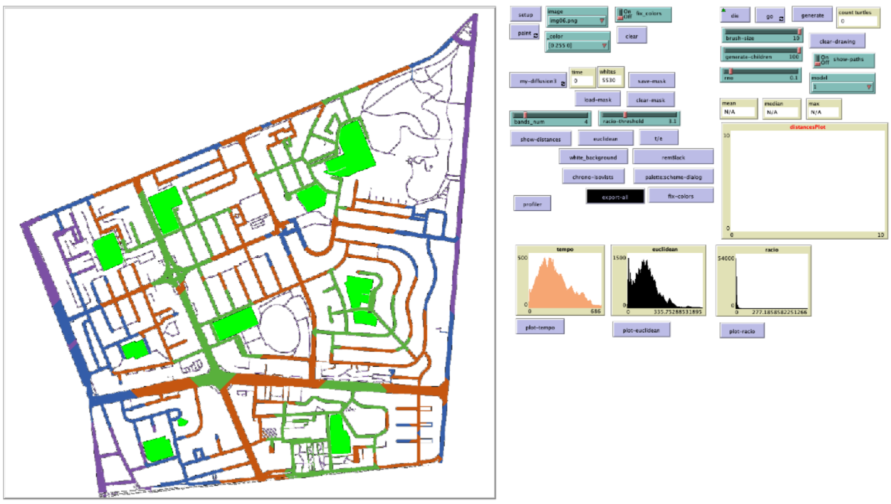

Figure 4. The interface of the simulation environment shows the resulting analysis on the left viewport and the different interaction widgets (buttons, plots, monitors) on the right side. The interface was designed to be expanded further with new models of pedestrian movement.

4. Results

Considering the typical speed of 1m/s (3.6km/h) it is possible to determine how far every building of Alvalade is from a school. This is seen in the resulting Figure 5 where the different chrono-maps are visible. Each colour marks the locations in the public space whose time travel to the closest schools falls in one of 4 brackets: red for times up to 5 minutes, orange for times up to 10 minutes, green for times up to 15 minutes, and violet for times over 15 minutes.

Figure 5. Chrono-map of the Alvalade neighbourhood for the 3 levels of schools studied: (left) levels 1–4, (middle) levels 5–9, (right) – levels 10–12.

It is clear from the measurements that the east cells of Alvalade lack it terms primary school (left on the figure). For levels 5–9, the southwest cell becomes isolated while in the cases of secondary schooling, both the northwest and southeast cells become also further distant from the schools. The northeast cell, although distant from schools of levels 1–9 is mostly an urban green park. This analysis shows that the flanking limits to the east (av. Gago Coutinho) and to the south (train line) are the most distant.

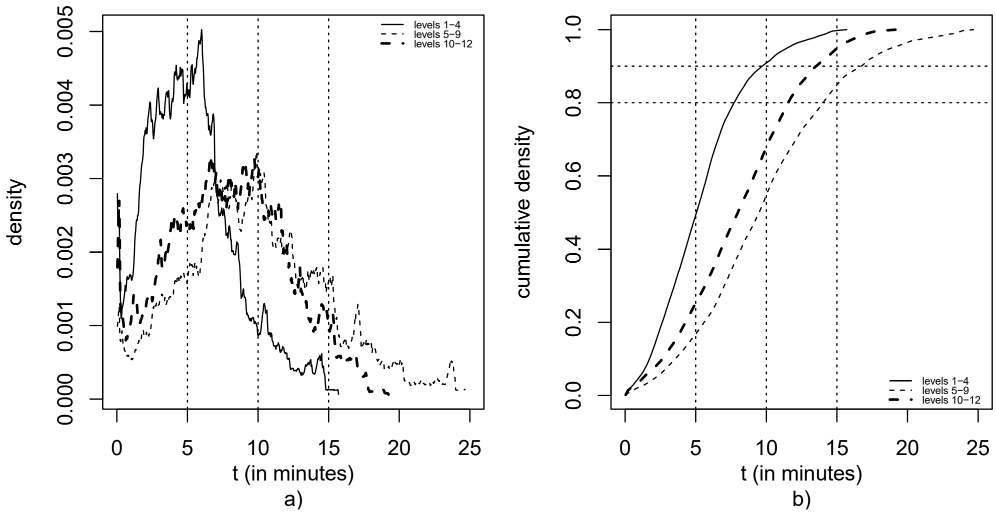

Figure 6. Time taken by walker of different levels to the nearest school considering a walking speed of 1m/s: a) density, b) cumulative density.

