Review Article GU J Sci, Part B, 10(3): 259-271 (2022)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

http://dergipark.gov.tr/gujsb

An Evaluation of Imprecise Outputs of Space Syntax Applied Urban Studies

Mert DURMAZ[1,*], Özlem SAĞIROĞLU DEMİRCİ[2]

[1] *0000-0002-0337-1187, Istanbul Medipol University, Department of Architecture, 34810, Istanbul, Turkey.*

[2] *0000-0001-6708-3208, Gazi University, Department of Architecture, 06570, Ankara, Turkey.*

Article Info

Received: 31/05/2022
Accepted: 09/09/2022

Keywords

Space syntax,
Building heights,
Altitude differences,
Pedestrian profiles,
Historic built environments

Abstract

Space syntax is a quantitative model utilized to examine spatial configurations in settlements. In space syntax analysis, only bird's eye drawings are utilized and settlements are treated as 2D-formations made of settlement plans only as the inputs, building heights and altitude differences, variations in pedestrian profiles, and characteristics of historic built environments, are neglected. The major problem handled in this paper is that space syntax analysis grants approximately identical results for multiple different settlements sharing similar settlement plan layouts and it makes space syntax outputs imprecise. The main research question in this study is: Do current space syntax applied urban studies involve additional approaches to refine imprecisions of outputs of space syntax analysis alone? If yes, what strategies have been implemented? The procedure consists of the following: introducing space syntax and imprecisions of its outputs, categorization and nomenclature of neglected inputs, strategies to overcome the imprecisions, and classification, analysis and assessment of case studies in terms of the neglected inputs to overcome the imprecisions. With the expectation of observation of diverse strategies, case studies have been chosen in accordance with three criteria: focusing on different urban issues, dealing with different locations, and hosting historic built environments with different status and layout. At the end, it has been deduced that most case studies still rely on space syntax application alone and the imprecisions persist as a result.

1. INTRODUCTION

Space syntax is a quantitative model utilized to examine relations between society and spaces to manage pedestrian movements in built environments varying in scale [1-3]. The model facilitates examination of economic and cognitive factors in relation to urban space [4]. Space syntax can be used for multiple purposes such as calculation of crime rates in a built environment, testing way finding, and development of fluent circulation schemes. Çil defines some other goals as follows: defining complex physical configurations of urban mediums, planning and determining pedestrian movements in large scale built environments such as museums, hospitals, and so on, and quantitative analysis of future pedestrian movements at a site that has been settled to undergo reclamation [5].

Space syntax is a sum of three sub-analyses: convex space analysis, axial analysis, and visibility analysis. Convex space analysis consists of convex articulation and grid convexity rates in which they denote number of nodes (turning points or corners) and resemblance rate of layout of a settlement to typical grid layout respectively. In axial analysis, axial articulation, axial integration of convex spaces, and grid axiality are calculated to estimate depth, integration (global and local), and intelligibility rates. Axial articulation grants linearity and span rates of axes in which low levels of turns mean that there is high axiality. Axial integration of convex spaces illustrates rate of orthogonal layout of convex spaces. Grid axiality indicates resemblance rate of layout of axes to typical grid layout. Visibility analysis ends up with a site map in which axes are dyed and from blue to red, rate of visibility rockets meaning that level of visual comprehension increases indicating that more pedestrians are likely to visually observe the red. In urban studies, axial analysis is utilized.

The prominent problem with space syntax focused on this paper is that during its application, only top-view based materials such as settlement plan layouts are utilized and settlements are treated as 2D

* Corresponding author, email: mertdurmaz_1995@hotmail.com

formations as impacts of the following inputs, building heights and different altitudes, different pedestrian profiles, and deep-rooted historic built environments functioning as urban services and attractions, are neglected. Therefore, researchers are likely to reach similar outputs in different settlements sharing similar settlement plan layouts and it makes space syntax outputs imprecise. This study is expected to make a contribution to the field literature in terms of detection and nomenclature of these inputs which require extra research in space syntax applied urban studies as application of the model ends up with general and non-specific outputs as a result of neglecting the inputs. In this paper, by examination of recent space syntax studies, it is aimed to find out whether inaccuracies are removed or not by conducting extra studies along with space syntax or by updating space syntax.

