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Space Syntax and Level of Permeability: An Analysis of Giant Interactive Group Corporate Headquarters in Shanghai

Nur Alaa Ahmad Azmi[1], Yasser Arab[2*], Ahmad Sanusi Hassan[1], Maryam Saeed[2], Bhattraradej Witchyangkoon[3], Wesam H. Beitelmal[4]

[1] School of Housing, Building & Planning, Universities Sains Malaysia, MALAYSIA.

[2] Department of Architectural Engineering, Dhofar University, Salalah, SULTANATE of OMAN.

[3] Department of Civil Engineering, Thammasat School of Engineering, Thammasat University, THAILAND.

[4] Department of Civil and Environmental Engineering, Dhofar University, Salalah, SULTANATE of OMAN.

**Corresponding Author (Tel: +968 9987 2907, Email: yarab@ du.edu.om).*

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Abstract

This study uses the Giant Interactive Group headquarters as a case study to analyze and understand the spatial configuration in an integrated commercial and hospitality building typology. The spatial layout's effectiveness is obtained by identifying the level of permeability and wayfinding in the case study. The levels are categorized following the five levels of permeability in the Likert scale. The graph is then scrutinized and compiled to highlight the result and discussion. The hierarchical order of space is organized to show the percentage of permeability level present in The Giant Interactive Group headquarters. The study shows how the building achieved a balance in public and private spaces' spatial configuration. The unique spatial structure of the hotel, nature, and commercial office present in the Giant headquarters are blended masterfully into a delicate balance of user and spatial environment. The analysis has shown a different spatial planning method in architecture by using spatial reasoning and justified graphs.

Discipline: Architectural Engineering, Built Environment.

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1 Introduction

In 1984, after publishing The Social Logic of Space by Hillier (1984), architectural theory related to spatial nature had been improving fast. 'Space syntax' is a social theory of space and a method of analyzing the areas in buildings and urban environments using an analytical and descriptive tool to represent the spatial formation (Hillier and Hanson, 1984; Hillier, 1996; Dawes and Ostwald, 2018). The analysis also includes graphs to understand and predict user movements (Ratti, 2003). This paper uses space syntax and applies it to achieve the research objective and finally determines how the spaces are configured will relate to the way humans perceive and move through the spatial system (Penn et al. 1998). The research objective is to analyze the flow of spaces or permeability (Ephes, 2006) of the selected case study building.

The case study, Giant Interactive Group Corporate Headquarters designed by Morphosis Architects is a compact village in Shanghai that accommodates diverse programmatic functions in a flexible framework of architectural forms that move into and out of a sculpted landscape. The design gives way to multiple types of users, and each will have a different level of permeability access and wayfinding according to the spatial building formations (Abd Rahaman, 2019). It is the headquarters of modern corporate China to show the limits of capitalist architecture and represent the new generation of China's office building design. Honored with China's 2013 Green Innovation Award and the 2011 and 2012 Chicago Athenaeum Awards, it is the focal point of many architectural articles that discuss the building's design.

2 Literature Review

Space syntax is a spatial theory that focuses on space arrangement in building or urban design. It is used as an analysis for space configuration in architectural elements such as buildings or landscapes (Hillier & Hanson, 1984; Hillier, 1996; Zhai & Baran, 2013). According to Nourian et al. (2013), space syntax can be used as a determinant for resolving the connection between social interaction and spatial configuration. Social interaction can be generated by applying space syntax to the built environment spatial arrangement (Ackerson & Straty, 1978; Suryawinata et al., 2017). Measuring accessibility of sustainable transportation using space syntax). Several methods can be used for displaying the result of space syntax analysis such as justified graphs and syntactic steps (Hillier et al., 2016). The graphical representation of the space syntax analysis allows for an easier understanding of permeability and the overall depth of the building's spatial configuration (Natapov et al., 2015). Permeability in this paper refers to accessibility concerning the spatial layout (Farhah, 2019). Permeability and wayfinding are the two measurable factors that space syntax consists of (Yi, 2019). Andrade et al. (2018) discussed permeability between private and public spaces. Erman (2017) analysed architectural space via spatial neighbourhood concept.

According to Nourian et al. (2013), space syntax in architecture identifies the relationship between spatial arrangements with social definitions. However, space syntax is also applicable to all building typologies and cultural buildings. The description related to this paper would be an application of space syntax to generate social interactions by spatial arrangement analysis

(Ackerson & Straty, 1978). The case study typology, a commercial office building, is designed to increase social interaction and relieve work stress by using spatial arrangements. Morphosis Architect designed the Giant Interactive Group Headquarters with the concept of "emerging organically from complexity". The Giant Campus is located in Shanghai, China, and covers a space of 3.2 hectares. The building was completed in 2010 and is home to the Giant Interactive Group, a software development company that creates gaming and entertainment software. The facility separates itself into the east and west sections where the East Campus houses the office complex where most of the company's work is done. The West Campus comprises a hotel and other entertainment facilities for office workers and hotel guests. The building is private and requires entry towards any part of the building.

