

Building–street interface types and their related outdoor activity patterns: the case of Da-An District, Taipei

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The interface between buildings and streets plays a vital role in public life. However, interface type as such, and its relation to activity, are under-researched. This paper creates a new classification of interface type and then studies related activity patterns in the Da-An district, Taipei. The paper first establishes a comprehensive catalogue of thirty-six possible interface types, organised in seven groups. Then the paper reports on a survey of local residents' outdoor activity (including trip-making) to understand the relationships between interface types and behaviour in residential streets in the study area. The study was able to distinguish more favourable and less favourable interface types, the determining factors being the quality of walking spaces, the quantity of parking spaces, and the ability to host outdoor activity in the semi-private/public front space.

Introduction

The urban ground floor or 'rez-de-ville' is a complex and contested realm, of varying degrees of 'publicness', and a setting for activities relating to the specific ground surface space as well as to through movement (Anderson, 1986; Marshall, 2005;

Loukaitou-Sideris and Ehrenfeucht, 2011; Mangin and Boudjenane, 2023).¹ Its significance has gained recent prominence as an area of practical experimentation during the COVID-19 pandemic (Finn, 2020; Mandhan and Gregg, 2023). Yet the urban ground floor is not just about the ground surface itself, but its interface with the vertical plane of built frontages. This interface between building and street has been a periodic topic of study, but interface type as a typo-morphological unit in its own right has been less clearly established. Yet interface type could provide enhanced understanding of the nature of the urban ground floor, through insights into one of the conundrums of urban form and activity patterns: how some dense, mixed-use areas of cities can nevertheless be dominated by private motorised vehicles and associated travel behaviour.

A substantial amount of research supports that higher density and mixed land use are associated with low carbon travel modes, such as walking or cycling (e.g. Campoli, 2012; Howley, 2009; McCormack *et al.*, 2001; Neuman, 2005), which can further lead to a safe, healthy and lively environment (Gehl, 2011; Jacobs, 1961; Speck, 2012); see also Aditjandra *et al.* (2012); Giles-Corti *et al.* (2013); Lang *et al.* (2020).

¹ Streets are often contested spaces, and allocation and regulation of public space in relation to buildings is not a neutral technical activity but reflects societal power dynamics, between different kinds of citizen, pedestrians and street vendors, and so on (see for example Kim, 2016; Loukaitou-Sideris and Ehrenfeucht, 2011; Piazzoni and Jamme, 2020). That said, the focus of this study is on the classification and use of interface types, rather than the rights and wrongs of space allocation, street regulations, street culture or citizen rights.

Nevertheless, in Taipei, the city studied in this paper, residents rely heavily on private motorised vehicles, even though it has been categorised as a compact city with high density and mixed land use (Lin and Yang, 2006; Yeh *et al.*, 2003; Tsai, 2009). Yet private vehicles were reported as the main transport mode for Taiwanese citizens with a mode share of 72.3% by The Department of Statistics (2022); and the rate of private vehicle ownership (939 per thousand people) was the highest out of the world's main developed countries (Department of Budget, Accounting and Statistics, New Taipei City Government, 2013), perhaps reflecting the high rate of ownership of powered two-wheelers at a level higher than that of automobiles (Table 1). This circumstance, which seems inconsistent with the theoretical beneficial influence of density and mixed land use on travel activities, provides a key motivator for this paper.

Table 1. Comparison of population, density and motorization rates in selected cities.

City	Population (inhabitants)	Density (persons/km ²)	Automobiles (per 1,000 citizens)	Motorcycles (per 1,000 citizens)
Istanbul	15,519,300	2,842	185	21
Moscow	12,678,100	4,949	349	–
Hong Kong	7,520,800	6,795 ²	98	8
Los Angeles	3,979,600	3,278	–	–
Berlin	3,669,500	4,118	333	29
Taipei	2,645,000	9,732	308	360
Vienna	1,911,200	4,607	374	48
Zürich	434,000	4,724	310	64

Source: Taipei Yearbook 2020, pp356–357.

This paper proposes that interface type could be an answer to the issue of high density and compactness of mixed land use with high vehicle dependence in Taiwan. As the capital city of Taiwan, Taipei is the most suitable case for this paper based on its high density, highly mixed land use and highly developed transport system, including mode choice diversity. The Da-An district is chosen to be the case study area as the population density is the highest out of all the districts in Taipei (over 25,000 persons per square kilometre); the area is mainly composed of both residential zones

² Density figures are sensitive to how boundaries are drawn, and different densities could be obtained for Hong Kong and other cities if measuring the urban area only versus the whole territory. For this table we chose to use a single set of figures from a single source as this includes both Taipei and motorcycles statistics for several cities.

(as observation sources) and school zones (as travel attractors), and the distribution of current mixed land use is spatially balanced.

Following a discussion of the literature and explanation of method, the paper studies the different kinds of interface type found in the case study area. The interface types are discussed and categorised to provide a comprehensive catalogue of types. Then, the paper reports on patterns of land use and outdoor space activity, and the extent to which different interface types are associated with more favourable and less favourable cases, in terms of sustainable travel activity or an activity-friendly neighbourhood. The paper concludes with reflections on the findings, and on the nature and functioning of interfaces in interpreting the nature of the 'urban ground floor,' which can potentially inform future design and planning.

Context and precedents

Research background

Within the literature concerning the effect of land use characteristics on travel and outdoor activities, Handy (1996b), Jacobs (1961), Moudon *et al.* (2002) and Speck (2012) all point out that mixed land use is a necessary but insufficient factor for an area being either walkable or lively, and equally important is the connection combining appropriately with other factors of urban form, such as street type and building fabric. Speck (2012) particularly contends that pedestrian-friendly environments are only

created when the built environment satisfies the four conditions of being useful, interesting, safe and comfortable, concurrently.

In part responding to their statements, Hsia *et al.* (2009) reveal that the designed walking spaces (e.g. pavements and arcades) in Taiwan urban areas are often occupied by parked cars or motor scooters, and in some places there are no purpose-designed walking spaces at all. That is, the urban environment could be said to be useful and interesting, but not sufficiently safe and comfortable to encourage higher rates of walking or cycling.

Thus, because Taiwan exhibits high density mixed land use and because pedestrians are nevertheless impeded in getting around the urban areas with ease, this paper contends that people's propensity to walk or engage in other outdoor activities is influenced by interface type, relating to the space between different urban form elements (buildings and streets especially), such as awnings, arcades, fences and pavements. This has been a particular concern in urban design and social activity related research (Dovey and Wood, 2015), and researchers believe that interface space plays an especially vital role in a human's daily outdoor activity (Dovey and Wood, 2015; Gehl 2011; Gehl and Svarre, 2013; Hess, 2008; Kamalipour, 2016). Indeed, Pafka and Dovey point out that Jane Jacobs saw the interface as 'a key to what makes cities tick' (2017:159) and suggest that the interface is perhaps 'the least developed area of Jacobs' work and most deserving of further research' (after Dovey and Wood, 2015:15).

Definition and importance of interfaces

As defined at the outset, interface adopted in this paper is a wide concept denoting a transitional element connecting each component of urban form – buildings, open spaces and streets, and functions like a mediator to glue different parts or components of urban form together. For example, the interfaces between buildings and streets could be front gardens or pavements, and the interfaces between streets could be crosswalks or cross-over bridges while the interfaces between buildings could be mews or walls.

Having said that, interface could be defined simply as a space between public and private realms, or more precisely the transition between streets and building frontages (e.g. from Bobić, 2004; Dovey and Wood, 2015; Kamalipour, 2016), relation to building lines or property lines (Parolek *et al.*, 2008: p.12) or otherwise related to the concepts of territorial depth or depth configuration (Habraken, 1998; Scheerlinck, 2010).

The possible types and typological features of these frontage types central to the concern of this paper. This is because most social or pedestrian activities happen to be engaged within this transition between private to public realms. Furthermore, it creates an edge to define a well-proportioned and comfortable, pedestrian-oriented streetscape, the location of which can be adjusted to the desired level of urbanism (Parolek *et al.*, 2008). Related to the nature of interfaces, some research claims that a better design of interfaces encourage more street activities (Appleyard, 1980; Dovey

and Symons, 2014; Gehl 1986; 2011; Handy 1996a; b; Hess, 2008), and lead to a more congenial and safer neighbourhood or city lives (Dovey and Wood, 2015; Ford, 2001; Jacobs, 1961).

Nevertheless, despite their pedestrian orientation, interfaces can also accommodate parking spaces, which may be a negative factor affecting residents' outdoor activity patterns. For example, parking location and condition (including illegal parking) directly affects residents' parking accessibility and convenience (regarded as one of the negative factors in encouraging walking by Speck, 2012 and Public Management Consultation of Shih-Hsin University, 2005). Parking location further affects residents' opportunity of having social contact with neighbours or pedestrians, or vice versa, by both shortening the change time from foot to drive and blocking the view of front gardens from streets (Gehl, 2011).