2. METHOD

The method of this paper is composed of the following: First, space syntax analysis is introduced. Secondly, case studies to address what additional research has been done to overcome imprecise outputs of space syntax applied urban studies are classified in accordance with the urban issue they focus as follows: Preservation of historic sites, reproduction of space, wayfinding, crime rates, and urban attractions. With the expectation of observation of varied strategies to refine imprecisions occurring as a result of application of space syntax to urban scale settlements, case studies have been chosen in accordance with three criteria: focusing on different urban issues, dealing with different locations so that settlement layouts (grid or organic) could be diversified, and hosting historic built environments with different status (abandoned or occupied) and layout (dispersed of concentrated). Thirdly, deficiencies of space syntax which have been detected by scholars are covered and depending on them, nomenclature and description of neglected inputs in which space syntax application results in non-specific outputs are introduced as follows: neglect of building heights and altitude differences, neglect of different pedestrian profiles, and neglect of different historic built environments, and their descriptions are made, respectively. Fourthly, case studies have been evaluated in terms of the strategies involved to refine the imprecisions. Finally, it has been concluded that most case studies still rely on space syntax analysis only and inaccuracies persist as a result.

3. OUTPUTS OF AXIAL ANALYSIS

In urban studies, space syntax application is about axial analysis outputs which are integration rate, intelligibility rate, and depth rate, respectively.

3.1. Integration Rate

Integration rate shows to what extent an axis is integrated into remaining axes and it means how often it is likely to be occupied during travelling between locations. In global integration (Rn), value of an axis is computed with respect to all other remaining axes in whole settlement. In local integration (R3), value of an axis is calculated in respect of the three closest neighboring axes. In integration rate maps, from red to blue, integration rate plunges and axes become less integrated (more isolated). Axes with the greatest integration rates are evaluated as the axes that pedestrians are likely to use most during daily travelling whereas axes with the lowest integration rates are assessed as the axes that pedestrians are likely to use rarely only during travelling between specific points.

3.2. Intelligibility Rate

Intelligibility rate illustrates from how many axes a specific axis is recognizable. To estimate intelligibility rate, global and local integration rates are taken into account together. Component with a high intelligibility rate is recognizable at both global and local scales which means that the component is recognizable for residents of whole settlement covering neighboring districts while a component with a low intelligibility rate is slightly recognizable at global and local scales meaning that it is weakly recognizable for residents of whole settlement covering neighboring districts.

3.3. Depth Rate

Depth rate indicates to what extent an axis is accessible and it is likely to be preferred by pedestrians. Deep axes are located near boundaries of settlements whose urban center is located near middle and deep axes are occupied rarely during travelling between specific points whereas shallow axes are located near center and they are occupied highly and daily during travelling between any points.

3.4. Common Assessment of Outputs

By common assessment of integration, intelligibility, and depth rates, it is aimed to rate occupancies of zones and axes with the most possible values. However, during estimation, space syntax only utilizes settlement plan layouts. Therefore, effects of sections, elevations, altitudes and other height based instruments, different pedestrian profiles, and diverse historic built environment layouts and status are ignored during analysis. Thus, space syntax is likely to be blamed for providing researchers with imprecise outputs.

4. IMPRECISE OUTPUTS OF SPACE SYNTAX

Since it was first proposed, space syntax has been satirized due to presenting non-specific general results and in which Ratti's criticism is as follows [6]:

- Different researchers may draw different maps of axes of view and whole of outputs might change,

- Building height and path width have no effect on analysis results,

- Sidewalks and traffic ways, and as a result, travelling by vehicles and walking are treated identically,

- Neglect of the fact that axes of view are interrupted due to altitude differences.

Peponis negatively criticizes space syntax for ending up with underlying already known fact-like outputs or contrarily, extremely complex outputs that are unlikely to be comprehended by the ones who are unfamiliar with space syntax [7].

Batty satirizes space syntax for the fact that lines of view are not absolute abstractions of reality and since they are drawn on digital media manually, it is impossible to come up with an absolute ending and beginning that fits every researcher [8].

Soja negatively criticizes space syntax from a sociological perspective by remarking that elements constituting urban mediums such as forests, recreational zones, wastelands, etc. can be evaluated as outer components, and they shall be taken into account before applying space syntax [9].

Taking criticisms above into account, flaws of space syntax analysis in urban studies are classified under three categories: neglect of building height and altitudes, different pedestrian profiles, and historic built environments with different spatial layouts.

