

## A Study on Influence of Traffic Conditions on Functions of Open Grounds in Residential Quarters

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**Keywords:** residential quarter, open ground, traffic, functions

**Abstract.** This paper takes some of open grounds in such typical urban residential quarters as HuaQingJiaYuan, FuRunJiaYuan, and GuoDianHuaYuan in Beijing as object of study. At-site survey was conducted based on theories and methods of environmental behavior studies, involving classification of users and activities, and detailed recording of user groups' behaviors by means of counting and photo taking. On basis of such, functions and utilization of open grounds were summarized for in-depth analysis of the relation between the traffic model and frequency of activities taken place. And the influence of such relation on utilization of open grounds is concluded, which is expected to guide the designing of open grounds in residential quarters.

### Background and objectives of study

Open grounds in residential quarters often witness poor utilization, which in general is attributed to the natural environment, security issues, and traffic conditions. Such defects, particularly those could be improved by designing, urge feasible solutions to solve practical issues.

This study, by conducting survey, analysis, and summarization to typical cases of open grounds in residential quarters and by adopting environmental behavior theories, aims to deeply discuss how the relation between outdoor environmental spaces and connected roads influences utilization of such open grounds, hoping to render referential information for open ground designing in residential quarters.

### Summary of survey

**Date, weather upon survey.** Dec. 16, 2013, 6/-7°C; Apr. 28, 2014, 26/9°C; July 12, 2013, 30/22°C

**Site involved.** Site: HuaQingJiaYuan, Chengfu Road, Haidian District; FuRunJiaYuan, Xueyuan Road, Haidian District; GuoDianHuaYuan, Anding Road, Chaoyang District, Beijing. Open grounds involved are given a number (see Fig.1).

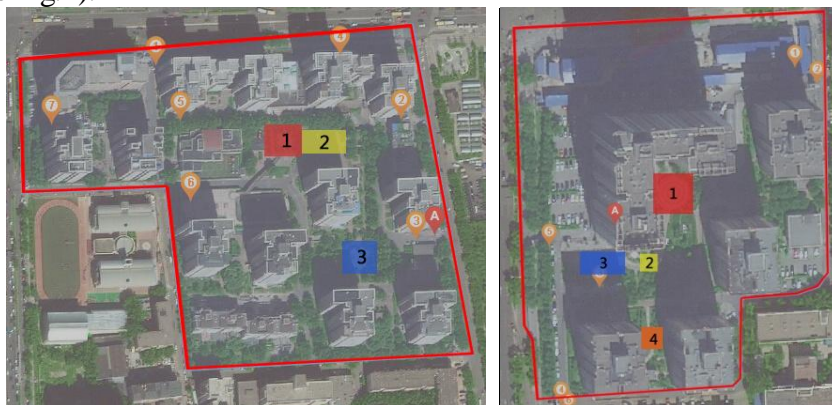


Fig.1-a: Overview of location, HuaQingJiaYuan Fig.1-b: Overview of location, FuRunJiaYuan

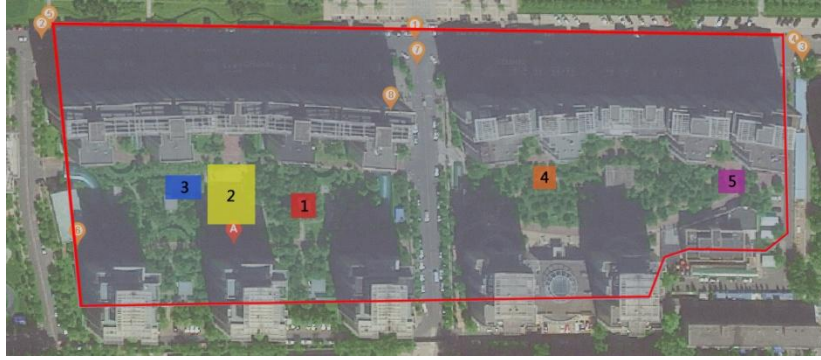


Fig.1-c: Overview of location, GuoDianHuaYuan

**Objects involved.** participants of outdoor activities in two residential quarters, traffic space characteristics, and the design of open ground where outdoor activities take place.