Figure 1: View of Giant Campus across the human-made lake on the outskirts of Shanghai, China
(Source: https://www.morphosis.com/architecture/1/)

3 The Giant Interactive Group Headquarters

The Giant Interactive Group headquarters is a complicated complex with a mix of landscaping and office architecture. Located in Songjiang, a reclaimed swampland site, the campus strives to become the center of Songjiang's industrial area. Although currently standing alone, China's development plan has highlighted the area as a new sustainable space with the campus being one of the first to be built.

Table 1: Schedule of accommodation for the ground floor plan

Code	Space of Accommodation	Code	Space of Accommodation
S1, S2, S3 etc.	Staircase	Ms2	Male Shower Room
V1, V2, V3 etc.	Vertical Access	Mc1	Male Changing Room
E1, E2, E3 etc.	Entrance	Gc1, Gc2	Gym Court
Lo1, Lo2, Lo3 etc.	Lobby	Gy1	Gymnasium Room
Ci1, Ci2, Ci3 etc.	Circulation Space	Su1, Su2, Su3 etc.	Hotel Suite
O1, O2, O3 etc.	Office	Mf1, Mf2, Mf3	Multi-Function Space
St1, St2, St3 etc.	Storage Room	Ex1, Ex2	Exhibition Space
M1, M2, M3 etc.	Maintenance Room	Me1, Me2	Media Room
Fw1, Fw2, Fw3	Female Toilet	Op1, Op2	Open Office Space
Fl2	Female Locker Room	Re1, Re2	Reception
Fs2	Female Shower Room	Sec1, Sec2	Security Room

Code	Space of Accommodation	Code	Space of Accommodation
Fc1	Female Changing Room	Gr1, Gr2, Gr3	Garden
Mw1, Mw2, Mw3	Male Toilet	N1, N2	Building System
Ml2	Male Locker Room	Pwr	Power Room
Lr1	Linen Room	Bh1	Back of House

