

Space Syntax as a Vital Tool to Enhance Urban Spaces

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ABSTRACT

Urban spaces are important for communities as places to practice different activities that help meet users' needs. Therefore, the study aims to examine the results of prior research using space syntax to understand the relationship between the spatial configurations of spaces and users' behavior, as well as its impact on improving the use of urban spaces. So, the paper began with a quick summary of the theory's foundational concepts. "The social logic of Space" by Bill Hillier and Julianne Hanson (1984) and "Space is the Machine" (1996) follow. Then, if it was essential, current publications and studies that had a significant influence on the theory were referenced. One of the main study questions in space syntax research has always been how to describe and predict socio-spatial experience. by analyzing Trafalgar and Old Market Square and studying the role of space syntax theory in enhancing these two squares. Results, there is a relationship between human behavior and spatiality in those two Squares. From the foregoing, it is clear that Space Syntax is a vital tool in understanding and predicting the movement and user behavior within urban spaces, which is recommended to be used to study and enhance the performance of urban spaces. In conclusion, this paper presents a theoretical basis for understanding and facilitating the application of space syntax in urban space.

Keywords: Urban Spaces; Space Syntax; Trafalgar Square; Old Market Square.

1-Introduction

Space syntax is a set of theories and techniques for the analysis of spatial configurations of all kinds. It was invented by the British architect John Peponis in the 1970s, at the Bartlett Unit for Architectural Studies, University College, London (Hillier, 1988; Hillier & Hanson; Hillier et al., 1989b); 9a; 1989b) ;), "is a technique used to describe and analyze patterns of architectural space in a building and on an urban level". Space syntax, at its heart, offers a way to describe how spaces connect in a building's or city's general structure [1].

The theory is a collection of various methods that are applied in a variety of fields. It makes significant contributions to and has a significant impact on the field of urban planning by identifying the fundamental connections between spatial planning and the social, economic, and environmental aspects of various places and spaces. Limiting them to the humanities, cognitive sciences, urban design, geography, information technology, and social sciences, it is theoretically conceivable to discover a level of compatibility and integration that would allow for the connection of these areas of study and their related applications under a unified framework [2].

Bill Hillier, who is regarded as one of the first to understand the relationship more logically and objectively between the elements of the physical structure of the space structure and the presence of people inside the spaces to practice various activities, has used the analysis of the spatial formations of the spatial network, which is the primary and most powerful influence on the rates of activities within any space. Additionally, a variety of studies in urban spaces based on the space syntax theory are conducted.

1-1-Research Aim

These studies aim to focus on how to highlight this information so that space syntax theory can be applied to enhance urban spaces.

1-2-Research Methodology

The study used a qualitative approach and focused on two areas: the analysis of the literature, which included 14 studies on the application of the space syntax theory to urban spaces, and the analysis of two real-world examples to which the theory had already been applied.

2- Literature review

Bill Hillier's (1993) study "Natural Movement: or Configuration and Attraction in the urban pedestrian movement". This study examined how rapidly people move to and from the attractions that lure them to address the question of how different mobility patterns impact the growth of metropolitan regions [3].

Twelve plazas in London were compared by **Campos, B. (1997)**, who concentrated on the spatial features of closure (visible connection with the surroundings), syntactic metrics, and the number of stationary users of the plazas. The findings demonstrated that the availability of seating areas and other physical components affects how well the plaza functions. Additionally, it was discovered that the plaza's static user population is influenced by both the plaza's global and local integration values and the number of axial lines that interact with it.

In a different study, **Campos & Golka (2005)** looked at how stationary activity patterns in six London public plazas related to visual fields. Although individuals do need to be able to see, the degree of isolation varies on the individual because the results showed that people avoid overly open settings and prefer spaces with vistas [4].

To determine why certain areas of the plaza are livelier and more populated than others, **Bada (2012)** looked at four plazas in Biskra, the capital of Algeria. He examined the relationship between human mobility and the spatial use of spatially arranged visual fields. According to the findings, people choose locations that offer some level of solitude, therefore spatial use is directly related to visual elements pertinent to the type of activity [5].

