Function, Role, Limitation, and Potential of Space Syntax Analysis in Architectural Field

Fitria Khairanisa

Building and Residential Analysis Staff, Cipta Karya Field, Dinas Pekerjaaan Umum Penataan Ruang
Sukoharjo Regency

Article Info	ABSTRACT
	This study aims to determine the function, roles, limitations, and potential of spatial configuration analysis with Space Syntax. The development of digital technology affects the development of science, including in the field of architecture. Digital technology is not only a design visualization tool but also a part of the design process and a thinking tool for architects in designing. One of them is the Space Syntax program. Space Syntax is a quantitative analysis tool used to analyze the pattern of relationships between spaces in various forms of architectural space: buildings, cities, interiors, and landscapes. The method used in this research is the literature study method. Data collection techniques are collecting several sources from the internet and journal references that discuss using the Space Syntax program. The results of this study indicate that Space Syntax has a function, roles, limitations, and potential in analyzing architectural space. SpaceSyntax can explore various horizontal space scales, including buildings objects and urban areas. However, the findings show that Space Syntax has limitations. Some studies use a combination of other methods to overcome this limitation. The combination method also raises the potential of Space Syntax as an analysis tool in the architectural field.

Corresponding Author

Fitria Khairanisa,
Building and Residential Analysis Staff, Cipta Karya Field
Dinas Pekerjaaan Umum Penataan Ruang (DPUPR) Sukoharjo Regency, Central Java
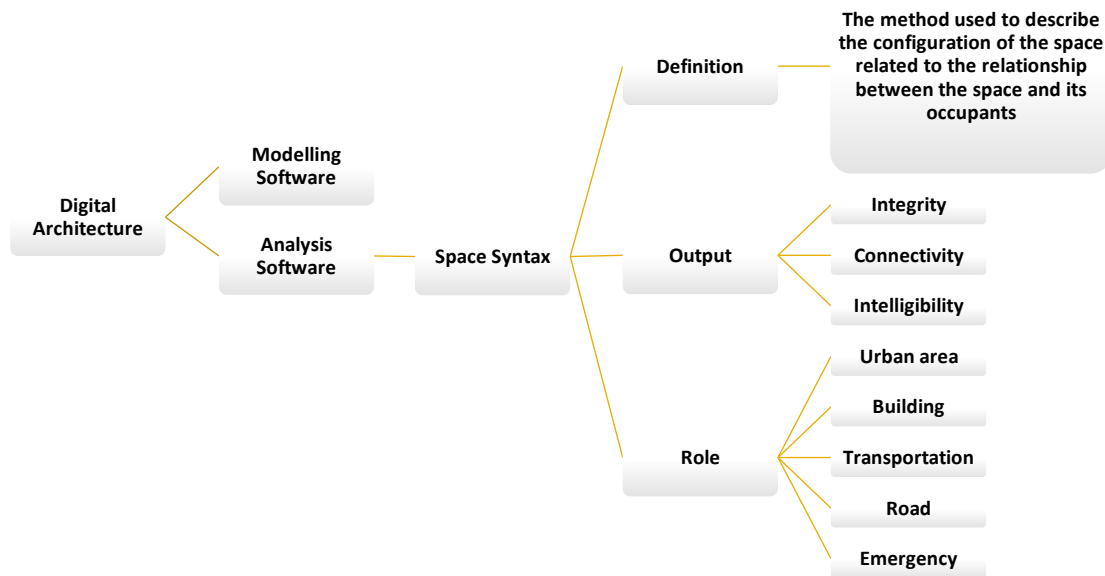Email: fitriakhairanisa@gmail.com

1. INTRODUCTION

Technological developments make life easier for humans. The trend of technological development towards automation is becoming increasingly unavoidable. From the invention of computer microchip technology in the 1960s, innovation and advancement of the human mind have been expanded by the presence of generally available sophisticated devices [1]. Digital technology is not only used to assist and speed up the drawing process, but now digital technology has been able to assist the design process as an analytical instrument. One is the Space Syntax, which aids in analyzing space configurations.