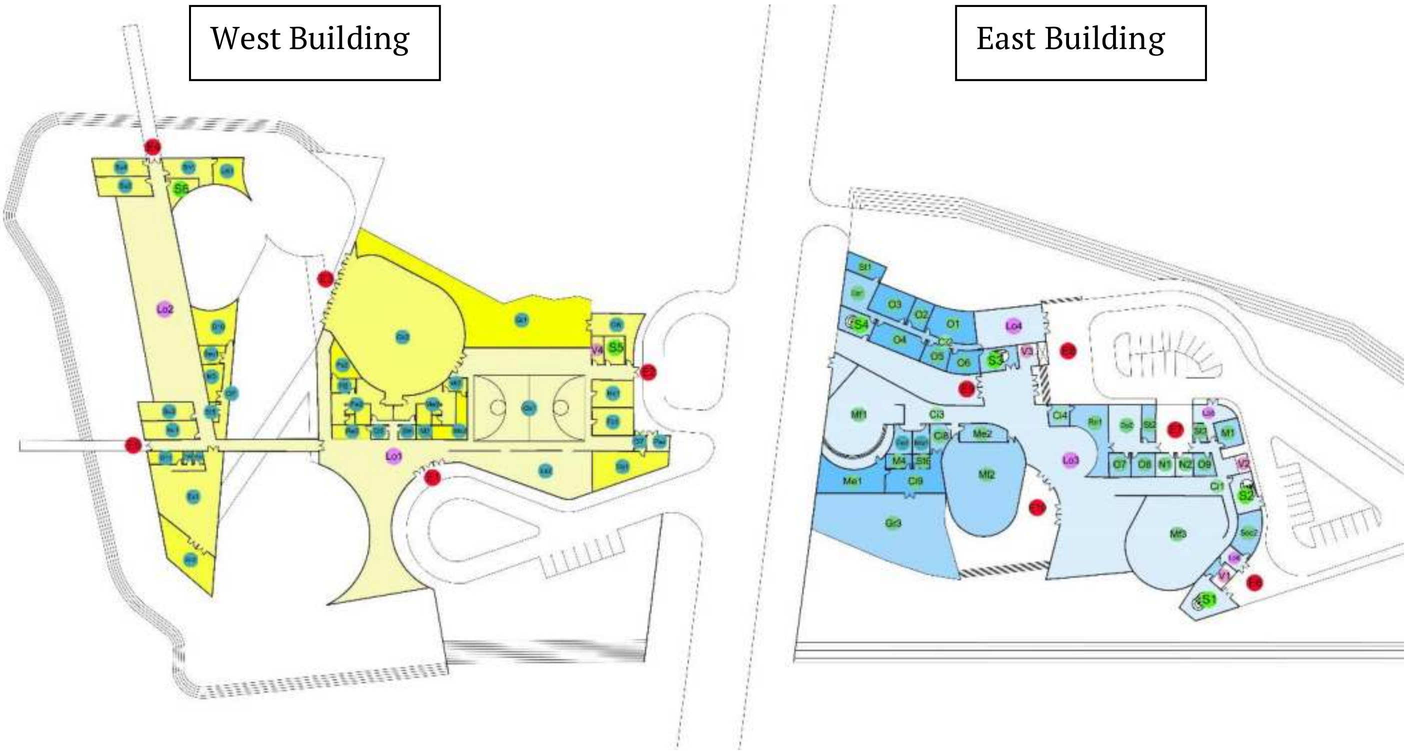

Figure 2: Ground floor plan of Giant Interactive Group Headquarters

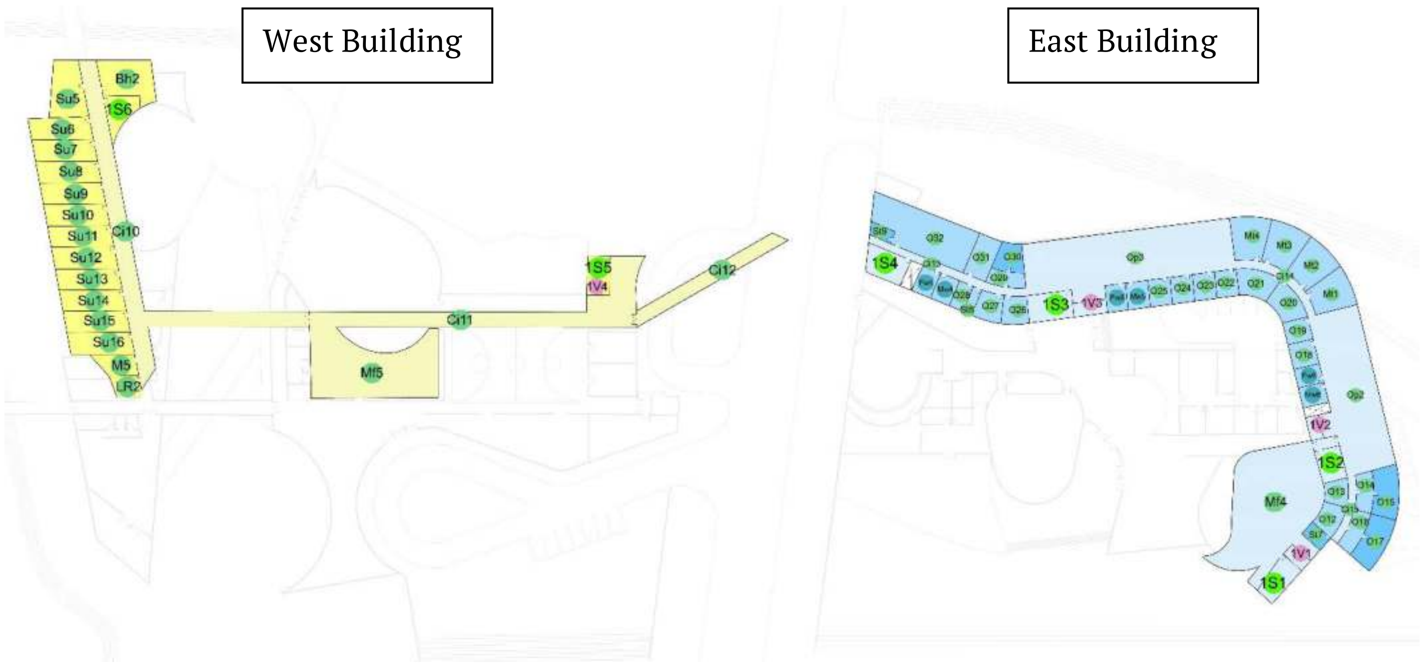

Figure 3: First-floor plan of Giant Interactive Group Headquarters

Table 2: Schedule of accommodation for the first-floor plan

Code	Space of Accommodation	Code	Space of Accommodation
1S1, 1S2, 1S3 etc.	Staircase	St7, St8, St9	Storage Room
1V1, 1V2, 1V3 etc.	Vertical Access	Op2, Op3	Open Office Space
Ci10, Ci11, Ci12 etc.	Circulation Space	Mt1, Mt2, Mt3 etc.	Meeting Room
Mf4, Mf5	Multi-Function Space	Lr2	Linen Room
O12, O13, O14 etc.	Office	Bh2	Back of House
Su5, Su6, Su7 etc.	Hotel Suite		

