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Evaluation of Space Syntax on Fisterra Fish Market in Spain

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Abstract

This paper intends to discuss the approach of space syntax analysis of a selected fish market as a representation of building typology based on the level of permeability and wayfinding. Fisterra Fish Market, Spain is selected as a case study for this research. The research is carried out by using a justified graph to understand the spatial relationship with the spaces and graphs labeled by the numbering system to explain the spatial configuration of the fish market. The result showed that Fisterra Fish Market has a clear level of permeability and wayfinding as a fish market for the public and staff. Fisterra Fish Market can accommodate both public users and staff without inferring to each other. The depth of permeability of the building from 0 to 5, the building provided easy accessibility and rational mapping to the public and staff in effective wayfinding and space configuration as a fish market building typology.

Discipline: Architecture.

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1 Introduction

The quality of the spatial arrangement of space is according to the design control of privacy in public and private spaces based on the building occupants' needs (Lim, et al., 2019). The human navigability patterns and spatial behavior are influenced by the spatial configuration of spaces (Hillier, 2007). Space syntax is a study of accessibility within graphs (Penn, 2003). Level of

permeability and wayfinding are the elements to determine the quality of the spatial configuration of the building (Lim, et al., 2019).

In this paper, the space syntax study will be carried out to evaluate the public and private space configuration of a fish market. The research objective is to study the layout plan of the case study, Fisterra Fish Market on its level of permeability and wayfinding. The differences in navigation strategies will be reflected by the understanding of inexperienced wayfinding (Holscher, et al, 2012). Fisterra Fish Market is selected as the case study of this paper since Fisterra Fish Market is one of the special fish markets that contain functions to effectively accommodate the visitors and staff at the same time. (Padin, et al., 2016)

The issue of the typical fish market is usually designed without fulfilling the required spaces and the circulation of workers and the public is mixed up in the fish market (Lem, 2004), while the Fisterra Fish Market is designed to accommodate workers and visitors without inferring each other. The building design intention is to separate the routes of visitors and workers from each other. The fish market consists of public and private spaces. The public spaces include a fish market stall, auction hall, and exhibition hall, while the private spaces include a seaport office, meeting room, freezer storage, etc. The information and data will be organized and translated into a justified graph to show the depth of the spaces and to explain the level of permeability of spaces.

2 Literature Review

Space syntax is a theory to determine the relationship between spatial configurations to generate social interactions in townships, cities, or buildings (Nourian, et al., 2013; Ackerson, et al., 1978; Hillier, et al., 1984; Hillier, 2007). Space syntax is focusing on the relationship between human beings and the spaces they occupy (Yusoff, et al., 2019). Wayfinding and place-learning are the spatial cognition aspects to analyze the space syntax theory and improve people's understanding and experience of the spaces (Beck, et al., 2009; Yasin, et al., 2017). According to Hillier, et al. (2016), graphs, syntactic steps, and justified graphs are space syntax analysis graphs that can be executed easily for reading and analysis. The depth and level of permeability of the case study will be analyzed by a justified graph (Natapov, et al., 2015). Level of permeability and wayfinding are the measurable factors of space syntax (Lim, et al., 2019).

2.1 Building Typology: Fish Market

According to the Oxford Dictionary, a market means "An open space or covered building where merchants gather to sell their goods to people. There are different types of markets, such as wet markets which are run by small vendors to sell meat, fish, fruits, and vegetables (Goldman, et al, 2005). While, hypermarkets have a wide variety of foods, clothes, and household products compared to the wet market since the hypermarket consists of many department stores in a covered building. There is also a fish market which is a marketplace for wholesale trade between fishermen and fish merchants, to sell fish and fish products to customers, and it is considered one typology of a wet market. There are various sizes of fish markets from small-scale fish markets to big fish

market complexes like the Tsukiji fish market in Tokyo, transferring about 700,000 tons of fish per year (Bestor, 2004).

The traditional fish market normally can be found in the marketplace, street, jetty, boat, and seaside. The open-air design of the fish stall allows fisherman and fishmongers to directly sell their goods to customers. The activities of selling fish and unloading fish in the traditional fish market normally are without proper planning and the circulation is mixed between the customers and workers. However, the modern fish markets have proper planning of spaces and circulation between customers and workers as seen in Tsukiji Fish Market, Sydney Fish Market, Fisterra Fish Market, etc. Modern fish markets usually have additional functions compared to traditional fish markets, such as an auction hall, freezer storage, exhibition hall, and management office (Graddy, 2006). The design of a modern fish market is usually for semi-public and semi-private use.