The distribution of the times described visually can be confirmed by the results shown in Figure 6. Most children studying in levels 1–4 will get to school under the 15 minutes proposed. Indeed, more than 90% are within the 10-minute walk mark. In contrast with this, elder children and adolescents will be at a disadvantage taking more time to go to school. Levels 5–9 have approximately 55% below the 10-minute walk and 85% under the 15-minute mark. Levels 10-12 are slightly better with 70% at 10 minutes or less, while almost 95% reside under the 15-minute time.

One could argue that elder children will be able to walk faster than the proposed 1m/s used in the simulation. In any case, this would shrink the distances for the elder students. As an example, using a walking speed of 1.3 m/s would reduce the 25-minute distances to approximately 20 minutes, still leaving students of levels 5-9 outside the 15-minute distance proposed in the literature.

5. Conclusions

Gaining an understanding of the interplay between walkability and the urban landscape necessitates an examination of the urban morphology within the studied territory. The built environment, shaped by urban morphology, exerts influence on the decision to walk, thereby emphasizing the importance of walkability and access to various amenities in cities. Increasing the provision of pedestrian-only streets and minimizing vehicular traffic are crucial steps toward creating pedestrian-friendly urban environments.

The quality of public spaces directly impacts the overall quality of life within a city. The excellence of public spaces facilitates pedestrianization efforts. To investigate the impact of public space quality on the pedestrian environment, we have selected Alvalade, a neighbourhood in Lisbon, Portugal, designed in the 1940s, which exemplifies some of Perry's principles.

This paper highlights how the historical neighbourhood of Alvalade aligns with the urban design principles set forth by the modern movement in the early 20th century. The site served as an experimental ground for applying urban design principles of that era. We have developed a cellular automata simulation using NetLogo to explore and test the urban design choices employed in Alvalade. The simulation indicates that the neighbourhood adheres to the principles of the modern movement, where public schools serve as the foundational entities for each sub-community within the neighbourhood. The simulation incorporates roads, squares, open spaces, and pedestrian passages to provide a comprehensive description of urban design. Our findings indicate that Alvalade aligns with current trends in urban design, particularly in relation to schools. However, the concept of the 15-minute city encompasses multiple dimensions beyond school routes.

Simulation offers valuable insights into the possibilities for studying urban design, and future work will focus on addressing the limitations of this model. Further aspects will be explored, and the motion of agents can be modelled to better resemble natural movement patterns. The inclusion of different modes of transportation, as well as the consideration of children residing outside the area, will introduce heterogeneity into a multi-level dynamic simulation.

Throughout history, numerous ideas and experimental approaches have been proposed to define what constitutes a "good city for living in," often driven by technological demands. The 20th-century automobile industry, for example, influenced the development of cities with wide avenues and extensive parking areas, which eventually proved excessive and are now being rejected. The 15-minute city concept aims to restore the local dynamics of small villages by localizing services, promoting walking, cycling, and integrating housing with green spaces. Our analysis reveals that Alvalade exhibits characteristics of the 15-minute city, and specifically in terms of schooling, attests to the enduring value of the practised urban design principles.

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Conflict of Interests

The authors declare no conflict of interest.

References

AA.VV (1999). Qualité architecturale et urbaine et satisfaction residentielle - Project nº 233 H3, rapport de mission.[Architectural Quality and Residential Urban Satisfaction] *Programme de Cooperation Scientifique et Technique Luso-Française - CSTB/ LNEC/ laboratoire de Sociologie Urbaine Générative* (CSTB, Paris, Setembro 1999).

Alegre, A. (2004). Casas de Rendas Económicas das Células I e II do Plano de Urbanização de Alvalade – 1ª Experiência de Urbanização Integral [Low Rent Houses of cells I and II of the Alvalade Urban Plan – 1st Integral Urban Experiment]; *Engenharia em Portugal no Século XX* (Edição Dom Quixote, Lisboa, 2004).

Allam, Z., Bibri, S., Chabaud, D., Moreno, C. (2022). The Theoretical, Practical, and Technological Foundations of the 15-Minute City Model: Proximity and Its Environmental, Social and Economic Benefits for Sustainability. *Energies*, 15, 6042 (2022), pp.1-20. https://doi.org/10.3390/en15166042

Amen, M. A. (2021). The Assessment of Cities Physical Complexity through Urban Energy Consumption. Civil Engineering and Architecture, 9(7), 2517–2527. https://doi.org/10.13189/cea.2021.090735

Aziz Amen, M. (2022). The effects of buildings' physical characteristics on urban network centrality. Ain Shams Engineering Journal, 13(6), 101765. https://doi.org/10.1016/j.asej.2022.101765

Amen, M. A., Afara, A., & Nia, H. A. (2023). Exploring the Link between Street Layout Centrality and Walkability for Sustainable Tourism in Historical Urban Areas. Urban Science, 7(2), 67. https://doi.org/10.3390/urbansci7020067

Amen, M. A., & Nia, H. A. (2020). The Effect of Centrality Values in Urban Gentrification Development: A Case Study of Erbil City. Civil Engineering and Architecture, 8(5), 916–928. https://doi.org/10.13189/cea.2020.080519

Aziz Amen, M., & Nia, H. A. (2018). The dichotomy of society and urban space configuration in producing the semiotic structure of the modernism urban fabric. Semiotica, 2018(222), 203–223. https://doi.org/10.1515/sem-2016-0141

Amen, M. A., & Kuzovic, D. (2018). The effect of the binary space and social interaction in creating an actual context of understanding the traditional urban space. Journal of Contemporary Urban Affairs, 2(2), 71–77. https://doi.org/10.25034/ijcua.2018.3672

Amen, M. A., & Nia, H. A. (2021). The Effect of Cognitive Semiotics on The Interpretation of Urban Space Configuration. https://doi.org/doi:10.38027/iccaua2021227n9

Aziz Amen, M. (2017). The inspiration of Bauhaus principles on the modern housing in Cyprus. Journal of Contemporary Urban Affairs, 1(2), 21–32. https://doi.org/10.25034/ijcua.2017.3645

Batty, M. (2001). Agent-Based Pedestrian Modeling. Environment and Planning B: Planning and Design, 28(3), 321–326. https://doi.org/10.1068/b2803ed

Blue, V. J., & Adler, J. L. (2001). Cellular automata microsimulation for modeling bi-directional pedestrian walkways. Transportation Research Part B: Methodological, 35(3), 293–312. https://doi.org/10.1016/S0191-2615(99)00052-1

Brito, M. M. A. (1991). Os anos 40 em Portugal: o país, o regime e as artes: restauração e celebração[The 40s in Portugal: the country, the regime, and the arts: restauration and celebration]. Ph.D. thesis, Universidade Nova de Lisboa, 1991. http://hdl.handle.net/10362/14822

Brito, V., Camarinhas, C. (2007). Elementos para o Estudo do Plano de Urbanização da Cidade de Lisboa (1938) [Elements for the study of the Urban plan for the city of Lisbon (1938)], *Caderno do Arquivo Municipal*, n.º 9 (2007), pp.163-189.

Burstedde, C., Klauck, K., Schadschneider, A., & Zittartz, J. (2001). Simulation of pedestrian dynamics using a two-dimensional cellular automaton. *Physica A: Statistical Mechanics and Its Applications*, 295(3), 507–525. https://doi.org/10.1016/S0378-4371(01)00141-8

Costa, J. P. (1998). Bairro de Alvalade: Considerações sobre o urbanismo habitacional[Alvalade Neighbourhood: Considerations on the residential urbanism]. *MSc. Dissertation*, UTL-Universidade Técnica de Lisboa. http://hdl.handle.net/10400.5/1629

David, K. S., & Sullivan, M. (2005). Expectations for Walking Speeds: Standards for Students in Elementary Schools. *Pediatric Physical Therapy*, 17(2), 120. https://doi.org/10.1097/01.PEP.0000163074.89545.FA

Helbing, D. (1998). A Fluid Dynamic Model for the Movement of Pedestrians [Internet]. *arXiv*; 1998 [cited 2023 May 4]. Available from: http://arxiv.org/abs/cond-mat/980521

Helbing, D., Molnar, P. (1995). Social force model for pedestrian dynamics. *Phys Rev E*. 1995;51(5):4282.