**Methods adopted.** observation and counting. Observation is conducted to outdoor activities taking place in selected open grounds, with records made and photos shot once every hour from 7:00 to 19:00.

**Items involved.** types of outdoor activities (i.e. functions), traffic space layout, and utilization of open grounds.

## Status quo and analysis of traffic conditions and functions of sites

### HuaQingJiaYuan.

**Traffic conditions at sites (see Fig.2).**



Fig.2-a: Traffic conditions at Site 1



Fig. 2-b: Traffic conditions at Site 2



Fig.2-c: Traffic conditions at Site 3



Fig.3-a: Traffic spatial relation at Site 1

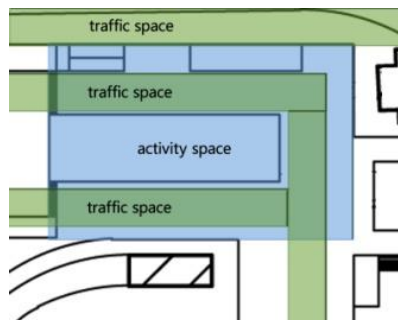


Fig.3-b: Traffic spatial relation at Site 2

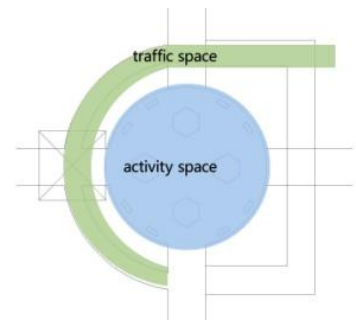


Fig.3-c: Traffic spatial relation at Site 3

Fig.3: Traffic spatial relation at sites in HuaQingJiaYuan

Site 1 is located by the main traffic of the residential quarter and features a different elevation from the surrounding. As it connects to a children playground to the west and roads on each side, it is a relatively open space. The relation between activity space and traffic space is one connects to the other.

Site 2 connects to Site 1 and is located on the east side of Site 1. It appears narrow and long, with a pool at its center as scenic spot, and east and west sides serve as traffic areas. Though Site 2 is also located by the main road, stream of people inside accounts for the leading traffic due to its space layout. The relation between activity space and traffic space is one intersects the other.

Site 3 looks round. Enclosed by pergolas and low walls, it is conspicuously an introversive space. Traffic encircles the ground, mainly the north and west sides. The relation between activity space and traffic space is one connects to the other.

**Functions of sites.** Various activities taking place while at-site survey and respective percentage points thereof are presented below (see Fig. 4)



Fig.4: Proportion of respective activities at sites in HuaQingJiaYuan

It can be observed, from the above figures, that:

Activities taking place at Site 1 are mainly body-building and exercising (accounting for 75% as surveyed). This site is a relatively complete space. It attracts participants by roads yet won't be divided into smaller spaces by stream of people, hence enjoys a higher utilization rate.

Site 2 is engaged in sight-seeing. Passing by, making phone-calls, and others happen the most (accounting for 34% as surveyed). However, common activities such as body-building, exercising, looking after kids, resting and chatting fail to play a leading role here. It is the west-to-east cutting-through traffic layout in this scenery space that seriously affects utilization of the ground.

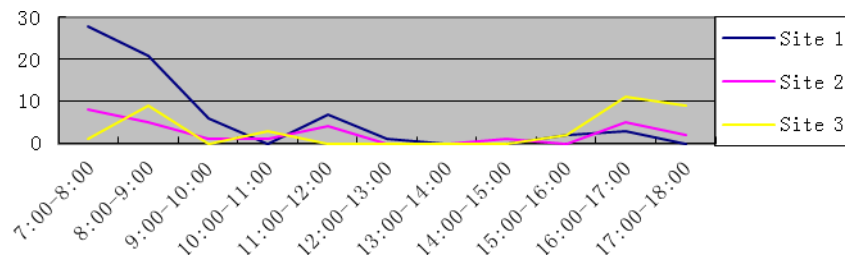
At Site 3, an enclosed space, body-building and exercising are dominating activities (accounting for 48% as surveyed), followed by resting and chatting (accounting for 26% as surveyed). There are sufficient facilities for resting, but only those located along the ground edges attract most of the users, leaving benches around tree beds inside and chairs under pergolas outside the ground poorly occupied. This, in addition to fringe effect, could be attributed to stream of people by way of the pergolas connected to roads, which affects people's activities.

