

Conceptual Model of Shelter Planning Based on the Vitae System

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Synopsis

In this paper, the concepts and types of disaster shelters are reviewed and systematically examined described at first, and then different area levels of shelter planning are addressed by comparing some existing shelter planning practices in some counties. Then three types of approaches are proposed, each focusing on one of the three basic functions as claimed by the Vitae System model, and later integrated with the remaining functions. Examinations are made of the applicability and potential of the proposed methodology. Further research needs are also suggested.

Keywords: shelter planning, the Vitae System, conceptual model

1. Introduction

The disaster shelter can protect people from a disaster due to aseismatic structure, fireproof walls and strong windows. In Japan, since the salvation hut (“Osukui Goya” in Japanese) in the Edo Period appeared as the rudiment of disaster shelter, now more than 1000 cities or wards have set up shelters, and lots of cities and wards have formed shelter management manuals (ANICE, 2005). After the 1999 tornadoes (on January 21, 56 tornadoes struck Arkadelphia, Arkansas and on May 3, 68 tornadoes struck Oklahoma and Kansas) in USA, tornadoes and hurricane shelters were set up in many states, and several national guide documents such as FEMA 320 (FEMA, 1998), FEMA 361(FEMA, 2000) and ARC 4496 (American Red Cross, 2002), as well as some local guide documents (ACOAEMO, 2003) were published as the disaster shelter planning standard.

With the increase of disaster preparedness and awareness, a large number of developing countries have also started to set up disaster shelters, for example in 2003 Beijing set up the first shelter in China, and till 2007 will set up another 18 (Rednet, 2004). Scientists and researchers are also starting to carry out shelter planning research, such as shelter location selection (Kongsomsaksakul et al, 2005) and shelter structure design or assessment for extreme wind events (Goulbourne et al, 2002; Pine et al, 2003). However, different countries, even different cities in a country, have different criteria of planning a disaster shelter.

Therefore in this paper by reviewing and comparing some existing shelter planning, we intend to present a common framework for disaster shelter

planning based on performance criteria developed from the view point of the “Vitae System” conceptual model proposed by Okada (2005).

2. Concept of disaster shelter

Table 1 listed the categories and definitions of disaster shelters in some countries. From the table, it is well-known that in Japan, basically there are four kinds of shelters, namely wide area shelter, temporary shelter, accommodation shelter and accommodation shelter for people who need support in the disaster. Wide area shelter and temporary shelter are often outdoor spaces, such as parks and playgrounds where living condition is not offered. These shelters are used to protect potential victims temporarily. People must evacuate or displace to accommodation shelters if their houses are damaged or the disaster will last for a certain long time. Often, these shelters are called “primary shelters”. Accommodation shelter and accommodation shelter for people who need support are often indoor spaces and living spaces and accommodation condition are provided inside. Obviously both of them are accommodation shelters, and the difference between them is that the latter requires special services for social vulnerable groups, such as the old, the pregnant, the handicapped or people who have a physical, medical or mental disadvantage.

In USA there are two kinds of shelters, namely emergency shelter and temporary shelter. In their definitions, the emergency shelter in USA is similar to the temporary shelter in Japan, while temporary shelter in USA almost has the same meaning and function as the accommodation shelter in Japan. In

