



Shelter planning based on self-saving concepts in urban residential districts

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ABSTRACT

With increasing population density in Asia, the potential higher risk was resulted from the residential districts with the higher plot ratio, especially in some megapolis (eg. Beijing and Shanghai). Presently it is more difficult for the rescue operation during the disasters because of the decreasing safe space among the buildings as a result of higher buildings and denser the district. Thus, an immediate self-saving action is more important than before during the disaster in the residential districts, and its realization depends on the reasonable shelter planning and its management system. In this study, the factors related to the self-saving were analyzed and concluded by the related the literatures retrieval and case study, and the case study was done by the in-depth interview and questionnaires in three different residential districts in Shanghai. It was found that the following factors related to the self-saving should be considered in the shelters planning: the distribution of the shelters including their space accessibility and area, evacuation passageways, the facilities of the disaster prevention (such as fire hydrant and guide signs) and subsidiary facilities (such as vegetation for the disaster prevention), the social cohesion, awareness of the self-saving and disaster prevention. Simultaneously, the shelters planning countermeasures based on the self-saving were proposed, which provided some theoretical bases for the study and plan of the security residential districts in future.

1. Introduction

Disasters occurrences are mostly unpredictable. Even though it is predictable the warning lead time that allows people to prepare is too short (Johar and Permana, 2015). When disasters strike the unprepared community, the loss and damage will be incredible (DeBreo, 2015). The well-prepared community with self-saving capability is therefore crucial. Around the whole world the frequency of the various casualties is increasing because of the climate change and increasing population density, and this seriously hinders the social stability and developments of the cities. To reduce the losses resulted from the casualties, the urban refuges, which are the important parts of the urban public spaces, were planned as the important locations for the citizens. However, the shelters which were based on the urban master planning were always paid more attention than that in the residential districts.

As the vital components of the cities, the majority of population are daily accommodated in urban residential districts during some specific time (such as sack time), and there amounts of the public infrastructures (such as facilities used for electricity and *Natgas* supplies) are intensively contained, but the residential districts were always mistaken for the relatively safer locations. Simultaneously, the larger potential risks have arisen in modern urban residential districts during the disasters because there the high density of population resulted from the increasing density and height of the buildings. So during the paroxysmal disasters these are prone to result in more casualties and the serious losses of properties compared with other urban areas, and even it may causes serious secondary disasters. Therefore, the shelters planning in urban residential districts have become more important for the modern city, especially in

China, compared with that in the last century. Actually the second world conference on disaster reduction (2005), held in Kobe, Hyogo, Japan, I have suggested that the urban residential districts should be as the elementary unit for disaster mitigation.

Generally the various relatively open areas, which include the green land, entrance halls, the top of the buildings and so on, can be planned as the shelters in the residential districts, and the residents can arrive there by some distinct guiding signs if necessary. For the high-rise buildings in residential districts, the areas divided regularly in floors are also planned as the shelters. Simultaneously, some infrastructures (such as fire hydrant and drinking water supply) and the special evacuation passageways for the disable are set in the shelters. In addition, with the synthetic consideration for the economics and necessity, the different shelters planning was implemented according to the density and height of the buildings and number of people in the resident district. So far many theories and methods of the shelters planning like above mentions have been proposed and studied, but few researches for the shelters planning based on the self-saving have been conducted.

The shelters in residential districts are generally planned as the preferred emergency refuge for the residents during the disasters, and the losses and casualties may be greatly mitigated during the paroxysmal disasters if these can be effectively utilized by the residents to realize stir-and mutual-rescue before the rescue teams' arrival, simultaneously which is also conductive to the rescues and reconstruction after the disasters. This relays on the following aspects: residents' needs, residents' familiarity with the shelters, maintenances

and improvements of their functions after the constructions. In addition, the shelter planning is a pattern of the resource allocation, and it is involved with the security interest of the residents. So it is necessary for the residents to participate in the planning, routine maintenances and use training of the shelters, which the social cohesion among the residents plays an important role in. Therefore, the social cohesion should be one of the main considerations for the shelters planning based on the self-saving.

In this study, the factors which were related to the self-saving and should be considered in the shelters planning were analyzed, and the shelters planning countermeasures based on the self-saving were proposed, which provided some theory basis for the studies and planning of the security residential districts in future.