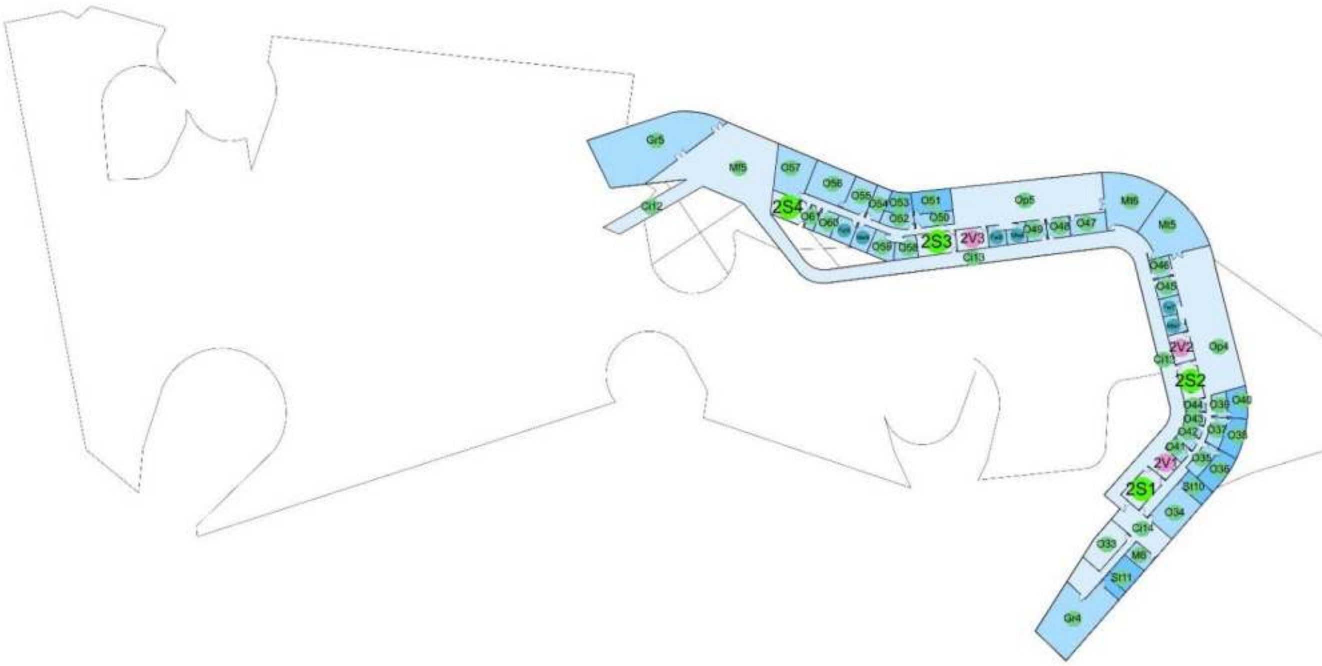

Figure 4: Second-floor plan of Giant Interactive Group Headquarters

Table 3: Schedule of accommodation for the second-floor plan

Code	Space of Accommodation	Code	Space of Accommodation
2S1, 2S2, 2S3 etc.	Staircase	St10, St11	Storage Room
2V1, 2V2, 2V3 etc.	Vertical Access	Op4, Op5	Open Office Space
Ci12, Ci13, Ci14 etc.	Circulation Space	Mt5, Mt6	Meeting Room
Mf6	Multi-Function Space	Gr4	Garden
O33, O34, O35 etc.	Office	Fw7, Fw8, Fw9	Female Toilet
Mw7, Mw8, Mw9	Male Toilet		

In Giant Campus, the building consists of two different wing sections separated by the central Shanghai Highway that connects Songjiang with central Shanghai. This physical environment helps create a territory that defines the level of privacy and access (Mustafa and Hassan, 2010). The east and west division was also highlighted in the building's spatial arrangement. The building has ten entrances in total with five on each wing. Figure 2 shows the west building entrance coded E1, E2, E3, E4 and E5 while the east entrance coded E6, E7, E8, E9 and E10. The west wing opening allows public access up to a certain degree, and the east wing only allows employees access. A walkway connects both wings on the first-floor level.

The office section building's east wing is split into three zones: open, non-hierarchical office space, private offices, and executive suites. Also included within both wings are a library, auditorium, exhibition space, cafe, and conference hall. Large open spaces create visual access visible from different vantage points and help generate a wayfinding guide for visitors (Li and Klippel, 2010). The building also houses various health spaces such as a multi-purpose sports court, fitness space, and jogging track.

Connecting the surrounding environment with the campus are several plazas and gardens that sprout from the landscape. At the south is a pedestrian path that connects to the water's edge, providing access to the lake. The site's circulation and the office building's interior create a wholesome approach used for jogging and scenic walkways. This built form showcases the attention to the environment and establishes a relationship between built form intelligibility and wayfinding performance, which gives birth to an interesting spatial configuration (Peponis et al., 1990).

The campus also boasts maximum energy efficiency and occupancy comfort with minimum heat gain and reduced cooling expenditures. The facade is a double-skin cladding structure, and the glass curtain is insulated to minimize solar heat gain and improve energy efficiency.

4 Research Method

A quantitative survey with space syntax graph illustration is used to determine the level of wayfinding and permeability. The survey data are analyzed through a measurable scale graph (Hassan, 2010). The graph can indicate the level of permeability, which is the paper's main focus. Figure 5 shows the steps of applying labels and constructing a justified graph.

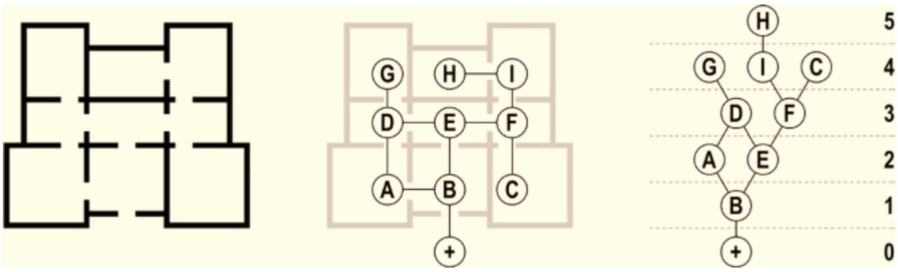

Figure 5: Step-by-step transformation to Justified Graph (after Dawes and Ostwald, 2018).