Space Syntax is software to determine visitor movement patterns by analyzing the layout of the space in the form of images by showing the value of intelligibility (clarity of space) in the area's configuration. The higher the syntax value, the easier it will be to understand so that it will encourage activities [2].

Space is a container of activity in which various activities require a spatial configuration, which then impacts an effective and efficient spatial arrangement determined by forming the spatial structure. In theory,

Hillier [3] reveals that space formation comes from relationships with other spaces as a place of user activity [2]. The pattern of relationships between spaces is known as syntax. The syntax is a pattern of spatial relationships that allows space configuration to mean everyone can read or understand. Space Syntax relates to the relationship between humans and the space they occupy. Uses Space Syntax to understand space in its configuration, especially the process of its formation and the social meaning conveyed [4].

Figure 1. Schematic Explanation of the Space Syntax Program

Based on the above background, there is a need for further research on various uses of Space Syntax analysis in architectural design. This study aims to determine the role, function, limitation, and potential of Space Syntax in architecture. Space Syntax needs to be discussed further regarding the roles, function, limitations, and potential in architectural design to contribute information to assist architects in developing artificial intelligence technology in architectural design.
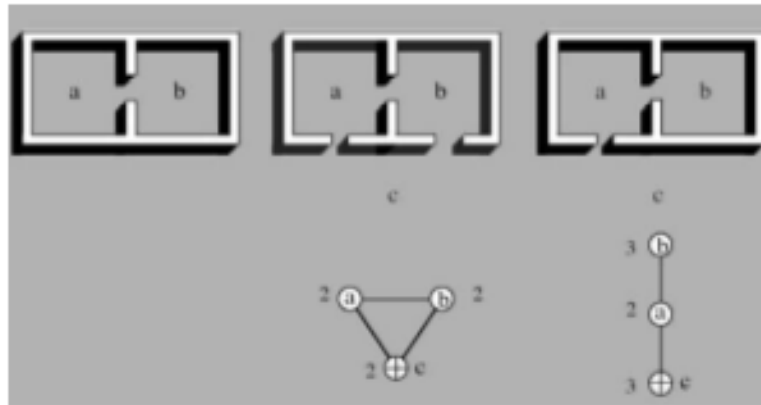
2. RESEARCH METHOD

This research uses the literature study method. The data collection technique was carried out with the Publish or Perish application. The Publish or Perish application collects national and international journal articles relevant to the theme. Primary data sources are literature studies of assorted journal references that use Space Syntax as an analytical method. The keywords used to search for articles in Publish or Perish are 'Space Syntax ' and 'configuration space.' There are 30 articles used as data sources in this study published in the last ten years, between 2012 and 2022. The literature study analyzed the function, role, limitation, and potential of using Space Syntax in analyzing the architectural space configuration.

3. RESULTS AND DISCUSSION

3.1. Function of Space Syntax

Architecture is a discussion about space that forms from people's activities and movements. Various exercises require a spatial configuration which then impacts an effective and efficient spatial arrangement determined from the formation of the spatial structure. This spatial relationship pattern is called spatial configuration. Space Syntax is a quantitative analysis program that helps architects design space configurations. An excellent spatial configuration will positively impact human movement and activities in the space.

Configuration is closely related to the relationship between spaces in a system or arrangement to comfort the user. A relationship between spaces largely determines how people or users use space. The pattern of relationships between spaces, called configuration in a system or arrangement by Hillier, is named by a syntax that has a value to be read and understood easily by everyone. With readable values, architects as designers or evaluators can easily understand how human characteristics or the users of a space act in response to a spatial configuration—this configuration approach by Space Syntax [5].

Figure 2. Configuration Concept
Source: Yudhanta, 2018

The concept of space configuration developed into a computer program as a Space Syntax analysis tool with graphical presentation. The Space Syntax analysis technique uses Depthmap (created by Hillier). Through the Depthmap software, the relationship between space configurations in a system can be used to evaluate how the space can work, then predict the next step to find the most suitable solution in an architectural design process.

