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ANALYSIS ON USERS' LEVEL OF PERMEABILITY AND WAYFINDING IN WASTE RECOVERY FACILITY'S FACTORY

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ABSTRACT

The study analyses the building space planning based on the level of permeability and wayfinding through the different types of users for the Sunset Park Material Recovery Facility, Malaysia. It is expected that various users may have the different level of permeability and wayfinding experience in the building. This study is executed by doing space syntax analysis of the building. Measurable scale graphs are used to study the level of permeability and wayfinding of the building. The results show that the Sunset Park Material Recovery Facility offers a different level of permeability and wayfinding to different types of the users. Overall, truck and barge garbage collectors have an excellent degree of permeability and wayfinding; the same goes for the staffs. However, for the visitors, the level of permeability and wayfinding at the first-floor level of the educational building is low due to inefficient space planning. This study finds that the different types of users may have different experiences of the building due to a different level of permeability and wayfinding.

1. INTRODUCTION

Theory and techniques of space syntax have been used widely in the architecture industry. It is used to analyse spatial cognition aspects of the place such as wayfinding and place-learning (Beck and Turkienicz, 2009). These are the process where space and individuals are interacting. This paper attempts to study the level of permeability and wayfinding based on the types of users in the material recovery facility also known as recycling factory. In common, there are three types of users for this type of typology which are the staff, visitors and garbage generator or collector. Each type of users may have different levels of permeability and wayfinding depending on the kind of spaces in the building.

The study is conducted to understand the space planning of the material recovery facility and to see the connectivity from one space to another. This study is also important to recognise the efficiency and functionality of the areas which may affect the human experience inside the building.

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Moreover, this paper aims to understand the level of depth of the spaces based on the user of the facility. The objectives of this study can be achieved by analysing building space planning based on the level of permeability and wayfinding through the different type of users. It is expected that the various user may have the different level of permeability and wayfinding experience in the building.

The case study chosen for this paper is a recycling factory which is Sunset Park Material Recovery Facility. It is located in New York City in the United States of America. This building has two main programs which are the processing building and an education centre. The processing building is the space where the garbage is collected and recycled, and the education building is the administrative building, and it is open to the public for educational purposes.

2. LITERATURE REVIEW

2.1 SPACE SYNTAX

Space syntax theory is used to study the spatial configuration developed by Bill Hiller and Julienne Hanson in the early 1970s at The Bartlett, London. It is a method to analyse the spatial complexes to classify its particular structure of the entire configuration (Hillier B., 1998). Part of the concept to study the space syntax is by using symmetry – asymmetry in spatial relationships as shown in Figure 1.

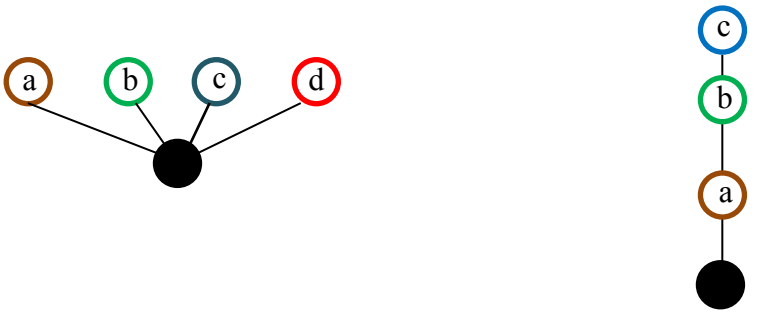

Figure 1: The symmetry-asymmetry in spatial relationships

Space syntax develops valuable technique in collecting information and analysing it in the way in which the social logic behind the configuration is drawn (Asif et al., 2018). It can be used as a tool to predict the socio-spatial knowledge which can be applied to a particular spatial configuration such as a building or even at the larger scale like the entire city. In this study, space syntax technique is used to study the depth of the space away from the original space. In this case, the unique space is the entrance or exit of the building. Based on the study, the level of permeability and wayfinding of the areas can be determined.

2.2 LEVEL OF PERMEABILITY AND WAYFINDING

Ephes (2006) defined permeability as the flow of spaces, from one to another. Permeability also is described as the peoples' opinion in satisfaction of the spaces based on the properties of the environment of the place (Yavus et al., 2012). In this study, permeability is defined as the level of accessibility of the space. The easier the accessibility of the space, the higher the level of permeability.

Meanwhile, wayfinding is the users' experiences of the context (Abrams and Brandom, 2010). Significant fundamentals for good human wayfinding performance depending on the visual-spatial

features of the environment. Simplicity, excellent form, visual access with the proper architectural features are the examples of it (Carratin, 2011).

2.3 THE MATERIAL RECOVERY FACILITY BUILDING

Material recovery facility (MRF) is a building which recycling the waste by manual or by using equipment or both. It is a facility which is collecting the wastes, and it may choose specific material to be recycled. At individual country such as Malaysia, the waste is mostly not segregate first at the consumer level, e.g. at home and construction site. So, at the MRF, they have to separate the waste before proceeding it to the recycling process. MRF is critical to reducing the amount of waste that will end up at the landfill. Plastic, metal, and timber are examples of waste materials that can be recycled and form a new material to produce a new product.

As stated by Leblanc (2018), MRF is a single-stream recycling program in the residential and commercial industry. It received waste materials, and the waste will be separated by using equipment and manual labour. Then, the segregated wastes are ship downstream to the recyclers based on the type of the waste to be recycled. MRF is also known as material reclamation facility or material recycling facility which it processes the recyclable material so that it can be selling to manufactures as a raw material to produce a new product (Hosonsky, 2014).

2.4 CASE STUDIES: SUNSET PARK MATERIAL RECOVERY FACILITY, NEW YORK, USA

Figure 2: Façade of Tipping Building (Photo Courtesy of ArchDaily).

Sunset Park Material Recovery Facility (Figure 2) is a centre where it processes the waste materials such as curbside metal, glass and plastic recyclables which taken from Sims Municipal Recycling and New York City. Selldorf Architects design this building in 11-acre waterfront prier in Brooklyn, New York. As it is located at the waterfront pier in Sunset Park, the recyclable waste is received by two ways which are from waterway by using barge and truck.

Its area is 140,000 square feet which it is consists of two main programs; the processing building and an education centre. The processing building consists of spaces such as tipping building, complex sorting equipment, electrical compressor, fire pump, supervisor rooms, and offices. Meanwhile, in the education centre, the structure contains programs for public including kids where there are classroom, exhibitions and interactive demonstration displays. The educational centre is connected to the processing building by the steel bridge which is connected at level two. From education centre building, the public can go to the viewing platform at the processing building by the steel bridge to see how the process of recycling happens.

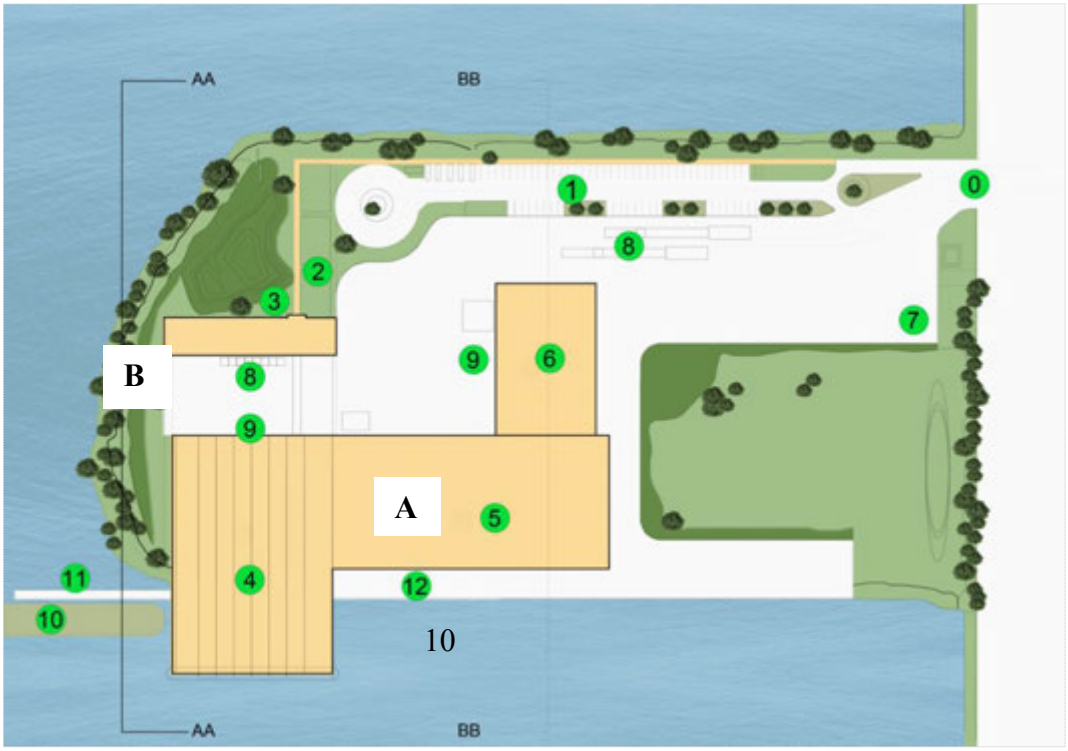

Figure 3: Site Plan of Sunset Park Recovery Facility
Redrawn of the ground site plan of Sunset Park Recovery Facility in ArchDaily

Figure 3 shows the site plan of the Sunset Park Recovery Facility. This facility consists of two buildings, recycling (A) and education buildings (B). Building A is the private building as only staff and permitted persons can access. Meanwhile, building B is open for public, and it is where offices for staff are located. There is just one entrance to the site, meaning the garbage truck, visitors and staff is sharing the same entrance to the site. The visitors and staff are sharing the same parking space which is connected to the building B. There is also access through water for the barge to send their waste. There is a platform along the sea to collect the waste to be sent to the recycling building.

Figure 4: Ground floor plan of Sunset Park Recovery Facility
Redrawn of ground floor plan of Sunset Park Recovery Facility in ArchDaily

Figure 4 shows the ground floor for building B, with seven entrances. Four entrances E1, E2, E3, and E4 are connected to the staff and visitors parking. Entrances E5 and E6 are connected to the recycling facility at the back of the building, and E& is the direct access for the staff to the office. This level also consists of office area, changing rooms and cafeteria. In the office area, there are spaces such as meeting room, conference room, open office, and private office. Meanwhile, changing rooms have two units which each unit have two, for male and female. These changing rooms are used for the staff to prep their self before entering the recycling factory (4, 5 and 6).

Figure 5: First-floor plan of Sunset Park Recovery Facility
Redrawn of first-floor plan of Sunset Park Recovery Facility in ArchDaily

The first-floor level (Figure 5) is designed for the visitors to learn and understand the whole recycling process. Public spaces at this level are consists of exhibition area, classroom theatre room, and classroom. There are also mechanical room and stores for services for this floor level.

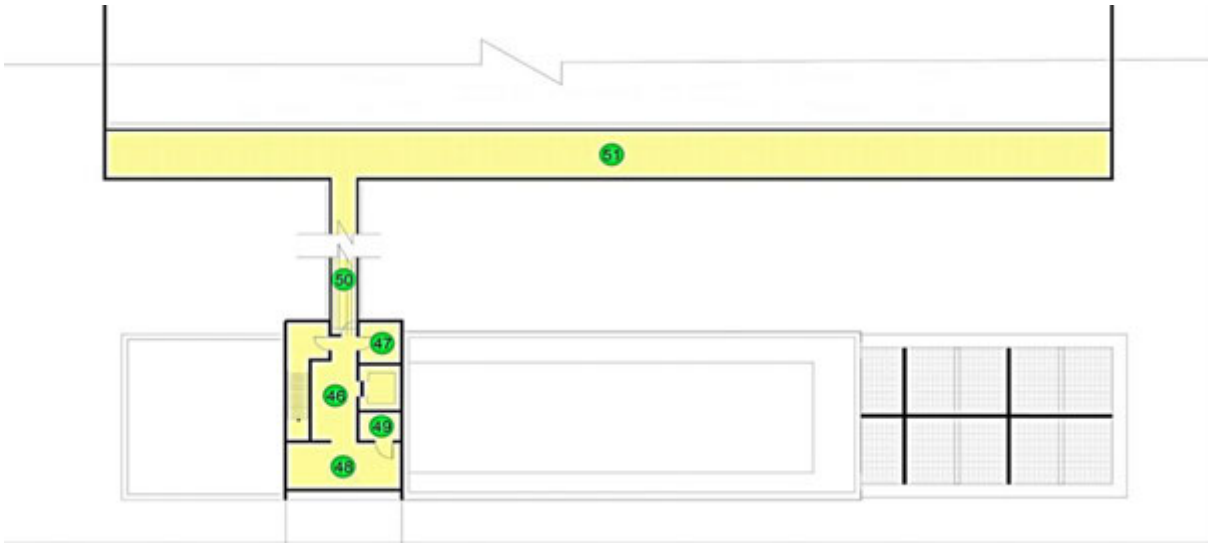

Figure 6: Second-floor plan of Sunset Park Recovery Facility
Redrawn of second-floor plan of Sunset Park Recovery Facility in ArchDaily.

Meanwhile, on the second floor (figure 6), the number of space is smaller compared to the ground and second floor. This level consists of the semi-public and private zone which pedestrian bridge and viewing platform are considered as yellow zone (semi-public), and offices, mechanical room, and stores are considered as red zone (private). The pedestrian bridge is the connector of the education building to the viewing platform in the recycling facility which visitors may access here only by authorisation from the administration. Figure 8 below shows the section A-A of the building to show the connectivity of the educational and recycling facility. Table 1 shows the list of spaces of Sunset Park Recovery Facility.

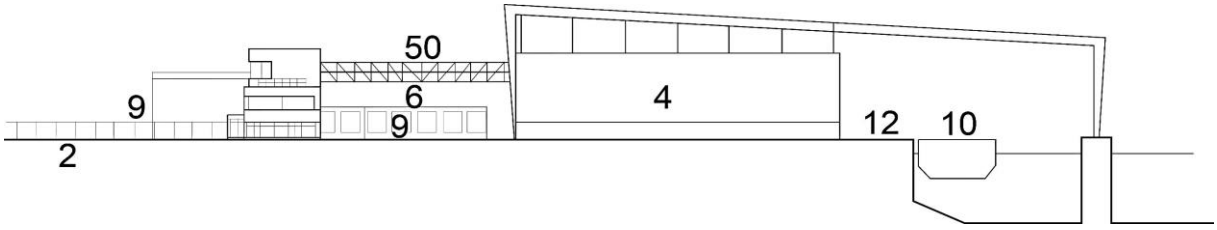

Figure 7: Section A-A of Sunset Park Recovery Facility
Redrawn of the section of Sunset Park Recovery Facility in ArchDaily.

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Table 1: Table of spaces inside Sunset Park Recovery Facility

No.	Name of Spaces	No.	Name of Spaces
1	Staff parking	24	Office store
2	Covered walkway	27	Conference room
3	Education centre foyer	29/30/31	Private office
4	Tipping building	13a/32/46	Lift lobby
5	Processing building	33/47	Store
6	Bale storage building	34	1st-floor lobby
7	Truck parking	36	Exhibition area
8	Truck scale	37	Restroom lobby
9	Truck loading/unloading	38	Restroom (public)
10	Barge area	39	Restroom cubicle
11	Mooring pier	41	Theatre room
12	Barge unloading	42	Waiting area
13	Lobby	43/44	Classroom
14/16/22/26	Locker room	45	Terrace
15/17/21/25	Restroom	47	2nd-floor lobby
18/35/40	Mechanical room	48	2nd-floor office
19	Mechanical room 2	49	Private room office
20	Cafeteria	50	Pedestrian bridge
23/28	Open office	51	Viewing platform

3. RESEARCH METHODOLOGY

This paper is conducted by using the quantitative survey with the graphic illustration of the space syntax graph. Spatial syntax and the studied of the building typology is reviewed first in the literature review to provide general information on the case study.

Next, the analysis of the case study is done by observing the spatial networking using the measurable scale graph. This method has been used in the study by Hassan and Mustafa in 2010. The graph indicates the level of permeability and wayfinding of the spaces in Sunset Park Recovery Facility. It will be analysed by the users' categories. In this study, primary user categories have been identified; garbage collector, visitors, and staff. There are two types of garbage collectors which are by truck and barge.

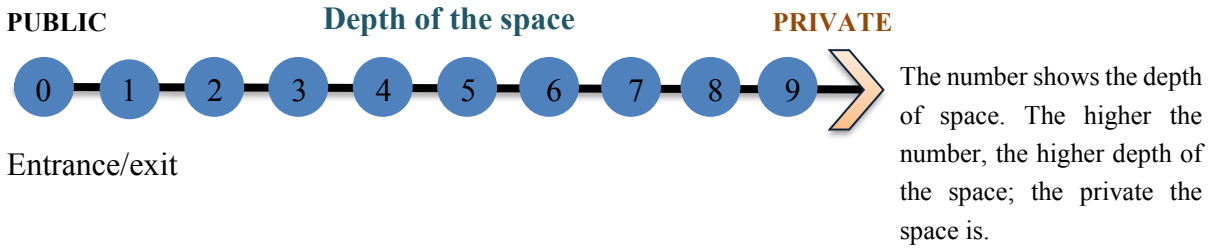

Figure 8: Level of Movement Graph.

From the result of the level of movement graph, the spaces will define in these categories

1. Public
2. Semi-public
3. Private

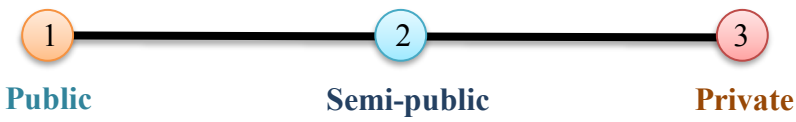

Figure 9: Likert Scale to identify the type of space.

4. ANALYSIS AND RESULT

The study of the level of permeability and wayfinding are defined by the types of use of this building. The type of users is: -

1. Waste truck collector
2. Waste barge collector
3. Visitors
4. Staff

4.1 WASTE TRUCK USER (PRIVATE USER)

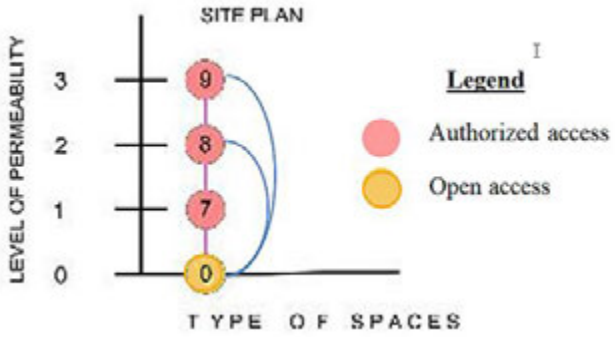

Figure 10: Level of Permeability of waste truck collector

The waste truck user is classified as the private users' category for this facility. The truck which is already registered is authorised to enter. Figure 10 above shows the level of permeability of the waste truck collector. There are two categories of spaces which are with authorised access (red) and open access (yellow). The level of accessibility for the truck user is designed with a restricted movement which is only limited at the site plan area. The accessible spaces of the waste truck user are parking area (7), truck scale (8) and truck loading and unloading spaces (9).

The truck users will enter the site through the entrance (0) and then the parking area (7). The parking area is also the space for waiting area if the loading/unloading spaces (9) are busy. The truck driver may pass the parking area and go straight to the truck scale. If the trucks are sending the waste to be recycled, they have to scale the initial weight at the truck scale (8) before access the loading/unloading area (9). If the truck users are collecting the recycled material from this facility, they can skip the truck scale (8) straight to the loading/unloading area (9) to collect the materials and weight the trucks before exiting the site.

Based on the graph in Figure 10, the highest level of permeability of the waste truck user is only at level 3 which is very low. It shows that the accessibility and wayfinding for the waste truck user are direct and straightforward. So, there is no issue regarding wayfinding for the user.

4.2 WASTE BARGE COLLECTOR (PRIVATE USER)

Figure 11 shows the level of permeability graph for barge collector. There are two categories of spaces which are with authorised access (red) and open access (yellow). Like waste truck collector, accessibility of waste barge collector only limited at the site plan compound. The accessible spaces of the waste truck user are barge area (10), mooring pier (11) and barge unloading space (12).

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Figure 11: Level of Permeability of waste barge collector

The barge that brings the waste will park at the barge area (10). Then, the waste will be load at the barge mooring pier (11). Then mooring pier (11), the waste is sent to the tipping building to be recycled. If the barge is collecting the recovered material from the facility, it will be collecting the waste at the barge unloading space (12) to the barge area (10).

Based on the graph in Figure 11, the level of accessibility of the waste truck user is all at level 2, which only at the outside of the facility building. So, the level of permeability and wayfinding are easy.

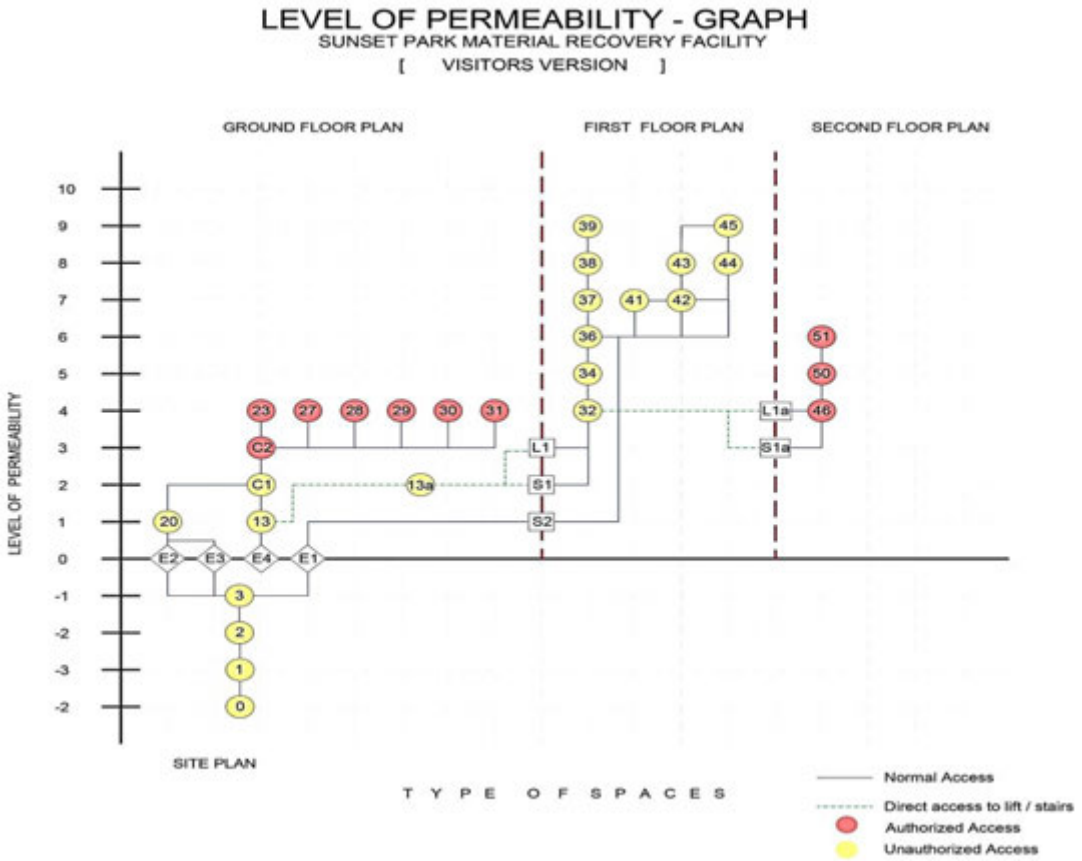

Figure 12: Level of Permeability of visitors

4.3 VISITORS (PUBLIC USER)

Visitors in this context are kids, student, and the public. Their accessibility is wider compared to the waste collectors. It is because the accessibility of the visitor to the facility is consists of outdoor and indoor spaces of the building. Figure 12 shows the graph of the level of permeability for visitors. However, not all the spaces inside the facility can be accessed. There are two categories of spaces which are with authorised access (red) and open access (yellow). Certain spaces can only be accessed with authorisation of the facility. At the site plan level, the visitor enters the site by the entrance (0)

and park the vehicle at the public parking (1). From the parking (1) they will walk along the covered walkway (2) to go to the education centre foyer (3). Education centre foyer (3) is the transition space from the more private accessibility.

At the ground floor level, there are six entrances to the educational centre labelled as E1, E2, E3, E4, E5, and E6. The main entrance E4 is connected to the lobby (13). E5, the entrance from the recovery facility, is also connected to the lobby (13). However, E4 access is limited because it is a private entrance due to the connectivity of the entrance to the recovery facility. The lobby (13) then connect the visitor to the corridor 1 (C1): this corridor linked to the cafeteria (20) and corridor 2 (C2). The visitor also can access directly to the cafeteria (20) by using entrance E2 and E3. All these spaces are considered as semi-public access. C2 is the corridor which acts as the transition space to the more private spaces. C2 is connected to C1 and two entrances which are E6 and E7. Both entrances are private access. C2 in linked the visitors to the office area which is consists of open offices (23 & 28) and to the conference room (27) and privates offices (29), (30) and (31). All of the spaces mentioned are only can be accessed if the visitors are authorised to do so.

The ground floor level is connected to the first-floor level by three vertical connectivity which are stair 1 (S1), stair 2 (S2) and lifts (L1). If the visitors are using S1 or L1 to go to the first floor, the first space they will be entering is the lift lobby (32) then floor lobby (34). From the lobby, the visitors will lead directly to the exhibition area (36). From exhibition area (36), they can go to other four spaces which are toilet lobby (37), theatre room (41), waiting area (42) and classrooms (43 & 44). If the visitors are using stair 2 (S2) to go to the first floor, they will be entering the exhibition area first. The toilet lobby then linked to the restroom (38) and the restroom cubicles (39). Besides, waiting area (42) is also directly connected to the theatre room (41) and classroom (43). Meanwhile, to access to the terrace (45), visitors must go through the classroom (43 & 44). The spaces that listed above are all can be accessed by the visitor without authorisation after they get a pass from the main lobby (34) at the ground floor.

The last floor which is the second floor can be accessed by the visitors by using stair 1 (S1a) and lift (L1a). The first space they will entering at the second-floor level is the lobby (46). From the lobby, the visitor may access the viewing platform (51) in the recovery facility through the steel bridge (50). Spaces 46,50 and 51 need authorisations to be accessed. There is also an office (48) and private office (49) at this level which is private and needs the approval to access. So, the spaces that can be accessed by the visitors at this level need approval before accessing the space.

Based on the discussion above, the visitor has the access through all the level of the building for the education building. The recycling factory is districted to staff only, and the visitor can only be accessed to the facility by viewing platform at level two only. The level of accessibility is high especially at the level one which the visitor can access about 80% of the floor space. The rest spaces such as offices and viewing platform can be accessed by authorisation from the management.

4.4 STAFF (PRIVATE USER)

Compared to the other users, the staff has full access to the entire space of the building depending on their roles and position in this company. The staff is divided into two categories; the recycling facility staff and education and administrative staff who may have a different level of permeability.

There are two groups of spaces which are with authorised access (red) and open access (yellow). Figure 13 shows the graph of the level of permeability for staff. At the site plan level, staff enter the site by the entrance (0) and park the vehicle at the public parking (1). From the parking (1) they will walk along the covered walkway (2) to access education centre foyer (3) or recycling building through tipping building.

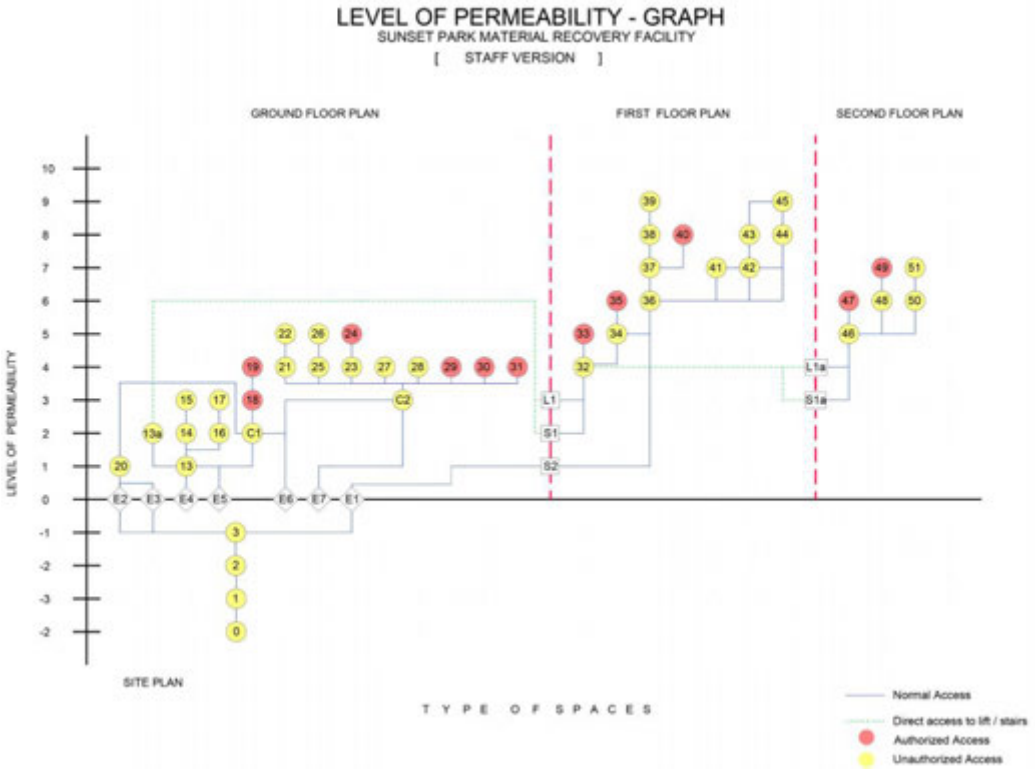

Figure 13: Level of Permeability of staff

At the ground floor level, there are seven entrances to the educational centre labeled as E1, E2, E3, E4, E5, E6, and E7. The main entrance is E4 which is connected to the lobby (13. E5 which is the entrance from the recovery facility is also connected to the lobby (13). The staff who want to change their cloth and prep before entering the recycling factory must access the changing room first (14 and 16). There is also washroom and toilet (15 and 17) which are limited access for the staff only. They can access the recycling factory through E5. The lobby (13) is also connected the staff to corridor 1 (C1): this corridor linked to the cafeteria (20), mechanical room (18) and corridor 2 (C2). The staff also can access directly to the cafeteria (20) by using entrance E2 and E3. C2 is the corridor which acts as the transition space to the more private spaces. C2 is connected to C1 and two entrances which are E6 and E7. Both entrances are private access for staff only. C2 in linked the staff to the changing room (21 & 25), washrooms (22 & 26), open offices and the conference room (7) and privates offices (9), (10) and (11).

The ground floor level is connected to the first-floor level by three vertical connectivity which are stair 1 (S1), stair 2 (S2) and lifts (L1). If the staff is using S1 or L1 to go to the first floor, the first space they will be entering is the lift lobby (32) then floor lobby (34). From the lobby, the staff can access the private areas which are mechanical room and store and the public area which is the exhibition area (36). From exhibition area (36), they can go to other four spaces which are toilet lobby (37), theatre room (41), waiting area (42) and classrooms (43 & 44). If the staff is using stair 2 (S2) to go to the first floor, they will be entering the exhibition area first. The toilet lobby is considered as

semiprivate space which then linked to the restroom (38), private and restroom cubicle (39), extremely private space. Besides, waiting area (42) is also directly connected to the theatre room (41) and classroom (43). Meanwhile, to access to the terrace (45), staff must go through the classroom (43 & 44).

The last floor which is the second floor can be accessed by the staff by using stair 1 (S1a) and lift (L1a). The first space they will be entering at the second-floor level is the lobby (46). From the lobby, staff may access to the private spaces such as a store (47), office (48) and private office (49) and semi-public space such as viewing platform (51) in the recovery facility through the steel bridge (50). Based on the discussion above, the staff has the authorisation to access through all level and spaces of the building depending on their role in this building.

5. DISCUSSION

5.1 WASTE TRUCK USER

At the site plans, the highest depth of spaces is at the level 3 showing that the depth of the accessibility for the truck user is very low. The level of permeability is increasing as the depth of public level is rising as showing in Figure 14. The level of permeability and wayfinding for the waste truck are also clear, direct and easy to understand. All the spaces except entrance are considered as private space because only permitted waste truck can access this facility.

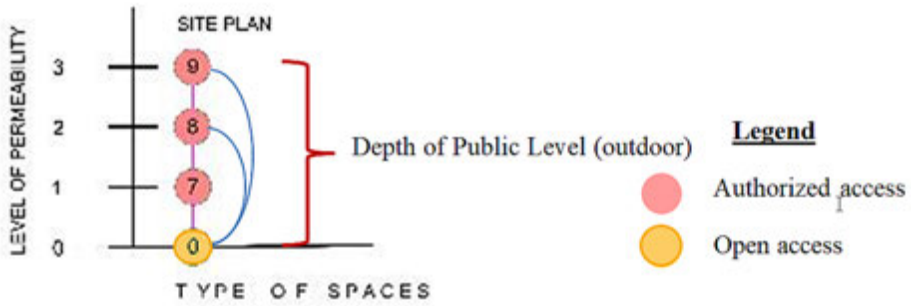

Figure 14: Level of permeability graph for waste truck user

However, they are sharing entrance (0) with the other user; staff and visitor which may create a problem, especially at the peak hours when they are sending the waste. The circulation of the truck to send the materials to the facility may be interrupted due to this problem. Barge truck user

5.2 WASTE BARGE COLLECTOR

At the site plans, the highest depth of spaces is at the level 2 showing that the depth of the accessibility for the barging user is very low. The level of permeability is increasing as the depth of public level is rising as showing in figure 15. The level of permeability and wayfinding for the barging user are also clear, direct and easy to understand. All the spaces permitted by waste barge collector to access the private area and only authorised barge can access the facility.

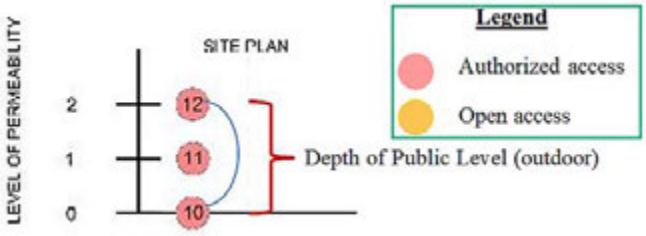

Figure 15: Level of permeability graph for waste truck user

Comparing to the waste truck user, waste barge collector has the lower depth of public level. Meaning, the accessibility is easier and more direct than the truck. Their accessibility is limited to loading/unloading area which the permeability is very high, and wayfinding is excellent.

5.3 VISITORS

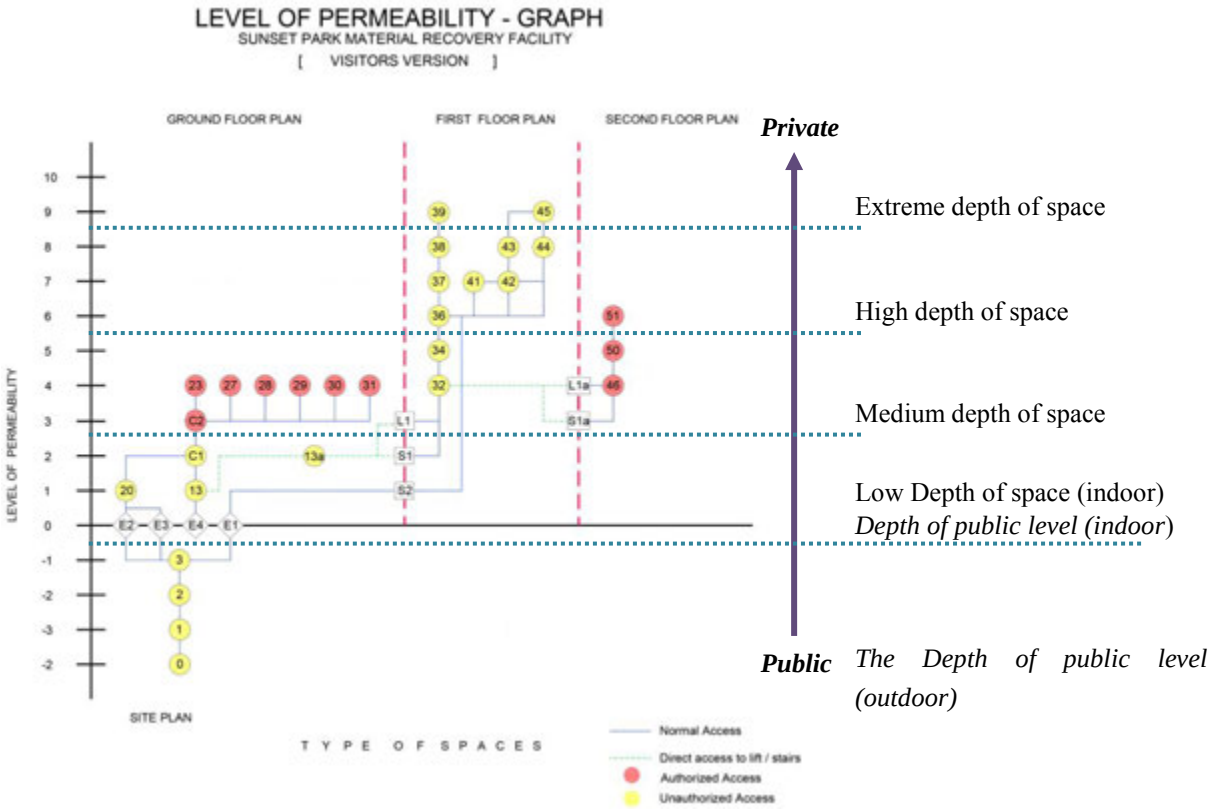

Figure 16: Level of permeability graph for visitors

Figure 16 shows the level of permeability graph for visitors. Based on the graph, the data regarding permeability, wayfinding, and type of space (public to private) can be determined. The higher the number of level of permeability in the graph, the lower the permeability and accessibility that users may experience in the building. This graph is divided into two part which is the indoor and outdoor area. The outdoor spaces below number 0 (-2 to -1). At this level, the depth of space is very low, so the spaces are categories as public. The spaces in this level are staff parking (1), covered walkway (2) and education centre foyer (3). So, visitors at this level may have high permeability, easier wayfinding because it is straightforward and also public accessibility.

Visitors may enter the building using the four entrance (E1, E2, E3 & E4). From 0 to 2 from the Y-axis of the graph, all the spaces in this range are considered as the low depth of space for indoor spaces. The spaces are considered semi-public, and level of accessibility and wayfinding are also accessible as the depth of the spaces is still low. This level is consist of lobby (13), cafeteria (20), corridor 1 (C1) and lifts lobby (13a). So, at this level, the public can easily access the spaces as the spaces also do not need the authorisation to be accessed.

When the level of permeability at the graph is in range 3 to 5, the depth of the space is higher. At this level, most of the spaces need the authorisation to be accessed such as open office (23 & 28), conference room (27) and private offices (29/30/31) at the ground floor level and lift lobby (46) and pedestrian bridge (50) at second-floor level. The level of permeability and wayfinding are also harder

compared to the lower level as the depth of spaces is higher.

At the higher depth of space, the permeability graph is higher (range 6 to 8). At this level, the spaces are more private compared to the lower level. It also has a low level of permeability and wayfinding. However, this level consists of spaces for visitor's activities such as exhibition area(36), theatre room (41), waiting room (42) and classrooms (43 &44). It means that these spaces are hard to access because of the arrangement of the spaces. For example, if the visitor is coming from the primary access with is s lift (L1) and want to access to the classroom (43 or 44), he has to pass through the lift lobby (32), lobby (34) and exhibition area (36) to arrived. So the wayfinding for this space is very hard to even this space is meant for the visitors.

When the level of permeability at the graph is at 9 and above, the spaces are considered as extremely private, and it is also in the extreme depth of space. This level is consists of toilet and terrace which is for visitors' activity. So the spaces are not well-planning as the permeability and wayfinding for this spaces are very hard. At the same time, these spaces should not be considered as extremely private spaces based on the function of the spaces.

5.4 STAFF

Figure 17 shows the level of permeability graph for staff. Based on the graph, the data regarding permeability, wayfinding, and type of space (public to private) can be determined. The higher the number of level of permeability in the graph, the lower the permeability and accessibility that users may experience in the building. This graph is divided into two part which is the indoor and outdoor area. The outdoor spaces below number 0 (-4 to -1). At this level, the depth of space is very low, so the spaces are categories as public. The spaces in this level are staff parking (1), covered walkway (2) and education centre foyer (3). So, the staff at this level may have high permeability, easier wayfinding because it is straightforward.