All plans included in the paper (Figures 2, 3, and 4) are colored to indicate each space's depth level. The plans are also labeled with alphanumeric symbols explained in the included table (Tables 1, 2, and 3) in a group form to analyze the case study (Nasiha, 2019).

Spaces are defined in different categories according to the accessibility of the area to determine the depth of permeability and wayfinding levels. This category is based on the Likert Scale, which is composed of:

1. Public (depth level 0 – 1)
2. Semi-public (depth level 2 - 3)
3. Semi-private (depth level 4 - 5)
4. Private (depth level > 6)

Each user category that corresponds to the spaces will then be arranged in a graph to represent how their permeability flows through the campus. After analyzing each type of user's level, a table of comparison highlights each graph's positive and negative aspects based on the previously done analysis and charts.

Wayfinding is defined through the space flow arrangement that guides people through the facility. The result of wayfinding analysis is categorised in four different levels that are based on the Likert Scale, which is composed of:

1. Very Easy
2. Easy
3. Hard
4. Very Hard

Both the permeability and wayfinding levels are finalized in tabular form for further discussion.

Table 4: Likert Scale Framework Example

Code	Depth Scale	Permeability Level	Wayfinding Level	User
		Public	Very Easy	
		Semi-Public	Easy	
		Semi-Private	Hard	
		Private	Very Hard	

5 Result

From this analysis, this research studied the level of permeability and wayfinding divided into respective West Building and East Building. The campus is a space that was divided in its accessibility. The Shanghai Highway splits the building into two different sections that serve other purposes. There are multiple entrances for each facility connected to various areas in the site plan. This building's types of use define the study of permeability level. The users are identified to be as follows:

1. Visitors
2. Staff

5.1 West Building

The West section of the building serves the purpose of relaxing and enjoyable for both the employees and visitors. The building consists of hotel suites and a gym court for various activities. From the ground floor plan in Figure 2, three of the main entrances into the building (E1, E4, and E5) lead the visitors into a lobby area (Lo1 and Lo2) where a reception counter (Re2) will greet them. This path is for visitors who are there for hotel service and exhibition. The other entrances (E2 and E3) lead visitors to the gym area. This path is for visitors who are there for exercising and sports activities. The hotel facilities are complete with 16 suites (Su1 – Su16) and back of house (Bh1 and Bh2) for service. An administration (O10) and a security office (Sec1) are also located in between.

For entrances E2 and E3, visitors entered the gym space (Gc1 and Gc2) where facilities such as showers (Ms2 and Fs2) for males and females are prepared. A separate changing room (Fc1 and Mc1) is also nearby for a quick clothes change. On the first floor level (1S5 and 1S6 staircase), visitors can see the environment downstairs through the open spatial arrangement and proceed towards their hotel suites. The upper-level suites have a higher privacy level with multiple spaces as a buffer. The multi-functional space (Mf5) is prepared for visitors to socialize.

A ramp connects the west building with the east building's second-floor level. This ramp is for the staff to access the sports facilities without going out of the building.