In neglect of building height and altitudes, an axis situated on a multi-altitude site with ascensions and descensions may seem to hold continuous vision from bird's eye until it is interrupted by a lot whereas in elevations, line of vision is interrupted without lots owing to altitude differences or building heights but in space syntax, the axis is evaluated as continuous since it only uses site plans or maps.

In neglect of different pedestrian profiles, it can be argued that path preferences of an overweight person and athlete or a young individual and an old person or a tourist and a resident are different. For instance, between two specific destinations, if there is a sloped path and flat path, and if both can be used for access, then, the overweight is most likely to prefer the flat even if it takes longer to reach or tourist is most likely to choose the path with more urban attractions without taking slopeness rate into account yet in space syntax, calculations are made for one specific user profile: healthy locals.

In neglect of different historic built environments, it can be asserted that status of them (being deserted or being considerably occupied) and spatial layout of them (being dispersed or concentrated) affect path preferences of users. If they still are occupied highly for example, then, they have been most likely to be centers of urban attractions for a long time and as a result, public transport is most likely to cause heavy traffic, and heavy traffic eradicates pedestrian movement even though space syntax does not distinguish traffic ways from sidewalks. If historic built environments are abandoned and located near middle of a settlement where multiple axes are condensed, then, they have low occupation rates in reality although space syntax analysis result in high occupation rates for them.

In short, for same axes, space syntax analysis may illustrate that it is lowly occupied whereas another survey or calculation method focusing on occupation rates might indicate that it is highly occupied. Space syntax analysis results either contradict or overlap with other studies computing occupation rates and it depends on states of altitudes and building heights, pedestrian profiles, and historical built environments.

5. STRATEGIES TO OVERCOME DEFICIENCIES OF SPACE SYNTAX

In accordance with up-to-date academic literature, no study has been made focusing on (compilation of) strategies to overcome deficiencies of space syntax since critics are satisfied only with listing flaws of space syntax analysis. However, some strategies to refine the bugs have been personally identified in case studies analyzed below as follows: Drawing land sections or elevations, conducting surveys among pedestrians to find out occupation rates of axes, labeling historic built environments and buildings of old town in maps or settlement plans to indicate how new settlements were organized. Researchers compare space syntax outputs with these additional studies to reinforce their argument if overlapping occurs and figures who negatively criticize space syntax can utilize the additional to refute space syntax outputs by revealing contradicting results. To illustrate, for same axis, space syntax analysis may indicate that it is lowly occupied whereas another survey organized among local pedestrians may result in high occupancy rates for it signifying that space syntax results are questionable. In short, space syntax analysis results either contradict or overlap with other studies computing occupation rates.

6. ANALYSIS OF CASE STUDIES

Case studies have been chosen with regard to three components that require extra research beyond space syntax: altitude differences and different building heights, various pedestrian profiles, status of historic built environment. First, it has been aimed to observe whether authors did additional research in terms of multiple altitudes as space syntax only utilizes site plans or maps and never uses sections, elevations, or other height based data, and supposes that whole settlement has a flat surface comprised of one single altitude. Secondly, integration, intelligibility, and depth rates are computed only for one single user profile in space syntax: a healthy adult with no disability or handicap who is a resident (not a tourist) in settlement and it has been searched if authors carried out extra studies for different pedestrian profiles or not. Thirdly, settlements have either condensed or dispersed historic city centers which are either abandoned or occupied highly, and if they still are occupied remarkably, then, they are likely to be the points of urban development and they may cause various urban development schemes, and it has been aimed to examine whether authors conducted extra studies with regard to testing impact of historic built environments. During determination of case studies, it has been forecast to encounter varied approaches aiming to refine possible bugs of space syntax. With the expectation of being able to make a comprehensive assessment at the end and observing various strategies to overcome flaws of space syntax in terms of the three components, case studies have been chosen in accordance with three criteria: focusing on diverse urban issues so as to observe multiple varied additional studies, studying different locations to observe various site layouts in terms of altitudes and building heights, and hosting historic built environments with different spatial layouts (concentrated or dispersed) and different status (abandoned or still occupied).