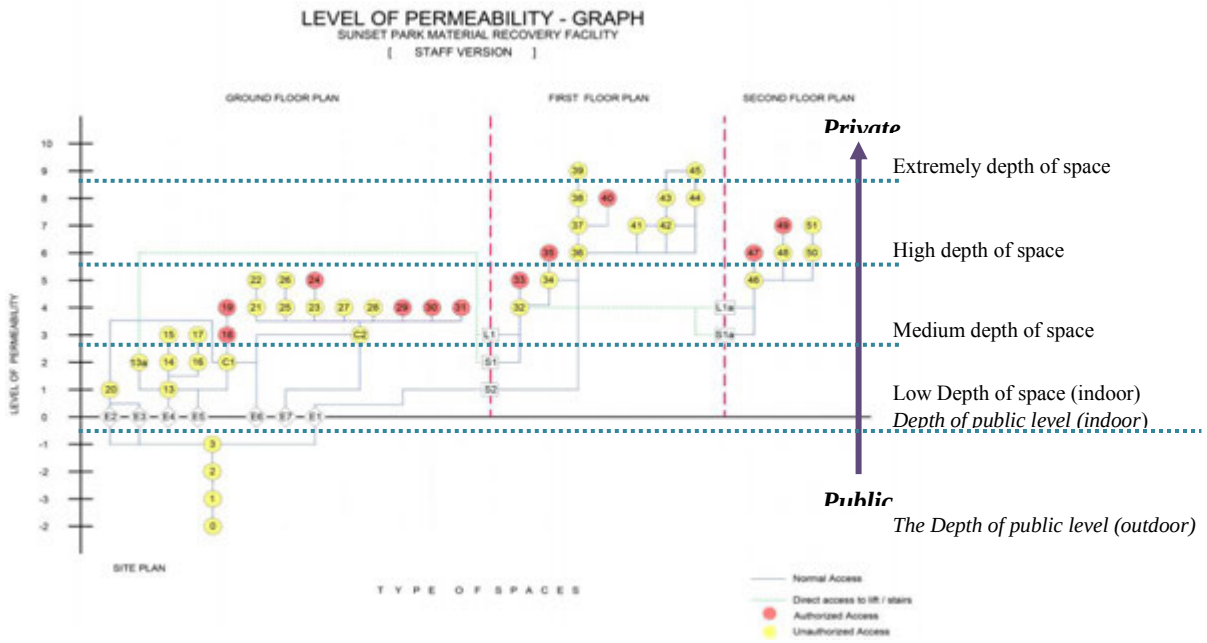

Figure 17: Level of permeability graph for visitors.

Staff enter the building using the seven entrance (E1, E2, E3 ,E4 ,E5, E6 & E7). From 0 to 2 from the Y-axis of the graph, all the spaces in this range are considered as the low depth of space for indoor

spaces. The spaces are considered semi-public, and level of accessibility and wayfinding are also easy as the depth of the spaces is still low. This level is consist of lobby (13), cafeteria (20), corridor 1 (C1) and lifts lobby (13a).

When the level of permeability at the graph is at range 3 to 5, the depth of the space level is higher. At the ground floor level, 60% of the spaces are open access, and the rest need to get permission to enter such as mechanical room (18 &19), office store (24) and private office (29,30 &31). At the first floor level, the lobbies (32 & 34) are the open access, and store needs the authorised access. Lift lobby is the only space at this level which staff can access easily without authorisation. At this level, the spaces have the lower permeability and wayfinding compared to the spaces at the 0-3 range as the depth of space is higher.

At the higher depth of space, the permeability graph is higher (range 6 to 8). At this level, the spaces are more private compared to the lower level. It also has a low level of permeability and wayfinding. Same with the visitors' experience, the permeability and wayfinding at the first and second floor are very hard because of the arrangement of the spaces. However, because the staff is familiar with the spaces, the space planning is not a huge problem for their experience.

When the level of permeability at the graph is at 9 and above, the spaces are considered as extremely private, and it is also in the extreme depth of space. This level is consists of toilet and terrace which is for visitors' activity. So the spaces are not well-planning as the permeability and wayfinding for this spaces are very hard. At the same time, these spaces should not be considered as extremely private spaces based on the function of the spaces. As for the staff, even the permeability and wayfinding are complicated, but there are familiar with the spaces, so the experience for them is better compared to the staff.

6. CONCLUSION

The overall planning of the building is excellent for the truck and barge waste collector. The permeability and wayfinding for both of user are direct and straightforward, so they may not be having confusion experience in understanding the flow of the spaces. Also, because their access is only at the outdoor level, so they have easier accessibility experience compared to the visitor and staff.

For visitors, the permeability and wayfinding at the site plan, from the parking to the educational building is direct and straightforward. Even at the ground floor level of the educational building, the ability to understand the flow of the spaces is good as it is direct. It only has lower permeability and wayfinding at the office area which this area need the authorisation to be accessed by the visitor. At the second-floor level, the arrangement of the spaces for the visitors is more complicated as at some spaces such as a terrace, and they need to enter other spaces to reach there (exhibition and classroom). It is not good for the public area because it has lower permeability and wayfinding. So, the visitor may have lost, and they need a guide to explore at this level. At the second-floor level, all the spaces need authorisation to be accessed. So, even the permeability and wayfinding are lower since it has a higher depth of space, but it is fine since it not an open access.

For staff, the level of permeability and wayfinding is lower as the depth of space is higher. The

higher the floor level, the higher the depth of space from the entrance. However, they may not be having any issue regarding they permeability and wayfinding because they understand better the space compared to the visitors. The main space for them to access which is the office area is located on the ground floor which has direct access from the parking space. So, staff may have an excellent experience in this building.

The space planning at the site plan level will be better if the building has the different entrance for the waste collector and visitor/staff. Visitor and staff also need to have separate circulation even they park in the same area. It is essential so that staff gets their privacy especially when the number of visitors is high which may interrupt their movement.

The open spaces in first floor level such as exhibition area, classroom, terrace, and theatre room need to arrange properly so that visitors understand better the flow of the spaces. The lower permeability and wayfinding of the spaces may affect the experience of the visitor. By adding a corridor to connect the floor lobby to the spaces, the accessibility would be easier.

Overall, waste truck and barge collector have the excellent permeability and wayfinding. Same goes to the staff. However, the visitor may be having some confusion at the level one of the educational building due to lower permeability and wayfinding of the spaces.

7. DATA AVAILABILITY STATEMENT

The used or generated data and the result of this study are available upon request to the corresponding author.

8. ACKNOWLEDGEMENT

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