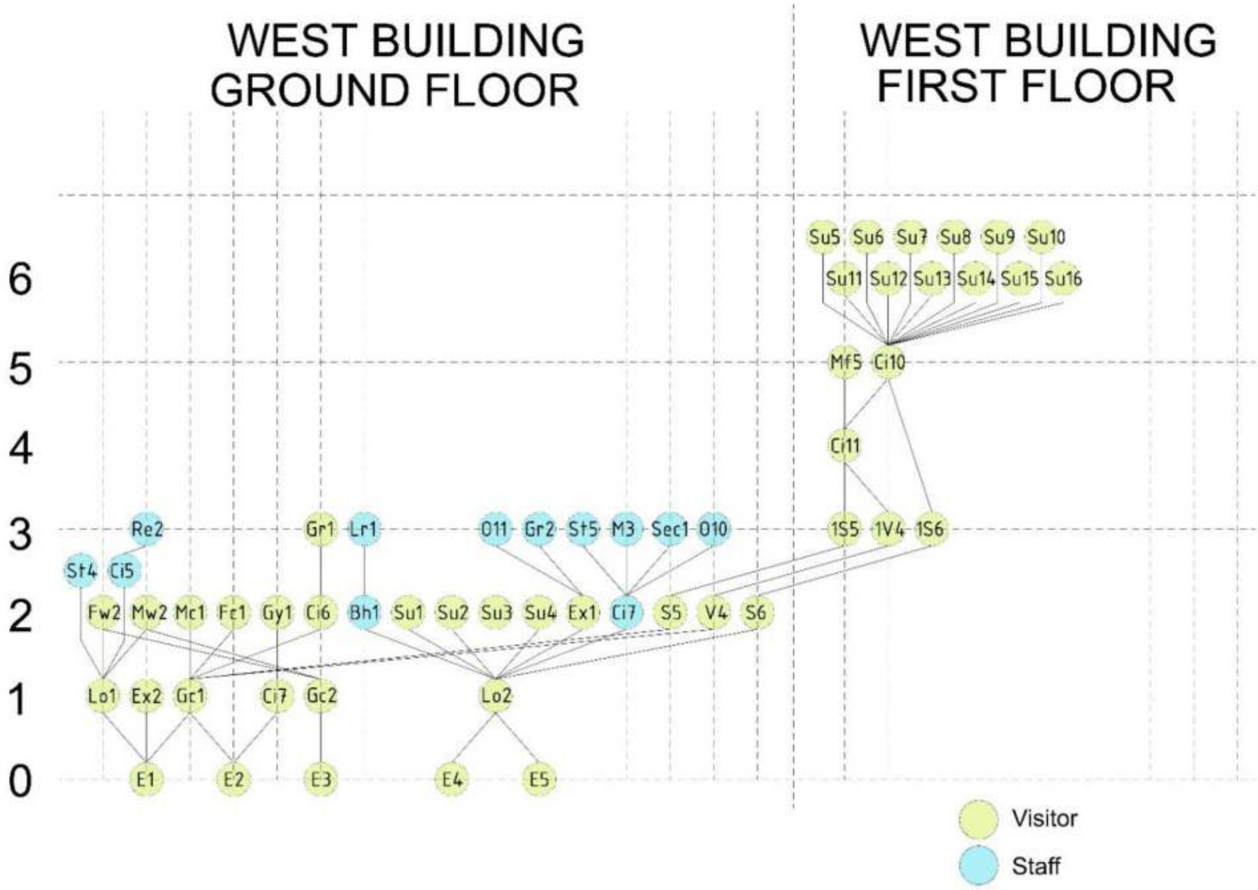

Figure 6: Justified Graph for Giant Interactive Group Headquarters' west building.

From the justified graph in Figure 6 and the floor plans in Figures 2 and 3, we can gather sufficient data to create a Likert Scale framework for further discussion.

Table 5: Likert Scale Framework of the West building

Code	Depth Scale	Permeability Level	Wayfinding Level	User
E1, E2, E3, E4, E5, Lo1, Lo2, Gc1, Gc2, Ex2, Ci7	0 - 1	Public	Very Easy	Visitor and Staff
St4, Ci5, Re2, Fw2, Mw2, Mc1, Fc1, Gy1, Ci6, Gr1, Bh1, Lr1, Su1, Su2, Su3, Su4, Ex1, Ci7, S5, V4, S6, O11, Gr2, St5, M3, Sec1, O10, 1S5, 1V4, 1S6	2 - 3	Semi-Public	Easy	Visitor and Staff
Ci11, Mf5, Ci10	4 - 5	Semi-Private	Hard	Visitor and Staff
Su5 – Su16	>6	Private	Very Hard	Visitor

5.2 East Building

The last section of the facility is mainly for staff usage. The interior environment's spatial design is more closed than the west wing. The building houses multiple office spaces (O1, O2, O3, etc..) and meeting areas (Mt1, Mt2, Mt3, etc..) while also providing spaces for major conventions and press releases. From Figure 2, the building has five entry points with three from the private parking area (E6, E7, and E8), one for emergency exit (E9), and the last one (E10) for pedestrians coming from the south. All entry point leads into a lobby area inside. The E6 entrance is used for employees on the first and second levels for quick access.

From the S1 staircase and V1 lift, staff can immediately access the first-floor multi-function space (Mf4) to go to the office area. The E7 entrance allows access to the building's system and maintenance space. The maintenance staff mainly uses this to access the maintenance office (M1) and the storage area (St2 and St3). The E8 entry point allows access to the ground-level administration office. This office (O1 – O6) deals with exhibition and gallery reservations. E8 also functions as a drop-off with direct access to the reception desk (Re1) and the three multi-function spaces (Mf1, Mf2, and Mf3). The Mf1 is equipped with multiple spaces (Ci8 and Ci9) to act as a pre-function area and is connected to a private garden (Gr3). The E10 entry point allows access for pedestrians into the spacious lobby.

On the east building's first floor level, the office space is arranged with a circulation path in the middle. This allows office space access to windows and enables maximum space efficiency. Vertical access such as staircases (1S1, 1S2, 1S3, and 1S4) are arranged along the inner side of the building together with the lifts (1V1, 1V2, and 1V3) and bathrooms. Meeting rooms (Mt1, Mt2, Mt3, and Mt4 are located at the best view of the environment. Open office space (Op2 and Op3) is provided for easier interior arrangement in future improvement.