Table 1 Traffic Information of Sites in HuaQingJiaYuan

Space No.	Relation between main road and site	Influence of road on site	Width of road connected to site
Site 1	One connects to the other	Minor	3m
Site 2	One intersects the other	Serious	3m
Site 3	One connects to the other	Moderate	1.5m

Spatial relation between Site 1 and roads is one connects to the other, which means activity space closely neighbors roads. Such relation allows the ground to become open and attractive, to some extent, to participants. Although Site 1 witnesses passing-by stream of people, mainly from children playground and Site 2, outside stream of people creates minor influence on Site 1 as it usually runs into the main road by cutting through south part of the Site. Therefore body-building and exercising are allowed. Spatial relation between Site 2 and roads is one intersects the other. As the roads run through the space, they constitute part of its pavement. This relation potentially increases stream of people and, at the same time, such openness creates the major influence on activities. Therefore, activities are diversified, such as making phone calls. Surrounded by a road for main traffic, Site 3 is basically free from passing-by stream of people to allow normal activities such as looking after kids, resting, and chatting.

**Utilization rate of sites.** Utilization rate is calculated by the ratio of number of participants to area of ground, and is subject to statistical comparison.



Number of participants at sites surveyed varies with time, as the figure shows. It can be observed that in respect of this survey, Site 1 is the leading one of open grounds for outdoor activities among residents.

Table 2 Utilization Data of Sites in HuaQingJiaYuan

Space No.	Area of site (sq.m.)	Participants	Utilization rate
Site 1	500	68	0.136
Site 2	525	27	0.051
Site 3	113	35	0.310

From the Table above, it can be observed that Site 3 enjoys the highest utilization rate, followed by Site 1, leaving Site 2 with the lowest. And the relation between Site 1, 3 and roads is one connects to the other, while one intersects the other in the case of Site 2.

#### FuRunJiaYuan.

##### Traffic conditions at sites (see Fig.7).



Fig. 5-a: Site 1



Fig. 5-b: Site 2



Fig. 5-c: Site 3



Fig. 5-d: Site 4

Fig. 5: Traffic conditions of sites in FuRunJiaYuan

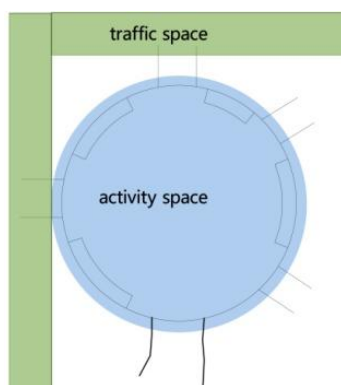


Fig. 6-a: Traffic relation at Site 1

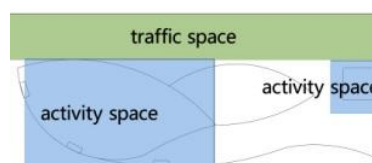


Fig. 6-b: Traffic relation at Site 2, 3

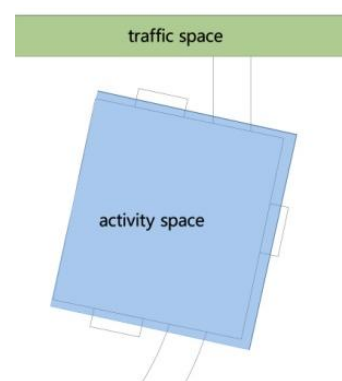


Fig. 6-c: Traffic relation at Site 4

Fig. 6 Traffic spatial relation at sites in FuRunJiaYuan

Site 1 is a round ground enclosed by an L-shaped tall building. This open space connects to several paths and neighbors main roads by its west and north sides. The relation between activity space and traffic space is one connects to the other.

Located in the south of Site 1, Site 2 is a space enclosed by rectangle pergolas. The north side neighbors main traffic, leaving limited space for activities. The relation between activity space and traffic space is one connects to the other.



