

Designing Facility Environments in Consideration of Elderly People with Dementia

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Abstract: We examined the elements necessary for designing facility environments for elderly people with dementia, hoping that the results could help establish a methodology for designing and evaluating such environments. We presented an element matrix method of design that includes the elements that might best aid elderly people based on the consideration elements, by developing appropriate products and environments for them. This method allows for systematization of various consideration items for elderly people. We thus examined the elements for designing environments for elderly people with dementia with reference to the items specified in previous studies on the Japanese edition of PEAP theory 3 and the guidelines and methods by Cohen et al, which are methodologies for creating facility environments for the elderly with dementia. We found that the items for elderly people with dementia were nearly identical to those for healthy elderly people. Furthermore, detailed examination revealed that some of the elements for elderly people were also important for elderly dementia patients, but had not been identified as such before.

Key words: *Design Method and Tool, Design Evaluation, Human Factors, Design and Usability*

1. Introduction

The creation of environments such as hospital wards that are friendly to elderly dementia sufferers which is a common disorder in the elderly has already been put into practice at many facilities in recent years. However, it is difficult to say that a methodology that realizes them has been established. The 'Professional Environmental Assessment Protocol' (PEAP), is a well-known set of environmental assessment guidelines proposed in the U.S.A. for use in many hospital dementia wards and care facilities, and it expresses the direction of environmental design [1], however, in order to translate it into specific designs the interpretation of personnel at each facility [is required], and the methodology has not been clarified. Manuals based on PEAP theory have been proposed for use by personnel at facilities in Japan [2], but personnel [are required to] extract problems and elicit solutions themselves, and a methodology to elicit specific measures has not been clarified. Alternatively, Professor Cohen and his fellow researchers at the University of Wisconsin [3] have expressed in their guidelines and methods the mindset behind the facilities design in order to make it usable in facilities construction architecture, however it has not been established as a methodology, and is not considered simple for facilities personnel to use. However, the design elements to position the items for the friendly to the elderly with dementia are not clearly specified in these methodologies and thus it appears difficult to analyze or assess the problems in facility environment properly and

efficiently. In this study, we therefore tried to examine the design elements for creation of environments in which elderly people with dementia can live at ease in hospital facilities and so forth. We then tried to derive the facility environment designs friendly to the elderly with dementia and connect them to the establishment of a methodology to assess them.

We presented the methodology for developing products and environments friendly to the elderly. To develop products and environments friendly to the elderly, it is necessary to think about a development concept that anticipates the ways in which the elderly need to be considered. To that end, it is necessary to establish the fundamental conditions which are indispensable for the development of products and environments friendly to the elderly. In this research, they are referred to as the 'elderly-friendly elements.' We consider that if these elderly-friendly elements can be clarified, the accurate development of elderly-friendly products and environments becomes possible. We proposed the element matrix method, based on the consideration elements and consideration items, which can be used in product design[4]. This elderly-friendly elements matrix systematically organizes the diverse consideration items for elderly people, and it is possible to analyze and assess the problems with high precision by using the element matrix. We have applied this elderly-friendly elements matrix in development of actual products for elderly people and confirmed its usefulness.

The method for elderly-friendly elements matrix people clearly specifies the positions of consideration items based on the various physical characteristics of elderly people using element matrix, and it was expected that it could be used for similar analysis and assessment as the case of elderly people, when this element matrix was used for dementia patients. We then used the elderly-friendly elements matrix by conducting a preliminary interview to the staff at hospitals where dementia patients are admitted, and confirmed that there was high potential for assessment with high precision.

In this study, we used elderly-friendly elements matrix whose usefulness was confirmed to examine in detail which of the consideration items can be associated with the consideration items in the Japanese edition of PEAP and the guidelines and methods by Cohen et al, and find the elements for facility environment designs friendly to the elderly with dementia.

2. Consideration elements for creating products and environments friendly to the elderly people

The consideration elements in the element matrix method for developing products and environments friendly to the elderly are divided into the physical aspect and the psychological aspect. There are five elderly-friendly elements to the physical aspect: "burden reduction" associated with the sensory-relevant stimulations and physical activity-related muscle load; "simplicity and clarity" associated with the information patterns and physical activity patterns; "continuity" associated with the time axis involving information flow and action flow; "flexibility" associated with individual differences and human error factors; and the physical "safety" of the user. It was then possible to extract the consideration items derived from these five items: "burden reduction," "simplicity and clarity," "continuity," "flexibility" and "safety" [5]. We proposed the element matrix in Table 1, based on the consideration elements and consideration items, which can be used in product design. This element matrix comprises of two axes: one on the physical aspect for the physical category (classified into sensory (five senses), cognition and comprehension, posture, action and operation, and movement); and one for the consideration elements. It clearly indicates the positioning of each consideration item based on the diverse physical