2. Definition of Concepts

There are some working definitions in this study. These definitions are given below.

Self-saving, in the context of disaster rescue operation, is an individual effort to avoid the injuries, casualties or deaths by his/her present own capability at the time of disasters or present dangers. This concept was based on the fact that the event of some kind of disasters is unpredictable and unforeseeable, for instance earthquake. Earthquake is unpredictable. Some other disasters are predictable but the time to respond is too short. The shortness of warning lead time makes the number of casualties or even loss of life can be higher. Thus, the self-saving practice becomes important to minimize the casualties or loss of life.

The residential districts are the areas with certain scale, which is divided by the roads or natural boundaries (such as rivers) in city and no main road is throughout, and there are the public greenbelts and the completed infrastructures which can meet the residents' daily life. A residential district comprised of several housing clusters is a unit of the resident area. According to Code of Urban Residential Areas Planning & Design (GB50180-93, 2002) in China, the scale of a residential district should range from 2,000 to 4,000 households (approximately 7,000-15,000 residents), and land-use area range from 10,000 to 36,000 square meters.

In the event of disasters, self-saving practices by the citizens within the urban residential districts play an important role in minimizing the number of casualties or loss of life. The self-saving practice becomes essential when the rescue team response was hampered by many factors such as disturbed connection i.e. cut roads/bridges, the equipment of the rescue team or even the team member itself struck by disasters. By this situation, the creativity to avoid the threats or injuries by the citizens through self-saving efforts would be indispensable.

The shelters mentioned in this study, which solely referred to the emergency and temporary refuges rather than the municipal or provincial refuges, are the transitional places before the refugees can be transferred to the larger public shelters together in the disasters (Design code for urban disasters emergency shelter- exposure draft, 2012, GB xxxxx-2012). Simultaneously, in this paper the shelters in which the infrastructures can be set are limited to the open area with a certain scale in the residential districts, and the residents can conveniently utilize them in daily life or disasters for the different purposes.

Other definition given is refugee behavior. This refers to all the

behaviors or actions which could be taken when people is in danger.

The psychology of refugee behavior refers to all the psychological activities which arise and directly result in producing the refuge behaviors when people are in danger. The physiology of refuge behavior significantly affect the refugees' choices of the evacuation passage ways and shelters, so that should be as important one of the considerations for the disaster prevention planning, which is helpful to improve the urban disaster prevention system and reduce the losses in the disasters.

The disasters mentioned in this study, which belongs to the urban disasters, likely occur in the residential districts and threaten the security of the residents' life and properties. These are composed of natural and man-made disaster and mainly include earthquakes, floods, severe colds, typhoons, tsunamis, fires, epidemics and the secondary disasters potentially resulted in by them (Liu, 2006).

The infrastructure to prevent the disasters refers to the supporting facilities which can meet the necessary needs of the refugees' living in the disasters. The facilities include tents, barrack-like temporary housing, emergency water supply, emergency power supply system and lighting facilities, emergency medical service and so on.

The emergency evacuation passageway refers to the preferred passageway to the shelters, which the residents can immediately utilize as soon as the disaster occurs. Most of them are the roads in the shelters and these also include a few urban minor roads.

The vegetation for disaster prevention refers to the plants which can, in subsidiary manner, prevent the refugees from harms in the disasters, and this includes mitigating the harms resulted from the falling objects, slowing the spread of flames and so on.

The term "social cohesion" was first coined by Emile Durkheim in 1983 (Regina, 2000) and defined that it was a characteristic of the social order, which was expressed by the interdependence, mutual loyalty and solidarity among members of society. Subsequently, it has various definition narrated by many scholars, and some governments and organizations have made many efforts for improving its level among their citizens or members. The Social cohesion is a tie among the members of society, and its level can be assessed by the following factors: social relationship, task relation, perceived unity and emotion (Forsyth, 2010). Actually except the expression of social cohesion mentioned above, there also include belongingness, inclusiveness, the participatory, recognition, legality, shared values, shared challenges, equal opportunities and so on.

3. Research Objectives

The objectives of this study were to (i) explore the roles of the influencing factors related to the self-saving in the shelters planning; (ii) Highlight the importance of the shelters planning based on the self-saving; (iii) propose some shelters planning countermeasures based on the self-saving.

4. Research Methods

A mixed method was designed and applied in this study. Firstly, we identified the related literatures by searching the electronic databases of SCI, EI and CNKI, and the following keywords were used in various

combinations: “self-saving”, “residential districts”, or “shelters planning”. Secondly, to obtain the real needs of the residents, we respectively made the in-depth interviews with 15 persons from the different residential districts, who are the residents, members of the neighborhood committees, or staffs from the property management companies. Every interview was randomly carried out for approximately half an hour, and the contents of the conversation were not limited before. Finally, the factors selected from the related studies were combined with the topics frequently mentioned in the interviews to design a questionnaire and a total of 100 questionnaires were distributed in three different residential districts located in Shanghai.

5. Results and Discussion

The serious losses of life and property were always caused because the calamities unpredictably and rapidly happened. The comprehensive measure for the disaster protection is one of effective methods to minimize the losses. A shelter in the residential districts is one of the important locations used for the disaster protection, so it is necessary for the immediate and efficient utilization of the shelters during the residents’ self-saving in the unexpected disasters, which is directly related to its planning. In this study, the factors related to the self-saving were investigated and highlighted in the shelters planning, and some shelters planning countermeasures based on the self-saving was suggested, which may be helpful to the related researches and planning.

5.1 Baseline of Case Study

A total of 100 questionnaires were distributed, and 92 valid questionnaires were identified for the subsequent analysis. The information mentioned in the questionnaires was obtained from three different residential districts located in Shanghai (Fig. 1).

5.2 Importance of the Shelters in Resident Districts

The various disasters can happen anywhere at any time. More than 64% of the respondents in this survey indicated that they or their friends suffered the disasters (Fig.2). The residential districts are the important one of the functional units in city and are the areas with the dense population. The population mobility in the residential districts always focuses on the special time in daily life. In our surveys, it was found that 28% of the respondents stayed in their home only at night and 45% for all day (Fig.3). Simultaneously, the plot ratio is gradually increasing with the increase of population density, which resulted in the reduction of their safe distances. The secondary disasters (such as Stampede) are more easily resulted from the above factors when many panic residents with simultaneously escape for the refuge in the crowded spaces during the disaster. The shelters in resident districts are generally planned as the preferred emergency refuge for the residents during the disasters, and its reasonable planning can partly mitigate the losses and above risks, which is also conducive to the rescues and reconstruction after the disasters.

The shelters in the resident districts are the important parts of the urban public spaces, but actually the other urban public spaces were always paid more attention than them. This may resulted form that the resident areas especially residential districts were mistaken for the relatively safe locations. So far, the follow-up of many existing shelters, including the construction, rationality of their utilities, maintenances, improvements of their functions and so on, was infrequently concerned by their planners after accomplishments of their planning.



Figure1: The Location of Three Residential Districts in Shanghai

Table 1 The Baseline Characteristics of Three Residential Districts

	Tang Chen Hao Ting	Pu Fa Bo Yuan	Chi Feng Xiao Qu
No of Respondents	30	32	30
Gender (Male:Female)	16:14	16:16	15:15
Age	Under18	2	3
	19-30	3	5
	31-50	21	19
	51-70	3	5
	Above70	1	0
Residence type	High-rise residential building and small high residential building	High-rise residential building and low-rise residential building	Multi-story residential building and low-rise dwelling
Housing ownership (Rent:Own)	1:5	1:7	7:8
Gross area	132,000 m ² (Large residential district)	8,700 m ² (Medium-sized residential district)	8,541 m ² (Medium-sized residential district)
Total number of households	466	590	1,200
Time Period of construction	2002-04	2009-09	1983-06
Plot ratio	1.2	1.3	1.8
Occupancy rate	44%	42%	72%
Parking space	Ground parking spaces 200, Underground parking 300	413	200
Greening rate	52%	36.10%	30%

5.3 Importance and Awareness of the Self-saving in Urban Residential Districts

The disasters are usually unanticipated and unpredictable for their rapid occurrence. It causes the losses of life and casualties before the rescue teams' arrival. For instance, the earthquakes only last for tens of seconds. If the self-saving can be felicitously taken in time, the rescue teams can learn the more detail information of disaster area from more survivors and take more pertinent measures, which can raise the efficiency of the rescues. Reversely, the following rescue work may be more difficult. So it is important for the reduction of the losses and casualties that self-saving is immediately adopted with the shelters and facilities of the disaster prevention.

5.4 Analysis for the factors related to the self-saving in urban residential districts

The factors which affect the self-saving are complex, and these can be roughly divided to the objective factors and human factors. The objective factors were paid more attentions in the previous studies or existing related planning (Ran; Jenks, M., Burton, E. and Williams, K., 1996; Meng, X.H. and Song, L., 2012; Han, R. and Liu, J.Y., 2009), and these included the facilities of the disaster prevention, the shelters, the roads and so on. In this survey, 80%-90% respondents in Tang Chen Hao Ting and Pu Fa Bo Yuan indicated that there are the fire hydrants and evacuation passageways in their residential districts, and the ratio was significantly higher than that in Chi Feng Xiao Qu (Fig.4 and Fig.5), suggesting that the facilities of the disaster prevention in the residential districts were gradually paid more attentions than before.

The shelters are also the important one of the objective factors related to the self-saving. The nearby and open areas (such as green lands) are

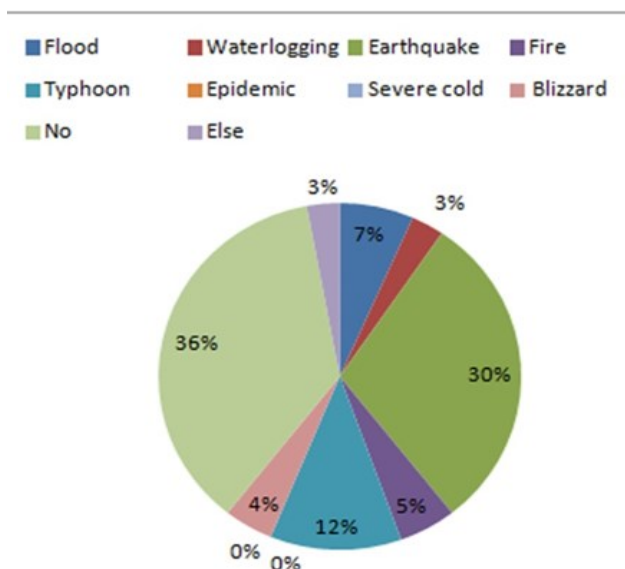


Figure 2 Disasters Experienced by Respondents

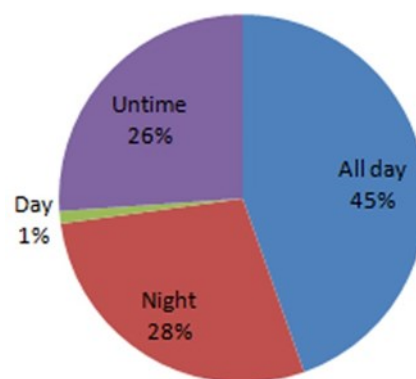


Figure 3 During Disaster Events when do You Stay in Your Home?

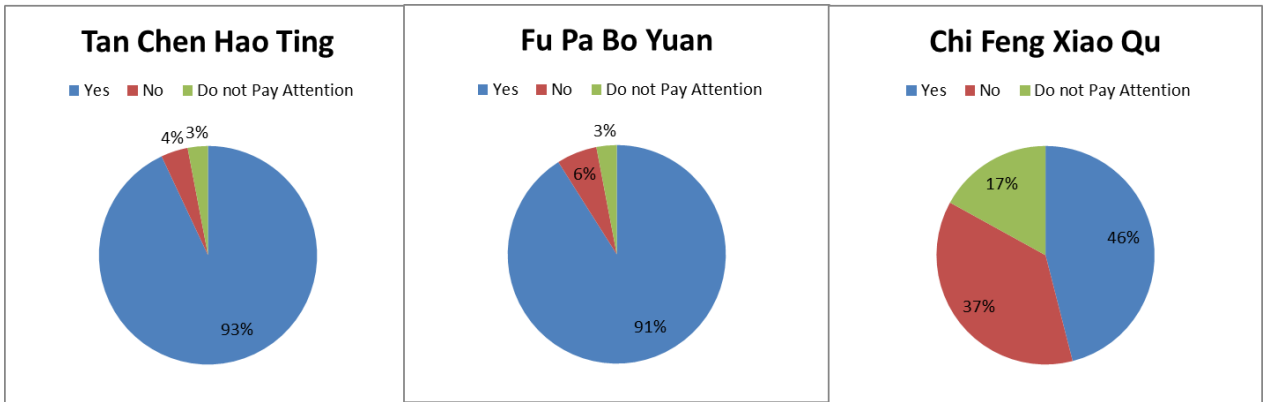


Figure 4 On the availability of the Hydrants of Fire Extinguishers

generally chosen or planned as the emergency shelters in the residential districts, which are relatively safer and convenient for the arrival, and the effective area of the shelters in the residential districts is the residual area except for water area and area potentially covered by the collapse of the buildings. In China it is generally thought that the area in a residential districts should be more than 500 square meters, and the average area per capita should range from 1 to 2 square meters (li,X.J. and Li,J.W.,2013; Ormsb,S.J.,1978; Emergency shelter for earthquake disasters-site and its facilities (GB21734-2008), 2008; Scientific Survey Team of National Earthquake Response Support Service (NERSS) 2008; Department of health of Qinghai province, 2010; Earthquake resistant design codes in Japan, 2000, Program on improved seismic safety provisions,1987). In this survey, for the convenience of this research, the average area per capita was artificially defined as 1square meter. It was better in Tang Chen Hao Ting and Pu Fa Bo Yuan that the existing effective area of the shelters in the residential districts can meet the above criteria, suggesting that the shelters in the residential districts were gradually improved.

In addition, the roads and the parking spaces are important to the self-saving. For instance, it is stipulated in China that the width of the roads in the residential districts should be not below 4 meters, and at least one of them should be linked with an urban road. This is not only convenient for residents but also enables the fire trucks or ambulance to smoothly enter the residential districts in time. Simultaneously, the enough parking spaces in the residential districts can avoid the jam by the disordered parking cars. In this survey, the parking spaces in Chi Feng Xiao Qu were seriously not enough for the real needs, and this resulted

in the half of the roads was occupied by the parking cars. The phenomenon in two other residential districts was significantly improved (Table 2), suggesting that the fluency of the roads in the residential districts were gradually paid more attentions than before.

Although the above objective factors related to the self-saving have been respectively improved at the various degrees, it was found in the survey that the related human factors were still not paid enough attentions, especially the social cohesion, awareness of the self-saving and disaster prevention. The formation of the social cohesion is affected by the complex and diverse factors, which include kinship, traditional or national concepts, class status, social mentality based on the consistency of the realistic interests and so on. For instance, it was founded from this survey that 92% of the respondents indicated that they prefer to stay with their family members when the disasters happen (Fig. 6). In this study, for the concretely reflecting the levels of the social cohesion in the resident districts, it was artificially and

Table 2 The Parking Space of Three Residential Districts

	Chi Feng Xiao Qu	Pu Fa Bo Yuan	Tang Chen HaoTing
Households	1200	590	466
Should have parking space	720	590	466
Existent parking space	200	413	400