Site 3 is a space featuring body-building facilities and children playground. It is open on east and west sides, closely neighbors a dry creek to the east, connects to a main road, and is distinguished from the surrounding by pavement. The relation between activity space and traffic space is one connects to the other.

Situated in the south of the residential quarter, Site 4 is a regular square-shaped space, and neighbors traffic to the south and north. It is about 3m away from the main road, where sight lines are never blocked by green plants. The relation between activity space and traffic space is one separates from the other.

#### Functions of sites.

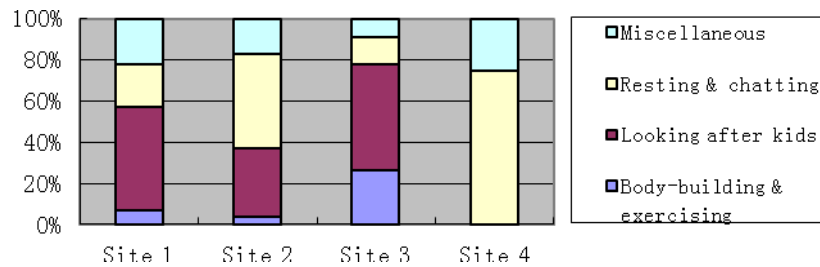


Fig.7: Proportion of respective activities at sites in FuRunJia Yuan

It can be observed, from the above figures, that:

At Site 1, looking after kids dominates (accounting for 50% as surveyed). A relatively enclosed and complete space creates favorable conditions for such activity.

Due to its limited space, Site 2 witnesses resting and chatting as leading activities (accounting for 46% as surveyed). It is not seriously influenced by traffic.

Activities taking place at Site 3 are mainly looking after kids (accounting for 51% as surveyed) and body-building and exercising (accounting for 27% as surveyed). The ground connects to an entrance, by which it attracts residents from the main road, and has no road leading to other spaces. It is a space simply for activities.

Resting and chatting constitute the majority of activities (accounting for 75% as surveyed) at Site 4. Such mono-style activity situation is mainly attributed to influence of traffic.

Table 3 Traffic Information of Sites in FuRunJia Yuan

Space No.	Relation between main road and site	Influence of road on site	Width of road connected to site
Site 1	One connects to the other	Moderate	3m
Site 2	One connects to the other	Moderate	3m
Site 3	One connects to the other	Moderate	5m
Site 4	One separates from the other	Minor	1.5m

The relation between Site 1 and road space is one connects to the other. This relation greatly increases stream of people. As the majority of activity participants occupies edges of the ground, stream of people creates minor influence on the space. Central part of the ground is suitable for kids to enjoy simple games such as riding and playing with toys. Similarly, Site 2 and Site 3 connect to a road. This not only attracts stream of people from the main road, but also leave activities inside unaffected. However, as a narrow space, Site 2 is only suitable for static activities such as resting. Site 3 is open to road space and connects to a children playground, therefore is good for looking after kids, body-building and exercising. The relation between Site 4 and road is one separates from the other. Such relation weakens its attractiveness to participants, and allows fewer people to linger. In addition, due to limited space, passing-by stream of people greatly affects utilization of the ground that it has become a traffic space, with limited functions.

**Utilization rate of sites.** As the figure shows, in respect of this survey, Site 1 is the leading one of open grounds for outdoor activities among residents. It can be observed that peaks happen at 11:00 and around 17:00, as a result of increased people who look after kids. They are parents to accompany kids at noon and those lingering here with their children after school in the afternoon. Besides, at noon, various sites witness

obviously decreased activities. Site 2 and Site 3 feature smooth changes in number of participants; Site 4 has very few participants.