3 Fisterra Fish Market, Spain

The case study selected for the fish market typology is Fisterra Fish Market which is located in Fisterra Seaport, Spain. The fish market was constructed in 2006 and designed by CreuseCarrasco Architects. The area of Fisterra Fish Market is around 2658m^2. Fisterra Fish Market consists of a conventional market and additional functions such as an information area, auction hall, didactic material exhibition hall, control room, and a freezer store. The design objective of Fisterra Fish Market was to separate the workers' and visitors' routes at the same time when the market was active. The worker's route is planned for the works at ground level with linear sequence and crossed accesses to load and offload the fish from the seaport. While, the visitor's route is designed as a longitudinal itinerary elevated around the auction hall, which begins and ends at the lobby.

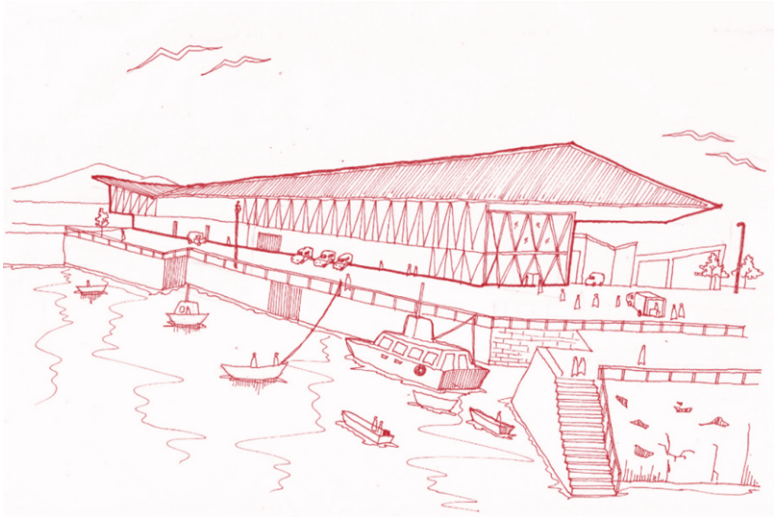

Figure 1: Sketch drawing of a perspective view of Fisterra Fish Market, Spain.

As shown in Figure 1, Fisterra Fish Market has a big eave design that welcomes visitors entering the glass lobby from the public entrance of the building, the entrance is covered by big eaves and the exterior space of the market also functions as a part of the lobby area. The double volume lobby is separated from the ground level as the auction hall while the upper level is the exhibition hall. Each volume creates a vertical communication and is connected by ramps and a

staircase from the entrance. Ring route design enabled the visitors to observe the activity in the auction hall from the upper level without interfering with it. There are ten departments of the old market and the packing warehouse is integrated with the building on the ground floor, while the other end of the building is the seaport office that controls the fishing activity. The first-floor area consists of the secretary's office and sales office.

3.1.1 Site Plan & Ground Floor Plan

Figure 2 is a drawing of site plan and ground floor plan of fisterra fish market, Spain. Figure 3 is the drawing of the first-floor plan of Fisterra Fish Market, Spain.