6.1. Preservation of Historic Sites

In the Ph.D. dissertation, "Tarihi Kentlerde Koruma Kavramının Mekan Dizim Yöntemi Üzerinden Araştırılması-Bergama Örneği", written by Baç, differently dated maps of a settlement in Turkey, Bergama, are exposed to space syntax analysis. It is asserted in the thesis that preservation of historic sites relies on occupation at modern ages [10]. It can be inferred from the assertion that as long as a site stays occupied, it is not likely to undergo desertion, and this can be interpreted as conservation of the site. To advocate the argument, before application of space syntax, multiple differently dated maps are overlapped, and it is illustrated that new zones and axes were always organized around the historic center. This shows that in case of Bergama, the historic built environment remained as the center during expansion of the settlement. Later, space syntax is applied to three differently dated maps belonging to Republic of Turkey era. In each of them, the historic owns high integration and intelligibility, and minimal depth rates. Baç points out that Bergama is a mountainside and it shall be studied along with height based data [10]. Therefore, land sections accompanied by buildings are drawn, and it is illustrated that throughout the site, the historic owns the least sloped axes which ease pedestrian access. It is explicitly remarked in the thesis that space syntax supposes sites to be flat and it may result in imprecise results [10].

In the master's thesis, "Ayvalık Kent Mekanının Mekan Dizim Yöntemiyle Analizi", written by Hayta, 2011 status of Ayvalık, a district situated next to the Aegean Sea in the West Anatolia, is examined with space syntax. Ayvalık holds multiple dispersed historic buildings which do not form a customary historic built environment condensed at one single location. Hayta points out that the historic had been abandoned and new settlements were founded at new zones [11]. After examination of 2011 status, the author proposes built environment design solutions to revive the historic by re-functioning, planning a touristic route which covers the historic as the destinations to visit, etc. She prepares new maps supposing her proposals to have been applied, and the new undergoes space syntax analysis. At the end, global and local integration, and intelligibility rates of axes in old and new maps are compared, and it is illustrated that both values grow in new map.

6.2. Reproduction of Space

In the Ph.D. Dissertation, "Kıyı Dolgusunun Kent Morfolojisine Etkisinin Mekan Dizimi Yöntemiyle İncelenmesi: İstanbul Tophane Bölgesi", written by Ardıçoğlu, Tophane – a district located at seaside in Istanbul – is studied. The main argument of the thesis is that land filling operations affect urban morphology and change integration of zones with each other [12]. To advocate the argument, in the thesis, space syntax is applied to differently dated maps of same zone, and it is illustrated that port building part has been holding big integration and intelligibility rates. Since the zone is located next to seaside, one may consider it a plain region and it may take reader to the conclusion that adding height based data would be unnecessary.

In the article, "Kula Tarihsel Kentinin Yirminci Yüzyıldaki Fiziksel Dönüşümünün Mekan Dizim Analiziyle İncelenmesi", written by Çil, urban development of Kula in the 20th Century, a district in the Aegean Region in Anatolia, is studied with space syntax via utilization of three maps from three different dates. The author applies space syntax to find out how local or global integration rates have changed in different times. Depending on space syntax outputs, she arrives at the following conclusions [13]: 1900-1930 was the last phase that Kula possessed an Ottoman style urban settlement character while in 1930-1970, Izmir-Ankara Highway was built, and in 1970-2000, laws of conservation were implemented. Until the 1950s, the bazaar was on the path with the greatest global integration rates (the bazaar was situated near middle of historic built environment of Kula) while mosques were on the path with the largest local integration rates. The bazaar lost its function as being a connection zone between locals and visitors, and interior zones of the historic built environment became less integrated around the 2000s while settlements built after 1980 became more integrated – especially the ones situated near Izmir-Ankara Highway. To promote integration levels of the bazaar and the historic built environment, new paths connected to settlements were formed after 1980 (the ones near Izmir-Ankara Highway in particular).

In the conference proceeding, "A Syntactic Analysis of Recent Changes in CBD of Balikesir, Turkey", Güney and her friends examine occupancy status of a specific zone in Balıkesir, a province in Turkey. It is stated that former intercity bus terminal had been displaced by public transport center and after the displacement, the settlement and a building located within the same district of public transport center underwent renovation, Akıncılar Neighborhood and train station, while new intercity bus terminal was located near boundaries of the city [14]. 2000 (the year when intercity terminal bus was located at city center) and 2004 (the year when intercity bus station was located near borders of Balıkesir) dated maps of Balıkesir are analyzed with space syntax. The researchers' findings are as follows after application of space syntax [14]: the most integrated are almost same yet there are slight shifts. Replacement of intercity bus terminal with public transport center, the renovations and other renovations which were determined to take place in future may result in more drastic shifts. By application of space syntax to small cities, shifts in centers where urban services are concentrated can be traced easily and continuously, and this can be utilized while making future oriented urban planning and design decisions. The study is anticipated to be useful for authorities who are in charge of urban planning of Balıkesir so as to prevent desertion of historic sites, uneven condensations in terms of population size, accessibility, and so on. It is recommended to utilize space syntax to obtain settlements with evenly distributed occupancies.