Table 1. Consideration elements and consideration items for the elderly

<Physical aspect>

Element	Physical division		Sensory & perception		Physical activity		
	Constituting element		Sensory (five senses)	Cognition & comprehension	Posture	Action & operation	Movement
Burden reduction	Volume & force		<ul style="list-style-type: none"> - Being not dazzling (anti-glare, etc.) - Easy and not tiring on the eyes - Not being too stimulating to the touch - Sounds are easy on the ears (kept to relatively low frequencies) 	<ul style="list-style-type: none"> - Information is the minimum necessary and easy to understand (few objects for visual recognition, etc.) 	<ul style="list-style-type: none"> - Not forced into postures that involve unrealistic bending - No parts of the body are overloaded 	<ul style="list-style-type: none"> - A little effort is sufficient - A little time exerting effort is sufficient 	<ul style="list-style-type: none"> - Short distance to move - Able to take a breath during and after walking - Carrying is easy
Simplicity & clarity	Patterns	Simplicity			<ul style="list-style-type: none"> - Able to take a natural, not problematic posture 	<ul style="list-style-type: none"> - Actions and operations can be performed simply or can be abbreviated 	<ul style="list-style-type: none"> - Walking paths are short and straight, or can be abbreviated (start to finish)
		Clarity	<ul style="list-style-type: none"> - Displays can be read with clarity (display contrast, etc.) - Sound can be heard clearly 	<ul style="list-style-type: none"> - Information can be clearly understood (simplicity and consistency of information, etc.) - Operation concept is easy to understand 		<ul style="list-style-type: none"> - Actions and operations are clear 	
Continuity	Time axis	Flow	<ul style="list-style-type: none"> - Movement of the line of sight is smooth and easy to see - Low burden of adjustment to light and dark through sudden changes in lighting - Low burden through no sudden temperature changes 	<ul style="list-style-type: none"> - Continuity of information input, easy to understand (no recognition of multiple information at the same time) 		<ul style="list-style-type: none"> - Actions and operations can be achieved smoothly - Residents not made to combine multiple actions and operations at the same time 	<ul style="list-style-type: none"> - Walking paths are smooth and continuous - No barriers to walking paths (steps, inclines, corrugated surfaces, etc.)
		Stability			<ul style="list-style-type: none"> - A stable and comfortable posture can be maintained 	<ul style="list-style-type: none"> - Fingers, etc. are stable 	<ul style="list-style-type: none"> - Walking is stable
		Experience		<ul style="list-style-type: none"> - The methods of use are ones [residents] have experience in, and are easy to understand 		<ul style="list-style-type: none"> - Action and operation methods are the same as previously and involve easy movements 	
Flexibility	Precision		<ul style="list-style-type: none"> - Displays do not require being looked at closely - Coping is possible even if not clearly heard 	<ul style="list-style-type: none"> - No problems even if mistaken cognition - No problems even if forget (operation methods, etc.) 	<ul style="list-style-type: none"> - Posture can be changed, not become fatigued 	<ul style="list-style-type: none"> - Can cater to rough movement (such as in case of operations) 	<ul style="list-style-type: none"> - There is flexibility in the walking paths (there is leeway in the space)
	Individual differences		<ul style="list-style-type: none"> - Easy to see regardless of variations such as strength of sight - If not possible through vision, then selection is possible through hearing or touch 	<ul style="list-style-type: none"> - Can be adapted to each individual's different cognition and comprehension levels 	<ul style="list-style-type: none"> - Usable even with differences in individual posture measurements 	<ul style="list-style-type: none"> - Can be matched to the individual's muscular strength - Can be used for different bounds of action - Copes with slow actions 	<ul style="list-style-type: none"> - Copes with differences in walking ability such as differences in walking speed - Walking is possible even if leg and hip function is degraded
Safety	Safe		<ul style="list-style-type: none"> - Can be used safely, such as not being burned even if [it is] touched 	<ul style="list-style-type: none"> - Able to recognize danger (such as hot items) - No danger even if mistaken cognition - No danger even if forget (operation methods, etc.) 	<ul style="list-style-type: none"> - Able to maintain bodily balance 	<ul style="list-style-type: none"> - Safe even if mistaken action - Fingers do not become snagged or jammed 	<ul style="list-style-type: none"> - Do not slip - Do not stumble - Injury minimized even in the case of a fall