In this sense, the interface has significant potential to encourage or discourage people to walk or socialise within the neighbourhoods depending on the design of the space. That is why this paper assumes that interface types are related to varied outdoor activities, such as use of front garden and neighbourhood-scale walking.

Clarification of terms involving interfaces

Researchers discuss the interface space which is between private and public areas, yet use different terms to describe the space. In addition to 'interface', **transition** is arguably the most commonly used term to describe the space between two domains; for example, transition space (Hess, 1997); transition point or transition area (Bobić,

2004); and transitional zone (Kamalipour, 2016). **Boundary** is also popularly used to represent interfaces, including relations between public and private spaces (for example, Hillier and Hanson, 1984; Kamalipour, 2016; Vis, 2018).

Also, some research names this kind of space lined between different domains as **buffers** or **border areas** (e.g. Turner *et al.*, 2006), while some research calls it a **mediator** between the public and private realm (Brown *et al.*, 1998). Besides this, **edge** or building edge is also used by Gehl (1986; 2011) and by Alexander *et al.* (1977) to describe the place which surrounds buildings and lies along streets; Gehl further divides edges into soft and hard types. As mentioned above, Parolek *et al.* (2008) precisely identify the interface spaces between building lines and streets, and name it as '**frontage type**', which is one particular kind of interface. Moreover, Speck (2013) and Campoli (2012) both recognise the interfaces between private and public areas comprise the crucial space to form **walkable spaces** for pedestrians.

As far as coverage is concerned, transition, boundary, buffer space, mediator and edge encompass all types of interface space, whereas frontage and walkable space are subsets of interface space. Frontage describes only the interface space in front of the buildings, and walkable space only represents those interface spaces used for pedestrians. Walkable space is the area which facilitates pedestrians to walk from the outside of buildings to the exterior edge of road as road is almost always planned for car use (Speck, 2013). Most interfaces, to some extent, could offer walkable spaces (although the quality may be varied), such as pavements, alleys, arcades, galleries, crosswalks, etc. That is the reason why this paper values the importance of interfaces

in encouraging people to walk, owing to the fact that most interface types have the potential to be developed into comfortable and suitable walkable spaces.

These definitions suggest a consensus of an interface as the space connecting different elements of urban form, or the specific space between public (streets) and private domains (buildings). In this sense, interface, transition, boundary, buffer, border, mediator, edge, frontage and walkable space are all used to describe this specialised space. Having said that, most researchers categorise the existing types of interfaces into a part of buildings or streets, and they do not have a specific definition of this kind of space. For example, they regard arcades and front porches as partial building constructions (Katz, 1994; Brown *et al.*, 2000; Steadman *et al.*, 1991), and pavements are considered as types of streets (Brown *et al.*, 1998; Ewing, 1999; Hess, 1997; Holtzclaw, 1994; Jacobs, 1961).

Key studies on interface type

As it happens, not many studies recognise and research interface type as a complete and independent element of urban form compared to building type and street type; however, we note that Bobić (2004), Dovey and Wood (2015) and Kamalipour (2016) particularly recognise the integrity of 'interface type' as an individual component of urban form and give interfaces more precise definitions. Moreover, these three studies classify interface types into some specific groups more systematically than other

studies focusing only on frontage types or façade types (e.g. Alexander *et al.*, 1977; Ford, 2000; Gehl, 1986; 2011; Parolek *et al.*, 2008; Steadman *et al.*, 2000).³

Bobić's (2004) book, *Between the Edges: Street-building Transition as Urbanity Interface*, develops an elaborate classification of interface types based on their typological features (e.g. scales, physical accessibility, and design quality), materialisation, functions, visual and psychological effect on users and relationship with streets. Bobić recognises and defines forty interface elements from European cities and further classifies them into seven prime classes and two sub-classes (whose elements are more flexible and removable) according to their positions relative to the building lines, or their relationships with streets, which connotes how accessible they are to pedestrians.

Bobić also clarifies the difference between interface area and transition point, where transition point is a node when the interior and exterior meet together and usually refer to entrance types (e.g. gates, arches, niches). This definition helps this paper both to clarify the features of interfaces, and also to categorise and name the groups of interface types observed by this paper (see Table 3, later).

³ The definition adopted by Dovey and Wood (2015) and Kamalipour (2016) is narrower than Bobić's (2004), where they focus on the spaces between buildings and streets confined to types of front setbacks, whilst Bobić broadly defines interfaces as transitions between various urban form elements as this paper does. That is, the interfaces which Bobić identifies can be a place adjacent to a building frontage (e.g. porches), an attachment (e.g. awnings) or an extension of street room (e.g. squares and street markets).

The above studies – especially Bobić's (2004) – help this paper not only establish a comprehensive catalogue of all the possible interface types, but also help recognise interface types in the fieldwork.

Research motivation

Despite the importance of interfaces acknowledged by the studies mentioned above, discussion on the relationship between interface space and travel or outdoor activity is somewhat lacking in most related research (Speck, 2012: p.144). Most studies relating urban form and outdoor activities do not recognise the interface as an efficacious element of overall urban design at all, either classifying it as a part of the street system or merely as an aesthetically pleasing extra. In other words, because the concept of interface has not hitherto been widely regarded as an independent component of urban form, it has become subsumed under, or scattered among, different variables.

As a result, the subtler details of the effects of different interface types have been left unanalysed (after Dovey and Wood, 2015). In particular, the question 'how do the characteristics of different interface types affect pedestrian activity?' has not had the deeper discussion and further development it perhaps deserves, leaving an obvious area for further research (Bobić, 2004). This evident gap provides motivation for this paper to especially explore interface type, for its importance and potential as an influential factor on walking and outdoor activities.

Research design

The study area

For addressing the urban issues in Taipei, the study area needs to meet two criteria: the pattern of mixed land use is spatially and functionally complementary; and the areas are within 800 metres (10-minute walk) of MRT stations or bus stops as the distance is widely applied as a typical catchment for estimating service areas of facilities or transit stations (CIHT, 2015). Following these requirements, the study area is selected and its general information is shown in Figure 1 and Table 2.

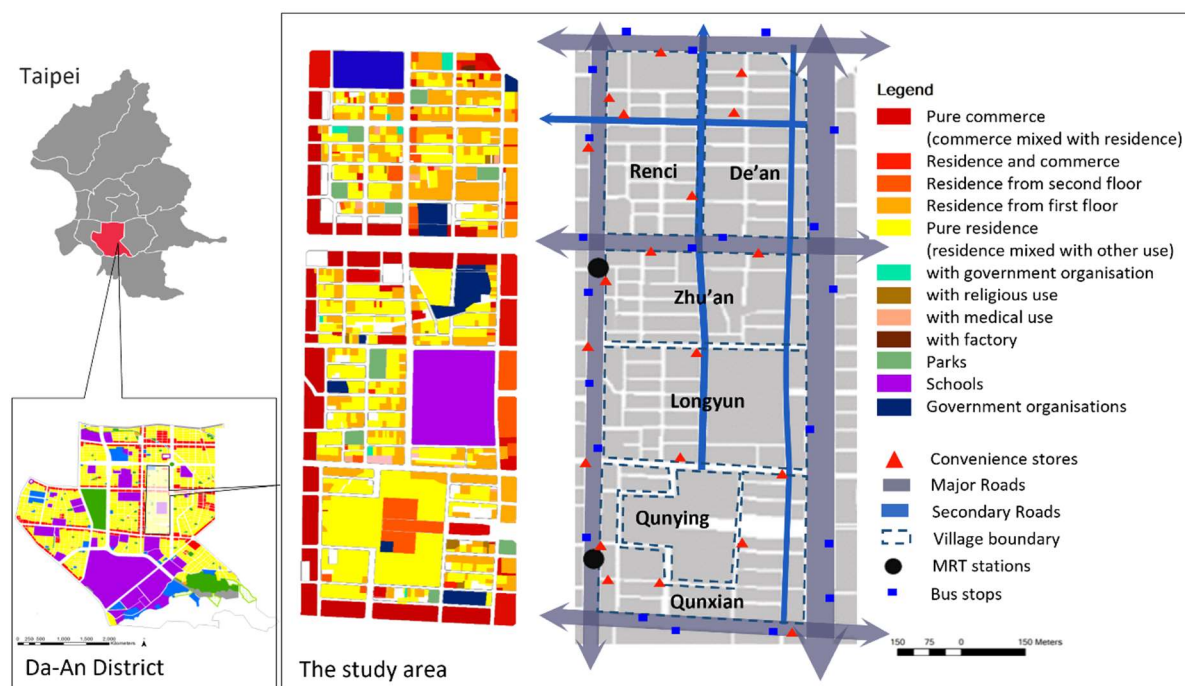


Figure 1. The locations of Da-An District as well as the study area, and their distributions of land use (*Source: Feng-shu Chang*)