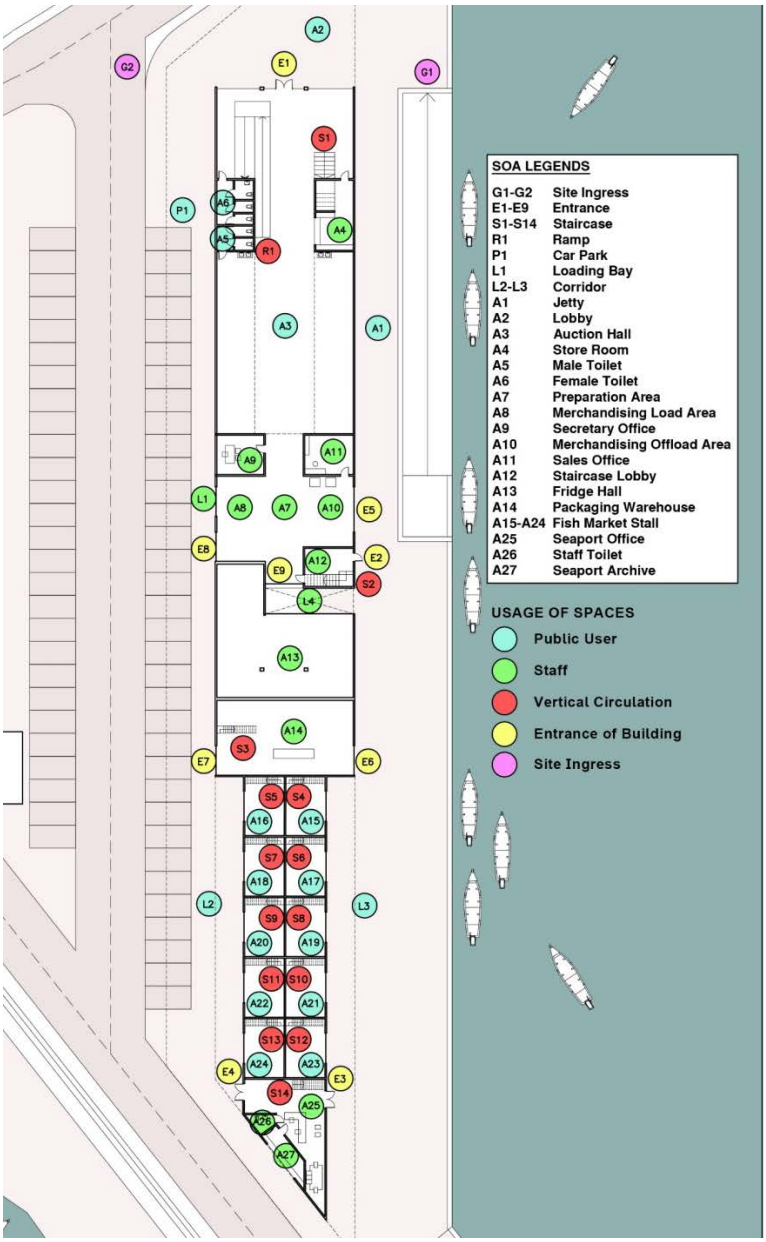

Figure 2: Site Plan and Ground floor plan of Fisterra Fish Market, Spain & SOA.