Table 6: Likert Scale Framework of the east building

Code	Depth Scale	Permeability Level	Wayfinding Level	User
E6, E7, E8, E9, E10, Lo3, Lo4, Lo5, N1, N2, Op2, Lo6, V1, S1.	0 - 1	Public	Very Easy	Visitor and Staff
Ci1, Ci3, Ci4, Ci2, O7, O8, St2, Sec2, 1S4, 1S3, 1S2, 1S1, 1V1, 1V2, 1V3, St3, M1, Mf3, Mf1, Mf2, Re1, Me2, Ci8, Mw1, Fw1, O1, O2, O3, O4, O5, O6, Op1, Op3, Mf4, Op2, 2S1, 2S2, 2S3, 2S4, 2V1, 2V2, 2V3.	2 - 3	Semi-Public	Easy	Staff
Ci9, Me1, Ci13, Fw5, Mw5, O25, O24, O23, O22, O19, O18, Ci14, Mw6, Fw6, Ci15, Op5, Ci16, Op4, M4, St6, Gr3, St8, O28, O26, O27, O31, O27, O29, O32, Fw4, Mw4, Mt1, Mt2, Mt3, Mt4, O21, O20, O12, O13, O14, O16, O57, O56, Fw9, Mw9, O54, O52, O59, O50, O58, Fw8, Mw8, O49, O48, O47, Mt6, Ci17, Mt5, St10, O34, O39, O41, O37, O42, O35, O42, O45, O44, O46, Fw7, Mw7.	4 - 5	Semi-Private	Hard	Staff
O30, St9, St7, O15, O17, O53, O51, O33, Gr4, M6, Gr5, O40, O38, O36.	>6	Private	Very Hard	Staff

The second floor of the east building shows a different spatial arrangement. The main circulation area (Ci16) that connects the building is located on the inner side rather than the center. This arrangement allows for quick and easy access to the ramp that connects the east and west wings. A roof garden is also placed at the building's ends for the staff to relax.

From the justified graph in Figure 7 and the floor plans in Figures 2, 3, and 4, we can gather sufficient data to create a Likert Scale framework for further discussion.

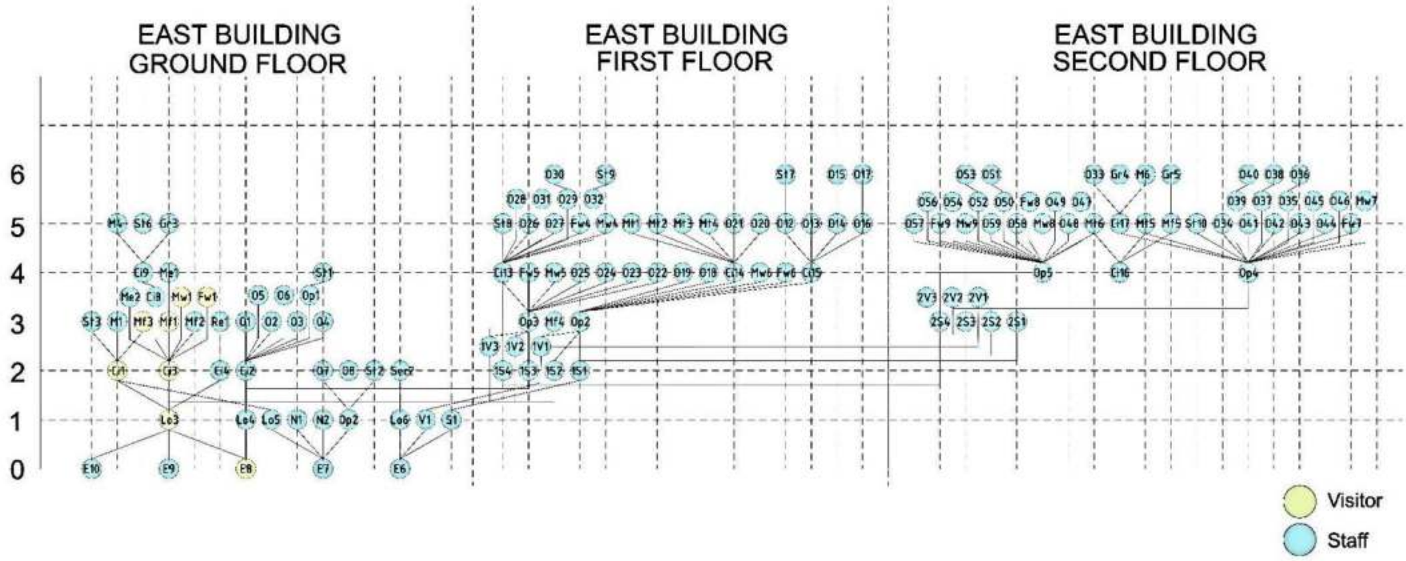

Figure 7: Justified Graph for Giant Interactive Group Headquarters' east building.

6 Discussion

From the research's overall result, the justified graph obtained was in the shape of a shallow tree model. The spatial relations shown in Figures 6, and 7 highlight the immediate branching of space starting from depth level 1. The building offers a complex spatial arrangement on the upper floor where the east and west buildings are connected. To understand the overall building's spatial configuration, the spatial order of all related spaces needs to be considered (Onur, 2017). The compiled results from Tables 5 and 6 are combined to create the following Table 7.