Table 1 Category and definition of disaster shelters in some countries

City/Country	Category	Definition
Tokyo, Japan (ANICE, 2005)	Wide area shelter (Shelter place)	A large-scale park or open space to protect refugees from the spread of a fire which caused by a large earthquake or the risk of other dangers
	Temporary meeting place	A playground, shrine or a temple that refugees in the neighborhood gather temporarily before evacuating to a shelter
	Shelter	A building such as a school or community center that can accept the persons suffered from disasters, especially the persons whose houses are damaged by an earthquake, a fire or other hazards.
	Secondary shelter	Social welfare facilities that provide the service to the old man and the handicapped person who need the care
Yokohama, Japan (ANICE, 2005)	Wide area shelter	The place to protect people against the radiant heat and smoke of a big fire caused by an earthquake, and the evacuation time is several hours.
	Temporary meeting place	A place that refugees gather temporarily before evacuating to a shelter
	Community disaster prevention foothold	A place, often an elementary school, where the refugees can live whose house are damaged by an earthquake or a fire caused by an earthquake, and where information can be transmitted and emergency materials are storied.
	Special shelter	A place which it provides priority services to the person who need support and care
Osaka, Japan (ANICE, 2005)	Wide area shelter	A large-scale place to secure people from a fire triggered by an earthquake or a hazard which is predicted can cause a big damage.
	Temporary shelter	A safe place, such as an open space or a park in a community to evacuate smoothly, and where more than 200 people should be accepted ($1\text{m}^3/\text{person}$)
	Accommodation shelter	A place where accommodation and food are supplied can accept the refugees whose houses are damaged or who need continual relief because of the disaster.
	Accommodation shelter for people who need support	A refuge, such as a ward residence service center or a community residence service station services to people who needs support.
Kobe, Japan (ANICE, 2005)	Wide area shelter	An enough big open space to protect people from a big earthquake or a fire cause by an earthquake. But according to the disaster, it can also used as an accommodation shelter.
	Temporary shelter	The outdoor space such as a playground of an elementary school or middle school, or a park to protect the people immediate after an earthquake. But by the situation, indoor space may also be used.
	Accommodation shelter	The facilities (often the indoor space of an elementary school or a middle school) to accommodate sufferers whose houses are destructed or collapsed by an earthquake or a fire. And by the situation a park will also be used as an accommodation shelter when tents are set up.
	Shelter for people who need support	The facilities such as welfare facilities to accept the old and handicapped who have difficulty to live in a normal accommodation shelter. And if necessary domestic helper is offered in these facilities.
USA (Quarantelli, 1995)	Emergency shelter	A place for potential disaster victims to stay for short period: hours in many cases, overnight at most
	Temporary shelter	A place for peoples' temporary displacement with an expected short stay: often several months
Beijing, China (Yang et al, 2004)	Emergency shelter	A place to protect refugees from a disaster (earthquake, flood, fire) to stay temporarily, and by the situation, tents will be set up for peoples' long term living

China, there is only one kind of shelter, namely emergency shelter, which is used as temporary shelter

generally. While at these shelters lifeline maintenance facilities are prepared and they can also

be used as accommodation shelter after tents are pitched.

From the review of current disaster shelters, we propose to classify disaster shelters into two types according to their functions, namely primary shelter (or temporary shelter) and accommodation shelter (or secondary shelter). The former, where living facilities are not available, is used to protect people temporarily during a disaster chaos period. If the disaster lasts or expands, victims must be displaced to accommodation shelters, where people can live before their houses are repaired or rebuilt after a disaster. Accommodation shelters are used to provide accommodation and to protect people during a disaster relief and rescue period, or even recovery and restoration period.

3. Area levels (spatial scales) of shelter planning

Shelter planning is one of the important parts of integrated disaster risk management, and should be made in consultation with local emergency management, public safety officials, and especially in collaboration with local people. One of important points of shelter planning is to define the spatial scale or area level. According to the existing shelters or one under construction in some countries, we can conclude that there are four different levels of shelter plannings.

3.1 Household level

Having a shelter, or a safe room, built into the house can help the victim protect him/her and his/her family from injury or death caused by the dangerous forces of extreme hazards, such as tornado and hurricane. It can also relieve some of the anxiety created by the threat of these oncoming extreme events. The shelter at this level is often a primary shelter. FEMA 320 (FEMA, 1998) is a typical guideline of setting up a household level shelter.