<Psychological aspect>

Consideration elements	Social division		Oneself	Person to person (relationships)
Affinity	Senses (five senses)		Experience	- Satisfying affinity between people
Status property (achievement)	Personality		Actions	
	<ul style="list-style-type: none"> - Satisfying the desire to possess - Satisfying one's heart 		<ul style="list-style-type: none"> - Having one's own way - Praising 	<ul style="list-style-type: none"> - Being praised

characteristics of elderly people using matrix. Consideration element "burden reduction" includes items to reduce the stimulation of five senses such as not making it too bright regarding category sensory (five senses), items to minimize the information and make it easy to understand regarding cognition and comprehension, items not to force difficult postures regarding posture, items to minimize the muscular burdens in movements or operations regarding action and operation, and items to reduce the moving distance regarding movement. Consideration element "simplicity and clarity" includes consideration to make indications clearly visible regarding sensory (five senses), provide information clearly in an easy-to-understand manner regarding cognition and comprehension, allow natural posture that is not problematic regarding posture, allow smooth action and operation regarding action and operation, and simplify the walking paths so they are straight and simple regarding movement.

Consideration element "continuity" includes consideration to make the line of sight smooth and easy to see regarding sensory (five senses), provide information with continuity and relate to their experience to facilitate understanding regarding cognition and comprehension, help maintain stable posture regarding posture, allow smooth action and operation regarding action and operation, and make the walking paths smooth and continuous so that it is easier to walk regarding movement. Consideration element "flexibility" includes consideration to cope with mistakes in vision or mishearing and address individual differences in eyesight regarding sensory (five senses), make it possible to adapt even if someone misunderstands and address the individual differences in level of understanding regarding cognition and comprehension, allow change in posture address the differences in body sizes regarding posture, allow rough operation regarding action and operation, and make the walking paths smooth and continuous so that it is easier to walk regarding movement. Lastly, consideration element "safety" includes consideration to prevent burning even if one touches regarding sensory (five senses), provide information so that danger is clearly recognized regarding cognition and comprehension, allow maintenance of balanced posture so that there is no falling regarding posture, eliminate danger in case one's hand slips during operation regarding action and operation, and prevent slipping while walking regarding movement.

For psychological aspect, two elements were extracted [6]; "affinity" for familiarity and "status property (achievement)" to satisfy the sense of status for oneself through the sense of achievement by owning or using something by oneself through respect for personality, and consideration items were derived from these two elements. Consideration element "affinity" includes consideration to reduce the sensory stimulation to remove anxiety and give experience regarding oneself, and give affinity among people regarding relationships. Consideration element "status property (achievement)" includes consideration to satisfy the desire to possess, respect personality through helping satisfy one's wishes, allow one to act as he/she wishes through actions, and help feel the sense of achievement and thus the sense of status by allowing self-assessment regarding oneself, and help facilitate the sense of status through evaluation by others regarding relationships.

3. Correlation between the consideration items of the Japanese edition of PEAP 3 and the guidelines and methods by Cohen et al. and our elderly-friendly elements

The Japanese edition of PEAP 3 includes guidelines for wide-ranging environmental support for elderly people with dementia sufferers in care centers and similar facilities. As shown in Table 2, these guidelines are comprised of eight dimensions; "I. Regarding support for orientation," "II. Regarding support for functional

ability," "III. Regarding quality and adjustment of stimulation in the environment," "IV. Regarding support for safety and security," "V. Regarding support for continuance of lifestyle," "VI. Regarding support for self-selection," "VII. Regarding securing privacy," and "VIII. Regarding promotion of contact among residents," and these are the items that become the pillars (objectives) in environmental support to elderly people with dementia. Each dimension is comprised of multiple items to be the points in environmental support.

The results of correlation between the items of the Japanese edition of PEAP 3 and the elderly-friendly elements using the elderly-friendly elements matrix described previously are shown in Table 4. That is, the table shows how the consideration items in the Japanese edition of PEAP 3 are positioned in the elderly-friendly elements matrix.

The items that seem to be related to the sensory (five senses) category of the elderly-friendly elements matrix are 1) Provision of sound with good quality and significance and 2) adaption to the environment by visual stimulation, which are environmental support points in "III. Regarding quality and adjustment of stimulation in the environment," and it is suggested that too much stimulation with noise and so forth that would be uncomfortable should be avoided. They are therefore consideration items corresponding to burden reduction, which is an elderly consideration element to reduce sensory stimulation. In addition, the consideration item 1) Utilization of information in environment in "I. Regarding support for orientation" considers the visibility of indicated information and so forth and thus can be assumed an item on simplicity and clarity in elderly-friendly elements.