Table 7: Likert Scale Results

Level	% of permeability % of wayfinding
Public / Very easy	12.75
Semi-Public / Easy	36.75
Semi-Private / Hard	37.75
Private / Very Hard	12.75

The result shows that the building is mainly a semi-private / semi-public structure with a difference of 1%. The designer has exhibited a great example of how a hospitality typology is combined with a commercial office building. The balance between the two is maintained and can be seen in the justified graph result.

The building's permeability level is at a medium level where the most private area is located at depth level 6 (CEO and manager's office). Other spaces are scattered at an acceptable level of permeability. The permeability level is very high at the west building, with 54% at the Semi-Public level, and easy to navigate. The west building permeability level is quite low, with 50.3% at Semi-private and hard to navigate due to the long winding access area design. For a private office, such a level of privacy is acceptable.

The overall building has a high number of end rooms due to its design nature. A total of 58.6% of the total spaces consist of end rooms. The building also consists of 10.2% of spaces with more than three branching connections. The busiest space is the open office area (Op4 and Op5) with more than ten connecting spaces. The total % for the staircase compared to the overall building space is 0.1% while lifts are at 0.08%.

7 Conclusion

The Giant Interactive Group headquarters is a building that challenges the nature of building typology by successfully integrating hotel, office, sports, and nature together. From the analysis, it can be concluded that the headquarters' spatial design is carefully thought out to ensure balance in permeability and wayfinding. The decision to integrate the building's natural environment shows the designer understood an integral part of wayfinding (Farr et al., 2012). The bold and innovative interior design and color choices also influence visitors to identify space. Such visual feedback can reduce pedestrian's uncertainty and anxiety, even with the curve and winding plan layout (Vaez et al., 2019). This strengthens the visual connection between the user and the environment and allows for better spatial memory to navigate the space. The open layout on the ground level also allows users to cross through spaces easily without memorizing pathing. The simple office arrangement also functions well to maximize space efficiency and simplify the overall building layout. Although the paper is limited to online sources for the case study, a comprehensive study in space syntax analysis was achieved.

8 Availability of Data and Material

All used or generated data from this study is included in this article.

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Nur Alaa Ahmad Azmi is a Master of Architecture student at the Universiti Sains Malaysia, Penang, Malaysia. He obtained a Bachelor of Science in Architecture from Universiti Sains Malaysia, Penang, Malaysia. He is interested in Adaptive Architectures and Parametric Design. His research thesis was about Integrated Transport and Hotel Hub and Passive Architecture.

Dr.Yasser Arab is an Assistant Professor at the Department of Architectural Engineering, College of Engineering, Dhofar University, Oman. He obtained his Bachelor of Architecture from Ittihad Private University, Aleppo, Syria. He obtained his Master's and PhD in Sustainable Architecture from Universiti Sains Malaysia (USM), Penang, Malaysia. His research focused on the environmental performance of Residential High-Rise Buildings' Façade in Malaysia. He is a Registered Architect in the Syrian Engineers Union. He is very active in research and publication, he published about 70 journal papers, book chapters, and conference proceedings.

Professor Dr.Ahmad Sanusi Hassan is a Professor in the Architecture Programme at the School of Housing, Building and Planning, Universiti Sains Malaysia, Penang, Malaysia. He obtained a Bachelor's and Master of Architecture degrees from the University of Houston, Texas, USA, and a PhD degree focusing on Sustainable Architecture and Urban Design Development for Southeast Asia from the University of Nottingham, United Kingdom. He lectures courses related to Urban Design, Studio Architecture, History and Theory of Architecture, and Computer-Aided Design (CAD).

Maryam Saeed is a practicing architect and Lecturer at the Department of Architectural Engineering, Dhofar University, Sultanate of Oman. She obtained her Bachelor of Architecture from the University of Greenwich and her Master of Fine Arts in Design from Sheffield Hallam University, the United Kingdom. She is a researcher in Architecture, design, and computation, centering her studies and professional practice on the Digitalization of Heritage and Generative Design Methodologies.

Dr.Bhattraradej Witchayangkoon is an Associate Professor at the Department of Civil Engineering at Thammasat University. He received his B.Eng. from King Mongkut's University of Technology Thonburi with Honors. He continued his PhD study at the University of Maine, USA, where he obtained his PhD in Spatial Information Science & Engineering. Dr. Witchayangkoon's interests involve Applications of Emerging Technologies to Engineering.

Dr.Wesam Beitelmal is an Assistant Professor position in the Civil and Environmental Engineering Department in the College of Engineering at Dhofar University in the Sultanates of Oman. He involves in many local communities' programs and feasibility studies such as Oman's Hydrogen Economy. His research focuses on Infrastructure Asset Management and How to Improve and Sustain the Quality of Life for the Citizens Facing Natural Disaster Risks, Funds Scarcity, and Climate Change Impact. Wesam holds a Ph.D. and MS in Civil Engineering from the University of Colorado Boulder, USA, an MS in Engineering Management from the Libyan Academy, and a BSc in Civil Engineering from the University of Benghazi, Libya. In 2020, Wesam is considered a Certified Asset Management Assessor (CAMA) by the World Partners in Asset Management (WPiAM). Recently, his application for the Advance HE fellowship was approved in August 2021