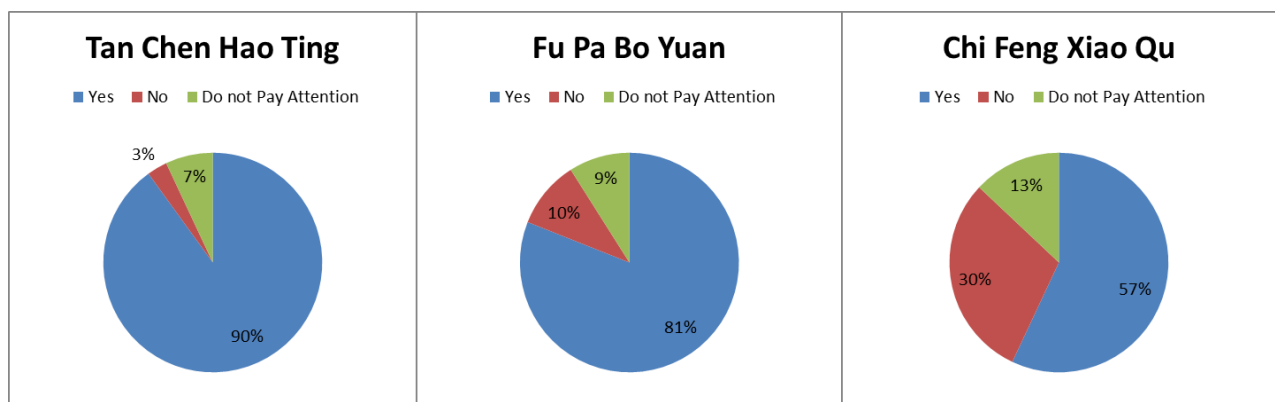


Figure 4 On the availability of the Evacuation Passageways in Buildings

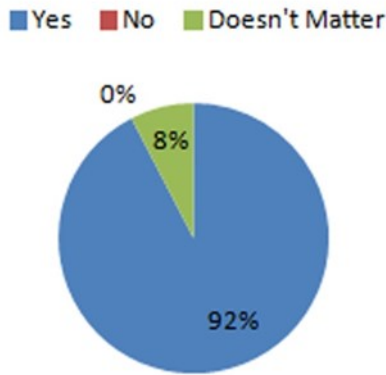


Figure 6 Preference to Stay with Your Family Members When the Disasters Happen

simplistically defined and assessed with the following factors in the resident district: the degree of familiarity among the residents, the frequencies and effects of the collective activities, the degree of residents' satisfaction for the public spaces, the utilization rate of the public spaces and so on.

It was proved above that the objective factors (such as facilities of the disaster prevention and the shelters) were important to the self-saving, and actually their effective utilization rely on residents' familiarity with them, their maintenances and improvements, which the social cohesion plays an important roles in. The shelters in the resident districts are planned for and will be mainly utilized by the residents, so it is rational to consider their needs in the shelters planning. The function conservation of the shelters can successfully be realized between daily life and disasters when the planning meets the needs of the residents, which is impossible without the residents' opinions. Simultaneously, actually the shelters planning is also a pattern of the resource allocation, and it is involved with the security interest of the residents. Marx (1956) said that people are fighting for everything to do with their interests. So it is necessary for the residents to participate in the planning, routine maintenances and use training of the shelters, which the social cohesion among the residents plays an important role in. In this survey, if the resident districts were dissatisfied, 50%, 28% and 3% of the respondents respectively chose to suggest property management companies, neighborhood committees or governments for it, and 5% chose to move and 14% did not know who should be in charge of it (Fig.7). This indicated that there was not a very definite way for the residents' participation in the affairs (such as the affairs related to the safety) of the resident districts.

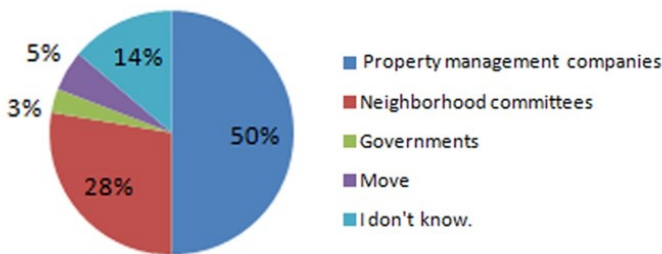


Figure 7 On the Agency in Charge in Residential District during Disasters

The success of the self-saving is also primarily actuated by the awareness of the self-saving, for which it is necessary that the residents should have the awareness and knowledge of the disaster prevention. In this survey, approximately 40%-50% of the respondents did not know where the shelters were in their residential districts (Fig.8), and more than half of the respondents indicated that they would need others' helps during the disasters (Fig.9), suggesting that the awareness of the self-saving and disaster prevention was not enough in the residential districts. Simultaneously, compared with two other resident districts, more respondents in Chi Feng Xiao Qu were not clear the location of the evacuation passageways or fire hydrant (Fig.4 and Fig.5), suggesting that the awareness was gradually improved with the construction of the new residential districts. In addition, the proportions of the respondents trained in the disaster prevention decreased with age (Fig.10), suggesting that the training had been increasingly paid more attentions. This suggested that the effect of the training was yielded and the psychological fore-warning system on residents trained had been gradually constructed.