Zhai and Baran (2013) investigated the space syntax that is utilized to comprehend the layout features of urban parks, particularly about users' movement patterns. They made a distinction between activity areas and paths, talked about the challenges of establishing spatial boundaries, and examined the discrepancy between spatial accessibility and visual accessibility. They put out broad guidelines for using space syntax to research urban parks and pedestrian behavior [6].

"People's movement patterns in space of informal settlements in the Cairo metropolitan area" was the focus of **Abdel-Basir Abdel-Rahman Bawan's (2016)** research. The results of this study indicate a considerable positive relationship between geographical accessibility and

the movement pattern of pedestrians. The study was concerned with the impact of different spatial patterns on social inequality [7].

Study "Investigation of Fear of Crime in City Centers through the Example of Beikta Sinanpa a Neighborhood" by **Elif Köklü and Funda Yirmibeşolu (2017)**. This study centered on the potential that, if the relationship between the physical elements of spaces and social institutions was not recognized, places would turn into barren settings suited for terror and crime. The analysis found that the distance needed to get to the spatial aim, the absence of lighting and guide signs, and the presence of people all contribute to the spread of crime [8].

"Using Space Syntax to Assess Safety in Public Areas-Case Study of Tarbiat Pedestrian Area, Tabriz-Iran" by **Kübra, Mehdi, and Sania was published in 2017**. This study investigated the user safety of urban environments using space syntax theory to identify and evaluate user-safe regions. When the theory's spatial measurements were verified, the study's results revealed that there were more and more secure locations for users to partake in a range of activities [9].

2019 study by Chiang and Li titled "Metric or topological proximity? the relationships between people's trips to parks often, their proximity to parks, and their perceptions of stress." This study set out to quantify park access based on the physical layout of streets and to ascertain if such topological metrics were related to park utilization. We investigated the associations between topological closeness, frequent park visits, and subjective stress using measures of space syntax. The conclusions on the impact of proximity on park attendance had implications for both the planning and policy-making of roadway layouts as well as streetscape [10].

In the year **2020**, there will be several studies of urban spaces that are heavily based on the Space Syntax theory. Regarding the study that **Askarizad and Safarified** that has to do with plazas titled "The influence of social interactions on the behavioral patterns of the people in urban spaces (case study: The pedestrian zone of Rasht Municipality Square, Iran)" This research made an effort to look at how social connections affect people's behavior in metropolitan settings. As a result, the Space Syntax approach was used to combine empirical axial line and visibility graph analysis. The findings of this study demonstrate that social interactions have a significant influence on how people behave in urban settings. As a result, this behavioral

influence which is derived from the quality of the built environment is transmitted to individuals and influences how they behave in their own private lives [11].

2021 study by Sheng et al. titled “Effect of Space Configurational Attributes on Social Interactions in Urban Parks”. In this study, space syntax theory was used to examine the relationships between spatial configurational characteristics and social interactions. Both a good and a negative impact on the intensity of social contact were discovered to result from the spatial scale and depth of the main city route [12].

2022 study by Zhaolian Xing. titled “A New Urban Space Analysis Method Based on Space Syntax and Geographic Information System Using Multisource Data” This research uses multisource data to undertake a new urban space analysis approach based on space syntax and the geographic information system. The investigation of urban issues, the examination of urban traits, and the formulation of urban plans all greatly benefit from this innovative approach to analyzing urban spaces [13].

2022 study by Aya Abdelalim titled “Space Syntax as a Tool to Enhance the Performance of El-Tahrir Complex Plaza” The purpose of the study is to look into how users' behavior and the physical layout of El-Tahrir Complex Plaza are related. In other words, this study explores how the spatial organization of plazas affects users' activities there. It aims to identify the physical and syntactical factors that influence users' behavior and contribute to space underutilization and user dispersion. Accordingly, space syntax can become a vital tool for urban designers to enhance the utilization of urban plazas. As a result, several design options were evaluated and one was picked because it had the best chance of increasing space utilization [14].

Among the most significant studies conducted in 2023, which were carried out by **Ju Hyun Lee, Michael J. Ostwald, and Ling Zhou**, entitled “Socio-Spatial Experience in Space Syntax Research: A PRISMA-Compliant Review” The study link between spatial attributes and experience values are the subject of the first comprehensive scope review of space syntactic research, which is conducted in this review. A combination of descriptive, correlational, and regression techniques are used in the studies that the systematic framework has identified to look at the dynamic impacts of spatial configurations on human experiences. Finally, this article looks at the body of knowledge's limits and research gaps while making recommendations for future study topics [15].

It has been demonstrated in several researches that there is a connection between pedestrian movement and integration maps. [15&16]. Therefore, by foreseeing the behavioral effects of proposed urban planning and design solutions, the Space Syntax technique can assist in arriving at an ideal solution to spatial difficulties.

3- Space Syntax of Urban Applications

Finding out what is intended to be achieved and what really can be done with the urban design concept is the main goal of space syntax. After several spatial possibilities have been explored using space syntax, potential impacts may be deduced and connected to existing theories on space and spatial relationships, as well as on space about mobility and economic development [18]. Therefore, everything hinges on the following scenario: "What if...?"

“If I do this, the effect will be that.”

“If I want this, I had better do that.”

If people's movement across the network of urban streets creates land use patterns associated with various values of spatial integration, urban design plans can be examined to ascertain the potential extent of urban street life [17].

Space syntax analysis enables one to evaluate effects for the potential future of street life connected to land use if the volume and density of people in the streets affect the land use intensity. The design of the built form can be done if the spatial conditions are evaluated. Space syntax can help urban planners and designers in their decision-making for well-functioning urban designs because it reveals the hidden spatial structures of various design proposals for the same area [19].

The research has reached the steps taken to deal with these urban projects, which can be depended upon in the applied study by analyzing the different urban applications of the space syntax theory. As it is in **Trafalgar Square** and **Nottingham's Old Market Square**, these stages can be identified by the following points:

3-1- Problem Diagnosis (before enhancement)

The two elements of this step are the field research utilizing observation and the syntactical study using space syntax, as seen in the following:

3-1-1-Observation

An important and valuable means of representing the prevailing conditions in an urban area is a survey of the physical makeup of the space in question.

- **In Trafalgar Square**, only moving or static activity is allowed in the north section of the square, where the experiment was conducted by knowledgeable observers at the Space Syntax laboratory using 300 gates at various times throughout the week, as shown in **Figure 1**.

According to the observational findings: The remainder of the square was empty as visitors flocked to the southeast corner. In addition, the visitor took a side street that led to King Charles Traffic Island from the south side of the square. Except for a few pedestrians, Londoners did not have access to the square and instead chose to move around its edges.

- **In Nottingham's Old Market Square**, for Gustafson Porter, an in-depth examination of the square was conducted, as well as general advice on public space design. By investigating spatial planning in the area, examining movement and space usage patterns, and showcasing how the design of space has impacted human behavior. This study was used to demonstrate why the plaza is currently failing, especially in the middle area, which was avoided by 78% of people [20], as shown in **Figure 2**.

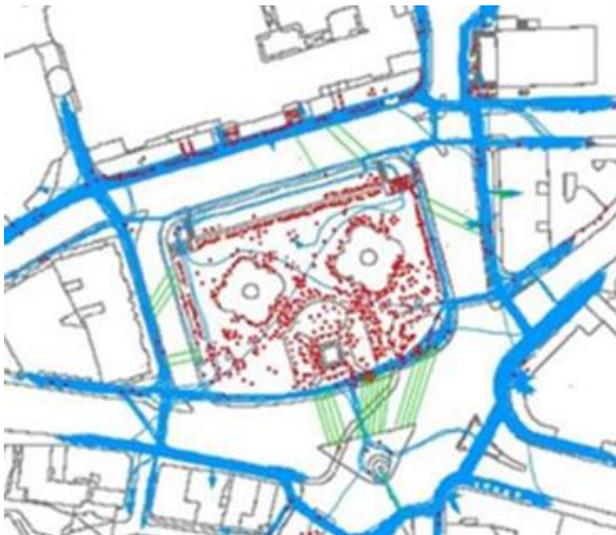


Figure 1. Observation of Trafalgar Square's existing layout [15].

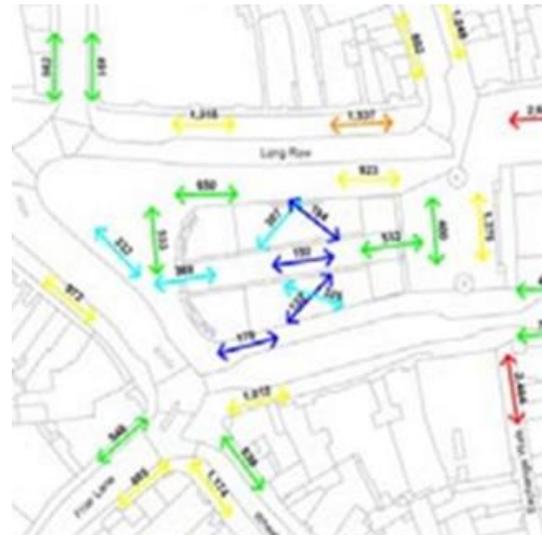


Figure 2. Observation of Nottingham's Old Market Square existing layout [17].

3-1-2-Syntactical Analysis

Examining the current spatial arrangement depends on space syntax.

- **Trafalgar Square**, the analysis indicates great accessibility outside the square but low accessibility inside. Axial lines in red indicate high value, whereas lines in green indicate low value, as shown in **Figure 3**.
- **Old Market Square in Nottingham**, by analyzing indicating more accessible space in red, then orange and yellow, to less accessible space in green. Visual accessibility attracts both movement and stationary activity, as shown in **Figure 4**.



Figure 3. All line maps for the existing layout [15].



Figure 4. Visibility graph analysis [17].

3-2- Proposals and analysis

At this stage, the syntactical studies were relied on to develop and analyze the proposals, as shown in the following examples:

- **In Trafalgar Square**, Norman Foster's team developed their proposal, and devise ideas for renovating the square by enticing people to enter. The goal is to alter the spatial structure to attract pedestrians rather than force them out of the square. Because traffic isn't the problem, eliminating it isn't the answer, according to Spaces syntax analysis. As a result, a suitable new design at the square must give an easy passage from the central island to the secure, well-connected visual and spatial surroundings, and provide amenities for eating, drinking, and resting, as shown in **Figure 5**.

When the spatial layout was analyzed following the remodeling, it was discovered that the accessible value rose both within and outside the square. There have been some new decisions made (16).

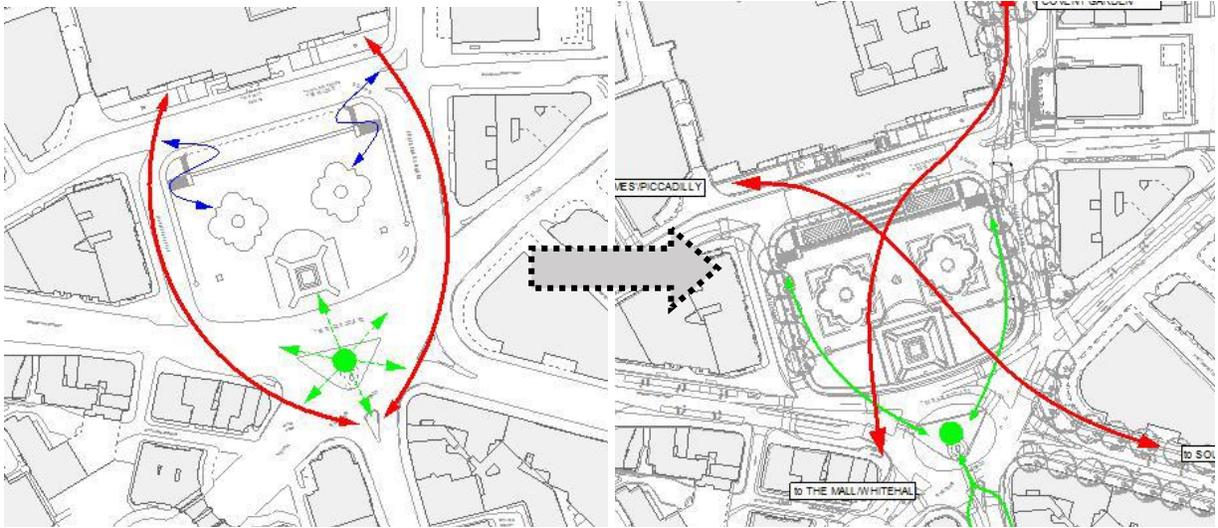


Figure 5. before and after developing the strategy to enhance Trafalgar Square's performance [15].

- In Nottingham's Old Market Square, they came up with the concept for the redesign, which is focused on the formation of two wide diagonal roads that connect in the square's center. Gustafson Porter embraced this notion and created a full design proposal for the competition submission, as shown in Figure 6.

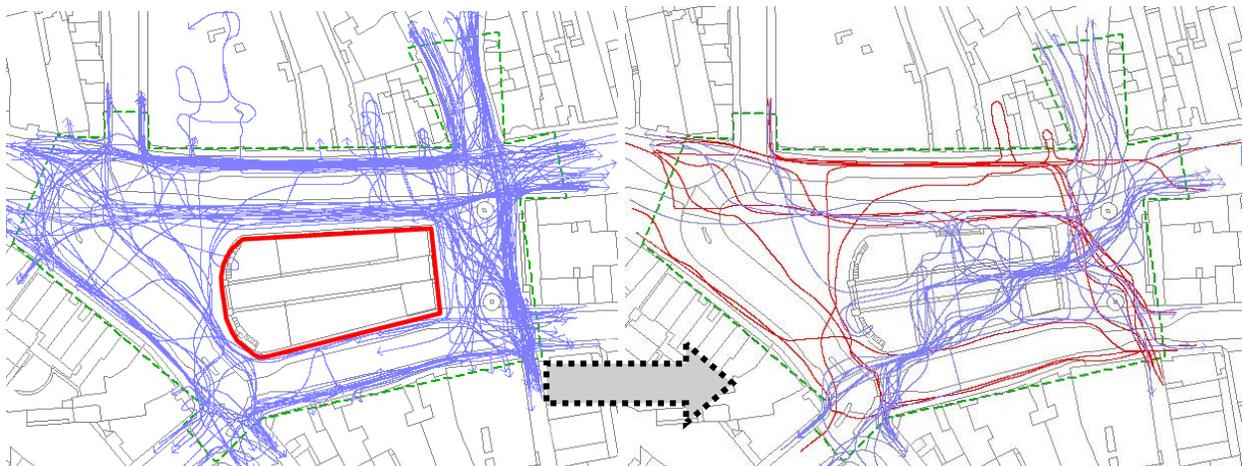


Figure 6. Before and after developing the strategy to enhance Nottingham's Old Market Square performance [15].

3-3- Final Project (After Enhancement)

After reviewing previous stages to address issues with current layouts, we reach this stage.

- **In Trafalgar Square**, after redesigning the space, accessibility value both inside and outside the square increased, according to an analysis of spatial configuration, as shown in Figure 7. There has been a change in decisions, as shown in **Figure 8**. The objective was to make the area more accessible and 'steer' the natural pedestrian flow through it rather than around it [16].

- Streets and traffic flow, Southside: the square extends down, redesigns Charles Island and creates new islands in its two directions to reduce walking. Northside: close the north side street as Pedestrian Street; Eastside: change to two lanes in two-way traffic; Westside: provide two lanes, one-way south; and Southside: provide two lanes for traffic.

- Pedestrian movement: Into the Square offers crosswalks at each of the square's four corners; pedestrian access to Charles Island is made possible by crossing from the main island at Main Street Whitehall to the new two islands; additionally, the design accommodates wheelchairs.

- Cyclists and public transportation: Establish bus lanes and bike-only lanes on either side of the square; Provide cafes and toilets under the north terrace near the new staircase.

- Planting: Additional trees were planted to maintain the area's aesthetic appeal.



Figure 7. All line maps after enhancement [15].



Figure 8. Decisions made to enhance [16].

The project proved that space syntax works well for urban design projects, and since the renewal, the square has become an important meeting place for tourists as well as for locals, as shown in **Figure 9**.



Figure 9. Changing at analysis after spatial configuration development [18].

- **Nottingham Old Market Square** the new design offers straightforward, extremely accessible paths that traverse the square from corner to corner, bringing pedestrian activity to the very center. In this plan, the square's middle was opened to make it easier for people to enter or exit the area, and the areas that were not as likely to be used by pedestrians were made into locations for stationary and leisurely activities. During the project's design development phase, specific design concepts, like the creative use of water features and urban furniture, were created and put to the test in order to influence the final design outcome.

This project's success is largely due to a strong correlation between spatial configuration and patterns of activity. Square is now a well-liked hub for urban activities and a place of transition. After it was put into action, the project received praise from numerous panels and experts for its contributions and success (Hillier, 2007). The square is now a well-liked hub for urban activities and a place of change. After it was put into action, the initiative received accolades from several committees and experts for its contributions and success, as shown in **Figure 10**.

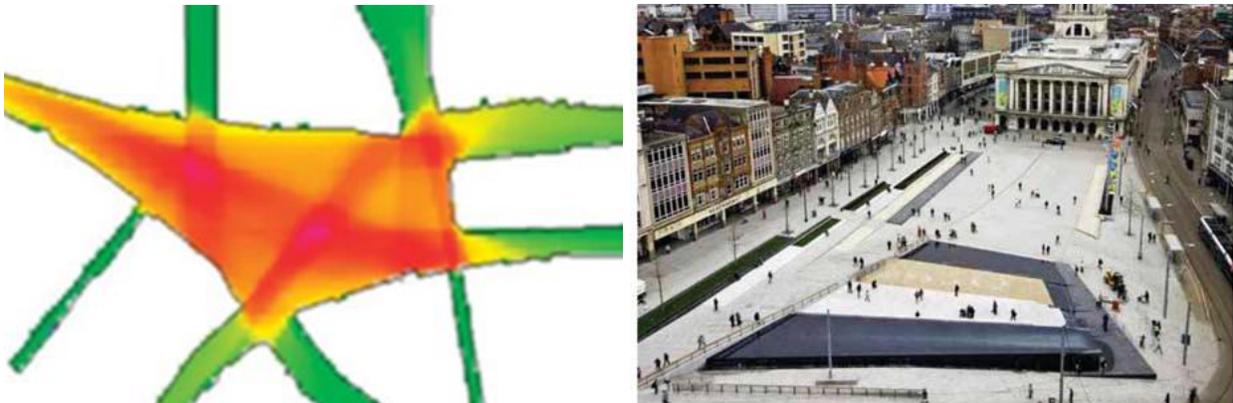


Figure 10. Pedestrian traces 30% of the diagonal movement in the center of the square [15].

4- Results and Discussion

In the first stage (identifying and confirming problems), this crucial point introduces how space syntax functions. The issues are initially indicated by the space syntax. The design team then provided an explanation of these issues based on the earlier analysis. Following that, the design team took some actions intended to address the problem that had been described and highlighted. Finally, the group put forth the design, as shown in Table 1

Table 1. Shown Discussion decisions, aims, and designs for Trafalgar Square and Nottingham Old Market Square.

Problem	Decision	Aim	Design
Trafalgar Square			
Pedestrians attracted to Charles Island instead of the square	Efficiently Redesign the island to be a link between the surrounding area and the square. Besides, the island's central location will attract people and transport them to the square.	using the island as the square's southern entrance because of its excellent visibility and accessibility.	Charles Island, the main island, will be widened, and two smaller islands will be added to either side of it.
Pedestrians are being pushed out of the square and now prefer to walk around it rather than through it.	Reconnect the square with the surrounding area to attract pedestrians inside the square. redesign the square's north entrance.	Create a square with high-integrated axial lines crossing it and connecting to the surrounding area.	Close the north street for pedestrians, and redesign the surrounding street for vehicle movement. A wide staircase connects the north street with the square.
Nottingham Old Market Square			
People's behavior and movement revealed that the square was unevenly used and populated.	suggested that by arranging movement channels diagonally through the square and using the 'shadows' cast by movement flows for stationary activities.	Improve the square's performance in terms of legibility and pedestrian flows, and balance the urban clamor created by movement with stationary activities that take place nearby to movement flows.	The square's center was expanded to make it easier for people to use or cross it, and the areas that were not as likely to be frequented by pedestrians were made into locations for stationary and leisurely activities.

By comparing Trafalgar Square and Nottingham Old Market Square, the prior analytical examples. The whole performance of Space Syntax to enhance an urban spaces process can be summarized as shown in **Figure 11**.