It can assess three aspects of space configuration in Space Syntax. The three aspects are connectivity (spatial relations), integrity (relative position of space), and intelligibility (clarity of space). Spatial clarity is the highest measurement stage in spatial syntax, resulting from the correlation between space (connectivity) and the relative position of space (integrity).

3.2.   The Role of Space Syntax in the Architectural Field

The development of the architecture world has experienced changes following the development of the digital industry 4.0, using Space Syntax software to help architects work. Space Syntax has been applied in various kinds of architectural analysis, as follows:

a)   Urban Area

It can use Space Syntax as a tool used in quantitative analysis for various scales of research objects. Space Syntax can help architects see the configuration of large (macro) spaces on a city/urban area scale. The following table will discuss articles that use the Space Syntax instrument in the scale of these objects:

Table 1. List of Researches That Use Space Syntax as An Analytical Instrument

Year	Writer	The Role of Space Syntax in Research
2012	Renaldi Abdul Halid, Ahmad Sarwadi	Using Space Syntax to determine the relationship between activity patterns and the configuration of the northern square space [6]
2016	Johannes Adiyanto	Using Space Syntax to examine changes to the open space configuration of historical areas [7]
2018	Muhammad Fajri Romdhoni, Priemadella, Adam Fitriawijaya	Using Space Syntax to analyze space configuration patterns to see spatial logic and space use [8]

2018	Mila Karmilah, Nyandra Sari Maagfiroh	Using Space Syntax for space configuration analysis in the Sangiran area [9]
2018	Try Ramadhan, Gema Ramadhan, Karto Wijaya, Asep Yudi Permana	Studying an area with Space Syntax analysis to determine the placement of social facilities [10]
2019	Adrianus Leo Liem, Budi Prayitno	Use Space Syntax to analyze the configuration of the urban village residential space footprint based on Space Syntax [11]

Based on the literature review, the Space Syntax software can be an architect's tool in analyzing the relationship between the configuration of the spatial structure and the pattern of activities to determine the value of the visibility of each space in an urban area.

b) **Architecture and Building Planning**

It can use Space Syntax as a tool used in quantitative analysis for various scales of research objects. Space Syntax can also help architects see the configuration of mezzo and micro spaces in the interior scale and architectural planning. The following table will discuss articles that use the Space Syntax instrument in the scale of these objects:

Table 2. List of Researches That Use Space Syntax as An Analytical Instrument

Year	Writer	The Role of Space Syntax in Research
2013	Maharani Isabela, Budi Prayitno	Use Space Syntax to see the integration value and space visibility [12]
2013	Wiwien Prasasti Barada, Dhani Mutiari.	Using Space Syntax to analyze the space performance level of the space configuration and its accessibility [13]
2016	Bayu Setyanugraha Rushadi, Tito Hadipradianto, Herry Santosa	Using Space Syntax to solve problems in the design of educational buildings [14]
2018	Widi Cahya Yudhanta, Budi Prayitno	Using Space Syntax to analyze the relationship between activity patterns and the configuration of the northern square space [5]
2018	Matheas Ellanda Wijaya, Tito Haripradianto	Using Space Syntax to examine the configuration of the market space for revitalization [15]
2018	Irfan Irwanuddin	Using Space Syntax to identify the genotype of the traditional house of West Sumba [16]
2019	Rachadian Hadiwibowo	Using Space Syntax to analyze vertical circulation elements in buildings with heritage criteria [17]
2019	Andi Andre Pratama Putra, Ardhya Nareswari, Budi Prayitno	Using Space Syntax to analyze space changes [18]
2020	Dewi Nurhalimah, Dyah Widi Astuti	Using Space Syntax to analyze the relationship between the distribution of Klewer Market visitors and the market space configuration [2]
2020	Asep Yudi Permana, Aathira Farah Salsabila Permana, Deka Andriyana	Using Space Syntax to analyze space configuration in office design [19]