6.3. Wayfinding

In the Ph.D. Dissertation, "Spatial Navigation in Immersive Virtual Environments", written by Conroy, participants wear virtual reality glasses, they are asked to travel between two locations in the virtual settlement, and their path preferences are evaluated. The author finds out that during travelling, the participants prefer paths with the least turns [15]. In space syntax, more turns result in smaller intelligibility rates since turns interrupt continuity of lines of sight. Therefore, it can be inferred from the study that pedestrians incline to travel between two points in settlements by walking on the most continuous axes with the least turns.

6.4. Crime Rates

In the conference paper, "Spatial Configuration and Vulnerability of Residential Burglary: a Case Study of a City in Taiwan", written by Shu and Huang, the researchers explore that low-income neighborhoods with great global integration rates hold low rates of thievery while in middle-income neighborhoods, zones with big local integration rates own smaller thievery compared to zones with great global integration rates. Besides, it is found that in middle-income neighborhoods, zones possessing either large global or big local integration rates are safer than isolated zones. No correlation is found among space syntax outputs and rates of safety at high-level income neighborhoods [16].

On the contrary, Nubani and Wineman find that isolated zones in Ypsilanti (Michigan) host slighter crime rates than integrated zones. They give its reason as high preference rate of automobiles in contrast to walking in which approximately all transportation depends on travelling by automobiles in Ypsilanti, not walking [17].

6.5. Urban Attractions

In the article, "Regularity and Change in Urban Space: A Syntactic Analysis of Movement and Co-Presence in Atlanta", written by Peponis and his friends, effect of stores – commercial units – on path preferences of pedestrians in Atlanta is studied. The researchers compare results of Atlanta with those of six settlements from Greece, and they find out that commercial units promote local integration rates whereas they have no impact on global integration rates. Moreover, the researchers deduce that mix use complex proposals neglecting pedestrian movement layout and site plan inputs are insufficient to promote urban life quality as they arrive at the conclusion by observation of ineffectiveness of mix use complexes with regard to global and local integration rates [18].

7. ASSESSMENT OF CASE STUDIES

In this part, approaches of authors of case studies are assessed in search of answering three questions:

1.Do the author(s) carry out extra analysis in terms of building heights and altitudes?

2.Do the author(s) conduct additional study in terms of various pedestrian profiles?

3.Do the author(s) take impact of historic built environment into account?

In Baç's study, Bergama is studied. Bergama is a hilly settlement composed of multiple altitudes. In the study, Baç supports space syntax outputs with manually drawn land sections filled with precise building heights. Additionally, he organizes a survey to detect path preferences of locals and tourists. Besides, he labels historic buildings in differently dated urban phase maps and illustrates the dispersed historic built environment in Bergama. It can be argued that in the study, altitude and building height, pedestrian profile and historic built environment are examined with additional studies and the author is not likely to rely on space syntax outputs alone during computations.

In Hayta's study, Ayvalık is studied. It is unknown if Ayvalık is built on flat ground or ground with multiple altitudes since nothing is stated on this issue in the study and the author does not present any height or altitude data. Moreover, she does not categorize pedestrian profiles. Additionally, she labels historic structures in maps and shows that Ayvalık possesses a dispersed historic built environment (historic buildings are not condensed in one or few specific zones). It can be asserted that the author aims to support the argument that the historic must be preserved since it still is occupied at modern times and she most likely labels the historic on maps to consolidate outputs of space syntax which means that there is extra study conducted for the historic built environment while in terms of pedestrian profiles and altitudes, the author only relies on space syntax outputs.

In Ardıçoğlu's study, Tophane is studied. It is unknown if Tophane has been settled on flat ground or ground with multiple altitudes. It is indicated in the study that Tophane is situated next to the Bosphorus. Therefore, one may consider it a location at sea level, and therefore, totally plain. However, the author does not remark anything on the issue. She does not carry out an extra study focusing on different pedestrian profiles. Moreover, she does not conduct an additional study addressing spatial layout of historical built environment. The author makes evaluation only by depending on space syntax outputs.