Henderson, L. F. (1974). On the fluid mechanics of human crowd motion. *Transp Res.* 1974 Dec 1;8(6), pp. 509–15.

Howel, M. S. L. (1995). Planos de Urbanização — A Época de Duarte Pacheco. Porto: *FAUP publicações*, 1995.

Khavarian-Garmsir, A. R., Sharifi, A., & Sadeghi, A. (2023). The 15-minute city: Urban planning and design efforts toward creating sustainable neighborhoods. *Cities*, 132, 104101. https://doi.org/10.1016/j.cities.2022.104101

Marat-Mendes, T., Sampayo, M. (2010). Étienne de Groër: The different scales of the urban intervention in Lisbon territory. *1st International Meeting European Architectural History Network*, Conference Proceeding (European Architectural History Network, Guimarães, 2010).

Moreno, C., Allam, Z., Chabaud, D., Gall, C. (2021). Pratlong F. Introducing the "15-Minute City": Sustainability, Resilience and Place Identity in Future Post-Pandemic Cities. *Smart Cities*. (2021 Mar);4(1), pp. 93–111. https://doi.org/10.3390/smartcities4010006

OpenStreetMap contributors (2017). Planet dump retrieved from https://planet.osm.org. 2017.

Perry, C. A. (1929). The neighbourhood unit: A scheme of arrangement for the family.

Pozoukidou, G., & Chatziyiannaki, Z. (2021). 15-Minute City: Decomposing the New Urban Planning Eutopia. *Sustainability*, 13(2), Article 2. https://doi.org/10.3390/su13020928

Procházka, J., Cimler, R., K. Olševičová (2015). Pedestrian modelling in NetLogo. *Emergent Trends in Robotics and Intelligent Systems: Where is the Role of Intelligent Technologies in the Next Generation of Robots?* Springer; 2015. pp. 303–12. https://doi.org/10.1007/978-3-319-10783-7_33

Sampayo, M., Sousa-Rodrigues, D. (2009). The five plans for the aftermath of 1755 Lisbon earthquake: the interplay of urban public spaces. *ISUF 2009 - Urban morphology and urban transformation* (ISUF, China, Guangzhou, 2009).

Sugiki, Nao, Shogo Nagao, Fumitaka Kurauchi, Mustafa Mutahari, and Kojiro Matsuo. Social Dynamics Simulation Using a Multi-Layer Network. *Sustainability* 13, no. 24 (January 2021): 13744. https://doi.org/10.3390/su132413744.

Terreno, P. (2013). João Guilherme Faria da Costa [Internet]. *Monumentos*. Available from: http://www.monumentos.gov.pt/Site/APP_PagesUser/Entity.aspx?id=a34edeeb-1d22-4f8b-ae46-368811ee28df

Tostões, A. (2001). O Bairro de Alvalade no quadro do desenvolvimento urbano de Lisboa [The Alvalade Neighbourhood in the Lisbon urban development framework]. *AAVV - Lisboa: Conhecer Pensar Fazer Cidade* (Centro de Informação Urbana de Lisboa, Lisboa, 2001), pp. 64-71.

Turker, Meliksah, and Haluk O. Bingol. Multi-Layer Network Approach in Modeling Epidemics in an Urban Town. *The European Physical Journal B* 96, no. 2 (6 February 2023): 16. https://doi.org/10.1140/epjb/s10051-023-00484-4.

Wegener, Michael, and Klaus Spiekermann. Multi-Level Urban Models: Integration across Space, Time and Policies. *Journal of Transport and Land Use* 11 (5 January 2018). https://doi.org/10.5198/jtlu.2018.1185.

Wilensky, U. (1999). NetLogo [Internet]. Northwestern University, Evanston, IL: *Center for Connected Learning and Computer-Based Modelling*, Evanston, IL; 1999. Available from: http://ccl.northwestern.edu/netlogo/

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Editors: Hourakhsh Ahmad Nia and Rokhsaneh Rahbarianyazd
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