Table 2. Contextual information for Da-An district and the study area

	Da-An District		The study area	
Data year	2015	2023	2015	2023
Registered population ^a	313,058	291,851	35,979	31,868
Population density (People/Km ²)	27,557 ^b	25,691	41,836	37,055
Area (Hectare)	1,136		86	
Land use (%) ^c				
Residential	29.40	27.91	59	-
Commercial	7.22	7.01	26	-
Educational	19.63	19.42	8	-
Others	43.75	45.66	7	-
Convenience store density ^d	One per 1474 people		One per 1593 people	
Public transport system				
MRT	5 lines and 14 stops		2 lines and 2 stops	
Bus ^e	Over 50 lines and 250 stops		20 lines and 21 stops	
Mode share of private vehicles ^f	39.50%	38.90%	33.5%	-

a. All the population data are from Household Registration Office, Daan District, Taipei City official website.

b. This is the densest area in Taipei.

c. Data for Da-An district is from Overall review of Da-An District (Detail-Plan Specification), and the latest version is published in 2021. It is worth noticing that restrictive commercial activity is allowable in residential zones according to Taiwan land use control, therefore, the actual commercial use investigated by this paper is much more than the planned zoning. Data for the study area is from the research reported in this paper.

d. Convenience stores density in Taiwan (one per 1703 people) is ranked number two in the world only second to South Korea-one per 897 (Ministry of Economic Affairs, 2024).

e. Calculated by this paper from the source on Taipei eBus website.

f. Mode share figures in the Da-An columns are for Taipei city as a whole (Ministry of Transportation and Communications, 2023: p2). Mode share figures for the study area are from the research reported in this paper.

For urban form related data, the average residential block size is about 0.3 hectares (equal to a 55 by 55 metre-square). Regarding land use, the types were diverse and a mix of land use is prevalent; for example, 59% of land is defined as being for residential use while 26% is considered to be for commercial use, and schools (one

primary and one junior high school) as well as government organisations (e.g. a municipal hospital, post office, police station, etc.) can result in different travel activity generation. Besides this, within the residential land category, nearly half of it is also mixed, especially with commercial use, such as retail, catering related shops, and daily life services (e.g. dry-cleaning shops, beauty salons, pharmacies, etc.). The most common mix type is to have shops on the ground floor with residential above that.

Following these, the study area is able to provide: (1) an apt and abundant source of population and residential buildings for questionnaire surveys and form types observations, (2) varied land use types and infrastructure for trips with different purposes and high accessibility, and (3) a complete transport network for varied mode choice and high mobility connecting that area to other districts. Hence, the urban form characteristics of this selected study area are consistent with those of Da-An as a whole (e.g. a high population density and mixed land use, transport convenience, etc.), so that it could be considered representative of the urban lifestyle in Taipei.⁴

⁴ Although the fieldwork and activity survey for this paper were conducted during 2014 and 2015, the changes since then, as may be inferred from Table 2, are arguably modest. For instance, mode share of private vehicles in Taipei reduced from 39.50% to 38.90%, a reduction of just 1.5%; and the public transport system has remained unchanged. Additionally, according to the Overall Review of Daan District (Detail-Plan Specification), there have been no major zoning plans implemented in the study area thus far, such as the construction of new infrastructure. Therefore, the issues and findings discussed in this paper are considered to remain broadly applicable to the study area, or for generalisability beyond the study area.

The possible interface types

This paper focuses on interface types based on their combination of interface element and front space type. This paper initially categorises the interface types into seven groups based on their spatial position and relationship within the urban ground floor, in doing so helping define or characterise the constitution of the urban ground floor (Figure 2). More specifically, it is the space that is within the property line and between the building line (building frontage) and street 'rooms'. The concept and criteria of this reclassification are comparable to Bobić's (2004) classification, but this paper names the groups based on their function, e.g. shelter provider (Table 3). The seven groups of type of interface are defined in Box 1. Examples of five of the most typical interface types are illustrated in Figure 3.

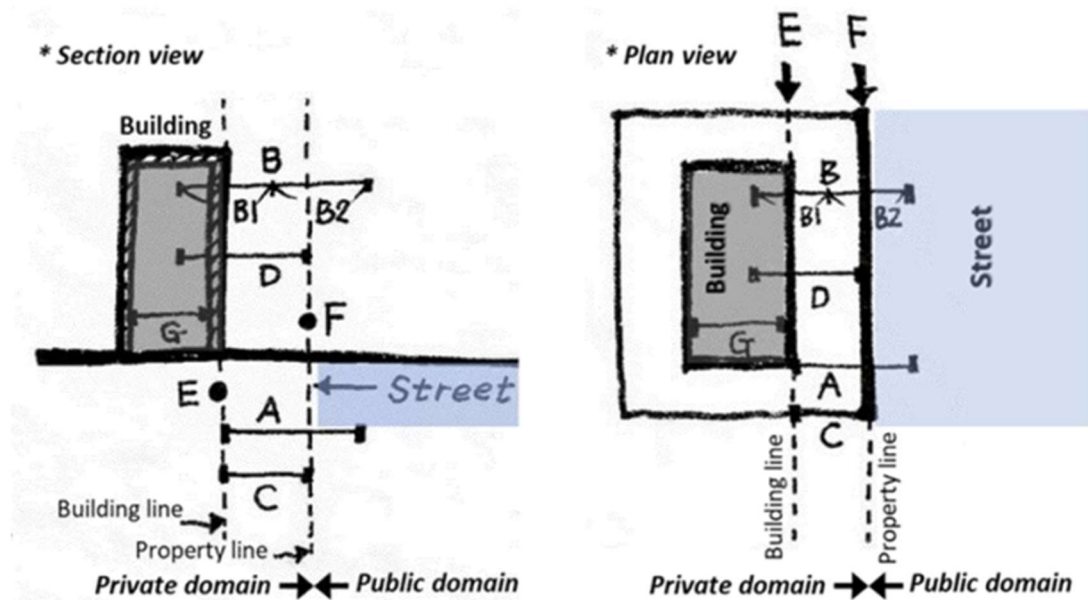


Figure 2. The positions of the seven groups, in the urban ground floor (for definitions of the seven groups of types, see Box 1). (Source: Feng-shu Chang)



Figure 3. Examples of five of the most typical interface types, in the Da-An district.
(Source: Feng-shu Chang)

Table 3. The list of initial interface types classified from the ‘key studies of interface types’ section and discovered in the study area by this paper (for definitions of the seven groups of types, see Box 1).⁵

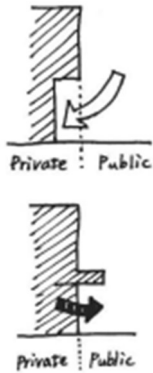
⁵ The initial interface types in Table 3 are presented in approximate order of their proximity to street, and pedestrian accessibility to interface space. Moreover, interface types classified into the same group by similar function are further sorted by their architectural structure. When a type is nearer the bottom of the order, it means that the structure is simpler, and more flexible for homeowners to attach to or remove from the main building, and can be easily replaced by other alternative types. To elaborate this, arcades, balconies, canopies and awnings are similar in terms of function, providing good shade and protection from bad weather and traffic, but the orders of canopies and awnings are lower, because their structures are less complex than that of arcades or balconies, and homeowners can more freely choose to place canopies or awnings rather than arcades or balconies.

Group	Character	Interface type	Pedestrian accessibility		Ability to provide shelter	Structural flexibility	
			Physical	Visual or psychological			
A	shelter provider	1.Mews or Private walkway			+		-
		2.Outdoor Café					
		3.Parking space					
B		4.Arcade					+
		5.Covered Street					
		6.Under the building					
		7.Gallery					
		8.Balcony					
		9.Overhang					
		10.Canopy					
		11.Awning					
		12.Signboard*					
C	ambiguous divider	13.Setback				-	
		14.Ramp or Steps*					
		15. Firewall*					
D	transition point	16.Portico or Porte-cochère				-	
		17.Front porch					
		18. Light court or Area**					
		19.Alcove or Niche					
		20.Garage					
		21.Stoop**					
		22.Raised platform					
E	visual attraction	23.Deck or Patio*				-	
		24Automatic door*					
		25.Shop window					
		26.Staircases					
		27.Sliding doors*					
		28.Shutter*					
F	territory protector	29.Mural**				-	
		30.Creepers					
		31.Fence or Railing					
		32.Hedge					
G	domestic connection	33.Wall				-	
		34.Pot-huis**					
		35.Covered enclosed ground-level circulation link					
		36.Circulation bridge	-				-
* only found in the fieldwork; ** only found in the literature			(impermeable)	(inflexible)			

Box 1. Definition of the seven interface types (see Figure 2, Table 3)

- **A group:** interface extends private space from building line into or sometimes beyond the street, namely mews/private walkway, outdoor café, and parking space. However, these three types do not have common character or function, whereby this group is not given a name from this paper.
- **B-Shelter provider:** interface extends from within private space through property line to or into the street. Moreover, these types, more or less, provide shelter from bad weather for residents or passing pedestrians via either recessed space or projected addition/attachment from the main building structure.