3.2 Neighborhood level

Having a shelter in the neighborhood area can offer the victim a place to take refuge temporarily during a disaster relief and rescue period, when it is impossible to evacuate to an accommodation shelter because of the limited time. People in the neighborhood will often evacuate to a park or an open space primarily when an earthquake, a tsunami or fire happens. Often the shelter at this level is also a primary shelter or a temporary shelter. Planning a safe place near one's home, such as garden and parking lot where one can evacuate immediate when a disaster happens, is typical of neighborhood level shelter planning. In Japan, almost all of the temporary shelters ("Ittoki hinansho" in Japanese) planning belong to this level.

3.3 Refuge zone level (Community level)

Often there is an accommodation shelter in a

community, so the shelter planning at this level means the planning of an accommodation shelter. Having an accommodation shelter in the community can provide a place (temporal house) for refugees whose houses are damaged or destroyed because of the disaster, and the shelter can help the victim tide over a difficulty during a disaster recovery and restoration period. FEMA 361 (FEMA, 2000) is a typical guideline of setting up a community level shelter. In Japan, most of the guidelines or manuals of setting up a disaster accommodation shelter ("Shuyo hinansho" in Japanese) based on its designated location belong to this level.

3.4 Regional or wider level

A region is composed of several communities, and different from the shelter planning at community level, the shelter planning at this level focuses more on the relation between different accommodation shelters. The shelter planning at this level is often developed by a local or the central government, who are primarily concern about the whole region. In Japan, the accommodation shelter locations are designated and potential victims to each shelter are assigned by the local government in a region, this kind of planning is the typical case of shelter planning at regional level. In USA, the shelter plannings, such as setting up elementary or middle schools as shelters, done by a local government belong to this level.

Fig.1 illustrates distinct scales and area levels of shelter planning.

4. Performance criteria from the viewpoint of Vitae System

Shelter planning should appropriately link up post-disaster processes to pre-disaster processes, so we need some special methodological approach that can systematically combines retroactive event and proactive event, such as enhancing coping capacity ("bousai-ryoku" in Japanese) and preparedness,

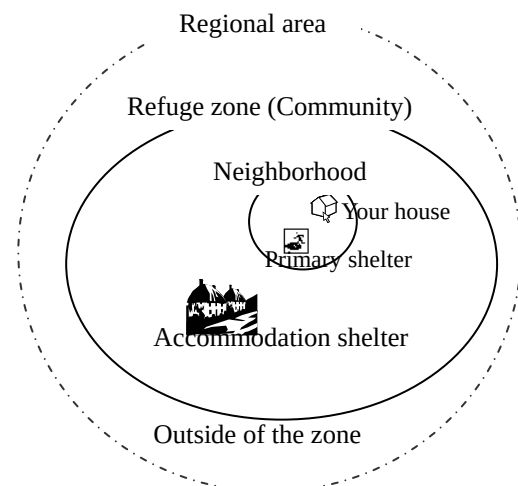


Fig. 1 Area levels of shelter planning

Table 2 Comparisons of several disaster shelter criteria

Contents	Tokyo, Japan Ordinance of earthquake disaster countermeasure of Tokyo Metropolitan (TMG, 2000)	Aichi Pref., Japan Shelter management manual of Aichi Prefecture, Japan (DPBAP, 2005)	FEMA 361, USA Design and construction guidance for community shelters (FEMA, 2000)	Beijing, China Earthquake emergency shelter criteria (Yang et al, 2004)
Hazard type	Earthquake and earthquake triggered fire disaster	----	Tornado and hurricane	Earthquake, flood, fire and gas explosion
Principle	1. To be located in safe area 2. With safe evacuation routes 3. To be managed by community people	1. To be located in safe area 2. Lifeline support is offered 3. To be managed by community people	1. To be located in safe area 2. With safe structure	1. To be located in safety area 2. With the shortest evacuation distance
Type	Primary shelter Accommodation shelter	Primary shelter Accommodation shelter	Accommodation shelter	Primary shelter
Location	----	----	Outside earthquake and flood prone area Away from large objects and multi-story buildings	----
Structure	Aseismatic and fireproof	Aseismatic and fireproof	Aseismatic and fireproof	----
Facility	Public or private facilities such as park and school	Public or private facilities such as park and school	Single-use and multi-use, stand-alone and internal shelter	Public facilities, such as park, green land, playground, or gym
Scale and Capacity	At least 600sq.m 1sq.m./person for primary shelter 1.5sq.m. /person for accommodation shelter	Accept at least 50 persons 2 sq. m. /person	6sq.ft/person for tornado 20sq.ft/person for hurricane	More than 10 000sq. m 1.5-2sq.m./person
Evacuation route	Wider than 12m	Wider than 12m	----	At least 2 routes
Evacuation tool	Walking	Walking	Walking	Walking
Evacuation distance or time	Service radius 500-700m	Service radius 500-700m	Within 5minutes	Within 5-10minutes Service radius 500m
Signal	National standard signal	National standard signal	Understandable signal	Multi-language, clear and understandable
Others	Local peoples' familiarity	Local peoples' familiarity	Ventilation, lighting, emergency supply and power	Emergency command center, lighting and toilet

citizen involved disaster drill and social co-learning, and participatory approach (citizen involved). When we talk about these combined approaches, especially coping capacity, some performance criteria are necessary. According to existing manuals or guidelines of shelter planning used in different countries, Table 2 listed up disaster shelter planning criteria which are interpreted to be applicable at community level. These criteria are shelter location, structure, facility, shelter scale and capacity, evacuation route, tool and distance and others. Shelter location and structure safety are the basic criteria of a shelter planning, and are also the most

important indicators of shelter security. Shelter scale or capacity is the main indicator of shelter acceptability (or accommodation capacity). Evacuation route, tool and distance, which affect evacuation time, are three important indicators of accessibility to the shelter. And some countries such as Japan consider also the habitability and local peoples' familiarity. We can see that for the shelter of same kind, at same level and used for same hazard type, their criteria are not completely the same in different countries and even in the same country. And the implementation standards of the same criterion are also not completely the same in different regions.

For example, the capacity is set as 1.5 sq. m. /person in Tokyo while 2.0 sq. m. /person in Aichi Prefecture. Though there is no reason why the capacity has to be always identical from place to place, we should examine more systematically how the capacity be coordinated with other performance levels. In this paper, we intend to systematically analyze appropriate coordination among different performance levels. In order to introduce some framework for the overall assessment of balanced coordination among different performance levels, the Vitae System model is proposed to be applied.

The Vitae System model as shown in Fig.2 claims that (i) any community, city, region or society should be modeled as a living body, that (ii) the coping capacity of any living body can be either enhanced or ruined if it is challenged by the impulse of an external shock, and that (iii) any living body has three basic and critical functions ①Survivability (to live through or become alive), ②Vitality (to live lively) and ③Conviviality (to live together or communicate)

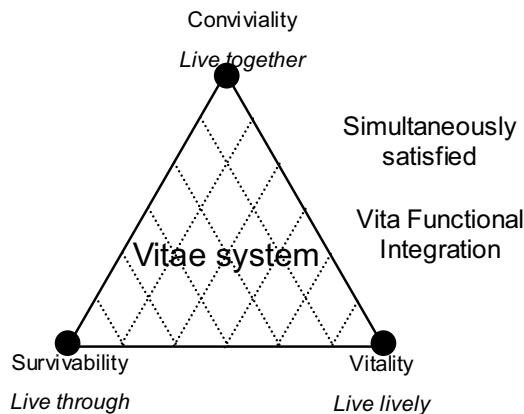


Fig.2 Vitae System Model

(Okada 2005; Misra and Okada, 2005). From the viewpoint of the Vitae System, the performance criteria of disaster shelter planning can be first classified into and then integrated together with three basic functions. Accordingly we can think of three types of approach, different in priority and order of the three basic functions. The three approaches are denoted by $S \rightarrow V$ & C type, $V \rightarrow S$ & C type and $C \rightarrow S$ & V type (Table 3).

In $S \rightarrow V$ & C type, we should first think about the survivability, and then at the same time we should think about the vitality and conviviality of a people in a shelter. Likewise, in $V \rightarrow S$ & C type, we first focus on vitality and then survivability and conviviality, and in $C \rightarrow S$ & V type, first conviviality, and then survivability and vitality.

4.1 Approach by $S \rightarrow V$ & C type

(1) Security from disaster risks

To protect people from a hazard and keep them safe are the main purposes of a disaster shelter. Thereby, the safety of a shelter is the first and most important component of the shelter planning. Here the security or safety of the shelter should include ①location safety and ②structure safety. The former means that evacuation shelters should be located outside of the hazard-prone areas, such as flood-prone areas, inundation zones and areas affected by other hazards. The latter mainly focuses on the engineering devices such as enforcing structure. At least, shelters should have aseismatic and fireproof wall, and also have strong wind resistance doors and windows if they are also used to protect people from strong wind hazard such as hurricanes and tornados.

So the security or safety of a shelter can be evaluated first by location safety and structure safety.

Table 3 performance criteria of shelter planning from the viewpoint of vitae system

Type	Criterion	Indicator (example)
	Security from disaster risks	Location, structure
	Accessibility to shelter	Evacuation route, time
	Accommodation capacity of shelter	Area, capacity
	Sustainability of lifeline service	Food and water supply
	Mutual assistance capacity	Inter-assistance between neighboring shelters
	Vital life support services	Improving privacy, spaces and rooms for relaxation
	Connectivity (accessibility) to external resources and information	Evacuate to neighboring shelter
	Connectivity(accessibility) to voluntary assistance and rescue	Voluntary agency
	Telecommunication capacity	TV, telephone
	Social network capacity	Private room

(2) Accessibility to shelter

Accessibility is another basic and critical issue of a disaster shelter selection. The accessibility here means the evacuation accessibility of the refugees to shelter from their locations immediately after a disaster happens. The accessibility can be evaluated by evacuation time, which mainly depends on evacuation route, evacuation tool and evacuation speed.

(3) Accommodation capacity of shelter

When planning a shelter especially an accommodation shelter, the capacity of a shelter in a community and total capacity of whole shelters in a region should be considered according to the possible number of people (potential refugees) to take refuge. And the capacity of accepting and taking care of the old, and the handicapped should also be taken into account. Often the accommodation capacity can be evaluated by dividing available area by necessary area per capita, thereby accepting the victims with special needs, corresponding facilities and equipments such as wheelchair are necessary.

(4) Sustainability of lifeline service

Sustainability in the sense of continuous operation is a fundamental condition from the viewpoint of a recovery and restoration process. Namely, for in the midterm and long term disaster shelter management, whether the necessities of life will be supplied continually and whether lifelines will be maintained stably and orderly in any event, are important for the sustainability of a community during the recovery and restoration period. Therefore the sustainability of lifeline services can be evaluated by the level of supplying necessities of life, such as food, water, power, and gas, etc.

4.2 Approached by V→S & C type

(1) Mutual assistance capacity

Mutual assistance means the inter-assistance between neighboring shelters, such as sharing lifeline maintenance supplies, physical or social care resources, and others.

(2) Vital life support services

To provide vital support services to those who stay in shelters is considered also an important function which tends to be usually neglected in the process of recovery and restoration. This may include improving privacy, protecting noises, and spaces and rooms for relaxation, and other amenity qualities, etc.

4.3 Approached by C→S & V type

(1) Connectivity (accessibility) to external resources and information

Connectivity in the sense of accessibility is mainly from the viewpoint of the disaster process. When a disaster lasts long or affected areas extend, primary shelters are not suitable or safe enough for taking

refuge, and refugees should be displaced to other safer shelters, such as long term shelters with a stronger structure and safer facilities. In this sense, the connectivity to neighboring shelters is important, and it can be evaluated by the number of neighboring shelters, the routes and distances to them. Also the connectivity to external resources and information, such as connectivity to a hospital, are important.