5.5 How to realize the shelters planning based on the self-saving

With the above analysis for the factors related to the self-saving, three kinds of the distribution of the shelters in the residential districts were proposed as the following. For the new large or medium-size resident districts with the relatively dense buildings, it was suggested that the centre squares should be planned as the shelters during the disasters (Fig.11: A). This is conducive to the space accessibility and intensively establishing the infrastructures because the wider and integrated areas located in the central can be used, which is also more

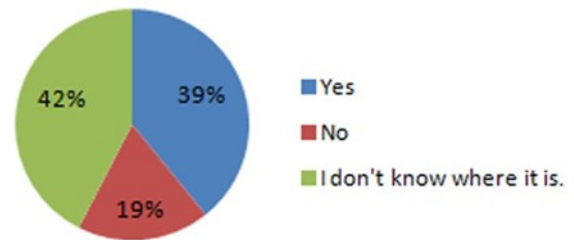


Figure.8 On the Satisfaction level with the residential area shelter

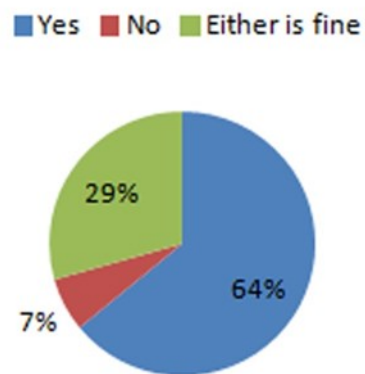


Figure 9 On Help needed from others During the Disasters

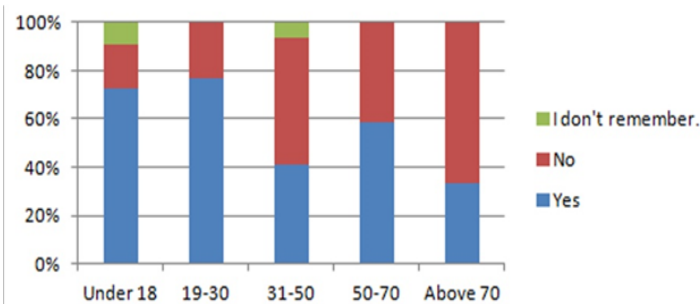


Figure 10 The Proportions of the Respondents Trained on Disaster Prevention

economical, and the shelter can simultaneously accommodate more people; For the old and small-size resident districts with the dense buildings, the joint areas of the resident districts and the outside can be utilized as the shelters during the disasters because there none large and integrated area located in the central is generally available (Fig.11: B). However, this may block the roads when the evacuation or rescues would be implemented; For the resident districts with the low plot ratio, the shelters can be planned with the scattered distribution (Fig.11: C). Although this can make the shelter nearer to the dwellings, but simultaneously more and similar infrastructures will be needed, which results in the increasing of the budget for the shelters construction. So which distribution of the shelters can be chosen should be referred to the land use and plot ratio of the resident districts.

Simultaneously in this survey, nearly 20% of the respondents did not know where the shelters were in their residential districts (Fig.8), suggestion the guide signs for the shelters were not marked. So the distinct and comprehensible guide signs should be used for the shelters. The vegetation for the disaster prevention can be also used in the self-saving and should be considered in the shelters planning.

In addition, the human factors should be also considered in the shelters planning based on the self-saving (or improvement) except for the above objective factors. In this survey, it was found that the social cohesion plays an important role in the self-saving. For instance, the respondents trained in the disaster prevention intended to choose the correct escape

routs and shelters; some shelters (such as schools and open areas in the enterprise) in or near to the resident districts may not be available during the disasters because of their management mechanisms. Simultaneously, more than 90% of the respondents would like to participated in the rescues or reconstructions and the group activities held in the residential districts if possible (Fig.12, Fig13 and Fig.14), although many respondents indicated that there the group activities were never held. So it should be considered how to utilize the enthusiasm to let them be familiar with the shelters for the self-saving in the disasters.