In Çil's study, Kula is studied. The author does not address building heights or altitudes. Additionally, she mentions possible encounter zones of tourists and the locals in the written text superficially, yet it is not illustrated in visual materials. Eventually, she labels multiple historic buildings. The aim of labelling can be interpreted as supporting the argument that the historic has been around new and old settlements in different periods which shows that the author carries out additional study with regard to historic built environment while she does not conduct extra study when it comes to altitudes and building heights, and pedestrian profiles.

In Güney and her friends' study, Balıkesir is studied. They never refer to altitudes and building height. Secondly, they do not carry out extra analysis for pedestrian profiles and they generalize them. Ultimately, they label historic settlements in differently dated maps. It is shown in the future dated map that after renovation of the historic, the settlement changes a bit in terms of path layout and it reveals itself in space syntax results. One can argue that to reinforce the fact, the authors mark the historic in both maps in particular in addition to space syntax analysis and this can be interpreted as an extra study in terms of historic built environment whereas they do not do the same for altitude and building height, and pedestrian profiles.

In Conroy's study, virtual settlements holding grid and organic layouts are studied. The author models multiple settlement site plans on computer, and applies space syntax to them to compute wayfinding rates. All settlements are virtual and fictional. The author does not carry out special analysis with regard to

altitude and building heights, pedestrian profiles, and historic built environment, and she relies on space syntax results only.

In Shu and Huang's, and Nubani and Wineman's studies, a zone in Taiwan, and Ypsilanti are studied respectively. The authors only depend on space syntax outputs and do not carry out extra study in terms of altitude and building heights, pedestrian profiles, historic built environment.

In Peponis and his friends' study, Atlanta is studied and they compare the outputs with their previous studies focusing on Greek settlements. The authors only rely on space syntax outputs and do not conduct additional study in terms of altitude and building heights, pedestrian profiles, and historic built environment.

In Table 1 below, the findings, "NO", indicate that the author(s) do not carry out additional studies and they rely on space syntax outputs only while the findings, "YES", show that the author(s) conduct extra studies in addition to space syntax. In Table 2 below, actions of the author(s) are elaborated.

Table 1. *Status of extra studies in addition to space syntax conducted by the researchers*

RESEARCHER(S)	ALTITUDE AND BUILDING HEIGHT (Do the authors carry out additional analysis with regard to altitudes and building heights?)	PEDESTRIAN PROFILE (Do the authors generalize pedestrians or categorize them and conduct extra study?)	HISTORIC BUILT ENVIRONMENT (Do the authors mention status of historic built environment and take special action?)
BAÇ	YES	YES	YES
HAYTA	NO	NO	YES
ARDIÇOĞLU	NO	NO	NO
ÇİL	NO	NO	YES
GÜNEY & HER FRIENDS	NO	NO	YES
CONROY	NO	NO	NO
SHU & HUANG	NO	NO	NO
NUBANI & WINEMAN	NO	NO	NO
PEPONIS & HIS FRIENDS	NO	NO	NO

Table 2. *Actions of the researchers*

RESEARCHER(S)	ALTITUDE AND BUILDING HEIGHT (Do the authors carry out additional analysis with regard to altitudes and building heights?)	PEDESTRIAN PROFILE (Do the authors generalize pedestrians or categorize them and conduct extra study?)	HISTORIC BUILT ENVIRONMENT (Do the authors mention status of historic built environment and take specific action?)
BAÇ	Drawing land sections filled with buildings and their accurate heights of the multiple altitude composed site	Counting of tourists and residents in specific axes	Labelling historical built environment in differently dated maps
HAYTA	-	-	Labelling historical built environment in differently dated maps
ARDIÇOĞLU	-	-	-
ÇİL	-	-	Labelling historical built environment in differently dated maps
GÜNEY & HER FRIENDS	-	-	Labelling historical built environment in differently dated maps
CONROY	-	-	-
SHU & HUANG	-	-	-
NUBANI & WINEMAN	-	-	-
PEPONIS & HIS FRIENDS	-	-	-

8. CONCLUSION

Space syntax is a quantitative model applied to settlements varying in scale to detect and rate the most possible occupation incidences of axes and zones. In urban studies, axial analysis is made to estimate depth, integration (global and local), and intelligibility rates which are the ultimate outputs of axial analysis, and their common evaluation results in carrying out the detection and rating process.