Based on the literature review, the Space Syntax software can be an architect's tool in analyzing the relationship between the configuration of the spatial structure and the pattern of human movement to determine the value of the visibility and accessibility of each space in a building.

c) **Permeability or Transport**

It can use Space Syntax as a tool used in quantitative analysis for various scales of research objects. Space Syntax can help architects see the circulation flow, analyzing permeability and transportation. The following table will discuss articles that use the Space Syntax instrument in the scale of these objects:

Table 3. List of Researches That Use Space Syntax as an Analytical Instrument

Year	Writer	The Role of Space Syntax in Research
2018	Lily Mauliani, Anisa, Wafirul Aqli	Space Syntax is an analytical method (simulation of Space Syntax) to determine the quality of accessibility and potential permeability of an area [20]

Based on the literature review, the Space Syntax software can be an architect's tool in analyzing the relationship between human movements to determine the right path based on accessibility in the regional structure.

d) **Road/Network**

It can use Space Syntax as a tool used in quantitative analysis for various scales of research objects. Space Syntax can assist architects in analyzing roadmaps and road networks in an area. The following table will discuss articles that use the Space Syntax instrument in the scale of these objects :

Table 4. List of Researches That Use Space Syntax as An Analytical Instrument

Year	Writer	The Role of Space Syntax in Research
2017	Ehsan Valipour, Samira Tayyebisoudkolaei, Abdolah Mobaraki	Using Space Syntax to read the city road network in Sari, Iran [21]
2019	Ehsan Valipour, Samira Tayyebisoudkolaei, Abdolah Mobaraki	Using Space Syntax to read the city road network in Famagusta City, Cyprus [22]
2019	Wafirul Aqli	Using Space Syntax to analyze roads in the UGM campus area to see the level of security and privacy [23]
2021	M.F. Arief, Titis Srimuda Pitana, Untung Joko Cahyono.	Using Space Syntax to analyze spatial transformations in the Klego Simo Boyolali corridor [24]

Based on the literature review, the Space Syntax software can be a tool for architects in analyzing road configurations in the regional structure based on the value of accessibility and visibility.

e) **Emergency**

It can use Space Syntax as a tool used in quantitative analysis for various scales of research objects. Space Syntax can be used as a disaster mitigation tool. The following table will discuss articles that use the Space Syntax instrument in the scale of these objects:

Tabel 5. List of Researches That Use Space Syntax as An Analytical Instrument

Year	Writer	The Role of Space Syntax in Research
2019	Atik Prihatiningrum, Samsul Bahri, Fitrianty Wardhani	Using Space Syntax to analyze the configuration of the Bengkulu University FKIP cluster room to design evacuation routes during an emergency [25]
2020	Valerio Cutini dan Camilla Pezzica	Using Space Syntax to analyze the structure and road network of the city of Genoa and the city of Bologna per period of urban development to predict disasters that will occur in the future [26]

Based on the literature review, Space Syntax has the potential to be developed in the concept of emergency analysis. In addition to architectural analysis, Space Syntax also has the potential as an analytical tool for emergencies. Space Syntax can predict disasters that are likely to occur in the future so that we can prepare plans and preventive actions.

3.3. Limitation of Space Syntax

Based on the literature review discussion results, the Space Syntax analysis has limitations. Several research journal articles that use Space Syntax overcome these shortcomings by combining other methods. The combination method aims to obtain comprehensive and relevant analysis results with actual conditions.