3.1.2 First Floor Plan

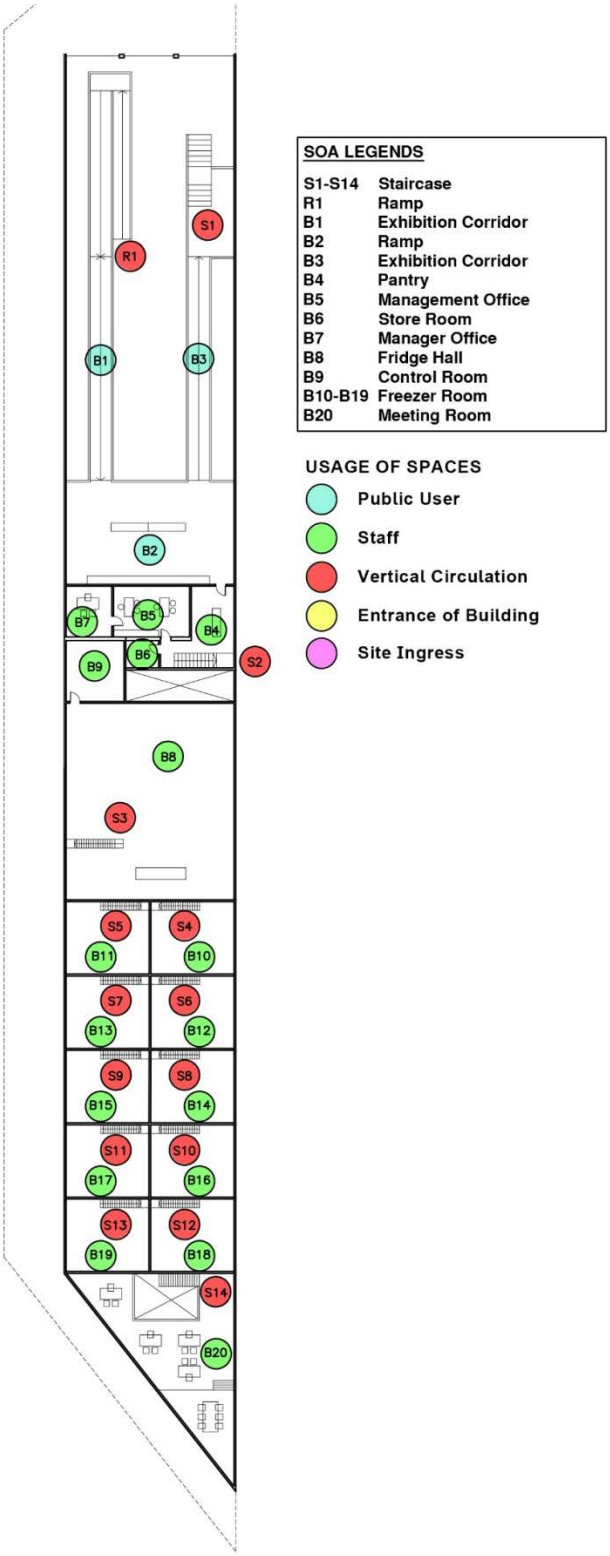

Figure 3: First-floor plan of Fisterra Fish Market, Spain & SOA.

4 Method

According to Brandon (2010), analysis of spatial hierarchy is an effective method of understanding wayfinding by using a leveling numbering graph. This paper is using a justified graph by employing a graph, a numbering system, and a Likert Scale of Measurement to analyze the layout plans of the selected case study. Firstly, the numbering system is labeled in each space of the layout plan with different categories and colors, after that translated into graphs for a better

understanding of the analysis. The Likert Scale of Measurement is used to determine the level of permeability and wayfinding. After that, the justified graph is produced to observe the spatial networking of the selected case study.

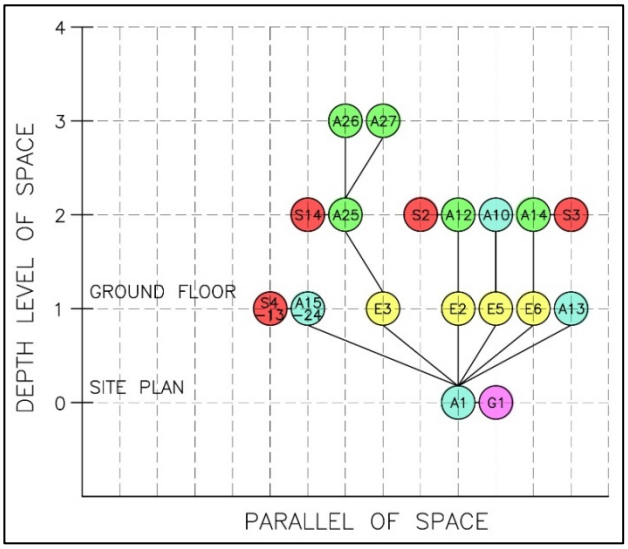

Figure 4: Example of a justified graph used for space syntax study.

4.1 Graph and Numbering System

Firstly, numbering is used for labeling each space of layout plans with different functions and categories. Each alphabet with different colors is represented as different usable spaces on different floors of the building. The alphabet G represents the ingress into the site (G1&G2), the alphabet E represents the entrance into the buildings (E1, E2, E3, etc), the alphabet S represents the staircase (S1, S2, S3, etc), the alphabet R represents the ramp in building, alphabet A represents the internal spaces on the ground floor (A1, A2, A3, etc) and finally, alphabet B represents the internal spaces on the first floor (B1, B2, B3, etc). Next, the numbers are translated into a justified graph to study the level of permeability and wayfinding as explained in Figure 4. In the graph, the vertical axis of the graph represents the level of permeability from most public spaces to most private spaces, while the horizontal axis of the graph represents the spaces of the same depth on a specific floor. The lines connect the spaces which are labeled by circles, and represent the relationship between the connected spaces. As can be seen from the graph, the higher the level of the vertical axis, the greater the depth of space, the higher the space privacy, and the lower the level of permeability.

4.2 Level of Permeability and Wayfinding

According to Yassin et al. (2017), wayfinding is the design in architecture to provide clues and guidance to the building users for understanding the spaces of buildings. The wayfinding in this research will be categorized as easy, medium, and difficult. Permeability is the way of users in a building to allow users to shift from one place to another. In this research, the level of permeability is the accessibility to the spaces of the building and it can be categorized as public zone, semi-public zone, semi-private zone, and private zone according to the flow chart (Figure 5).

4.3 Likert Scale of Measurement

The level of permeability and wayfinding of this study is applied by Likert scale measurement to indicate the public, semi-public, semi-private, and private space in the building. The higher the number of depth, then the higher the level of permeability and wayfinding. The Likert scale of measurement is defined in Table 1.