Therefore, more specifically, the spaces are further divided into two subtypes:



- **B1 Open to the public:** the public space extends behind the building line into the main building structure-private space is invaded by public space. These types usually provide better shelter than B2 types do; e.g. arcades, under the buildings.
- **B2 Extends out to the public:** the private space penetrates public space through the projected structural addition (e.g. balconies, overhangs, etc.) or temporary attachment (e.g. canopies, awnings, etc.)
- **C-Ambiguous divider:** interface extends from building line to property line, without penetrating either private or public space. These types provide a softer edge and more ambiguous delineation between private space and street area compared to Group F-territory protector. For example, setbacks or ramps/steps remind pedestrians that they are entering private domains without working as hard barriers such as walls or metal railings.

- **D-Transition point:** interface extends from within private space through to property line without penetrating public space. Transition point is named as a transition changing from private to the public, and vice versa. As referenced by Bobić (2004), it usually refers to an entrance type when the interior and exterior connects (e.g. arches, alcoves and niches). These types provide possibilities for both residents and pedestrians to linger and to observe or be observed, and also, they are popular for people to stand offering an attractive semi-private or semi-public situation, e.g. front porch, portico, etc.
- **E-Visual attraction:** interface adheres to building line and it also describes the form of a building façade. Most types in this category allow pedestrians to view into and are usually attractive for pedestrians, e.g. shop windows.
- **F-Territory protector:** interfaces adhere to property line. They provide the strongest sense of privacy out of the seven categories by inserting barriers between private and public areas, such as walls, railings and fences. Hence, they secure the domestic area and keep it private from the outside environment. However, from the perspective of the pedestrians' view, F-types, more or less, make the walking environment dull and keep pedestrians away from interacting with residents.
- **G group:** interface runs entirely behind building line, either within or outside main building structure. They are usually used as passages connecting different buildings within the same plot, such as circulation bridges.

Questionnaire of outdoor activities

The questionnaire consists of four main subjects, relating to transport modes, use of front door space, walking behaviour and basic demographic information.⁶

- Travel modes:

main transport mode both for work/school, and for errands.

- Use of front door space:

both frequency and duration of weekly use of front door space, and types of activities: entry and exit, park or get a private vehicle, relax, smoke, read, maintain car, do housework, exercise or ball games, garden, watch children, people watch, socialise with neighbours.

- Walking behaviour:

usual reason for walking within the neighbourhood, both frequency and duration of weekly walking within the neighbourhood, and walking attitude as well as preference (used a five-point Likert scale used): 'I like walking and

⁶ The structure of the questionnaire design is mainly based on the survey questions used in Hess (2008)'s article, but adjusted according to the contexts in Taiwan and other similar studies. For example, the options of outdoor activities were basically employed from Hess (2008), but variables of the use of front door space, weekly use duration and frequency, the two important indices used to describe the characteristics of outdoor activity by Gehl (2011) are adopted in this questionnaire. And the questions related to walking preference are adopted from Cao *et al.* (2007; 2009), Handy *et al.* (2006), Handy *et al.* (2004), Hsia *et al.* (2009), Mokhtarian *et al.* (2001), and Redmond's (2000) research.

strolling'; 'Walking can sometimes be easier for me than driving'; 'I am willing to walk for short distances in daily life'; 'I prefer a street with good surroundings (neighbourhood), even if a little detour is necessary'.

- Basic demographic information:

household characteristics, annual disposable income per household, number of vehicles, vehicle licence ownership, usual parking location, overnight parking restrictions, and residential self-selection reasons.

Consequently, this paper is able to understand the relationship between interface types and outdoor activities – how the varied types of interfaces relate to different front door use patterns and walking behaviour.

The questionnaire was undertaken in October and November (2015): the most comfortable season for pedestrian walking and for residents doing outdoor activities in Taiwan; as Gehl and Svarre (2013) suggest, the investigation period would be better on days with good weather for the time of year since it provides the best conditions for outdoor public life (including walking).

The ways in which the survey is conducted and respondents are recruited as follows:

- Posted and shared a link of the online version of the questionnaire (created by Google Forms) through social network websites and emails.
- Surveyed the residents (probably leading to a brief interview) within the study area on the streets in person.

- Placed hard copies of the questionnaire in community centres (or local leaders' office), and then collected them once a week during the investigation period.

For the survey respondents, this paper selects and interviews study area residents who are over eighteen years old and physically mobile (eligible for holding motorised vehicle licences and able to choose their preferred transport modes). Moreover, the final respondents are selected based on their similar socio-economic profiles: over three quarters of respondents are fell into the middle-income bracket set by Accounting and Statistics Executive Yuan (Directorate-General of Budget, Accounting and Statistics, 2023:p23), similar walking attitude and similar self-selection traits, so that this paper can minimise the effect from the respondent bias and maximise the influence from form related characteristics on respondents' outdoor activity. Following this, the final valid sample number is 284, which is able to represent the population in the observation area when the confidence level is set at 90%.

Analysis

The results are first analysed according to typological and spatial characteristics, and then interpretation of space and activity relating to interface type. In the course of the latter, we highlight examples of 'more favourable' and 'less favourable' interface types, selected in effect due to their association with lower private vehicle mode share.

Results

Typological and spatial characteristics

There are 24 interface types finally classified by the results of clustering. These 24 interface types constituted about 90% of the interface spaces in the study area; it means that these final types were able to describe and represent the particular urban form in the study area.

Figure 4 is a complete catalogue with illustration of the final interface types following the classification of these five groups, whilst Figure 5 shows the distribution of the final interface types. The colour scheme of interface types connotes their spatial characteristics; for example, in principle, an interface type's shelter effect is greater when the colour is greener and darker; their connection with pedestrians or street activities is stronger when the colour is closer to purple (e.g. interface types in E-group); and the orange-red-like colour means this type has wall protection.

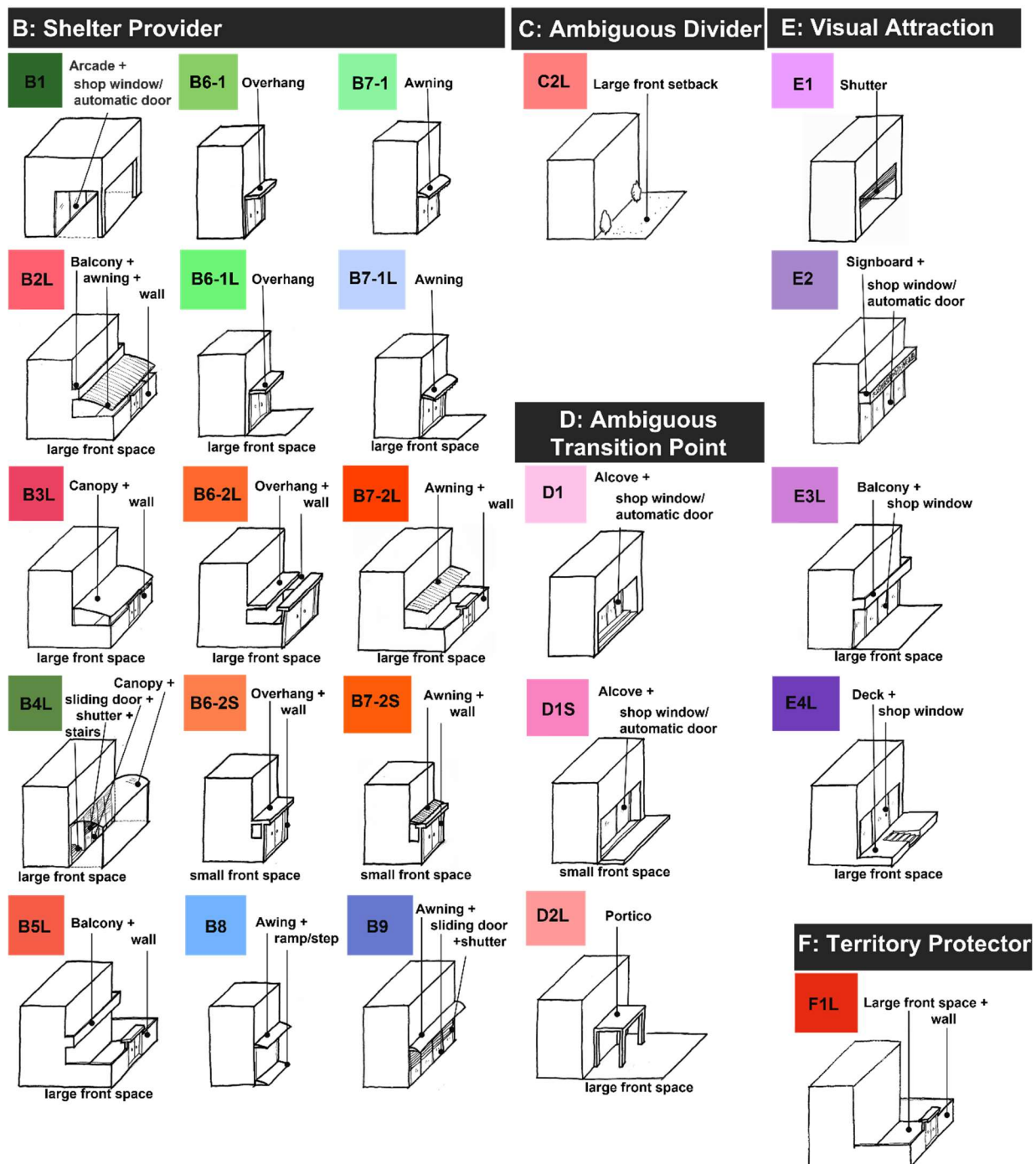


Figure 4. The catalogue and illustration of the final 24 interface types. (Source: Fengshu Chang)

However, some of the interface types have multiple functions. Consequently, although the interface types classified into the B group all have shelters, the interface

types in reddish colours imply that the effect of wall protection might be greater than the effect of shelters in those interface types; and the interface types in blue might have a stronger relationship with street activities than the other B-types.⁷

Figure 5 gives an overview of the percentage of each interface type out of the overall interface objects taken up by in terms of object numbers and object areas, in order to discover which interface types are prevalent, common, or rare in the study area.⁸

⁷ For example, B1 consists of arcades (the element subsumed under shelter provider) and shop windows/automatic doors (the elements subsumed under visual attraction). Related to that, almost all B1 were commercial use because the combination of arcades and shop windows/automatic doors can be attractive for passing pedestrians by means of providing good shelter and displaying products simultaneously. By contrast, B3L has walls (the element subsumed under territory protector) to form strong territory boundaries to protect privacy, although canopies of B3L provide good shelter. Related to that, most of B3L were purely residential, whereby the shelter provided by canopies are confined to the residents (or their visitors) only. Thus, the multiple functions of specific interface types are related to the homeowners' needs, yet they may also provide a public function for visitors or passing pedestrians.

⁸ The percentages of object numbers and of object areas, and the accompanying rank of individual interface types are generally similar, except the interfaces used as communal entrances. For example, B6-1, B6-2S, B7-2L, B7-2S and B8 have percentages and ranks of object areas which are much lower than that of their object numbers since their ground floor areas (as communal staircases rooms) were relatively smaller than other types. By contrast, C2L and D2L usually have large setbacks or front gardens, therefore, their percentages and ranks of object areas are much higher than that of their object numbers.

Legend

B1	Arcade + shop window/automatic door (6.70 / 8.97)
B4L	Canopy + sliding door + shutter + stairs (LFS) (0.99 / 1.36)
B6-1	Overhang (5.71 / 1.83)
B6-1L	Overhang (LFS) (2.26 / 2.39)
B7-1	Awning (4.30 / 5.53)
B7-1L	Awning (LFS) (2.47 / 1.05)
B8	Awning + ramp/step (3.46 / 1.28)
B9	Awning + shutter + sliding door (5.01 / 2.64)
E4L	Deck + shop window/automatic door (LFS) (0.49 / 0.33)
E2	Signboard + shop window/automatic door (4.65 / 3.24)
E3L	Balcony + shop window/automatic door (LFS) (1.34 / 4.86)
E1	Shutter (0.99 / 1.05)
D1	Alcove + shop window/automatic door (4.23 / 5.82)
D1S	Alcove + shop window/automatic door (SFS) (2.61 / 2.43)
D2L	Portico (LFS) (1.20 / 5.8)
C2L	Large front setback (1.69 / 16.31)
B2L	Balcony + awning + wall (LFS) (11.57 / 7.08)
B3L	Canopy + wall (LFS) (9.03 / 5.99)
B5L	Balcony + wall (LFS) (4.80 / 3.46)
B6-2S	Overhang + wall (SFS) (2.82 / 0.56)
B6-2L	Overhang + wall (LFS) (1.48 / 0.71)
B7-2S	Awning + wall (SFS) (1.90 / 0.61)
B7-2L	Awning + wall (LFS) (6.42 / 3.36)
F1L	Wall (LFS) (6.91 / 8.57)

(): percentage of object number / percentage of object area
LFS: large front space; SFS: small front space

----- Less favourable neighbourhood boundary
- . - . - . Favourable neighbourhood boundary



Figure 5. The distribution and the percentage of 24 interface types. (Source: Feng-shu Chang)

The spectrum presented in Figure 5 suggests the functions of each interface type using various colours and in several shades. For example, the types in green/blue provide shelter, while those in dark green (e.g. arcades) provides better shelter than bright green (e.g. awnings). The types in blue/purple provide a visual attraction for pedestrians. The types in pink are transition points or ambiguous dividers. The types in red/orange provide good territory protection. However, they might be unfriendly for pedestrians, whilst pedestrian accessibility of interface types in green/blue/purple is higher than others.

To enhance methodological simplicity and visual clarity, the categories applied to the entire plot represent only the frontage type (entrance or façade) adjacent to the streets. However, from the pattern showed in Figure 5, we are able to imagine how the urban ground floor would look like in this study area, and by extension, the pedestrian experience – which streets may provide a more comfortable and interesting walking environment than the others, or which streets may have more social/outdoor activities engaged within in the interfaces have more open up or soft edge (so probably not in the blocks with too much red/orange).

Space and activity relating to interface type

The survey generated a wealth of information about the relation between interface type and aspects such as commercial or residential land use, parking, planting condition, transition type (soft or hard edge), open or closed space, walkable space and outdoor activities in the front door spaces (Table 4). Here, we focus on the latter

two, as these relate most directly to the relationship between interface type, street space and activity. That said, other aspects such as parking and planting will also feature as part of the interpretation of 'favourable' and 'less favourable' neighbourhoods in later sections.

Walkable space

Walkable space herein only refers to the setback belonging to the private domain instead of the pavement planned by the government. Deducting the space occupied by private vehicles and other obstacles like stalls, interface type B1 can provide the most adequate and the most continuous walkable space among all the final interface types (67% of B1 has walkable space). Besides this, 57% of B7-1L and 55% of E3L are able to provide walkable space. Having said that, most of the walkable space in B7-1L is not continuous since most of B7-1 L are adjacent to B2L, the interfaces with walls, hence most of B7-1L's front spaces are places for pedestrians to stay or stand instead of walking through. By contrast, the main building appearance pattern of most E3L is either row or semi-detached, so E3L provides relatively continuous walkable space compared to B7-1L. In addition, around 45% of C2L, D1S and D2L's front spaces are walkable. The interface spaces with walls and the ones without setback space are unable to provide walkable space. Therefore, in terms of providing more private walkable spaces, B1, E3L, C2L, D1S, and D2L are the 'favourable' interface types.