Space syntax treats settlements as 2D formations made of top view-based components only. The major research problem in this paper is that space syntax analysis only utilizes 2D-top view images such as site plans and in different sites which have the same settlement plan layout, it always grants identical outputs. Thus, space syntax outputs are likely to be unspecific, and ignoring the inputs, multiple altitudes and different building heights, different pedestrian profiles, and different historic built environment layouts, reinforces non-specificity. Therefore, critics have indicated that for the same settlement, space syntax analysis and another research method aiming to detect and rate occupation rates of zones and axes may contradict with each other. It has been aimed to inquire whether current space syntax applied urban studies carry out additional analyses to refine the imprecisions or not and if yes, then, what strategies have been implemented. To encounter multiple diverse approaches, case studies are chosen in accordance with three criteria: concentrating on different urban issues, studying different locations, and having historical built environments with diverse layouts and status. Case studies have been examined in accordance with three inputs whose impacts are omitted in space syntax analysis: multiple altitudes and different building heights, different user profiles, and different historical built environments. The procedure followed in this paper is comprised of introduction of space syntax and its imprecisions, categorization and nomenclature

of neglected inputs, strategies to overcome the imprecisions, and classification, analysis and assessment of case studies in terms of neglected inputs to overcome the imprecisions.

With regard to altitudes and building heights, it has been found out that out of 9 studies, only in 1 study this component is examined with an additional study by drawing land sections showing different altitudes and precise building heights. It is inherent that altitude differences and building heights have drastic impact on path preferences of pedestrians as a ramped path is unlikely to be preferred to a flat path or a path that presents continuous vision is likely to be preferred to another path with a discontinuous vision due to safety issue. Depending on this, it can be argued that it does not matter for what purpose space syntax is utilized. Thus, it has been deduced that altitude differences and building heights are still an ignored input in most of the case studies.

When it comes to pedestrian profiles, it is explored that out of 9 studies, only in 1 study this input is examined with an additional study by organizing a survey and counting numbers of locals and tourists in axes manually to find out occupation rates created by them. Alone, space syntax analysis presents general results in terms of integration, intelligibility, and depth rates which means that outputs are not obtained for different pedestrian profiles. Therefore, a survey examining visit rates of locals and tourists is not covered within the scope of space syntax. To sum up, it has been concluded that pedestrian profiles are still an omitted input in case studies.

In terms of status of historic built environments, it has been observed that out of 9 studies, in 4 studies this component is examined with an additional study in which authors label historic buildings and they show whether historic built environments have dispersed or condensed layouts. At a first glance, one may consider inclusion of this component necessary only in building heritage and conservation studies. However, historic built environments which still are occupied and not abandoned can still be major centers of urban attractions and urban services which means that they might host high occupation rates. To sum up, it is inferred that in terms of this component, extra studies are carried out in slightly below half of the case studies.

Out of 27 findings in Table 1, there are 6 “YES”, and this is equal to 22.22% of the findings. This illustrates that out of 5 studies, roughly 4 study relies on space syntax outputs alone while 1 study makes additional examinations beyond space syntax analysis. As shown in this study, in most of the recent space syntax applied urban studies, the three inputs are still dramatically ignored meaning that settlements are still being treated as 2D formations made of top-view based materials only.

Although additional studies have been made for the same input in different cases, the addition has been the same as in terms of historic built environments, labelling them in differently dated maps is the only addition in different cases, and building heights and altitudes, and different user profiles have been analyzed with extra research in 1 case only. It can be argued that additional studies concentrating on path preferences of pedestrians affecting occupation rates of axes and zones shall be more varied and multiplied so that the imprecisions could be removed and findings become precise at maximum level. For instance, changes in status of historic built environments such as transition from desertion to occupation (and vice versa) implemented by re-functioning or renovation, or function changes, and destructions shall be introduced, or building heights could be labelled in maps or site plans and changes in altitudes in history could be marked in differently dated site plans, sections and elevations, and in terms of user profiles, multiple surveys could be organized among different pedestrian groups (different age groups, residents and tourists, domestic tourists and foreign tourists, disabled residents and typical healthy residents, etc.). In short, additional studies shall be more varied and multiplied to refrain from generalizations presented by space syntax which end up with the imprecisions.