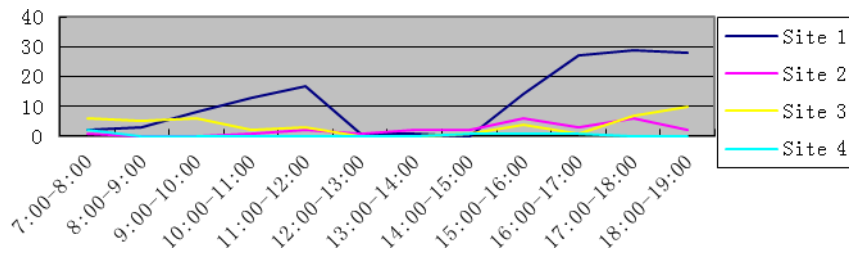


Table 4 Utilization Data of Sites in FuRunJiaYuan

Space No.	Area of site (sq.m.)	Participants	Utilization rate
Site 1	200	143	0.715
Site 2	16	26	1.625
Site 3	98	45	0.459
Site 4	45	5	0.111

It can be observed from the above table that Sites 1, 2 and 3, which connect to main road, enjoy a much higher utilization rate than Site 4, which separates from main road. The highest utilization rate happens to Site 2, which is believed to be attributed to its too small area.

#### GuoDianHuaYuan.

**Traffic conditions at sites (see Fig.8).**



Fig. 8-a: Site 1  
Fig.8 Traffic

Fig. 8-b: Site 2

Fig. 8-b: Site 3

Fig. 8-a: Site 4

Fig. 8-b: Site 5

conditions of sites in GuoDianHuaYuan

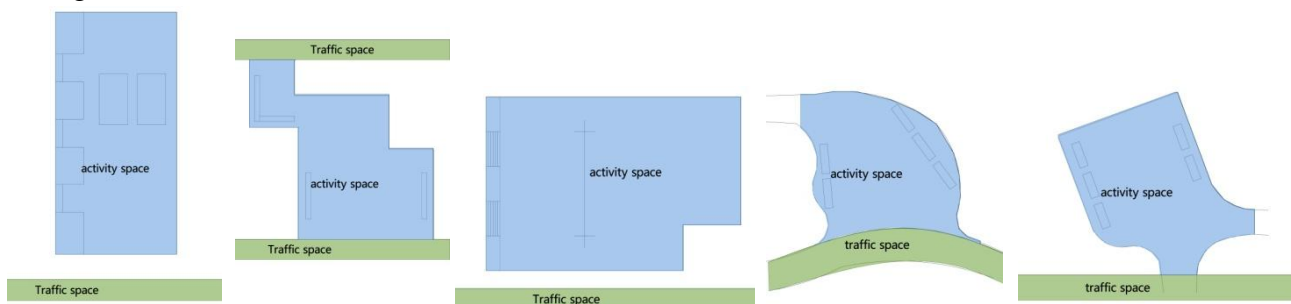


Fig. 9-a: Traffic relation at Site 1 Fig. 9-b: Traffic relation at Site 2 Fig. 9-c: Traffic relation at Site 3 Fig. 9-d: Traffic relation at Site 4 Fig. 9-e: Traffic relation at Site 5

Fig.9: Traffic spatial relation at sites in GuoDianHuaYuan

Site 1 has two table tennis tables inside. There is traffic in the north, and enclosure in the rest directions. It is a space for activities while enjoys favorable privacy. The relation between activity space and traffic space is one separates from the other. The ground is about 5m away from main road, with sigh lines blocked by green plants.

Site 2 is an open space for activities. There is traffic in the north and south. Body-building facilities are built along the boundary. The relation between activity space and traffic space is one connects to the other.

Dominated by badminton courts, Site 3 is mainly for body-building. There are flower beds and benches along the boundary, and a path runs from the west side to the traffic space in the south, creating high level of privacy. The relation between activity space and traffic space is one separates from the other.

Site 4 enjoys appropriate sizes, with benches deployed. There is traffic in the north and south. This ground appears comfortable while simple. The relation between activity space and traffic space is one connects to the other.

Site 5 connects to a pergola, with traffic mostly in the south as there is a kindergarten. Therefore the ground witness relatively large stream of people. It is about 5m away from main road, with sigh lines blocked by green plants.