Table 4. Interface type, transition type and actual use on the ground floor space and their related mode share

Interface types		Front space content			Transition type			Ground floor use		Mode share of private vehicle (%)
		Parking (%)	Plant-ing (%)	Private walkable space (%)	Soft or hard edge	open up or closed in	semi-private	Commercial vs Residential (%)		
B1	Arcade + shop window/automatic door	12	11	67	S	V	V	98 (shops: retail, catering-related, daily life services, medical services, banks, etc.)	2	10
B2L	Balcony + awning + wall (large front space)	30	42	0	H	X	X	12 (less intense commercial activity)	88	41.5
B3L	Canopy + wall (large front space)	33	52	0	H	X	X	16	84	17
B4L	Canopy + sliding door + shutter +stairs (large front space)	82	68	10	S	Δ	V	75 (catering, daily life related businesses, e.g. small-scale eateries, laundries and grocery stores)	25	70
B5L	Balcony + wall (large front space)	36	92	0	H*	X	X	12 (less intense commercial activity)	88	33
B6-1	Overhang	12 (illegal)	16	0	H	X	.	as communal entrance		53.5
B6-1L	Overhang (large front space)	37	46	19	S*	X	Δ	1	99	37
B6-2L	Overhang + wall (large front space)	10	28	0	H	X	X	as communal entrance		25
B6-2S	Overhang + wall (small front space)	0	18	0	H	X	X	as communal entrance		25
B7-1	Awning	0	11	0	H*	X	.	as communal entrance		19
B7-1L	Awning (large front space)	29	26	57	S*	X	X	as communal entrance		33
B7-2L	Awning + wall (large front space)	21	22	0	H	X	X	10	90	18
B7-2S	Awning + wall (small front space)	0	9	0	H	X	X	as communal entrance		33
B8	Awning + ramp/step	0	25	0	H*	X	X	as communal entrance		45
B9	Awning + shutter + sliding door	22 (illegal)	20	0	S*	V	.	89 (varied: catering and retail)	11	45
C2L	Large front setback	38	84	46	S	X	V	30 (shops)	70	8
D1	Alcove + shop window/automatic door	0	38	0	S	Δ	V	80 (medical-related business, banks, catering and daily life services, e.g. dry-cleaning)	20	42.5
D1S	Alcove + shop window/automatic door (small front space)	23	63	43	S	Δ	V	75 (cafés and restaurants)	25	37.5
D2L	Portico (large front space)	17	100	47	S	X	V	53 (18% are public buildings)	47	37.5
E1	Shutter	16	8	0	S	V	.	100 (lower requirements of environment quality, e.g. indoor car park, plumbing, car maintenance and repair, storage companies, street food and drink takeaways)	0	41.5
E2	Signboard + shop window/automatic door	40	27	0	S	V	.	100 (varied: catering, retail (especially clothing shops), and daily life-related services)	0	41.5
E3L	Balcony + shop window/automatic door (large front space)	40	67	55	S	Δ	V	83	17	37.5
E4L	Deck + shop window/automatic door (large front space)	0	100	0	S	Δ	V	88 (businesses with higher standards of interior design, e.g. beauty and hairdressing salons, flower shops and high-end restaurants)	12	41.5
F1L	Wall (large front space)	27	70	0	H*	X	X	30 (less intense commercial business)	70	17.5
Those in green are interpreted as more 'favourable', those in red as 'less favourable'										

Outdoor activities in the front door spaces

The activities within the front spaces can be roughly classified into three groups by their sociability level, as identified by Gehl (2011). The general rule of the classification for Table 5 is: the less sociable the activities are, the closer they are to the top of the table; by contrast, activities nearer the bottom are more likely to create opportunities for neighbourly interaction between neighbours, or to increase the possibilities of residents spending a longer amount of time in their front spaces. To illustrate this, “Entry and exit” and “Park or get a private vehicle” could be regarded as derivatives from transport activity (or necessary trips defined by Gehl, 2011); for example, people get their private vehicles which are parked in front spaces in order to go somewhere, and they pass through the front space to go out for work, school, or to conduct errands. Strictly speaking, people do not really use the front spaces when they do these types of activities. Having said that, sometimes optional activity and social activity have a correlation as optional activity can develop into social activity. For example, when residents are gardening, they may get a chance to chat to their neighbours, and the conversation probably continues longer if the weather is good or they have more time.

According to Table 5, up to 80.4% of residents used their front spaces as transition points for entering or exiting, instead of spending time in them as gardens. Using front space could sometimes be very personal and private; it is not necessary to have direct social interaction with their neighbours. Having said that, using front door space provides a chance to see your neighbours or to be seen by people, so it can

increase the interaction between neighbours (Gehl, 2011). Following this concept, when the intentional use of front space (not just passing through) is not frequent in the study area, there is less social interaction between the respondents and their neighbours. In fact, there are only 13% of respondents who socialised with their neighbours via front spaces.

Table 5. The number and percentage of each activity engaged in within the front spaces

Classification of front space activities engaged in		Responses		Percent of
		Number	Percent	Cases
		(214 samples*)		
Derivative from necessary activity	Entry and exit	172	41.7%	80.4%
	Park or get a private vehicle	43	10.4%	20.1%
Optional activity	Relax	42	10.2%	19.6%
	Smoke	6	1.5%	2.8%
	Read	11	2.7%	5.1%
	Maintain car	5	1.2%	2.3%
	Do housework	43	10.5%	20.1%
	Exercise or ball games	25	6.1%	11.7%
	Garden	25	6.1%	11.7%
	Watch Children	6	1.5%	2.8%
	People Watch	6	1.5%	2.8%
Social activity (Expecting longer stay or more social contacts)	Socialise with neighbours	28	6.8%	13.1%
Total		412	100%	
* Respondents who lived in the dwellings with front space. There was no control of their socio-economic background as the main purpose for this table is to show the use pattern of front spaces.				

After comparing and comprehending the characteristics of outdoor activity among the final interface types, e.g. usual mode choice, walking frequency as well as duration, and weekly frequency and duration engaged in the front door space of the individual interface type (Table 6), this paper categorises some specific interface types as ‘favourable’ to a sustainable and lively environment (e.g. B1: arcades with shop

windows, and C2L: large landscaped front setbacks), whilst some others are found to be 'less favourable' (e.g. B6-1: overhang without setbacks) leading to what could be considered a pedestrian-unfriendly and private-vehicle-oriented environment. In essence, there is a tension between benefit to individual residents (e.g. walls for privacy, security; Figure 3, F) versus benefits to pedestrians/neighbourhood (interest, active frontages; Figure 3, B); here, neighbourhood favourability is aligned with the latter.

Table 6. The overall performance of selected interface types.

Interface types		Sustainable mode share for <i>errands</i>	Weekly walking		Weekly use of front space	
			<i>frequency</i>	<i>duration</i> (hour)	<i>frequency</i>	<i>duration</i> (hour)
'favourable'	B1	94	14.14	3.4	-	-
	C2	100	12	3.9	8	0.8
	average	66.5	11.56	3.12	5	0.5
'less favourable'	B6-1	43	10	2.91	-	-
	B4L+B2L	44	14.29	3.64	21	3

Selected interface types, neighbourhoods⁹ and their related outdoor activity patterns

Type B1 provided a good quality of pedestrian environment by offering shelters from arcae roofs, enough walkable space (around 3.5 m wide) and attractive shop windows

⁹ The location of the selected neighbourhoods is given in Figure 5.

and glazed automatic doors (Figure 6). According to Taiwanese building regulations, the minimum height of arcades typically falls within the range of 2.73 to 3.5 metres. Nearly all the ground floors of B1 interfaces are utilized for various commercial purposes, including retail businesses, catering-related establishments (such as bakeries and restaurants), daily life services (such as grocery stores and dry cleaning services), medical services (such as general and dental practices, pharmacy) and banks.

'Favourable' interface type: B1



Figure 6. The elevation and images of B1 (*Source: Feng-shu Chang*)

Regarding the relationship with street space, 60% of B1 interfaces were found to be directly adjacent to well-conditioned pavements: covered by bricks without any damage. That is, pedestrians have the chance to choose to walk in a comfortable walking space even when the arcades are occupied by obstacles, such as mopeds, stalls, etc. Correspondingly, B1 is associated with higher sustainable mode share (94.4%) than most other interface types are.

Having said that, when it comes to the detailed travel activity data related to B1, we find that respondents who chose private vehicle mode as their main mode choice for errand trips are particularly clustered in specific dwellings. Therefore, we

further compared these two types of B1, and defined that 'favourable' B1 as where residents used public transport, walk, or bike for errand trips, and 'less favourable' B1 where residents used private vehicles for their errand trips.

In 'favourable' B1 (Figure 7), the entire arcade floor is on the same level as the street (including pavements), and the most important thing is that there is neither moped parking allowed nor parking mopeds observed during fieldwork in these arcades. We find 76.3% of this B1 adjacent to at least 1.5 metre-wide pavements, and 63% is adjacent to streets without official parking spaces. The residents living in this specific interface type have an average weekly walking frequency and duration (14.14 times and 3.4 hours) which is higher than that of the whole study area (11.56 times and 3.12 hours).



Figure 7. 'Favourable' B1 type: the same level as pavements, no moped parking.
(Source: Feng-shu Chang)

By contrast, in 'less favourable' B1 (Figure 8), the entire arcade floor is two steps higher than the level of the pavements (this B1 is all connected with 1.2 metre-wide pavements). The most critical difference from 'favourable' B1 and this B1 is that there are 50% of these arcades occupied by mopeds, and 71% of the pavements mentioned

above are also adjacent to official parking spaces. The residents living in this type have an average weekly walking frequency and duration (9 times and 0.93 hours) which is much lower than that of the whole study area.¹⁰



Figure 8. 'Less favourable' B1 type: two steps higher than pavement level, with mopeds parked on it. (Source: Feng-shu Chang)

In this case, whether the arcades allow mopeds to park on them or not, and whether the arcades are near official parking space or not, these two conditions seem to be the critical reasons for people living in B1, but choosing private vehicles for errand trips. As Speck (2012: p.115) writes in *Walkable City*, cheap and plentiful street parking space is the problem influencing people to choose driving instead of walking.

¹⁰ Further to the differences between these two B1 types, in terms of the level difference between the arcade floor and street level, it needs further observation and more samples to figure out whether it really influences residents' mode choice or not in future research. Beside this, the presence of pavement does not seem to affect residents' mode choice most, because the entire less favourable B1 type connects to pavements, but more than a quarter of favourable B1 type does not connect to pavements, although many studies state that there is a positive relationship between the presence of pavement and walking behaviour.

This finding suggests that residents' travel activities will be influenced simultaneously by the characteristics of the entire environment, not only the presence of pavements or parking spaces. In other words, pavements or parking spaces indeed affect residents' travel activity, to some extent, but the most important thing is how these different urban form elements combine together.

'Favourable' neighbourhood: C2L



Figure 9. The elevations and images of C2L. (Source: Feng-shu Chang)

The most 'favourable' neighbourhood, a massive collective condominium block or superblock (Cardno, 2016; Chen, 2023), can be considered as such because it mainly consists of C2L (large front setback, Figure 9) where its interior network is given over entirely to pedestrians (no access for private vehicles), by being surrounded by large, landscaped setbacks providing good walkable spaces between the edges (Figure 10).



Figure 10. Layout and images of the most 'favourable' site (*Source: Feng-shu Chang*)

This site is mainly made up of thirty-eight condominiums with landscaped front setbacks, and this is a complete community scale of about 10 hectares, approximately 300 by 300 metres. Within the block, the ground spaces between the buildings are covered in brick mosaics, marked as pedestrian areas. What is more, there are also circulation bridges, one kind of interface type recognised by Steadman *et al.* (2000), linking the separated buildings from the first floor and above (Figure 10). These connections serve to link not only the residents' dwellings but also buildings with diverse functions within the block. For example, the ground to first floors of the inner buildings provides varied commercial and public services, such as supermarkets, laundries (dry cleaners), barbers, cafés, pharmacies, post offices, children playgrounds and even consul nurseries, so residents living above the shops can walk down to them or visit their neighbours via the bridges from either side of the

condominiums without being exposed to the elements. That is why most of the residents interviewed by this paper say that it is very convenient for them to conduct almost all the essential errands within the community by walking or biking (on the brick pavements or circulation bridges) without passing through streets outside the block.

Although most respondents used the local shops for their errands and these served mainly residents, people living outside the block can still walk in to use these services via the open access (open front setbacks). These kinds of interconnected pedestrian paths and internal access for local residents not only provide a safe and convenient walking environment but also have an influence on neighbourly interactions (Grannis, 2005).

When it comes to the boundary design of this community block, the entire setback space (from 3 to 8 metres wide) has a brick surface with planting. There are landscaped dwarf walls (sometimes combined with railings) located in partial setback spaces as barriers or protection between gates (which imply entry to the domestic domain) and streets. Besides this, some setback spaces over 8 metres wide also provide parking spaces for the residents living in this condominium block. However, apart from the parking spaces (taking up over 6 metres in width), there are still at least 2 metre-wide pavements within the block for residents. Therefore, this kind of setback provides comfortable and safe spaces for pedestrians.

This neighbourhood is arguably the most suitable environment for pedestrians in the observation area. In addition to the good quality of the pedestrian environment

and self sufficiency within the neighbourhood, the block is almost completely surrounded by official pavements. There is less than 18% of the block connecting to streets with illegal parking (Figure 11). Even with the 18% of the block connecting to illegal on-street parking, the block itself still provides a good walkway due to its interface space: large landscaped front setback (Figure 12).



Figure 11. The surveyed distribution of walking and parking spaces. (*Source: Feng-shu Chang*)



Figure 12. Observed distribution of pavements and parking spaces. (Source: Feng-shu Chang)

Most important is that the parking space (whether off-street, on-street or illegal) is not directly accessible to residents' front doorways because of the layout of these collective condominiums. Generally speaking, there is a certain distance between on-street parking space and every dwelling's main entrance. This research, therefore, deduced that this on-street parking space is unable to directly increase the parking convenience for the residents. The parking location might not be only related to the lowest use of private vehicles for errands previously revealed but also more social activities engaged in within this neighbourhood (revealed below) than the total average of the whole study area, as there is a strong relationship between parking convenience and private vehicle use as mentioned in a considerable pool of research (e.g. Badland *et al.*, 2010; Hess, 2001; Kitamura *et al.*, 1997; Speck, 2012; Weinberger, 2012).

When it comes to C2L's related activity patterns, in addition to its sustainable transport performance, this neighbourhood is also recognised as the best neighbourhood design due to its physical and social structure as far as a healthy and liveable society is concerned. The average weekly walking frequency here (12 times) is higher than that of the whole study area. The average weekly duration and frequency of using front space in this neighbourhood is also nearly 1.5 times higher than that in the whole study area at 45 minutes and 8 times. Around 25% of residents living in this community use their front door spaces (or the public courtyards) for relaxing, exercising, playing with children, and communicating with neighbours (Figure 13).



Figure 13. Social activities engaged in within the 'favourable' neighbourhood. (*Source: Feng-shu Chang*)

This is because this neighbourhood design is able to facilitate walking behaviour by both achieving the four attractors (useful, safe, comfortable and interesting environment and making parking less convenient) to make a city walkable as asserted by Speck (2012), and by supporting various social activities by providing different planned hierarchical semi-private or semi-public communal spaces. To

illustrate this, some buildings' ground to first floors provided commercial and public services to meet residents' daily needs (useful and interesting), while within the block, there are pedestrian paths, enclosed ground level circulation links and circulation bridges linking both separated dwellings and varied services (safe and comfortable).¹¹



'Less favourable' interface type: B6-1

Figure 14. The elevations and images of B6-1. (Source: Feng-shu Chang)

¹¹ Having said that, collective condominiums are regarded as unfavourable by Kitahara (2003) as high-rise blocks of flats in park-like open spaces often leave elders and children physically and mentally isolated from the community. Comparably, Alexander *et al.* (1977) and Gehl (2011) point out the issues of being inconvenient and the lack of space for residents to interact or participate in high-rise buildings. However, in this case, there are communal halls where residents meet each other within the same floors or the same buildings; communal gardens where residents spend their time; the neighbourhood scale communal square and the community centre where the entire neighbourhood or people living nearby can socialise. The positive designs probably then diminish the aforementioned problems peculiar to high-rise buildings. What is more, this structure transfers public life into a part of private, family life, which can not only attract more walking behaviour (Gehl, 1986; 2011) but also decrease crime incidence, and then enhance the sense of safety in both living and walking (Alfonzo *et al.*, 2008; Gehl, 2011; Giles-Corti *et al.*, 2009; Moudon *et al.*, 2002; Speck, 2012).

Interface type B6-1 comprises an overhang, typically 0.5 metres wide by 2.5 metres long, which merely provides shelter above the entrance (Figure 14). Type B6-1 has relatively higher percentages of private vehicle use for errands than most other interface types. The mode share associated with B6-1 is: 57.1% for private vehicles, 28.6% for transit and 14.3% for walk or bike.

Only 8.5% of B6-1 connect to pavements of 1.2 metres wide. Although the spatial characteristics of B6-1 mean that it is unable to provide parking space, 45% is near to streets with official parking spaces, and more than half are adjacent to streets without strict parking restrictions. In other words, fewer than 5% of residents live near streets with parking restrictions. Therefore, for residents in B6-1, on-street parking is an available and convenient choice for parking even though they do not have their own parking space in their dwellings. Moreover, over 90% of B6-1 connected to streets without providing a good pedestrian environment that contained neither pavements nor street trees. Related to that, people living in this type have an average weekly walking frequency and duration of 10 times and 2.91 hours, which is lower than that of the whole study area. This suggests that the fact that B6-1 has the highest private vehicle mode share out of all interface types is highly related to the convenience of street parking and the lack of good walkable spaces.