Table 1: Likert Scale for Space Syntax Analysis

Level of Depth	Level of Permeability	Level of Wayfinding
0-1	Public	Very Easy
2	Semi-Public	Easy
3	Semi-Private	Hard
4-5	Private	Very Hard

5 Result

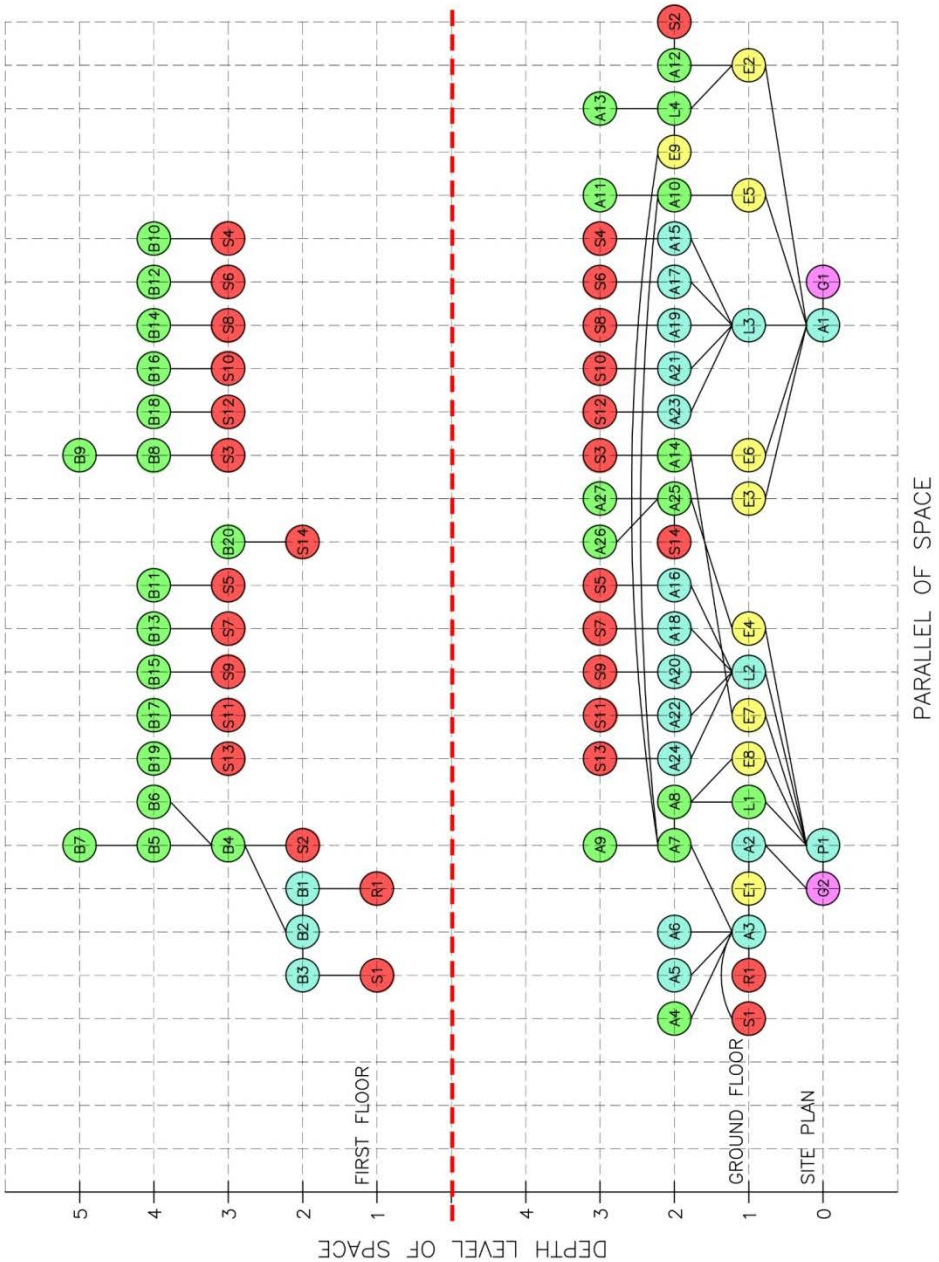

Figure 5: Overall Justified Graph

5.1 Level of Permeability and Wayfinding

Table 2: Likert Scale for Space Syntax Analysis of Ground Floor Plan.

Area	Number of Space	Depth of Space	Level of Permeability	Percentage of Level of Permeability	Level of Wayfinding	Percentage of Level of Wayfinding
G1 & G2	2	0	Site Ingress	Public - 19/58 * 100% = 32.7%	Very Easy	Very Easy - 19/58 * 100% = 32.7%
P1	1	0	Public - Car Park		Very Easy	
A1	1	0	Public - Jetty		Very Easy	
E1 - E8	8	1	Entrance to the building		Very Easy	
S1	1	1	Vertical Access - Staircase		Very Easy	
R1	1	1	Vertical Access - Ramp		Very Easy	
L1	1	1	Public - Loading Bay		Very Easy	
L2	1	1	Public - Corridor		Very Easy	
L3	1	1	Public - Corridor		Very Easy	
A2	1	1	Public - Lobby		Very Easy	
A3	1	2	Public - Auction Hall		Very Easy	
E9	1	2	Semi Public - Entrance to the building	Semi Public - 23/58 * 100% = 39.7%	Easy	Easy - 23/58 * 100% = 39.7%
L4	1	2	Semi Public - Loading Bay		Easy	
S2	1	2	Vertical Access - Staircase		Easy	
S14	1	2	Vertical Access - Staircase		Easy	
A4	1	3	Semi Private - Store Room		Easy	
A5	1	3	Semi Private - Male Toilet		Easy	
A6	1	3	Semi Private - Female Toilet		Easy	
A7	1	2	Semi Public - Preparation Area		Easy	
A8	1	2	Semi Public - Merchandising Load Area		Easy	
A10	1	2	Semi Public - Merchandising Offload Area		Easy	
A12	1	2	Semi Public - Staircase Lobby		Easy	
A14	1	2	Semi Public - Packaging Warehouse		Easy	
A15 - A24	10	2	Semi Public - Fish Market		Easy	
A25	1	2	Semi Public - Seaport Office		Easy	
S3 - S13	11	3	Vertical Access - Staircase	Semi Private - 16/58 * 100% = 27.6%	Hard	Hard - 16/58 * 100% = 27.6%
A9	1	3	Semi Private - Secretary Office		Hard	
A11	1	3	Semi Private - Sales Office		Hard	
A13	1	3	Semi Private - Fridge Hall		Hard	
A26	1	3	Semi Private - Staff Toilet		Hard	
					Hard	
A27	1	3	Semi Private - Seaport Archive		Hard	

Total number of space in ground floor = 58

Table 3: Likert Scale for Space Syntax Analysis of First Floor Plan.

Area	Number of Space	Depth of Space	Level of Permeability	Percentage of Level of Permeability	Level of Wayfinding	Percentage of Level of Wayfinding
S1	1	1	Vertical Access - Staircase	Public - 2/35 * 100% = 5.7%	Very Easy	Very Easy - 2/35 * 100% = 5.7%
R1	1	1	Vertical Access - Ramp		Very Easy	
					Very Easy	
S2 & S14	2	2	Vertical Access - Staircase	Semi Public - 5/35 * 100% = 14.3%	Easy	Easy - 5/35 * 100% = 14.3%
B1	1	2	Semi Private - Exhibition Corridor		Easy	
B2	1	2	Semi Private - Exhibition Area		Easy	
B3	1	2	Semi Private - Exhibition Corridor		Easy	
S3 - S13	11	3	Vertical Access - Staircase	Semi Private - 13/35 * 100% = 37.1%	Hard	Hard - 13/35 * 100% = 37.1%
B4	1	3	Semi Private - Pantry		Hard	
B20	1	3	Semi Private - Meeting Room		Hard	
B5	1	4	Private - Management Office	Private - 15/35 * 100% = 42.9%	Very Hard	Very Hard - 15/35 * 100% = 42.9%
B6	1	4	Private - Store Room		Very Hard	
B8	1	4	Semi Private - Fridge Hall		Very Hard	
B10 - B19	10	4	Semi Private - Freezer Room		Very Hard	
B9	1	5	Private - Control Room		Very Hard	
B7	1	5	Private - Manager Office		Very Hard	

Total number of space in first floor = 35

Table 4: Overall Percentage of Level of Permeability

Level of Permeability	Overall Percentage of Level Permeability
Public	19.20%
Semi-Public	27.00%
Semi-Private	32.35%
Private	21.45%

Table 5: Overall Percentage of Level of Wayfinding

Level of Wayfinding	Overall Percentage of Level Wayfinding
Very Easy	19.20%
Easy	27.00%
Hard	32.35%
Very Hard	21.45%

Based on Figure 5, this research analyzes the level of permeability and wayfinding of Fisterra Fish Market according to the site plan, ground floor plan, and first-floor plan. The spaces of Fisterra Fish Market are well connected, and the spaces of the building are separated according to its depth of permeability. Every space is labeled in different colors to specify the type of users using the spaces. There are two main types of users, which are public and staff. The color labeled for the public is cyan, while the staff is green. Also, the color labeled for vertical circulation is red, the entrances of the building are yellow and the site ingress is purple. The level of permeability and wayfinding are clearly explained by the particular function and the users of the spaces. Thus, the main users of Fisterra Fish Market are:

- Public Users
- Staff

As shown in Figure 5, the graph is translated from the overall floor plan of Fisterra Fish Market to show the depth of spaces and the connection within spaces. G1 and G2 indicated that Ingress 1 and 2 were access to the site. From the ingress points, they will lead to different entrances into the building. G1 is accessible from the sea to the site. G1 leads to Jetty (A1) and this is also the access for fish landing from the boat. The Jetty (A1) is directly connected to the Fridge Hall (A13) and the 10 Fish Market stalls of the building (A15-24), while the Jetty (A1) also links to Entrance 2 (E2), Entrance 3 (E3), Entrance 5 (E5) and Entrance 6 (E6) respectively which are private entrances and restricted for the staff usage only. G2 connects to Lobby (A2) and Car Park (P1) respectively, G2 is also the ingress point where vehicles and pedestrians enter the site. The Car Park (P1) connects to Loading Bay (L1) and Entrances 4,7 & 8 (E4, E7 & E8) respectively, and these are considered private entrances and only for staff usage. Lobby (A2) is located at the edge of the building and links to Entrance 1 (E1), while E1 is considered the only public entrance to the building. Thus, the entrances of the building normally are separated into public entrances and private entrances to separate the public access, staff access, and the loading and unloading process.

The building has ground floor level and first-floor level only and the spaces at different levels are connected by vertical circulation such as staircases and ramp. The spaces are highly

permeable and easily accessible from many directions due to the building's typology and function. While the building is trying to separate the public and staff circulation in the building. The public entrance (E1) is directly linked to the Fish Auction Hall (A3). A3 is connected by a Public Toilet (A5 & A6) and Ramp (R1) for allowing public access to the Exhibition Area (B2) at the first-floor level for observing the bidding fish activity in Fish Auction Hall (A3). However, the other edges of the Fish Auction Hall (A3) are linked to Preparation Area (A7), Merchandising Area (A8), Secretary Office (A9), Merchandising Offload Area (A10), and Sales Office (A10) at the same level, the spaces are labeled in green color because there are allowed for staff. At the ground floor level, the Fish Markets (A15-24) are labeled in cyan color since the users of these spaces are public, each Fish Market is interconnected by Staircases (S4-S13) where these staircases are linked to the Freezer Room (B10-19) at the first-floor level. The other edges of the building are mainly for administrative purposes such as the Seaport Office (A25), Seaport Achieve (A27), and attached Staff Toilet (A26). The Meeting Room (B20) at the first-floor level is interconnected by a Staircase (S14) from the Seaport Office (A25) and is only accessible to staff.

Entrance 2 (E2) is the staff entrance to access the Management Office (B5) and Manager Office (B7) at the first-floor level, and are interconnected by Staircases 2 (S2). Management Office (B5) and Manager Office (B7) are separated by Pantry (B4) and Store Room (B6) to have a higher depth of permeability. After fish landing from Jetty (A1), fish is delivered to the Fridge Hall (A13) and Packaging Warehouse (A14), which are located on the ground floor. The Packaging Warehouse (A14) is linked to Fridge Hall (B8) at the first-floor level by Staircase 3 (S3), the Control Room (B9) is attached to Fridge Hall (B8) that is only restricted for staff due to higher depth of permeability.

