Exploration of Long-Term Care Institution Managers' Perceptions of Institutional Indoor Environment Quality and Ease of Administration

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This study investigated the level of management's perception of the importance of indoor environment indicators at long-term care facilities as well as the differences between the level of perceived importance and the level of implementation. This study also analyzed the indicators for improving indoor environments. This study selected Taiwanese long-term care facility managers as its subjects to whom questionnaires were distributed by mail. Descriptive statistics, a one-way analysis of variance (ANOVA), and an importance-performance analysis were used to conduct analyses on the data retrieved from the questionnaires. The results indicate that, of the indoor environment indicators of four facility spaces, bedrooms had the highest perceived level of importance. The lounge was the easiest space in which to implement the indicators. Differences were found between the perceived level of importance and the level of implementation for six of the indoor environment indicators of the four facility spaces. In these four spaces, the ventilation indicator was the most important, whereas implementing the temperature and humidity indicators was the most difficult. The highest priority for indicator improvement was given to the temperature in the bedrooms and bathrooms, whereas control over temperature, humidity, and sound had a low priority. The indicators seen as requiring continuous maintenance were lighting and ventilation. Facility managers had a high level of awareness and competence in implementing the ventilation indicator. However, although they were aware of the importance of the temperature, humidity, and sound indicators, their implementation was difficult, suggesting that they needed to be improved.

Keywords: indoor environment quality; long-term care institution; long-term care institution director; lighting; ventilation; sound

A long-term care (LTC) institution should attach particular importance to indoor environment quality because the most frequently occurring infectious diseases in LTC institutions are respiratory infectious diseases such as tuberculosis (Bradley, 1999; Chen, Chiung, Yong, & Dah-Shyong, 2008; Hu et al., 2007; Lin, Lang, Hua, & Tiau, 2004). In 1993, Taiwan's proportion of older adult rose to more than 7%, whereupon Taiwan formally became an aging society. By 2010, the proportion of older adult was 10.7%, and the number of LTC institutions had risen from 183 in 1999 to 1,441. Given this increase in the number of LTC institutions, their ability to manage the quality of their indoor environments has become an important factor in the physical health of their residents.

Numerous studies have investigated the indoor environment indicators of LTC institutions such as indoor air quality (IAQ), temperature, humidity, sound, lighting, and ventilation. They have emphasized that the provision of an appropriate indoor environment enables residents and caregivers to enjoy a comfortable environment (Hoof, Kort, Duijnstee, Rutten, & Hensen, 2010; Ming, Cheng, Ming, & Yi, 2001; Taiwan Architecture & Building Center, (n.d.); Jiang & Ryu, 2010; Jiang, Ryu, & Kagawa, 2008; Jiang, Ryu, & Liu, 2009). However, few studies have investigated the issues concerning LTC institutions' control over their indoor environments. It is therefore unknown whether facilities are capable of controlling and managing indoor environment indicators. Managers of LTC institutions are responsible for handling facility-related affairs (Robbins & Langton, 2000). According to studies on managerial competency and the definitions provided by the existing literature, managers must possess knowledge and skills, be capable of implementing various activities in their professional fields, and achieve a high level of implementation (Katz, 2009; Quinn, Clair, Faerman, Thompson, & Mcgrath, 1996). Therefore, this study selected

http://dx.doi.org/10.1891/1521-0987.13.3.121

managers as its subjects to investigate the differences between management's perception of the importance of indoor environment quality and the level of its implementation. This study also analyzed the indoor environment indicators that must be improved before the indoor environment quality of an LTC institution can be improved.

EMPIRICAL STUDIES OF INDOOR ENVIRONMENT QUALITY

The Taiwan Environmental Protection Administration (EPA; n.d.) has established recommended indoor air quality values for Type 1 buildings (sites that require unique IAQ levels such as hospitals and care facilities for the older adult and people with disability). It recommends a maximum CO_2 level of 600 parts per million (ppm; over 8 hours), a maximum fungi level of 1,000 (colony forming units) CFU/m^3, and an O_3 level of 0.03 ppm (over 8 hours). According to the EPA's advice, the best method of improving IAQ is to install a new ventilation system or change the current ventilation system.

Studies concerning the IAQ of LTC institutions have pointed out that the concentration of fungi or total bacteria may also vary according to the facility's ventilation system. These studies have advised LTC institutions to attach importance to the ventilation components of air conditioning systems and reduce the grouping of residents to ensure good IAQ (Fang et al., 2010; Tsu, Li, Chou, & