The space-time relations between pedestrians and street vendors: a case study in Suihua, China

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Abstract: This paper is set in a broad scope of urban walkability research related to street vending practices. How are urban streets temporarily re-calibrated by mobile street vendors and dynamically used by the presence of pedestrians? The empirical basis and temporary data are lacking at a micro-scale. Using on-site observation and behaviour mapping, this study incorporates both social and physical elements to provide a fine-grained picture of human activity in urban spaces where street vendors operate. This compares the space-time patterns of street activities during four daily periods of three urban street spaces in the smaller Chinese city of Suihua. The empirical evidence produced reveals two co-operations of environment-behaviour interactions (e.g. micro-climates and street characteristics) and socio-spatial relations (e.g. the presence of street vendors and pedestrians). This study interprets a notion of flux in patterns of vending-walking relations, which could reveal an alternative understanding of Chinese urban walkable space via the temporary practices of street vendors. This knowledge and its application of designing active street spaces could benefit future policy-making and urban design practitioners.

Keywords: transient walkable space; urban walkability; everyday street activity; street vending

1. Introduction

1.1 Brief

This paper provides an alternative way of understanding urban walkability through dynamic street vending practices (Sun et al. 2016). Fan et al. (2018) indicate that street vendors as an interesting factor can impact walkability in contemporary Chinese cities, but there are no empirical studies. This research is an attempt to fill some of the emerging gaps. The aim is to be able to link who are they, what they do, where and when they do it. Golicnik et al. (2010) note the value of behaviour mapping and GIS techniques in producing detailed mappings of urban park spaces, which could help to understand the relationships between the built environment and human behaviour. This paper reflects on the development of the methods having collected empirical evidence in three urban street spaces, with a view to understanding the space-time relations between heterogeneous uses of pedestrian groups and street vending types.

1.2 Walkability and pedestrians

In light of the multiple benefits of walking (e.g. promoting public health, enhancing social interaction, increasing land value and reducing environmental pollution), improving walkability is becoming increasingly significant among urban designers and public health researchers (e.g. Saelens et al. 2003, Kashef 2011, Speck 2013, Duncan et al. 2015, Sun et al. 2016, Brookfield et al. 2017). The relevant studies on walkability have covered numerous different aspects, especially in developed countries: 1) The influence of urban fabric and spatial configuration on walking behaviours, such as the Walkability Index (Frank et al. 2010) and Space Syntax (Hillier et al. 1993, Koohsari et al. 2016), which could be applied in order to quantitatively evaluate cities and regions; 2) Walkability has been studied via ecological models and environmental factors, such as the Context-specific Behaviour Model (Giles-Corti et al. 2005) and Neighbourhood Environment Walkability Scale (Cerin et al. 2013), which attempt to explore correlations of perceived environmental attributes with walking behaviours; 3) Walkability could also be subjectively studied in relation to sense of place and experience of environment, such as Ewing & Handy's (2009) Urban Design Framework and Gehl's (2010) Three Types of Outdoor Activities, which present spatial meanings in terms of human-scale design guidance.

Despite the complexity of approaches to the concept of walkability, some studies have focused on specific aims, for instance, pedestrians on urban streets. Mehta (2008) notes three street characteristics (physical, social and land use), which simultaneously impact pedestrians' attitudes and perceptions. Whilst in most instances street features are relatively fixed, pedestrian behaviours are dynamic and difficult to determine. Hall (1966) defines the intimate, personal, social and public distances, which might relate to different sizes of pedestrian group. Furthermore, several studies indicate that sensitive pedestrians (e.g. older people, children, women, people with accessibility support needs and low-income groups) should be considered differently in the same environment (e.g. Unt et al. 2014, Brookfield et al. 2017, Jensen et al. 2017). However, it could be argued that street design generally focuses only on one human type (i.e. the "average person") (Jacobs 1961). Inspired by the idea of environmental affordances (Gibson 1986, Heft 2010), this study contends that pedestrians need to be more variously defined in specific urban streets.

According to the Oxford English Dictionary (2018), the word "pedestrian" is a noun, which means "a person who is walking rather than travelling in a vehicle". Therefore, pedestrianism could be defined as a transportation mode distinct from other such modes (e.g. driving) in streets. However, the word can be traced back to the early 18th century, from the French pédestre or Latin pedester "going on foot", which expands the definition of pedestrian to walking for non-transportation purposes, such as recreation, leisure, exercise, shopping, parades and social interaction (Lo 2009). The status of stationary pedestrians is also ambiguous regarding walking or standing. As such, pedestrians could be regarded as undertaking various street-based physical activities. The ambiguous activities of pedestrians could be further distinguished related to a specific purpose, population and behaviour.

1.3 Chinese cities and street vending phenomenon

The rapid urbanisation in China has led, in most cases, to urban developments, which ignore the everyday life for urban residents and the need for walkable neighbourhoods. Decreased walkability and its multiple consequences have emerged during the past few decades. For example, since China's economic reform in the late 1970s, the number of people walking and cycling has declined (Su et al.. 2017). From 1992 to 2002, the increasing number of overweight and obese people in China reached

approximately 100 million (Chinese Academy of Sciences, 2009). In recent years, the Chinese scholars have begun to outline the various negative consequences of fast urban development and to undertake research into walkable environments (e.g. Sun et al. 2015, Zhou et al. 2017, Su et al. 2017, Fan et al. 2018). However, the majority of published research in this field is mostly quantitative, especially at a large-scale, and based on the study of western urban models.

Returning to the idea of distinguishing pedestrians via a specific purpose and behaviour, street vendors are a common feature of numerous streets in residential neighbourhoods, dynamically occupying space where many people regularly walk (Sun et al. 2016, Flock et al. 2016), leading to alterations of street layout and spatial use in contemporary Chinese cities. Although some Chinese scholars note that street vending can improve public vitality, its inherent mobility is considered problematic from the management perspective, such as trying to govern, control or manage the phenomenon or considering it as a necessary conflict (Huang et al. 2014, Xue et al. 2015). According to the Lefebvrian proposition that "(social) space is a (social) product" (1991 p.26), walkable space is not a pre-existing or a timeless container which pedestrians fill up and move around in, rather it is temporarily co-produced by street vendors and pedestrians. In other words, the inherent mobility should not be viewed as an "issue" but could be a positive approach to understanding a transient walkable space via ontological forces of local everyday life (e.g. habit, demand, culture and socio-economic situation), which can be further used to comprehend dynamic pedestrian behaviours.

1.4 Research aims and objectives

The challenge, therefore, is to explore the space-time patterns of street vendors and pedestrians by empirical studies of three specific urban street spaces in Suihua, in order to understand how these relations operate and how they in turn influence the walkable space at different times. The research aims and questions are:

Investigating activity types: the everyday street activities can be further distinguished via the paired types of street vendors and their clients (i.e. pedestrians), specific walking behaviours and populations, in order to identify detailed correlations across heterogeneous pedestrians and street vendors or other co-existed activities;

Understanding everyday uses in flux: how the space-time patterns differ at the three sites, periods and days; how the correlations between temporary street vendors and ever-changing pedestrians operate.

2. Methodology

This methodology included four phases: pilot study, workshop data collection, GIS database archive and analysis. A pilot study was undertaken by the researcher to develop a detailed protocol for the following workshop. Its tasks were selecting observation sites and times, drawing site plans, analysing site contexts, and summarising presence of activity types. The workshop was designed to collect data from three selected sites simultaneously, to refine the previous tasks (e.g. the activity types), and to discuss potential results or reasons, with 9 observers together, thereby ensuring inter-rater reliability and being more comprehensive when reflecting on the findings.

2.1 Developing behaviour mapping

This development has been presented in a working paper (Sun et al. 2019). The behaviour mapping method is an objective tool to study the relationships between the built environment and human behaviour through observing different activities in selected surroundings with minimal intervention by the observer (Golicnik et al. 2010, Unt et al. 2014, Ghavampour 2017). Behaviour mapping juxtaposes subject-related behaviours with the properties of space, making it possible to ascertain environment-behaviour interactions. This study has further distinguished the subject-related behaviours (i.e. Chinese everyday street activities) at specific times of the day.

The original method has five important steps: an initial site survey to collect the characteristics of the selected sites via photographs and notes; a symbolic coding system for the types of existing activities with demographic characteristics; a method of mapping the symbols or codes (e.g. activity, age, and gender) to the spatial characteristics (e.g. site plan) during a survey; iterative site surveys and recording of the microclimate at different periods (e.g. times and days); combined mappings and comparative analysis. However, this pilot study has identified the following limitations of the foregoing method:

- It is only valid for implementation in places of relatively fixed behaviours. Such streets and markets contain numerous pedestrians and changing behaviours that are impossible for observers to record.
- Observers must use the symbolic coding system creating mappings by hand. The low efficiency leads to a challenge for simultaneous recording in different streets.
- The data/mappings could not be repeatedly checked due to the activities disappearing shortly after the recording.

2.2 A workshop for data collection

This study proposes further development of the method, to include a fieldwork workshop dealing with the limitations in urban street spaces with plentiful everyday activities. The workshop entitled “Walking Practice” recruited 9 observers from various subject areas, who were studying at different Chinese universities. The multiple perspectives and interdisciplinary knowledge were significant in enriching the findings. Due to local residents were most likely to spend their time outdoors during the warmest month of the year, the workshop was held between 23 and 31 July 2017. The first day of data collection was designed for an initial practice (i.e. a weeklong survey).

Considering higher pedestrian movement and density of the selected urban street spaces, the on-site mapping by hand was replaced by taking panorama photos from high spots by observers with an average approach. 13 photos per hour were taken at each site (i.e. on average one photo was taken every 5 minutes). The date and time of each photo were archived. Furthermore, the micro-climate (i.e. approximate temperature, rainfall, cloud and wind) and special annotations (e.g. impression, light, and noise) were noted separately.

The data were simultaneously recorded from three selected sites during four different hours of the day, to have the maximum sampling of the various uses of spaces regarding the rhythm of everyday life. The four selected hours (i.e. 07.00-08.00, 11.00-12.00, 16.00-17.00 and 18.30-19.30) could be summarised as “morning commute to work”, “high temperature and lunchtime”, “commute to home after work” and “recreational phase”. The remaining hours and dates would comprise theory lectures, mapping practices, critical reviews, discussions and reflections. Three observers’ spots were selected in a higher position enabling observers to visually record a given observation area (around 1500 m^2).

With the aim to create a GIS database, gender and twenty-six activity types (Table 1), were identified or refined during the workshop and discussed twice with the on-site observers. Paired activities were not only regarding street vendors and their clients, but also included some specific population groups and behaviours. For instance, children most often emerged with adults in urban street spaces. Therefore, a filtrating system was developed to distinguish all activities from explicit behaviours to ambiguous behaviours. It included five layers (Table 1): selling, buying, specific population (e.g. street cleaners), specific behaviour (e.g. dog walking) and common behaviour (e.g. walking).

2.3 Database creation and analysis techniques

The seven days’ data (i.e. the panorama photos) was recorded in digital form onto a GIS system using ArcMap 10.5 (ESRI, USA). From 13 photos taken per hour, 7 were input to the GIS database (i.e. an average of ten minutes per photo). Other 6 redundant photos were retained in case of needing to replace blurred photos systematically. The inputted photos were archived and used to repeatedly check the GIS database (i.e. spot checks). Moreover, some supplementary elements for training subjective judgment were used to refine age, gender and activity from the photos (e.g. clothes’ style or colour, schoolbag and hairstyle). The individual locations would be referred to the site settings (e.g. pavement crack, building façade, curb, tree, public furniture and private stall). The completed GIS database included 84 hours and 588 photos from three sites.

The sophisticated recording of individual spatial location, activity type, gender, time and date, created an explicit GIS database that could then be analysed through different hours, days and sites. There was no clear boundary of street vending spaces, so comparing the proportions (e.g. of percentage and mean) is more appropriate for this study. Furthermore, the database allows cross-comparison with other factors (e.g. micro-climate, spatial feature and on-site observation). The three sites were analysed separately, then the space-time patterns were compared and discussed with social relations together.

2.4 Introduce the selected sites

Site 1 is situated in Xishi street (Guangming Hutong). Figure 1 shows the spatial fabric, settings and observation area. The spatial fabric represents a high-density residential area and a feature of shortcut. There are two influential amenities around the selected site – 93 Market and Suihua People’s Hospital. The market engages numerous vendors (e.g. farmers and peasants) and pedestrians. The selected observation point is in the middle of the alley (i.e. a less integrated and narrow road), with

less vehicle movement but a higher pedestrian flow. According to the latest master plan (2012-2030) in Suihua, the alley will be removed in the future.

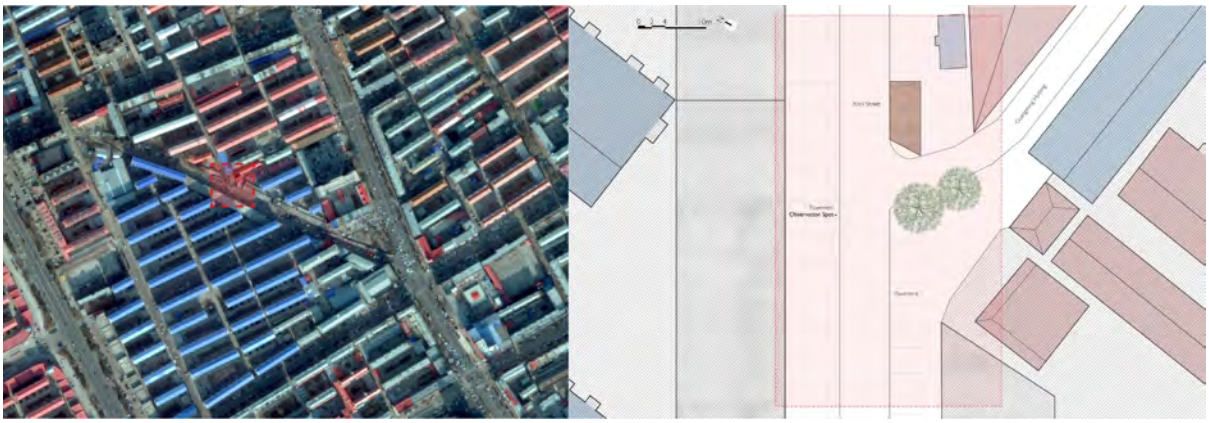

Figure 1: Urban fabric and spatial settings at Site 1, Suihua

Site 2 is situated in Guangsheng Street. Figure 2 shows the fabric, settings and observation area. The spatial fabric represents a high-density residential area, but a main street feature (i.e. a wider pavement with a roadway). There are many street vendors and pedestrians. The selected observation point is in front of the school and focusing on the corner (i.e. around the intersection). In addition, this site might attract many games players together (e.g. poker or Chinese chess).

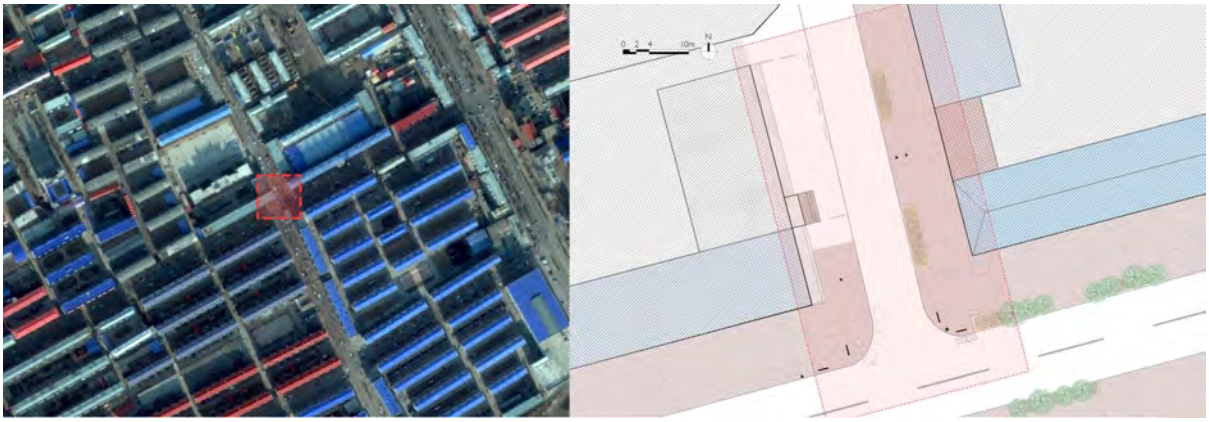

Figure 2: Urban fabric and spatial settings at Site 2, Suihua

Site 3 is situated in Zhifu Street. Figure 3 shows the fabric, settings and observation area. The spatial fabric also represents a high-density residential area and a secondary street feature (i.e. an inconsistent/incomplete pavement and relatively wide roadway). The selected observation point is in the middle of the street (i.e. a relatively less integrated area). Due to the abundant street vendors having appropriated the pavement in various ways, vehicle movement and pedestrian flow are mixed on the roadway.

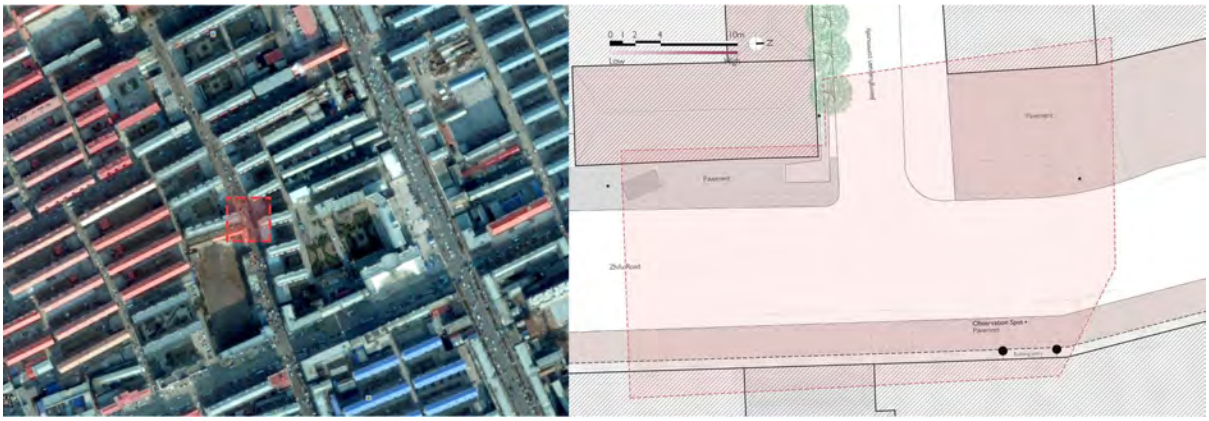

Figure 3: Urban fabric and spatial settings at Site 3, Suihua

3. Results

3.1 Variety of everyday street activities

Table 1 shows twenty-six activities within five layers at the three sites. It illustrates how the proportions, gender, and workweek/weekend means of the everyday activities differed in the streets. At Site 1, the gender distribution was female (3443) and male (2356). At Site 2, the gender distribution was female (1768) and male (3581). At Site 3, the gender distribution was female (2933) and male (2396).

The common behaviour layer demonstrated that walking was the most common activity at the three sites. *At Site 1*, the proportions in order (Walking, Cycling, Standing and Sitting) were 39.9%, 6.5%, 5.1% and 1.0%. While walking and standing females were higher, sitting and cycling females were lower. At weekends the mean of walking decreased, but that of other three activities increased. *At Site 2*, the proportions in order (Walking, Standing, Sitting and Cycling) were 27.9%, 15.8%, 7.6% and 7.4%. All females in this layer were lower. At weekend all four activities unexpectedly decreased. *At Site 3*, the proportions in order (Walking, Cycling, Standing and Sitting) were 26.8%, 9.6%, 4.3% and 3.0%. While walking females were obviously higher, cycling and sitting females were lower. At weekends the changes of walking, standing and sitting were slightly, but the mean of cycling decreased.

The selling and buying layers showed paired activities, and female buyers were generally higher. *At Site 1*, the paired activities selling/buying vegetable (19.0% and 11.8%) as well as fruit (7.8% and 4.3%) were higher in this layer. At weekends, selling/buying vegetable and fruit increased remarkably. *At Site 2*, apart from the fruit vendors/buyers, others were lower compared to Sites 1 and 3. At weekends, there were no significant changes. *At Site 3*, the paired activities selling/buying cooked food (13.2% and 8.7%) as well as vegetable (11.0% and 8.2%) were prominent. At weekends vegetable and sundry vendors increased and others decreased.

The specific population layer identified different occupations who possibly emerged in urban public spaces. At the three sites, the cleaner proportions were the highest (0.6%, 0.3% and 0.2%) and all delivery people were male. The specific behaviour layer identified the higher proportions of adults walking with children were 0.8%, 0.5% and 2.9%. The number of girls walking with adults was

obviously higher than of boys. Compared to Sites 1 and 3, males playing at Site 2 was extremely noteworthy and its mean was higher at weekends.

Table 1 Activities performed at the three sites in male/female number, mean during workweek/weekend and total percentage (abbr. V-vending & B-buying)

Activities	Site1						Site2						Site3					
	Male	Female	Weekday M	Weekend M	Total	%	Male	Female	Weekday M	Weekend M	Total	%	Male	Female	Weekday M	Weekend M	Total	%
Selling Layer																		
Food v	1	7	1.4	0.5	8	0.1	36	48	7.6	23	84	1.6	286	420	110.4	77	706	13.2
Fruit v	157	296	48	106.5	453	7.8	119	65	26.8	25	184	3.4	14	40	10.8	0	54	1.0
Veg v	382	718	154.4	164	1100	19.0	44	38	13	8.5	82	1.5	296	290	79.6	94	586	11.0
Sundry v	22	46	12.6	2.5	68	1.2	7	38	5.8	8	45	0.8	174	74	35.2	36	248	4.7
Service v	1	1	0	1	2	0.0	27	2	3.6	5.5	29	0.5	0	0	0	0	0	0.0
Meat v	4	1	0.2	2	5	0.1	18	22	6.8	3	40	0.7	0	0	0	0	0	0.0
Buying Layer																		
B food	17	27	3.2	14	44	0.8	19	14	3.8	7	33	0.6	188	275	78.4	35.5	463	8.7
B fruit	96	153	29.6	50.5	249	4.3	46	67	18	11.5	113	2.1	22	76	19.6	0	98	1.8
B veg	213	473	80.4	142	686	11.8	34	66	15.6	11	100	1.9	132	307	68.2	49	439	8.2
B sundry	21	24	8	2.5	45	0.8	4	14	3	1.5	18	0.3	69	106	30.4	11.5	175	3.3
B meat	1	0	0.2	0	1	0.0	15	10	4.2	2	25	0.5	4	7	2.2	0	11	0.2
B service	0	0	0	0	0	0.0	6	2	0.4	3	8	0.1	0	0	0	0	0	0.0
Specific People Layer																		
Cleaner	21	15	3	10.5	36	0.6	6	8	2.8	0	14	0.3	6	7	1.8	2	13	0.2
Delivery	6	0	0.4	2	6	0.1	5	0	0.8	0.5	5	0.1	4	0	0.8	0	4	0.1
Police	1	0	0.2	0	1	0.0	1	0	0.2	0	1	0.0	8	0	1.2	1	8	0.2
Manager	0	0	0	0	0	0.0	0	0	0	0	0	0.0	1	0	0.2	0	1	0.0
Flyer	0	0	0	0	0	0.0	0	0	0	0	0	0.0	2	0	0.4	0	2	0.0
Wheelchair	0	1	0	0.5	1	0.0	0	0	0	0		0.0	0	0	0	0	0	0.0
Specific Behaviour Layer																		
Child playing	1	0	0.2	0	1	0.0	1	4	1	0	5	0.1	16	14	5.6	1	30	0.6
Child walking	13	31	5	9.5	44	0.8	7	19	5.2	0	26	0.5	48	107	28.8	5.5	155	2.9
Adult playing	0	0	0	0	0	0.0	1241	149	164.8	283	1390	26.0	0	0	0	0	0	0.0
Dog walking	2	3	0.4	1.5	5	0.1	2	0	0.4	0	2	0.0	2	5	1.2	0.5	7	0.1
Common Behaviour Layer																		
Walking	984	1329	357.6	262.5	2313	39.9	754	741	227.2	179.5	1495	27.9	605	825	201.4	211.5	1430	26.8
Standing	123	175	38.4	53	298	5.1	642	205	139.8	74	847	15.8	117	112	32.4	33.5	229	4.3
Sitting	38	19	5.6	14.5	57	1.0	286	122	66.2	38.5	408	7.6	96	62	22	24	158	3.0
Cycling	252	124	44.4	77	376	6.5	261	134	66	32.5	395	7.4	306	206	79.8	56.5	512	9.6
Total	**2356**	**3443**	**793.2**	**916.5**	**5799**	**100**	**3581**	**1768**	**783**	**717**	**5349**	**100**	**2396**	**2933**	**810.4**	**638.5**	**5329**	**100**

3.2 Temporal vendors and pedestrians in numbers

Table 2 shows the observation period, temperature, proportion of people, correlation and number of street vendors and non-vendors (i.e. various pedestrians) during the four periods at the three sites. The lowest average temperature was 20.6 ℃ (a range of 18-23℃) at 07.00-08.00. The highest average temperature was 24.3℃ (a range of 21-27℃) at 16.00-17.00.

At Site 1, the highest proportion (32.1%) was at 07.00-08.00 and the lowest proportion (15.2%) was at 18.30-19.30. The correlations between street vendors and pedestrians during the four periods were strong and fluctuated slightly - the weakest (2.9) was at 18.30-19.30 and the strongest (2.2) was at 11.00-12.00. *At Site 2*, the highest proportion (37.7%) was at 16.00-17.00 and the lowest proportion (19.1%) was at 07.00-08.00. The correlations were generally week - the weakest (17.1) was at 18.30-19.30 and the strongest (6.3) at 11.00-12.00. *At Site 3*, the highest proportion (39.4%) was at 16.00-

17.00. The lowest proportion (16.6%) was at 07.00-08.00. The correlations fluctuated slightly - the weakest (3.0) was at 07.00-08.00 and the strongest (2.1) was at 16.00-17.00.

Table 2 Period of observation, number of days, times, temperatures, total people, vendors and non-vendors

Period of this study	24th -30th July 2017			
Time of day	7.00-8.00	11.00-12.00	16.00-17.00	18.30-19.30
Temperature (M/Range)	20.6℃/18-23℃	23.3℃/21-27℃	24.3℃/21-27℃	21.1℃/18-24℃
Site 1 (N=5799) %	32.1	24.6	28.0	15.2
Site 1 Correlations V/N	2.7	2.2	2.6	2.9
Site 1 Vendors/Non-vendors	505/1358	447/982	457/1166	227/657
Site 2 (N=5349) %	19.1	19.6	37.7	23.7
Site 2 Correlations V/N	8.4	6.3	13.1	17.1
Site 2 Vendors/Non-vendors	108/911	143/903	143/1871	70/1200
Site 3 (N=5329) %	16.6	22.1	39.4	21.8
Site 3 Correlations V/N	3.0	2.2	2.1	2.7
Site 3 Vendors/Non-vendors	224/663	364/815	677/1422	317/847

** Special weather: Rain 7.27 7.00-8.00, Cloud 7.26 whole day & 7.27 11.00-12.00*

4. Discussion

Returning to the two research questions in this study, the first question has been answered through the activity filtering method (i.e. twenty-six street activities within five layers at four periods of the day in three urban street spaces). Based on the specific activities, sites' characteristics and periods, the answer to the second question is multifaceted. Examination of the space-time patterns across the three sites revealed two crucial co-operations of environmental affordances (Gibson 1986) and socio-spatial practices (Lefebvre 1991) at different times and sites. The findings are further discussed at specific sites.

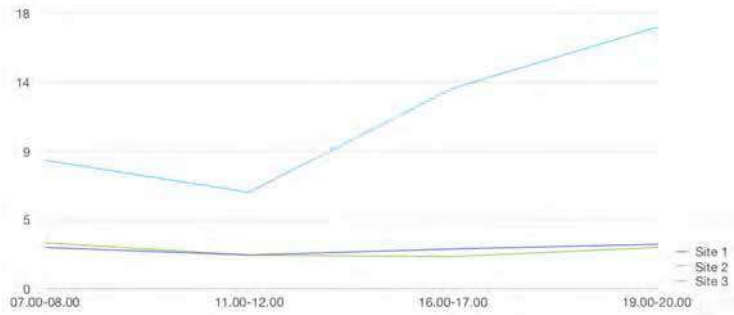

Figure 4: Correlations between vendors and non-vendors at four period of the day

Site 1, an alley connecting a popular market and hospital in the city centre, could engage many pedestrians. In this sense, the walkable environmental characteristic was less influenced, such as the thermal comfort and street design (Ewing et al. 2009, Gehl 2010, Speack 2013). Based on the field observation, the market generated numerous people in the early morning since 04.00, leading to the highest percentage of people at 07.00-08.00. Compared to the two periods of 11.00-12.00 and 16.00-17.00 (i.e. the comfortable temperature), the numbers of street vendors were similar, but the number of pedestrians dramatically increased in the afternoon during the recreational time. Also, at weekends, the number of people increased obviously (Table 1). However, at the recreational period of 18.30-

19.30, the cold temperature might result in the lowest number of pedestrians. After a whole-day selling, the vendors decreased dramatically, leading to the weakest correlation in the evening.

Site 2, an intersection connecting central urban areas, has a high accessibility (Figure 2). However, this space overlapped with another system of older people playing (Table 1), unlike Sites 1 and 3. As such, the correlations between vendors and non-vendors were significantly weak (Figure 4). The temperature and street elements play a significant role to influence when people occur and where they stay. For example, the percentage of adult playing (26%) was high (Table 1) and many pedestrians emerged during the recreational periods, particularly at 16.00-17.00 with a comfortable temperature (Table 2). Compared to Sites 1 and 3, this reveals two distinct systems (i.e. vending-walking space and playing-walking space), producing different walking behaviours and socio-spatial meanings in Chinese urban streets, which deserves to be further studied.

Site 3 is situated in an ordinary residential neighbourhood connecting central urban areas. The correlations between vendors and pedestrians were strong during the four periods, similar to Site 1. Due to this area does not have a market, the pedestrians were hurried to go to work or school and most vendors did not appear yet in the early morning, unlike Site 1. However, the highest and lowest percentages of people at different periods were similar to Site 2 (Figure 5), closely related to the two periods of the highest and lowest temperature (Table 2).

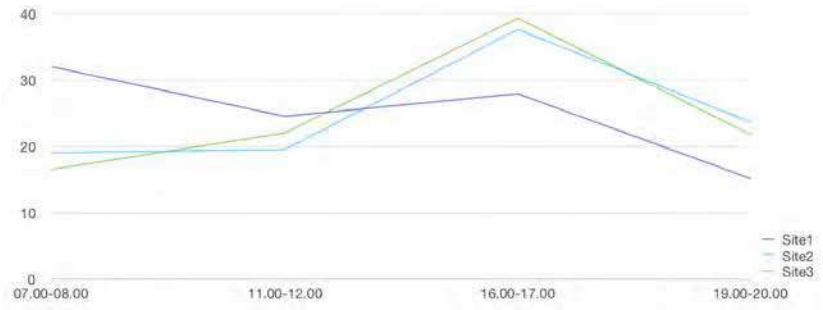

Figure 5: Changing proportions during four periods of the day at the three sites

Returning to the gender equity of everyday activities (Jensen et al. 2017), this study shows the "real life" in Chinese street space. Other studies have considered walking and cycling together as a mode of active travel (e.g. Saelens et al. 2003, Giles-Corti et al. 2005). The results show that walking females and female buyers were statistically high at Sites 1 and 3, as they still generally take care of their family. At Site 2, the number of male playing was extremely high, indicating a different family role. The most important result is that girls tended to be more linked to their guardian's short-term movement at an intimate distance (Hall 1966, Gehl 2010) at the three sites, revealing that gender behaviours in Chinese public street space have been unconsciously formed since childhood.

5. Conclusions

This study has three main contributions. First, most previous studies show that neighbourhood walkability (determined by population density, land use diversity and street connectivity) significantly impacts physical activities. However, this study further explored the two co-operations of environmental affordances and socio-spatial practices at specific street spaces and times. Second, this

study distinguished different walking behaviours and time-related variations between the market street (Site 1) and everyday street (i.e. Sites 2 and 3). For instance, the numbers of urban pedestrian unexpectedly decreased during the recreational times (i.e. weekends and evenings) in the ordinary streets. Third, the correlations between street vendors and pedestrians existed and simultaneously changed at different periods (i.e. Sites 1 and 3). Although the correlations at Site 2 differed, this provided another system about adults playing.

This study shows how the detail of dynamic street activities was temporally related to environmental affordance, temperature variation, human feature and time characteristics. In short, the method incorporates both social and physical elements to provide a fine-grained picture of Chinese street activities, going beyond a general narrative of street vending itself or common studies on walkability, towards a precise empirical study in specific urban spaces at specific times. Although all three street spaces in Suihua are walkable, the socio-spatial practices differ, producing distinct walking behaviours and space-time meanings. This is a dynamic system of spatial uses and social practices, which possibly operates at all urban scales from the city to the street corner, recalibrating urban street spaces at different times of the day and night. This recalibration itself was also dynamic according to ever-changing or alternate demands of emerging pedestrians, and nuanced by development situations of a neighbourhood, commuting or recreational periods. Street vendors occupy marginal street spaces as transient and mobile amenities that could dynamically improve walkability via heterogeneous tactics of mixed land use.

Acknowledgements

This research has been fully funded by the China Scholarship Council (No.201608060149) and supported by the Tweedie Exploration Fellowship, Henry Lester Trust and Great Britain-China Educational Trust. I would like to thank Simon Bell, Iain Scott, Chengrun Li, Xi Chen, Junchao Qian and the 9 workshop participants who contributed fruitful discussions and/or parts of the GIS database in this study. I would also like to express my gratitude to Yang Yu, Ruyue Zhao and the 13 students at Harbin Institute of Technology who supported this methodology development in the early stage.

References

Brookfield, K., Ward Thompson, C., & Scott, I., 2017, The uncommon impact of common environmental details on walking in older adults. *International Journal of Environmental Research and Public Health*, 14(2).

Cerin, E., Conway, T. L., Cain, K. L., Kerr, J., De Bourdeaudhuij, I., Owen, N., . . . Sallis, J. F., 2013, Sharing good NEWS across the world: developing comparable scores across 12 countries for the Neighborhood Environment Walkability Scale (NEWS). *BMC Public Health, 13*, 309.

Chinese Academy of Sciences, 2009, *Technology Revolution and Chinese Modernity: Reflections on Technology Development Strategy in terms of China 2050*, Science Press, Beijing

Duncan, G. E., Cash, S. W., Horn, E. E., & Turkheimer, E., 2015, Quasi-causal associations of physical activity and neighborhood walkability with body mass index: a twin study. *Prev Med, 70*, 90-95.