As items related to cognition and comprehension, environmental support points 1) Utilization of information in environment, 2) Assistance in recognition of time and space, and 3) Spaces and places that are easy to understand in "I. Regarding support for orientation" are suggested. These are consideration items to help people with dementia understand where the living room, bathroom and so forth are with indications and pictures and help them understand the flow of time, spaces and events such as meals so that their everyday life is stable, and they are consideration items regarding space such as varying the interiors to clarify where one is. Thus they are assumed to be consideration items for simplicity and clarity in elderly-friendly elements. In addition, an item called "Reduction of living unit scale" is suggested as a measure for 3) Spaces and places that are easy to understand. It means that the scale of the living space should be minimized so that there is no need to take in a

Table 2 Consideration items of the Japanese edition of PEAP 3

Dimension	Points in environmental support
I. Regarding support for orientation	1) Utilization of information in environment, 2) Assistance in recognition of time and space, 3) Spaces and places that are easy to understand, a measure for 3): Reduction of living unit scale, 4) Ensuring field of vision
II. Regarding support for functional ability	1) Assistance to facilitate the self-supporting abilities of residents in self-care, 2) Assistance to eat by oneself, 3) Assistance in activities such as cooking, washing and shopping
III. Regarding quality and adjustment of stimulation in the environment	Regarding quality of stimulation in the environment, 1) Provision of sound with good quality and significance, 2) Adaption to the environment by visual stimulation, 3) Appealing to senses with scent, 4) Provision of soft materials Regarding adjustment of stimulation in the environment, 1) Adjustment of noise that may disturb living, 2) Provision of appropriate visual stimulation, 3) Adjustment of foul odor, 4) Consideration for dangers posed by changes in material in floor and so forth
IV. Regarding support for safety and security	1) Ease in watching over the residents, 2) Securing safe daily life
V. Regarding support for continuance of lifestyle	1) Assistance for continuance of familiar actions and lifestyle, 2) Expression unique to oneself, 3) Creation of homely environment
VI. Regarding support for self-selection	1) Flexible handling of the residents, 2) Selection of spaces and places, 3) Existence of many small tools including chairs, 4) Room for selection in the living room
VII. Regarding securing privacy	1) Privacy policy for the facility, 2) Securing privacy in living room, 3) Selection of space for securing privacy
VIII. Regarding promotion of contact among residents	1) Provision of space to facilitate contact, 2) Furniture and its arrangement to promote contact, 3) Provision of small tools to trigger contacts, 4) Supporting social life

lot of information, and thus it is considered an item for burden reduction to minimize the amount of information in elderly-friendly elements.

As items considered to be related to posture, action and operation or movement in physical activity, there are three environmental support items in "II. Regarding support for functional ability." The item called assistance to facilitate the self-supporting abilities of residents in 1) Self-care corresponds to the assistance to facilitate the self-supporting abilities of the residents as much as possible in using bathrooms, taking baths, strengthening posture, and putting on or taking off clothing. The item 2) Assistance to eat by oneself indicates consideration to allow one to eat by himself/herself. 3) Assistance in activities such as cooking, washing and shopping indicates consideration to make the activities of cooking, washing, shopping and so forth easier to use and access. These three items correspond to all categories of posture, action and operation, and movement in element matrix, and seemed to correspond to all five items of burden reduction, simplicity and clarity and so forth which are the consideration elements to help them relax and move, although there is no clear specification of items. In "IV. Regarding support for safety and security," there is item 2) Securing safe daily life as an environmental support point, and it seems to correspond to safety, which is a physical consideration element, although there is no clear specification of items.

Regarding items in psychological aspect, quality of stimulation in environment as four environmental support points in "III. Regarding quality and adjustment of stimulation in the environment," which are 1) Provision of sound with good quality and significance, 2) Adaption to the environment by visual stimulation, 3) Appealing to senses with scent, and 4) Provision of soft materials are applicable. In addition, three items of 1) Adjustment of noise that may disturb living, 2) Provision of appropriate visual stimulation and 3) Adjustment of foul odor correspond to the adjustment of stimulation in environment. These items are all consideration to familiarize the stimulation of five senses in the environment and thus can be assumed those corresponding to affinity to facilitate familiarity in sensory (five senses) category of psychological aspect. However, 4) Consideration for dangers posed by changes in material in floor and so forth, which is an item for adjustment of stimulation corresponds to the safety in movement category of physical aspect. Furthermore, 4) Ensuring field of vision in "I. Regarding support for orientation" is consideration to increase security by seeing the familiar life scenes through experience, and environmental support points 1) Assistance for continuance of familiar actions and lifestyle and 3) Creation of homely environment in "V. Regarding support for continuance of lifestyle" are consideration to allow familiarity in living and actions through experience. These are considered as items corresponding to affinity which helps the feeling of security using experience. Items related to relationships include the four environmental support points in "VIII. Regarding promotion of contact among residents," which are 1) Provision of space to facilitate contact, 2) Furniture and its arrangement to promote contact, 3) Provision of small tools to trigger contacts, and 4) Supporting social life. The environmental support points of these four items try to satisfy affinity between people, and they are considered the items for affinity in psychological aspect of elderly-friendly elements. In addition, environmental support point 1) Ease in watching over the residents in "IV. Regarding support for safety and security" refers to consideration so that the residents would not feel anxious or lonely and thus should correspond to consideration for relationship in affinity in the psychological aspect of elderly-friendly elements.

Next, 2) Expression unique to oneself in "V. Regarding support for continuance of lifestyle" is consideration of individual personality and thus corresponds to the status property element in psychological aspect. There are four environmental support points in "VI. Regarding support for self-selection," which are 1) Flexible handling of

the residents, 2) Selection of spaces and places, 3) Existence of many small tools including chairs, and 4) Room for selection in the living room. The point of environmental support in these four items is assumed to lead to the establishment of one's status through free selection of environmental factors by the elderly people with dementia, and thus they seem to correspond to achievement in psychological aspect of the elderly-friendly elements. The item related to action in 2) Assistance to eat by oneself of "II. Regarding support for functional ability" also corresponds to the consideration element for status property to satisfy the desire for achievement in the psychological aspect so that one would want to eat meals as his/her own action. As items related to relationships, "VII. Regarding securing privacy" has three environmental support points, which are 1) Privacy policy for the facility, 2) Securing privacy in living room, and 3) Selection of space for securing privacy. Since the point of environmental support in these three items is to establish one's status through securing of privacy for elderly people with dementia, they seem to correspond to status property in relationship category of psychological aspect of elderly-friendly elements.

Next, the correlation between the items of the guidelines and methods by Cohen et al. and our elderly-friendly elements is discussed.

The guidelines and methods by Cohen et al. propose the method for creating living spaces to mitigate the symptoms and help the care of elderly people with dementia. As shown in Table 3, the basic principles of the design comprise of 1) Environment with features unlike those of detention facilities, 2) Removal of environmental barriers, 3) Effect of things one owns for a long time, 4) Sensory stimulation without stress as environmental attributes and 1) Clustered arrangement of small social activity spaces, 2) Opportunities for walking with significance, 3) Effective outdoor spaces, 4) Environments with life forms, and 5) Continuous and diverse spaces for both public and private as the building structure attributes. For each basic principle, multiple design concepts are assigned. Table 4 shows how these consideration items are positioned in the elderly-friendly elements matrix.

As items related to sensory (five senses) in the elderly-friendly elements matrix, design concepts "adjustment of stimulation corresponding to the living patterns," "stimulation level adjustment method" and "necessity for appropriate stimulation" for environmental attribute 4) Sensory stimulation without stress are applicable. "Adjustment of stimulation corresponding to the living patterns" indicates adjustment so that there will be no

Table 3 Consideration items of the guidelines and methods by Cohen et al.

Basic principle	Design concept
Environmental attributes	
1) Environment with features unlike those of detention facilities	"Human scale," "avoiding hard structures," "variation in a common theme"
2) Removal of environmental barriers	"Diverse sensory signals," "consistent message," "emphasizing of necessary messages by mitigation of background stimulation," "supplementary design"
3) Effect of things one owns for a long time	"Space for familiar tasks," "art gallery," "familiar places and people," "relations to facility policy"
4) Sensory stimulation without stress	"Adjustment of stimulation corresponding to the living patterns," "stimulation level adjustment method," "necessity for appropriate stimulation"
Building structure attributes	
1) Clustered arrangement of small social activity spaces	"Clustered space configuration," "encouragement of wide range of homely activities"
2) Opportunities for walking with significance	"Continuity," "walking paths that are easily recognized," "landmarks," "limitation of area," "alcoves for activities," "outdoor walking paths"
3) Effective outdoor spaces	"Opportunities for activities given in outdoor spaces," "outdoor view," "natural surrounding and physical safety," "discreet surveillance," "effective control regarding climate," "freely movable chairs"
4) Environments with life forms	"Places for plants such as greenhouses and sun-rooms," "pets for homes"
5) Continuous and diverse spaces for both public and private	"Space to be alone," "protected space," "intermediate spaces," "public space"

excessive stimulation of elderly people with dementia, such as alarms, and "stimulation level adjustment method" and "necessity for appropriate stimulation" also indicate consideration so that the stimulation of five senses in elderly people with dementia is adjusted to a proper level. Thus they correspond to burden reduction in consideration elements. Since the item "effective control regarding climate," which is a design concept for 3) Effective outdoor spaces in building structure is consideration to avoid severe climatic environments for elderly people with dementia, it is also assumed an item for burden reduction to reduce the stimulation of sensory (five senses) category in physical aspect. The environmental attribute in the basic principles, 2) Removal of environmental barriers has a design concept "emphasizing of necessary messages by mitigation of background stimulation," which is consideration of clarifying information with visual contrast. It is thus an item for simplicity and clarity in sensory (five senses) category. Similarly, "diverse sensory signals," a design concept for 2) Removal of environmental barriers refers to addressing individual differences and thus corresponds to flexibility in sensory (five senses) category of elderly consideration.

Regarding the items related to cognition and comprehension, "human scale," which is an environmental design concept for environmental attribute in the basic principles 1) Environment with features unlike those of detention facilities, is applicable as consideration for burden reduction in the sense that information in space should be minimized to make it easier to recognize by minimizing the building and dividing its indoor spaces into clearly recognizable spaces. In addition, "walking paths that are easily recognized," "landmarks" and "limitation of area" which are the design concepts for 2) Opportunities for walking with significance in building structure correspond to simplicity and clarity in cognition and comprehension category of physical aspect as they help the environment to be clearly recognized using indications and landmarks. "Consistent message," a design concept for environmental attribute in the basic principles 2) Removal of environmental barriers can be considered an item for continuity in the sense that consistency in information makes it easier to understand.

As items related to action and operation, "supplementary design" which is a design concept for environmental attribute in the basic principles 2) Removal of environmental barriers applies to all of the five items of burden reduction, simplicity and clarity and so forth in the action and operation category as it refers to assistance in movements.

For the category of movement, "natural surrounding and physical safety," a design concept for building structure attribute 3) Effective outdoor spaces, is considered an item for safety since it indicates ensuring the range of movement without danger.

For items in psychological aspect, design concept "avoiding hard structures" for the environmental attribute in the basic principles 1) Environment with features unlike those of detention facilities applies as it indicates mitigation of sensory impression of being hard by minimizing the "hard" quality for elderly people with dementia. "Adjustment of stimulation to address the living patterns," a design concept for the environmental attribute in the basic principles 4) Sensory stimulation without stress as environmental attributes, refers to mitigation of sensory stimulation by spatial separation. "Stimulation level adjustment method" and "necessity for appropriate stimulation" indicate adjusting to eliminate very low stimulations that may cause one to become mentally unstable in an empty space or conversely excessive stimulation such as alarms from around elderly people with dementia. These items are consideration to mitigate the sensory stimulation, and thus they correspond as affinity in psychological aspect. However, consideration to avoid stimulations that are too low seems to be an item that is not required very much for elderly people in general. The design concept "continuity" for building structure

attribute 2) Opportunities for walking with significance means not causing anxiety by creating dead ends. The design concepts "outdoor view," "natural surrounding and physical safety" and "discreet surveillance" for building structure attribute 3) Effective outdoor spaces have the effect of reducing the detention center-like image of the facility. These items seem to correspond to affinity in psychological aspect in the sense that they reduce sensory stimulation. Furthermore, design concepts "space for familiar tasks" and "familiar places and people" for the environmental attribute in the basic principles 3) Effect of things one owns for a long time indicate provision of familiar environment through one's own experience. "Art gallery" also corresponds to satisfaction by exhibition of tools and so forth one used to use in the past. "Relations to facility policy" indicates bringing possessions or furniture from the homes of elderly people with dementia. "Encouragement of wide range of homely activities" means providing a wide range of opportunities for activities that are close to those conducted typically in ordinary homes. These items correspond to affinity in psychological aspect to remove anxiety by providing environments with experience. Design concepts "places for plants such as greenhouses and sun-rooms" and "pets for homes" for building structure attribute 4) Environments with life forms correspond to satisfying affinity in psychological aspect by enjoying familiar nature for people or keeping familiar animals. As items related to relationships,

Table 4. Consideration elements for creation of environments for elderly people with dementia

Physical aspect ● PEAP Japanese version 3 ○ Guidelines and methods by Cohen et al.