‘Less favourable’ neighbourhood: B4L and B2L

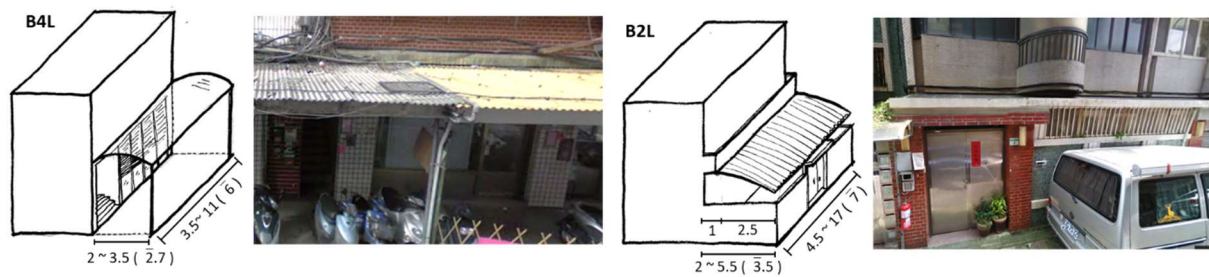


Figure 15. The elevations and images of B4L and B2L. (Source: Feng-shu Chang)

The ‘less favourable’ neighbourhood is mainly formed by both B4L and B2L (Figure 15). B4L is the row flats with glazed and removable sliding doors, and its ground floor is usually used for catering commerce purposes.

The front space in B4L is around 2.5 metres wide and the canopy is about the size to be able to fully cover the front space for good shelter. However, the front space could not offer suitable walking space as almost all of it is occupied by obstacles, such as mopeds, stalls, shop owners’ equipment, tables and chairs, or clothing hung out by house owners (Figure 16).



Figure 16. The contents of B4L’s front space and the illegal on-street parking. (Source: Feng-shu Chang)

Regarding B2L, the shelter both from balconies and iron sheet awnings also fully covered its front space. The typical scale of its front space is 3.5 metres wide by 7 metres long, which is theoretically spacious for parking the homeowners' cars, but in real use, most residents park their vehicles on the lanes instead.

Overall, this neighbourhood did not provide a pleasant walking environment in both private and public realms since there is not enough setback walkable space provided either by house owners or pavements planned by the government. What is more, the shops even attracted more customers from outside the neighbourhood, who illegally parked their vehicles on the streets near them (also see Figure 17). Illegal on-street parking is an issue not only because it makes parking convenient, but it also reduces pedestrian walking space (Figure 17).



Figure 17. The locations of no-street official and illegal parking, and photographs of the illegal parking. (Source: Feng-shu Chang)

In short, this neighbourhood design is beneficial to vehicle users because of the parking convenience. It could be a vicious circle that this hostile pedestrian

environment forces residents who are originally willing to walk to give up and switch to driving since it is relatively easier or less dangerous under these circumstances. Consequently, the increasing on-street parking and the worsening pedestrian environment cause more people to drive.

As respondents complain, the illegal on-street parking indeed makes walking uncomfortable and dangerous, especially for parents who are walking children to schools or playgrounds. Thus, some of these respondents think driving children to school is much easier for them than walking. However, they do enjoy walking around in the countryside where the environment is better.

Corresponding to the hostile characteristics, there are up to 56% of residents in this neighbourhood using private vehicles as their main mode for errands. However, there are some interesting findings when considering walking frequency, walking duration, and the characteristics of front space use. The averages of weekly walking frequency and duration are higher in this neighbourhood than in the whole study area, with 14.29 times and 3.64 hours, despite the fact that over half of residents choose private vehicles as their main mode for errands. This might be related to the resident's walking habit or lifestyle, which is also mentioned by Hess (2008) to explain why his case study town with less parking restrictions has higher walking mode share for shopping than another town with strict parking restrictions. Corresponding to Hess (2008)'s finding, this paper finds that up to 75% of residents in this neighbourhood also choose walking as exercise out of habit.

What is more, in terms of the characteristics of front space use, the averages of weekly frequency and duration are about five times higher in this neighbourhood than in the whole study area. More than half of residents used the front space for relaxing, gardening, exercising, doing housework (hanging out clothes) or household projects, and socialising with neighbours; especially the percentage of residents who visit neighbours is also three times higher in this neighbourhood than in the whole study area. These research findings are consistent with Talen and Koschinsky (2014) finding a positive relationship between social activities and a 'CWD' neighbourhood (Compact, Walkable and Diverse), but a CWD neighbourhood is not necessarily a sustainable one.

This selected 'less favourable' neighbourhood is indeed compact and diverse in terms of its high density of commercial and residential mixed land use and the diversity of commercial services (and probably some walkable spaces provided from B4L). However, this neighbourhood does not provide enough good quality and quantity of walkable places to reduce residents' private vehicle use, so this may be the reason why this neighbourhood has more social activities engaged in but a higher mode share of private vehicle use than the whole study area.

Following these findings, this neighbourhood is not recognised as a transport sustainable neighbourhood, but it might be a good neighbourhood in terms of social interaction with neighbours. It might be contributed by B4L's architectural characteristics: open or transparent façade (removable glazed sliding doors) and narrow land subdivision (Gehl, 2011) or small plots (Kitahara, 2003) as the typical size

of this kind is around 4 to 5 metres wide and 17 metres deep. Actually, this inference both corresponds to the openness principle suggested by Kitahara (2003) which brings frequent social communication, and also to the narrow principle stated by Gehl (2011) that row flats with narrow units and many doors with various uses, which can host events and enhance street life. Moreover, its travel activity characteristics (more social activities and more recreational walking than the average of the whole study area) is also consistent with Hess (2008)'s assumption that when the neighbourhood environment can encourage people to socialise with their neighbours, then it can also engage people in walking.

Conclusions

This paper was originally motivated by the contradiction between the theoretical benefits of high density and mixed land use and the actual high dependence on private vehicles in Taiwan despite most urban areas in Taiwan being compact with mixed land use. However, the important but less aired discussion of interfaces directed the focus on the contributions both about typo-morphological traits of interface types and about the outdoor activities related to the defined types as the first step to address and understand the urban and transport related issue in Taiwan. The detailed study of defining interface type and associated activity has in turn helped to enrich understanding of the nature and character of the 'urban ground floor.'

This paper has two main contributions. First, it has established a comprehensive catalogue of interface types, where the enumeration of interface types

compiled from the literature and fieldwork can be regarded as a contribution to understanding of interface type. This paper is relatively more able to precisely demonstrate and present the actual complexity of interface forms or streetscape in local areas as Bobić's (2004) work focuses on recognising individual interface elements, whilst Dovey and Wood (2015) and Kamalipour (2016) broadly categorise interfaces and name the categories according to the characters shaped by the spaces (e.g. impermeable/transparent classes). Beyond those approaches, this paper particularly values the ability of sheltering, which could potentially have a great impact on pedestrians' activities.

In the course of this research, the position of different interface areas in relation to the 'urban ground floor' has been articulated (e.g. Figure 2), which could in a way help further define or refine the latter concept. Indeed, the 'urban ground floor' can be seen as a composite including not only the public street space and frontage, but the uses and activities in the adjoining buildings, especially the ground floor of the fronting buildings. Seen this way, an interface is not just an urban element of itself, nor just an overlapping part of both street and building, but could even be seen as an integral, indeed pivotal part of the larger 'urban ground floor.'

Secondly, the paper has gone beyond previous studies by establishing relationships between interface type and outdoor activity patterns, and outcomes such as less private vehicle dependence, more walking and social activity. The three key determining factors affecting being 'favourable' or 'less favourable' are (i) the quality of walking spaces, (ii) the quantity of parking spaces, and (iii) the ability to host

outdoor activity in the semi-private/public front space. This is because various interfaces suggest different capacities of parking space, and also show how much or how good walking spaces they could provide. More precisely, private vehicle use is higher when people can park their vehicles more easily; in contrast, useful, safe, interesting and comfortable walking spaces are the important conditions to encourage people to walk and engage in social activity.

Of course, our treatment of interfaces is not the whole story, and the research reported herein has a number of caveats and limitations. First, the results and any generalisation from them should be interpreted within the spatial and temporal context of the study research. Secondly, the study does not systematically address the social context of the residents (including matters of demographics or affordability affecting behaviour or quality of the built environment), nor political context of who makes what rules for which parts of the urban ground floor. Thirdly, there are a number of other issues which we have necessarily only touched on briefly (e.g. regulations, materials, building heights, trip purposes) or that lie beyond the scope of the paper (e.g. relation to wider context and public transport); such issues could deserve more systematic study in future research.

As it is, this paper's primary contribution is its treatment of interface itself (including the definition, importance, categories and typological features) to advance beyond existing understanding in the literature, and provides an operable classification system to classify and present the current urban fabric, in terms of interface appearance, as applicable in Taipei. The paper also shows that residents'

outdoor activities are related to the interface types which they live within; that is, this paper can state the importance and influence of interface on outdoor activity on the 'urban ground floor.' As such, this study identifies not only desirable aspects of interfaces and space in a general sense, but could be used more specifically to inform future urban design guidance for how a successful, liveable 'rez de ville' could support a successful, liveable city. ●

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