### Functions of sites.

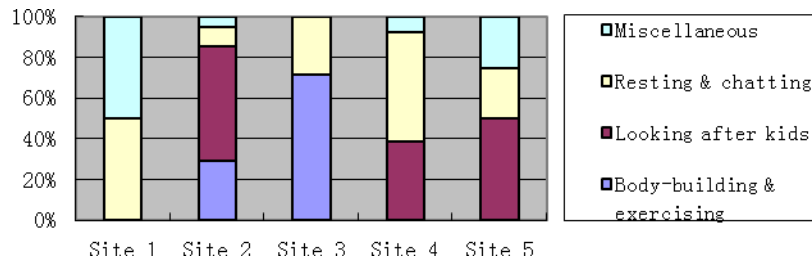


Fig.10 Proportion of respective activities at sites in GuoDianHuaYuan

It can be observed, from the above figures, that:

Site 1 witnesses very few participants and types of activity, which is conspicuously reflected by proportion figures.

Activities happen in Site 2 are mainly looking after kids (accounting for 56% as surveyed) and body-building and exercising (29%). The space is basically not influenced by traffic.

Body-building and exercising dominate Site 3, which could mainly be attributed to its functions defined by badminton courts.

Site 4 witnesses resting and chatting as leading activities (accounting for 54% as surveyed).

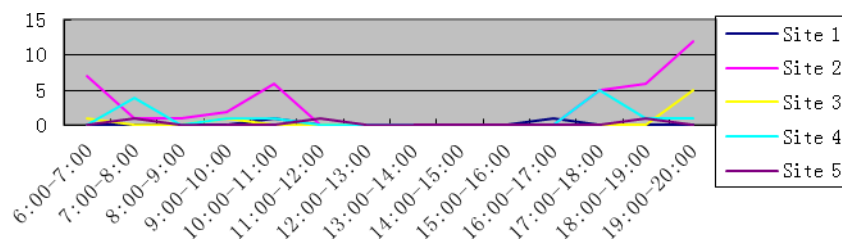
There are few participants and activity forms at Site 5. This could be caused by the kindergarten located in the south, as people going there usually pass by the ground to influence its utilization.

Table 5 Traffic Information of Sites in GuoDianHuaYuan

Space No.	Relation between main road and site	Influence of road on site	Width of road connected to site
Site 1	One separates from the other	Minor	3m
Site 2	One connects to the other	Moderate	3m
Site 3	One separates from the other	Minor	3m
Site 4	One connects to the other	Moderate	3m
Site 5	One connects to the other	Moderate	3m

Spatial relation between Site 1, 3 and road is one separates from the other. This could be attributed to defined functions of the ground: Site 1 serves as table tennis courts, Site 3 badminton courts. To minimize influence from outside, such traffic model was adopted. However, with very few participants and activity forms, these sites witness poor utilization rate. Spatial relation between Site 2 and roads is one connects to the other, with traffic in the south connected to that in the north to create even greater openness. Site 4, 5 also connect to road, while Site 5 neighbors a kindergarten in the south that passing-by people influences to some extent utilization of the ground. Therefore Site 4 enjoys a higher utilization rate than Site 5.

### Utilization rate of sites.



Number of participants at sites surveyed varies with time, as the figure shows. It can be observed that in respect of this survey, Site 2 is the leading one of open grounds for outdoor activities among residents.

Table 6 Utilization Data of Sites in GuoDianHuaYuan

Space No.	Area of site (sq.m.)	Number of participants	Utilization rate
Site 1	85	2	0.024
Site 2	139	40	0.288
Site 3	64	7	0.109
Site 4	36	13	0.361
Site 5	38	3	0.079

From the above Table, it can be observed that Site 4 enjoys the highest utilization rate, followed by Site 2. The relation between Site 2, 4 and 5, respectively, and main road(s) is one connects to the other, while that between Site 1, 3, respectively, and main road is one separates from the other.

### Comparison among all sites in terms of traffic and utilization

Table 7 Summary of Traffic and Utilization of Sites Surveyed

Site	Relation between main road and site	Distance between main road and site	Sight-line blocking (by green plants or scenery creation)	Utilization rate
Fu 2	One connects to the other	0	No	1.625
Fu 1	One connects to the other	0	No	0.715
Fu 3	One connects to the other	0	No	0.459
Guo 4	One connects to the other	0	No	0.361
Hua 3	One connects to the other	0	Yes	0.310
Guo 2	One connects to the other	0	No	0.288
Hua 1	One connects to the other	0	Yes	0.136
Fu 4	One separates from the other	3m	No	0.111
Guo 3	One separates from the other	5m	Yes	0.109
Guo 5	One connects to the other	0	No	0.079
Hua 2	One intersects the other	0	No	0.051
Guo 1	One separates from the other	5m	Yes	0.024

All sites involved in the survey are ranked by utilization rate from the highest to the lowest, as presented in Table 7. By analytical comparison, it can be observed that utilization rate could be influenced by the relation between site and road and by the sight-line exchange.