(2) Connectivity (accessibility) to voluntary assistance and rescue

Once a disaster survivor has exhausted all other programs in pursuit of assistance, voluntary assistance and rescue are necessary to assist people in meeting their essential and necessary remaining unmet needs. For example, the American Red Cross (ARC), Salvation Army, and other voluntary organizations active in disaster management can and will provide immediate aid such as clothing, emergency food, medical assistance, emergency shelter, clean-up help, transportation help, and furniture. This kind of assistance is available upon the request of the individual or government agencies during any significant emergency. Connectivity to voluntary assistance and rescue can be evaluated by the number of voluntary agencies and their rescue ability.

(3) Telecommunication capacity

Telecommunications infrastructures are assigned a special position in policy partly because of their important roles in the everyday functioning of society. The best way to appreciate that role is to experience or imagine the effects of a disaster that partially or completely affects the telecom infrastructure. In addition to the direct effects of loss of service, failure of the telecom infrastructure cripples coordination capabilities, significantly hindering rescue and recovery operations. Repairs to other infrastructures, usually also affected by disasters, are difficult to conduct in the absence of a working telecom system. Telecommunication capacity can be evaluated by the number of information and communion facilities, such as telephone, radio, and others.

(4) Social network support capacity

The maintenance of the social network of the victimized community is important after a disaster relief and rescue period. The social network capacity here means the level of aids or probability guaranteed for them to recover the normal function of their social network during the difficult period. That kind of support capacity may be measured by the availability of thoughtful devices for accommodation facilities. For instance, refugees should be assigned their apartments so that basically the same neighborhood location relationships may be guaranteed for them. This is found to provide the minimum condition for victims to maintain their normal social network.

5. Conclusion and discussion

Primary shelters and accommodation shelters are two basically kinds of disaster shelters. The former type of shelters is used to protect people temporarily. In principle they need to be displaced to the latter type of shelters if people are forced to live relatively long if the disaster lasts or expands.

The area level or spatial scale is considered as another important component of shelter planning, and there are commonly four levels, namely household, neighborhood, community and regional or wider level.

From the viewpoint of the vitae system, the performance criteria of shelter planning can be classified into three basic types, ①Survivability (to live through or become alive), ②Vitality (to live lively) and ③Conviviality (to live together or communicate). With this model in mind we have proposed three approaches, each of which is to first focus on either of the three basic functions and then later relate it to the remaining ones in an integrated manner. The three approaches are represented by the symbol $S \rightarrow V$ & C type, $V \rightarrow S$ & C type and $C \rightarrow S$ & V type, respectively. For different hazards and different types of shelters, the criteria may better be changed, but the proposed approaches are expected to apply to any case with specifics being developed case by case.

To further examine the proposed approaches and performance criteria through other case studies and to systematically compare the different results is considered as the next step of our continued research on shelter planning. To follow up on our analysis in terms of risk communication media for a participatory shelter planning and management, shelter analysis at neighborhood level with the support of a GIS will also be carried out in near future.

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生命体システムに基づく避難所計画の概念モデル

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要旨

本研究では、災害避難所の概念とタイプをシステム論的に検討する。さらに、いくつかの国における既存の避難所計画の実例を比較することによって、避難所計画がいくつかの地域レベルに分類できることを示す。次に、生命体モデルに基づいて、三種類の基本的な機能を取り上げるとともに、そのうちの各一つ機能にまず着目し、その後、他の二つの機能に関連付けて総合的に評価する三通りのアプローチを提案する。本方法論の適用可能性と発展の可能性について検討するとともに、今後の研究の必要性についても言及する。

キーワード： 避難所計画，生命体システム，概念モデル