ESRI: ArcView Software.

Ewing, R., & Handy, S., 2009, Measuring the Unmeasurable: Urban Design Qualities Related to Walkability. *Journal of Urban Design*, 14(1), 65-84.

Fan, P., Park, H., Wan, G., Xu, L., Xie, Y., Liu, Y., Yue, W., ... Chen, J., 2018, Walkability in urban landscapes: a comparative study of four large cities in China. *Landscape Ecology, 33*, 2, 323-340.

Flock, R., & Breitung, W., 2016, Migrant Street Vendors in Urban China and the Social Production of Public Space. *PSP Population, Space and Place*, 22(2), 158-169.

Frank, L. D., Sallis, J. F., Saelens, B. E., Leary, L., Cain, K., Conway, T. L., & Hess, P. M., 2010, The development of a walkability index: application to the Neighborhood Quality of Life Study. *Br J Sports Med,* 44(13), 924-933.

Gehl, J., 2010, *Cities for people*. Washington: Washington: Island Press.

Ghavampour, E., Del, A. M., & Vale, B., 2017, GIS mapping and analysis of behaviour in small urban public spaces. *Area, 49*, 3, 349-358.

Gibson, J. J., 1986, *The Ecological Approach to Visual Perception*. Lawrence Erlbaum Associates, Hillsdale, NJ.

Giles-Corti, B., Timperio, A., Bull, F., & Pikora, T, 2005, Understanding physical activity environmental correlates: increased specificity for ecological models. *Exercise and sport sciences reviews,* 33(4), 175-181.

Goličnik, B., & Ward, T. C., 2010, Emerging relationships between design and use of urban park spaces. *Landscape and Urban Planning, 94,* 1, 38-53.

Hall, E.T., 1966, *The Hidden Dimension: Man's Use of Space in Public and Private*. Bodley Head, London.

Heft, H., 2010, Affordances and the perception of landscape: an inquiry into environmental perception and aesthetics. In Thompson, C. W., Bell, S., & Aspinall, P. (Eds.), *Innovative Approaches to Researching Landscape and Health*. Hoboken: Taylor & Francis.

Hillier, B., Penn, A., Hanson, J., Grajewski, T., & Xu, J., 1993, Natural movement: or, configuration and attraction in urban pedestrian movement. *Environment and Planning B: Planning and Design*, 20, 1, 29-66.

Huang, G., Xue, D., & Li, Z., 2014, From Revanchism to Ambivalence: The Changing Politics of Street Vending in Guangzhou. *ANTI Antipode*, 46(1), 170-189.

Jacobs, J., 1961, *The death and life of great American cities*. Penguin Art & Architecture.

Kashef, M., 2011, Walkability and residential suburbs: A multidisciplinary perspective. *Journal of Urbanism, 4,* 1, 39-56.

Koohsari, M. J., Sugiyama, T., Mavoa, S., Villanueva, K., Badland, H., Giles-Corti, B., & Owen, N., 2016, Street network measures and adults' walking for transport: Application of space syntax. *Health and Place, 38*, 89-95.

Lefebvre, H., 1991, *The production of space*. Oxford, UK: Blackwell.

Lo, R. H., 2009, Walkability: what is it? *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 2(2), 145-166.

Mehta, V., 2008, Walkable streets: pedestrian behavior, perceptions and attitudes. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, 1(3), 217-245.

Saelens, B. E., Sallis, J. F., & Frank, L. D., 2003, Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. *Annals of Behavioral Medicine*, 25(2), 80-91.

Speck, J., 2013, *Walkable city: How downtown can save America, one step at a time*. New York: North Point Press.

Su, S., Pi, J., Xie, H., Cai, Z., & Weng, M., 2017, Community deprivation, walkability, and public health: Highlighting the social inequalities in land use planning for health promotion. *Land Use Policy, 67,* 315-326.

Sun, Z., Bell, S., & Scott, I., 2016, How Does Street Vending Contribute to Walkability? A report on a study in Suihua, China. *E-BPJ Environment-Behaviour Proceedings Journal*, 1(4), 203-213.

Sun, Z., Bell, S., Scott, I. & Qian, J., 2019, Everyday use of urban street spaces: the spatio-temporal relation between pedestrians and street vendors in Yuncheng, China. A working paper.

Sun, Z., Liu, C., & Kong, W., 2015, The Study of Walk Score and its Enlightenment in China: Based on the International Research Development, *Chinese Annual National Planning Conference Proceedings*, 4(11), 2015:12.

Unt, A.-L., & Bell, S., 2014, The impact of small-scale design interventions on the behaviour patterns of the users of an urban wasteland. *Urban Forestry & Urban Greening, 13,* 1, 121-135.

Xue, D., & Huang, G., 2015, Informality and the state's ambivalence in the regulation of street vending in transforming Guangzhou, China. *Geoforum, 62,* 156-165.

Zhou, Y., & Long, Y., 2017, Large-scale Evaluation for Street Walkability: Methodological Improvements and the Empirical Application in Chengdu, *Shanghai Urban Planning Review*, (01):88-93.