- Reliance on observational techniques to solve the issues in Trafalgar Square and Nottingham Old Market Square, including counting gates, movement pattern maps, and space syntax analysis.
- Making use of space syntax to evaluate and enhance the suggested design options to arrive at the most workable one.

- Finally, utilizing space syntax, the suggested alternative test was run to enhance Trafalgar Square and Nottingham Old Market Square and compare the results to the existing situation.

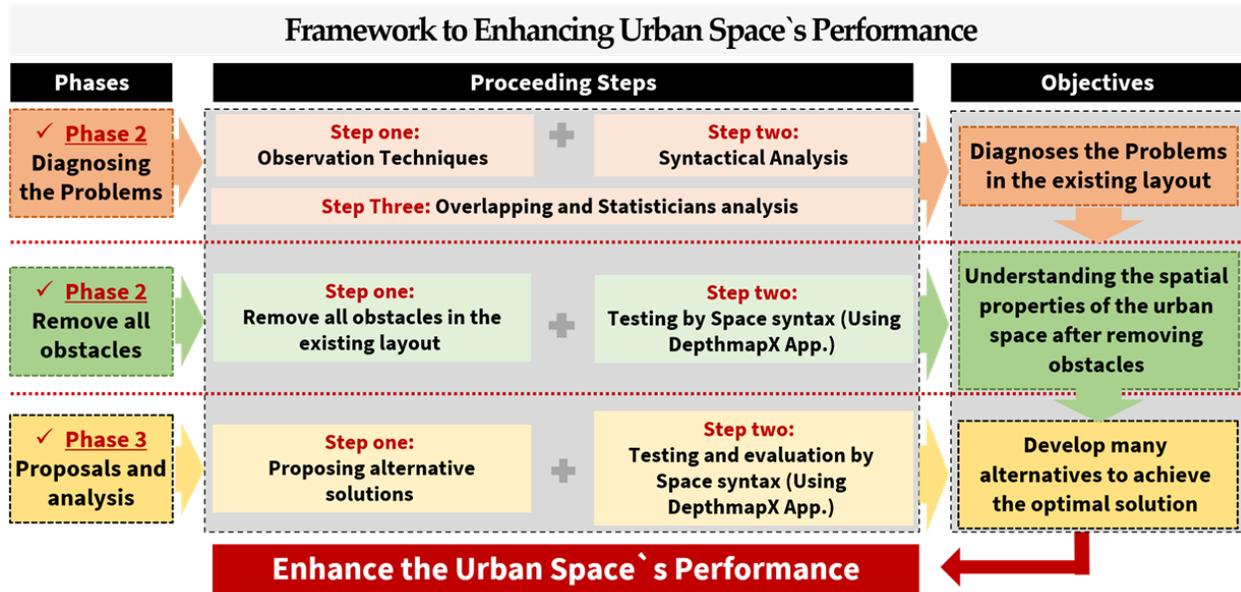


Figure 11. Framework to enhance urban space's Performance, source: Authors

5- Conclusion

Space syntax is an efficient tool for developing and designing urban places for pedestrians. Making decisions about shared, vehicle and pedestrian streets is aided by this. Crosswalks, bike lanes, desired landscape paths, and public transportation network locations could all be found using space syntax.

Space Syntax was used in the study's methodology as a design tool as well as an analytical and diagnostic tool. Analysis and diagnosis of the current situation led to the identification of issues, the proposal of remedial measures, the testing of potential alternatives, and the identification of the best option likely to increase plaza usage.

This study supported previous studies showing Space Syntax is an effective tool for analyzing how urban environments are used and performed. It supported studies indicating accessibility affects how people use public spaces. To conclude, the study concluded that Space Syntax is a very helpful evidence-based diagnostic and design tool that could significantly enhance the process and results of designing urban spaces, resulting in better-designed places that satisfy their users' needs.

Future post-occupancy evaluation studies of finished projects where Space Syntax was utilized as a diagnostic or as a design tool are required to confirm its findings and ascertain how well it predicts user behavior. The prediction power of Space Syntax would increase with additional research that takes into account a variety of aspects to create more precise predictive models and algorithms. These kinds of research are required to enhance the Space Syntax methodology and persuade practitioners of its benefits as a trustworthy design tool in urban consultation.

- **Conflict of Interest**

The authors declare no conflict of interest.

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