Table 6. List of Researches That Use Space Syntax as An Analytical Instrument

Year	Writer	The Limitation of Space Syntax in Research
2012	Rafael Henrique Moraes Pereira, Frederico Rosa Borges de Holanda, Valério Augusto Soares de Medeiros, Ana Paula Borba Gonçalves Barros.	The limitations in the Space Syntax method prevent observations in the regression analyses performed in this study. Space Syntax cannot control other factors that can affect the travel time of urban transport, such as the number of traffic lights, the speed limits of the routes, and the highway network capacity in terms of lanes [27]
2021	Claudia Yamu, Akkelies van Nes, Chiara Garau.	Space Syntax has limitations for its lack of 3D information and failure to account for urban features, such as public transport hubs and wayfinding. Space Syntax initially only works with topological distances (number of changes in direction) [28]
2021	M F Arief, T S Pitana, U J Cahyono	The use of spatial syntactic analysis has limitations. Other factors include government policies, the presence of investors, and so on. It can combine with other methods, such as this study, for a more accurate analysis [24]

3.4. Potential of Space Syntax

Based on the literature review discussion results, there is still a lot of potential for Space Syntax that can develop in space analysis. One of them is testing acoustic space, especially acoustics in public open spaces in urban areas. This study explains the potential Space Syntax used in various analyses by combining other methods, such as the GIS (Geographic Information System) method. We hope to find more consistent results

with the help of studies that can control for several other factors. In addition, different statistical analysis methods can also give more consistent results.

Table 7. List of researches that use Space Syntax as an analytical instrument

Year	Writer	The Potential of Space Syntax in Research
2014	Weronika Dettlaff	This research uses Space Syntax, which combines with other methods. Combination with different ways to get balanced and comprehensive results according to plan [29]
2017	Itzhak Omer, Ran Goldblatt	This study presents the potential combination between Space Syntax and Q-analysis methodology for investigating building flow movement patterns. Q-analysis is used to identify the spread of individual movement paths and their conjunction within the movement area. At the same time, Space Syntax allows examining how this aspect of movement flow is affected by the spatial configuration of the mall. The combination of Space Syntax and Q-analysis improves the understanding of the role of the spatial arrangement of buildings in shaping the flow of motion
2020	Clua, Álvaro Llorca-Bofí, Josep Psarra, Sophia	Space Syntax can be used as an analytical method (simulation of Space Syntax) to test urban acoustics. This study uses a VGA and isovist approach and a combination method in the form of a Convex map, justified graph, and visual graph analysis [30]
2021	Cemil Atakara, Mitra Allahmoradi	This study analyzes the spatial growth of the City of Famagusta using a combination of Space Syntax and GIS methods [31]

4. CONCLUSION

The development in human activities and movements makes the spatial scale even more complex. Space from the smallest to the most significant scale has a spatial configuration with people's movements and actions. The area development can use Space Syntax to analyze space, including micro, mezzo, and macro scales. A review of the published research literature shows that the Space Syntax can explore urban area space, building planning, permeability/transportation, road/network, and emergency planning.

Although the Space Syntax program has a limited space analysis, it can be solved by other methods. We can combine the results of the Space Syntax analysis with other research methods for a more detailed and relevant analysis process to the research object to provide better results with better accuracy. Space Syntax has the potential to be used in other analyzes when combined with other methods, such as the GIS (Geographic Information System) method and other statistical analysis methods.

REFERENCES

[1]   M. G. Gunagama dan N. F. Lathifa, "Automatictecture : Otomatisasi Penuh Dalam Arsitektur Masa Depan," *NALARs*, vol. 16, no. 1, pp. 43, 2017.

[2]   D. Nurhalimah dan D. W. Astuti, "Analisis Hubungan Konfigurasi Ruang dengan Penyebaran Pengunjung Pasar Klewer Menggunakan Space Syntax ," *Sinektika J. Arsit.*, vol. 17, no. 1, pp. 13–20, 2020.

[3]   B. Hillier, *Space is the machine: a configurational theory of architecture*. Space Syntax, 2007.

[4]   S. Bafna, "Space Syntax: A brief introduction to its logic and analytical techniques," *Environ. Behav.*, vol. 35, no. 1, pp. 17–29, 2003.

[5]   W. C. Yudhanta, "Pengaruh Konfigurasi Dan Visibilitas Ruang Pada Aksesibilitas, Studi Kasus Pada Kawasan Xt Square Yogyakarta," *J. Arsit. KOMPOSISI*, vol. 12, no. 1, pp. 67, 2018.

[6]   R. A. Halid, "HUBUNGAN POLA GUNA RUANG DENGAN KONFIGURASI RUANG DI ALUN-ALUN UTARA YOGYAKARTA Menggunakan metode analisa Space Syntax ," Universitas Gadjah Mada, 2012.

[7]   J. Adiyanto, "Kajian Perubahan Ruang Terbuka pada Kawasan Bersejarah dengan Metode Space Syntax (Studi kasus Kawasan Kampung Kapitan Palembang)," *J. Perenc. Wil. dan Kota*, vol. 27, no. 2, pp. 103, 2016.

[8]   M. F. Romdhoni, "Analisis Pola Konfigurasi Ruang Terbuka Kota Dengan Penggunaan Metoda Space Syntax Sebagai Spatial Logic Dan Space Use," *NALARs*, vol. 17, no. 2, pp. 113, 2018.

[9]   M. Karmilah dan N. S. Magfiroh, "Using Space Syntax To Determine The Form And Pattern Of Heritage Site (Case Study: Sangiran Heritage Site)," *J. Planol.*, vol. 15, no. 1, pp. 81, 2018.

[10]   T. Ramadhan, G. Ramadhan, K. Wijaya, dan A. Y. Permana, "Kajian Spasial Penempatan Fasilitas Sosial di Pemukiman Padat Kota Bandung: Analisis Space Syntax Studi Kasus : Wilayah Kelurahan Burangrang, Kecamatan Lengkong, Kota Bandung," *J. Arsit. ARCADE*, vol. 2, no. 2, pp. 66, 2018.

[11]   A. L. Liem, "Analisis Konfigurasi Tapak Ruang Permukiman Kampung Kota Berbasis Space Syntax (Studi Kasus : Perumahan Padat Penduduk Kelurahan Sindulang Satu , Manado)," *J. Malige Arsit.*, vol. 1, no. 2, pp. 11–20, 2019.

[12]   M. Isabela, "INTERKONEKTIVITAS RUANG PUBLIK SEBAGAI PENINGKAT KUALITAS KAWASAN PEMUKIMAN TEPIAN SUNGAI GAJAH WONG, MENGGUNAKAN SPACE SYNTAX ," Universitas Gadjah Mada, 2013.

[13]   W. P. Barada dan D. Mutiari, "Analisis Space Syntax Rumah Susun Berbasis Gang Kampung," *Simp. Nas. RAPI XII*, pp. 59–63, 2013.

[14]   H. S. Bayu Setyanugraha Rushadi, Tito Haripradianto, "Sekolah Fotografi di Kota Malang Dengan Pendekatan Analisa Space Syntax ," *Jurnal*, 2016.

[15]   M. E. Wijaya, "Revitalisasi Pasar Blauran Surabaya Dengan Pendekatan Analisis Space Syntax ." Universitas Brawijaya, 2018.

[16]   I. Irwanuddin, "Identifikasi Genotype Rumah Adat Sumba Barat dengan Metode Space Syntax ," *J. RUAS*, vol. 16, no. 1, pp. 58–70, 2018.

[17]   R. Hadiwibowo, "Penataan Elemen Sirkulasi Vertikal Pada Gedung Unpar Jl.Merdeka No.30 Bandung Melalui Pendekatan Space Syntax Dan Kriteria Heritage," 2019.

[18]   A. A. P. Putra dan A. Nareswari, "Space Consolidation for Fishing Settlement in Mariso District, Makassar City with Space Syntax," *J. Archit. Res. Des. Stud.*, vol. 2, no. 2, 2019.

[19]   A. Y. Permana, A. F. S. Permana, dan D. Andriyana, "Konfigurasi Ruang Berdasarkan Kualitas Konektivitas Ruangan Dalam Perancangan Kantor: Space Syntax Analysis," *J. Arsit. Zo.*, vol. 3, no. 2, pp. 155–170, 2020.