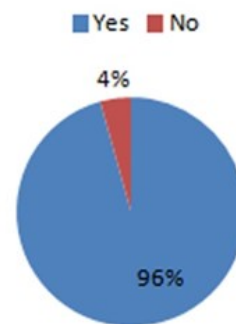


Figure 12 Willingness to Participate in the Rescue Operations

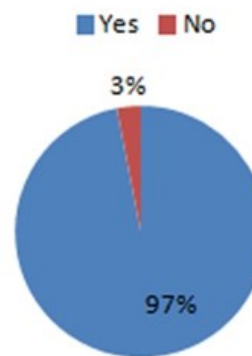


Figure13 Willingness to Participate in the Reconstructions

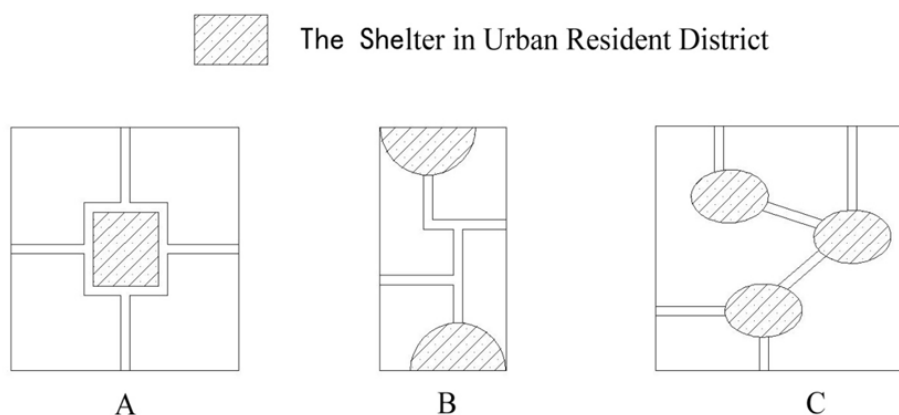


Figure 11 Three Types of the Shelter distributions in the residential districts

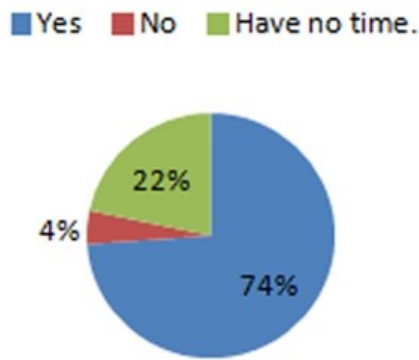


Figure 14 Willingness to Participate in group activities held in the residential districts

The guidance for improving the awareness of the self-saving is also one of the conditions of the shelters planning based on the self-saving, which can be partly realized by the disaster prevention trainings. The mechanisms that the residents participate in the maintenances and improvements of the shelters should be also considered, which can include the collection and feedback of the residents' advices, managements of the neighborhood committees, emergency plans of surrounding environment or infrastructures and so on.

6. Limitation

Due to limited number of respondents, there were certainly several limitations in this study. Firstly, there were the biases of the amount of the different classified respondents, which was resulted from the limited total number of the respondents, and this may resulted in the deviations in the analysis results; Secondly, the refuge behaviors and the corresponding physiology could be only forecasted by some of the respondents who had never suffer the disasters. It may be bias since the respondents have never really experienced with disasters. Thirdly, the questionnaires were only distributed in Shanghai, and the results of this survey were not compared with that in other places for the further confirmation; Therefore, a detailed and well-designed study by univariate analysis and the multivariate analysis should be performed to further confirm our results.

Even though the study may not statistically reflect the real situation of the whole citizens in the study area, the most important point of this study is that the messages of the potential victims must be taken into account seriously. The stakeholders of disasters, particularly authority must provide the disaster preparedness efforts to reduce the number of death tolls and casualties. The citizens must be equipped with sufficient knowledge and practices on how to do self-saving procedures. From the urban planning viewpoint, the built environment must be planned and designed to minimize the damages by any disasters. Buildings codes and development control must be followed accordingly.

7. Conclusion and Recommendations

In conclusion, the shelters in residential districts are the important parts of the urban public spaces, which are closely related to residents' daily life and self-saving in the disasters. Our study does support that the self-saving should be important one of the considerations in the shelters in urban residential districts. The recommendations for the shelters planning based on the self-saving were summarized as follows:

the distribution of the shelters can be planned according to the land use and plot ratio of the resident districts; the facilities of the disaster prevention (such as guide signs for the shelters or evacuations passageways) should be planned for the more effective utilization, and the subsidiary facilities (such as vegetation for the disaster prevention) can also be appropriately planted in the shelters; simultaneously, the social cohesion and aware of the self-saving, which is contributed to arouse the enthusiasm of the residents' participation in the planning, maintenances and improvements of the shelters in daily life, should be also paid more attentions in the shelters planning, and the group activities in the resident districts (such as disaster prevention trainings) should be frequently held, which can make the residents be familiar with the shelters in order to raise their effective utilization rate in the self-saving. Consequently, the more effective self-saving was taken, the smaller losses would be during the disasters.

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