Researchers must be aware of the fact that sample space formed is likely to cause drastic deviations in terms of findings which means that addressing a wholly different case study set might come up with different and even totally contradicting results. Therefore, findings of this paper shall not be adopted as eternally valid as statistics may change in time.

At the end, this paper is forecast to be beneficial for researchers studying space syntax analysis and looking for strategies to overcome the imprecisions of it. No matter for what purpose space syntax is utilized in urban studies, the three inputs – multiple altitudes and different building heights, different user profiles, different historic built environments – whose states are evaluated in this paper via recent space syntax applied urban studies require additional treatment beyond space syntax since they are likely to have huge impacts on path preferences of pedestrians affecting occupation rates of axes and zones which turn out to be imprecise when only computed with space syntax.

REFERENCES

[1] Gündoğdu, M., *Mekan Dizimi Analiz Yöntemi ve Araştırma Konuları.* Art-Sanat, 2014(2): p. 251-274.

[2] Hillier, B. and J. Hanson, *The Social Logic of Space*. 1984, Cambridgeshire: Cambridge University Press.

[3] Osman, K.M. and M. Suliman, *The Space Syntax Methodology: Fits and Misfits.* Architecture and Behaviour, 1994. **10**(2): p. 189-204.

[4] Yamu, C., et al., *The Virtual and the Real in Planning and Urban Design: Perspectives, Practices and Applications*. 2017, Oxon: Routledge.

[5] Çil, E., *Bir Kent Okuma Aracı Olarak Mekân Dizim Analizinin Kuramsal ve Yöntemsel Tartışması.* Megaron, 2006. **1**(4): p. 218-233.

[6] Ratti, C., *Space Syntax: Some Inconsistencies.* Environment and Planning B: Planning and Design, 2004. **31**(4): p. 487-499.

[7] Peponis, J. *Proceedings of the 3rd International Space Syntax Symposium*. in *3rd International Space Syntax Symposium*. 2001. Atlanta, the USA.

[8] Batty, M. and S. Rana, *The Automatic Definition and Generation of Axial Lines and Axial Maps.* Environment and Planning B: Planning and Design, 2004. **31**(4): p. 615-640.

[9] Soja, E. *In Different Spaces, Interpreting the Social Organization of Societies*. in *Proceedings, 3rd International Space Syntax Symposium, pp. s1*. 2001. Atlanta, the USA.

[10] Baç, S., *Tarihi Kentlerde Koruma Kavramının Mekan Dizim Yöntemi Üzerinden Araştırılması-Bergama Örneği*. 2012, Dokuz Eylül Üniversitesi Fen Bilimleri Enstitüsü.

[11] Hayta, D., *Ayvalık Kent Mekanının Mekan Dizim Yöntemiyle Analizi*. 2011, YTÜ Fen Bilimleri Enstitüsü.

[12] Ardıçoğlu, R., *Kıyı Dolgusunun Kent Morfolojisine Etkisinin Mekan Dizimi Yöntemiyle İncelenmesi: İstanbul Tophane Bölgesi*. 2019, Ankara Üniversitesi Fen Bilimleri Enstitüsü.

[13] Çil, E., *Kula Tarihsel Kentinin Yirminci Yüzyıldaki Fiziksel Dönüşümünün Mekan Dizim Analiziyle İncelenmesi.* Gazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi, 2008. **23**(2): p. 283-293.

[14] Guney, Y.I., et al. *A Syntactic Analysis of Recent Changes in CBD of Balikesir, Turkey*. in *Proceedings of the 7th International Space Syntax Symposium, School of Architecture and the Built Environment, KTH, Stockholm, Sweden*. 2009. Stockholm, Sweden.

[15] Conroy, R., *Spatial Navigation in Immersive Virtual Environments*. 2001, University College London the Faculty of the Built Environment Department of Architecture.

[16] Shu, S. and J. Huang. *Spatial Configuration and Vulnerability of Residential Burglary: a Case Study of a City in Taiwan*. in *4th International Space Syntax Symposium*. 2003. London, the UK.

[17] Nubani, L. and J. Wineman. *The Role Of Space Syntax in Identifying the Relationship Between Space and Crime*. in *Proceedings of the 5th Space Syntax Symposium*. 2005. Delft, the Netherlands.

[18] Peponis, J., et al., *Regularity and Change in Urban Space: A Syntactic Analysis of Movement and Co-Presence in Atlanta*. Ekistics, 1996. **63**(376-378).