[20]   W. A. Lily Mauliani, Anisa, "Permeabilitas Blok Perkantoran Jl.MH. Thamrin Untuk Akses Stasiun MRT Bundaran HI Jakarta Menggunakan Space," *Univ. Muhammadiyah Jakarta*, vol. 38, no. 4, pp. 7–17, 2018.

[21]   E. Valipour, S. Tayyebisoudkolaei, dan A. Mobaraki, "Establishment of Space Syntax to read urban road network; the case of Sari, Iran," *J. Contemp. Urban Aff.*, vol. 1, no. 2, pp. 69–75, 2017.

[22]   E. Valipour, A. Mobaraki, M. Nikoofam, dan S. Tayyebisoudkolaei, "Establishment of Space Syntax to read and analyze urban network; the case of study, Famagusta city of Cyprus," *J. Contemp. Urban Aff.*, vol. 3, no. 1, pp. 154–160, 2019.

[23]   W. Aqli, "Space Syntax Analysis On Level Of Security And Privacy Of Road Space. Case Study: Campus Area Of Universitas Gadjah Mada, Yogyakarta," *Int. J. Built Environ. Sci. Res.*, vol. 3, no. 1, pp. 39, 2019.

[24]   M. F. Arief, T. S. Pitana, dan U. J. Cahyono, "Spatial transformation in Klego Simo Corridor, Boyolali," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 871, no. 1, 2021.

[25]   A. Prihatiningrum, "Desain konfigurasi bangunan dan hubungannya dengan aktivitas akademik dalam upaya mitigasi bencana," *Civ. Eng. Built Environ. Conf. 2019*, pp. 62–71, 2019.

[26]   V. Cutini dan C. Pezzica, "Street network resilience put to test: The dramatic crash of Genoa and Bologna bridges," *Sustain.*, vol. 12, no. 11, 2020.

[27]   R. H. M. Pereira, F. R. B. De Holanda, V. A. S. De Medeiros, dan A. P. B. G. Barros, "THE USE OF SPACE SYNTAX

IN URBAN TRANSPORT ANALYSIS: limits and potentials," *Inst. Appl. Econ. Res.*, no. 188, pp. 1–25, 2015.

[28]   C. Yamu, A. van Nes, dan C. Garau, "Bill Hillier's legacy: Space Syntax —a synopsis of basic concepts, measures, and empirical application," *Sustain.*, vol. 13, no. 6, 2021.

[29]   W. Dettlaff, "Space Syntax analysis-methodology of understanding the space," *Ph.D. Interdiscip. J.*, pp. 283–291, 2014.

[30]   Á. Clua, J. Llorca-Bofí, dan S. Psarra, "Urban opportunities and conflicts around street musicians: the relationship between the configuration of public space and outdoor acoustics in Ciutat Vella, Barcelona," *J. Urban Des.*, vol. 25, no. 5, pp. 561–589, 2020.

[31]   C. Atakara dan M. Allahmoradi, "Investigating the urban spatial growth by using Space Syntax and gis—a case study of Famagusta city," *ISPRS Int. J. Geo-Information*, vol. 10, no. 10, 2021.

BIOGRAPHIES OF AUTHORS

Fitria Khairanisa	The author completed her education in the Bachelor of Architecture at the Faculty of Engineering, Sebelas Maret University Surakarta, and continued the Postgraduate Masters in Architecture Program, Universitas Atma Jaya Yogyakarta. Currently the author serves as a staff of Building and Settlement Analysis, Cipta Karya Field, Dinas Pekerjaan Umum dan Penataan Ruang (DPUPR) Sukoharjo Regency. Previously the author had two years of experience working at PT Intan Sejati Contractor Division (ISDK) Klaten. Then the author worked at PT Surya Unggul Nusa Consultant for two years, working on a project in the planning field for Public Service Facilities.