Physical classification Consideration elements	Sensory (five senses)	Cognition & comprehension	Posture	Action & operation	Movement
Burden reduction	● Provision of sound with good quality and significance ● Adaption to the environment by visual stimulation ○ Principle: Sensory stimulation without stress (alarm sound, etc.) ○ Effective control regarding climate	● Reduction of living unit scale (reduction in scale of living space) ○ Human scale		○ Principle: Removal of environmental barriers (supplementary design)	
Simplicity & clarity	● Utilization of information in environment (how easy it is to see the indicated information) ○ Emphasizing of necessary messages by mitigation of background stimulation	● Utilization of information in environment (information that is easy to understand) ● Assistance to recognition of time and space ● Understandability of space and place ● Ensuring field of vision ○ Corridors, landmarks and zones that are easy to understand		● Assistance to facilitate the self-supporting abilities of residents in self-care ● Assistance to eat by oneself ● Assistance in activities such as cooking, washing and shopping	
Continuity	✳	○ Consistent message			
Flexibility	○ A variety of cognitive signals	✳			
Safety		Ensuring safe daily life			● Consideration for dangers posed by changes in material in floor and so forth ○ Natural enclosure and physical safety
Psychological aspect					
Social division Consideration elements	Oneself			Person to person (relationships)	
Affinity	● Senses (five senses) ● Dimension: Quality of stimulation and adjustment (visual impact, sound, scent, material, etc. in the environment) ○ Avoiding hard structures ○ Principle: Sensory stimulation without stress ○ Continuity ○ Outdoor view ○ Natural surrounding and physical safety ○ Discreet surveillance	● Experience ● Ensuring field of vision ● Continuation of familiar behavior patterns and lifestyle ● Creation of homely environment ○ Principle: Utility of old possessions ○ Principle: Environments with life forms		● Ease in watching over the residents ● Dimension: Promotion of contact among residents ○ Principle: Cluster-like arrangement of small social activity spaces ○ Opportunities for activities given in outdoor spaces ○ Freely movable chairs	
Status property (achievement)	● Personality ● Expression of one's own ● Dimension: Assistance for self-choice ○ Principle: Variation in a common theme	▲ Actions ● Assistance to eat by oneself ○ Alcove for activities ○ Outdoor walking paths		▲ Dimension: Ensuring privacy ○ Space to be alone ○ Protected space ○ Freely movable chairs	

● Match with elements for healthy elderly people
 ○ Slight match with elements for healthy elderly people but no clear indication of specific items
 ▲ Slight match with elements for healthy elderly people but lacking in important items
 ✳ No items matching with elements for healthy elderly people

design concept "clustered space configuration" for building structure attribute 1) Clustered arrangement of small social activity spaces indicates assistance in social activities of elderly people with dementia by connecting the small spaces for related activity units (eating, washing, etc.) in a cluster, and it corresponds to affinity in the consideration elements for constructing environments to satisfy affinity among people. However, "public space" corresponds to affinity in psychological aspect in the sense that consideration should be made not to overwhelm elderly people with dementia by visual stimulation in spaces where many people gather, such as lobbies and cafeterias.

Next, design concept "variation in a common theme" for the environmental attribute in the basic principles 1) Environment with features unlike those of detention facilities seems to correspond to status property in psychological aspect to respect the individual personality by adjusting for each person. Design concept "alcoves for activities" in building structure attribute 2) Opportunities for walking with significance indicate establishing spaces that would interest elderly people with dementia along the paths, and it corresponds to status property in psychological aspect as the will to act leads to satisfaction of desire for achievement, and "outdoor walking paths" also corresponds to the same for inducing the will to act and go out, although it is a simple extension of utilization of outdoor space. As items related to relationships, there is 5) Continuous and diverse spaces for both public and private as a building structure attribute in the basic principles, and its design concepts "space to be alone" and "protected space" correspond to status property in psychological aspect in the elderly-friendly elements in the sense that the privacy of elderly individuals with dementia is respected. "Intermediate spaces" refers to spaces where they do not need to actively participate in activities but can observe perceptively, and it seems to correspond to both affinity and status property for relationships in psychological aspect. Design concept "opportunities for activities given in outdoor spaces" for building structure attribute 3) Effective outdoor spaces applies to affinity in psychological aspect of the elderly-friendly elements in the sense that connection among people and social (group) activities are induced. Design concept "freely movable chairs" for building structure attribute 3) Effective outdoor spaces in the basic principles seems to apply as affinity as well as status property in relationships category of psychological aspect as it is useful in ensuring enjoying social exchanges and privacy.

4. Consideration elements for creation of environments for elderly people with dementia

All the items in the Japanese edition of PEAP 3 and the guidelines and methods by Cohen et al. corresponded to the elderly-friendly elements, and none was inapplicable to any of the elderly-friendly elements, including ambiguous items. Therefore, it was found that the consideration elements for creation of environments for elderly people with dementia nearly matched the elderly-friendly elements.