Where the relation is one connects to the other, the utilization rate is generally higher than the case of one separates from the other. This relation features flexibility, as roads attract stream of people yet the latter won't create much influence on activities in the ground. Where the site separates from main road while the distance is short, the result is similar to the case of one connects to the other, which means the ground remains open to certain extent. Where the site separates from main road while the distance is long, and there is no sight-line blocking between, then the site enjoys higher level of openness than privacy, with a higher utilization rate than



the case of one separates from the other while the distance is long in addition to sight-line blocking by green plants or scenery creations. In this survey, there are not many cases of the site intersected by road. Such relation is usually seen at central scenery spots but rarely at other open grounds, as main road intersecting open ground would effectively increase stream of people, yet at the same time create adverse influence on activities.

From an overall point of view, most of sites in FuRunJiaYuan connect to main road, therefore enjoy a higher utilization rate than those in HuaQingJiaYuan and GuoDianHuaYuan.

## Conclusion

As concluded from the survey, the relation between main road and site mainly comes in three styles as follows: **Main traffic connects to activity space – connected model (see Fig. 11-a).** This model is the most ideal model. On one hand, passers-by enjoy favorable sight-line exchange with those having activities, that the site features publicness and openness; on the other hand, either the road and the site has its own independent space, that the ground owns its territory while traffic creates no influence on activities inside the ground. Where main road separates from the ground and the distance between them is short, similar results are gained. Where the distance is long without sight-line blocking, the utilization rate is still higher than the case of long distance with blocking.

**Main traffic runs through activity space – intersected model (see Fig.11-b).** In the case of this model, traffic flow of residents usually runs through activity ground. On one hand, the road and the ground share common space, that such ground enjoys the best publicness and openness to attract more participants; on the other hand, the ground is poor in sense of territory, as the intersected traffic interferes to some extent utilization of the ground, resulting in a moderate utilization rate. This model is only suitable for large-sized while small traffic cases. For small-sized spaces, it is possible that the ground would simply become a traffic space.

**Main traffic separates from activity space – separated model (see Fig. 11-c).** Under this model, as the ground is far from main road, and there are green plant barriers between, the ground enjoys complete territory while suffers poor publicness and openness. Such sense of privacy means lack of exchange with outside and creates feeling of insecurity, which does not conform to people's psychological expectations in public areas. Therefore low utilization rate is seen. This model is most unsuitable for multi-functional outdoor activity space construction.

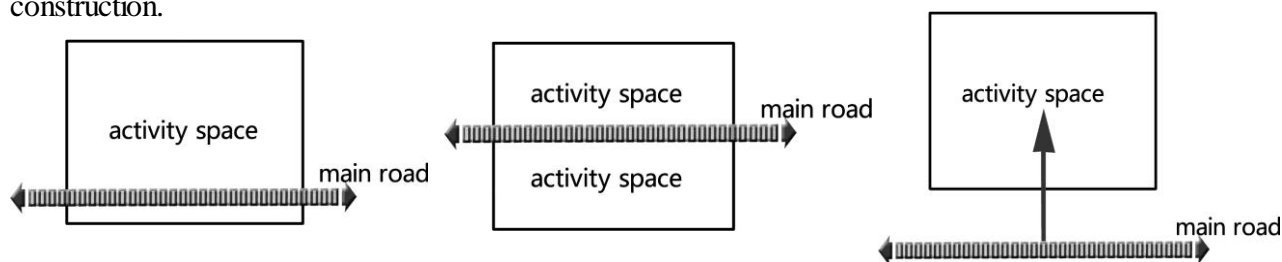


Fig.11-a Connected model

Fig.11-b Intersected model

Fig. 11-c Separated model

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