6 Discussion

According to the analysis, the connectivity and accessibility of the overall spatial layout are determining the pattern of wayfinding and the level of permeability of the spaces. Based on Table 2, semi-public spaces have the highest percentage of the overall ground floor area which is 39.7%, and 32.7% of public spaces, while semi-private spaces consist of the lowest percentage of the overall ground floor area which is only 27.6%. This is because the fish market stalls occupy most of the spaces and the ground floor of the building is main functions for public use purposes such as the lobby, fish auction hall, jetty, and loading bay. Thus, the public spaces are important on the ground floor, and the public is allowed to access easily to the public spaces. In terms of the level of wayfinding, 32.7% of the spaces are very easy to access, 39.7% of the spaces are easily accessible, and 27.6% of the spaces are hard to access at the level of wayfinding. The result shows that most of the public spaces are easily accessible by the public users and staff. In contrast, the semi-private spaces consist of the highest level of difficulty in wayfinding to provide privacy to the staff such as the secretary's office, sales office, fridge hall, staff toilet, and seaport achieve room.

In Table 3, private spaces have the highest percentage of the overall first-floor area, which is 42.9%. At the same time, the semi-private and semi-public spaces consist of 37.1% and 14.3% respectively. In contrast, public spaces have the lowest percentage of the overall first-floor area,

which is only 5.7%. The result and analysis showed that the percentage of semi-private and private spaces in the first-floor area is higher than in the ground-floor area. This is because the majority of the spaces in the first-floor area are mainly for staff, such as the pantry, meeting room, management office, manager room, and services rooms. The spaces require more privacy, thus there is a lower level of permeability and difficulty in the level of wayfinding. 80% of the spaces on the first floor are difficult in terms of the level of wayfinding due to privacy, there is only 20% of spaces are easy in terms of the level of wayfinding. Based on the result and analysis, it is shown that the main spaces in the first-floor area consist of an exhibition corridor and an exhibition area which need to be easily accessible by the public users where its permeability is connected by vertical access such as staircases and ramp.

Overall, Fisterra Fish Market consists of 19.2% of public space, 27% of semi-public space, 32.35% of semi-private space, and 21.45% of private space (Table 3). Table 4, there are 46.2% of the spaces are easy to wayfinding, and 53.8% are difficult in the level of wayfinding. Thus, the result shows that due to the building typology, the fish market building can accommodate the public users and staff at the same time. Half of the building requires privacy and security to sort the fish and manage the fish market, while the other half of the building is easily accessible by public users.

The pattern and way users get into and away from the spaces of the building are shaped by the permeability and wayfinding properties of space. The result and analysis showed that Fisterra Fish Market is an easily accessible building for many users. The users of the building mainly consist of public users and staff, including the fish market stall vendors. The ground floor area of the building mainly consists of public spaces connected from different directions such as the ingress of the site, car park, and jetty. However, the circulation of users on the ground floor area is also separated into public users and staff. The other edge of the building on the ground floor level is for staff purposes such as seaport office, seaport achieves, and staff toilet. And also connected to the first-floor level by a staircase to provide more privacy to the meeting room on the upper floor. Public users are only allowed to access the building from the lobby and visit the Auction hall from the ground floor area and also the exhibition area on the first-floor level which is connected by a staircase and ramp. The spaces behind the Auction Hall are mainly for staff, which are the Merchandising Load & Offload Areas, the fish can be easily delivered into the building from the jetty. Thus the ground floor area of Fisterra Fish Market can accommodate both circulations of public users and staff without interfering with each other. The 10 fish market stalls are right facing outward from the building and have a higher level of permeability, public users can easily access and find the spaces on the ground floor area. However, each of the fish markets consists of a freezer room on the first-floor area which is connected by the staircases. Since the freezer room required more privacy and only allowed staff to access it.

7 Conclusion

The building typology of the fish market is designed with porous spatial configuration with the site context and building entrances that potentially allow the public access to the building from

the main road and the jetty. The fish can be easily delivered to the building from the jetty without interfering with the circulation of public users. In conclusion, Fisterra Fish Market consists of 19.2% of public space, 27% of semi-public space, 32.35% of semi-private space, and 21.45% of private space. There are 46.2% of the spaces are easy to wayfinding, and 53.8% are difficult in the level of wayfinding. The analysis shows that Fisterra Fish Market is highly permeable and easy to wayfinding to accommodate the huge amount of public users and staff without interfering with each other. The building is mainly separated into two sections to differentiate the circulation of public users and staff. The connections between the ground floor and the first floor are mainly staircases and ramps, which function as connections and linkages that increase the privacy of spaces on the first-floor area. Fishterra Fish Market has showcased a successful permeability and wayfinding system in providing navigation and rational mapping to all users, like a fish market building typology for semi-public and semi-private use.

8 Availability of Data and Material

All analyzed data is incorporated in this article.

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