First, on physical aspect, consideration elements in the five items of "burden reduction," "simplicity and clarity," "continuity," "flexibility" and "safety" were confirmed in the items of the two methodologies. However, for the sensory (five senses) category, the consideration elements were confirmed in three items "burden reduction," "simplicity and clarity" and "flexibility" and for the cognition and comprehension category, elements for three items "burden reduction," "simplicity and clarity" and "continuity" were confirmed. For consideration element "safety," elements for physical aspect in overall were confirmed, but the only clear item that can be corresponded in the physical classification was for the movement category. "Safety" is also an important element for elderly people with dementia, and items corresponding to each of the categories such as sensory (five

senses) and cognition and comprehension in the elderly-friendly elements matrix need to be specified in order to consider safety.

While there were few items that could be clearly identified in the two methodologies as elements for posture, action and operation or movement in the physical aspect, there is a symptom called "precedence," which is a conduct disorder depending on the purpose in elderly people with dementia, and they are also known to have higher tendency to fall than healthy elderly people. Therefore, consideration of items in categories posture, action and operation and movement is also necessary in the elderly-friendly elements matrix. Since similar consideration items as elderly people are expected to apply in terms of physical activities, it is assumed that items corresponding to the five items of "burden reduction," "simplicity and clarity," "continuity," "flexibility" and "safety" in elderly-friendly elements need to be specified. Although items on flexibility in the cognition and comprehension category were not found in the items for elderly people with dementia, recognition errors such as forgetting in elderly people with dementia shall be addressed. The element of flexibility in the cognition and comprehension category is important. The items on continuity were lacking in the sensory (five senses) category. Since consideration of adaptation to light and dark as well as the line of sight to facilitate seeing needs to be made in a similar fashion to elderly people, this category in continuity also needs to be specified with items.

In psychological aspect, consideration elements for both two items "affinity" and "status property (achievement)" were confirmed from the two methodologies. When correlation between the items of the two methodologies and the elderly-friendly elements is studied in detail, the items in sensory (five senses), experience and relationships categories matched those of elderly-friendly elements as shown in Table 2. However, "appropriate sensory stimulation" is specified as an item in addition to simply minimizing the sensory stimulation in the sensory (five senses) category, unlike the case of the friendly to the elderly. While it is necessary to incite the will to act as an item on action in the element of status property, items such as "Having one's own way" and "praising" in elderly consideration items are also important so that they can have the sense of achievement in acting to feel their own status property. The items of the two methodologies do not include those that would give the sense of achievement of actions taken. The consideration item for giving the sense of achievement may be an important clue in considering environments to induce positive actions from elderly people with dementia. Lastly, it is also considered important to include items to allow the sense of status by being "praised" by others, as indicated by an item in the elderly consideration items, while it is also necessary to ensure privacy in relationships. Consideration to facilitate high evaluation from others through the good appearance of the things they wear or have around them and so forth is necessary. It was found that the items in the two methodologies regarding the consideration element of status property were not sufficient to address the element, and that some important items for satisfying the sense of status were lacking.

Creation of environments friendly to the elderly with dementia must be done with designs based on the elements to be considered for these people. Therefore, the design elements for creation of environments friendly to the elderly with dementia correspond to the five items of physical aspect; "burden reduction," "simplicity and clarity," "continuity," "flexibility" and "safety," and the two items of psychological aspect; "affinity" and "status property (achievement)," which we have confirmed as the consideration items for elderly people with dementia. As shown in Table 4, items corresponding to each of the five items such as "burden reduction" and "simplicity and clarity" should be assigned in each physical category in the physical aspect, and the items corresponding to each of the elements "affinity" and "status property (achievement)" should be assigned in the psychological aspect.

5. Conclusions

To examine the design elements for creation of environments friendly to the elderly with dementia, we used the elderly-friendly elements matrix to examine the items in the Japanese edition of PEAP theory 3 and the guidelines and methods by Cohen et al., which are guidelines for elderly people with dementia. As a result, we found that the consideration items of the two methodologies corresponded to the elderly-friendly elements, and that the consideration elements for creation of environments for elderly people with dementia nearly matched the elderly-friendly elements. We also examined each consideration element in detail and found that there were some important elements which had not been pointed friendly to the elderly with dementia before that were included in elderly-friendly elements. We also found that some important items were lacking in the psychological aspect, while some matched the elderly-friendly elements.

It is surmised that the design elements for creation of environments friendly to the elderly with dementia correspond to the five items of physical aspect; "burden reduction," "simplicity and clarity," "continuity," "flexibility" and "safety," and the two items of psychological aspect; "affinity" and "status property (achievement)," which are the consideration elements for elderly people with dementia. As the design elements for creation of environments friendly to the elderly with dementia are identified, it will be possible to position the diverse consideration items and thus to conduct analysis and assessment with high precision by combining both physical and psychological aspects in creation of such environments.

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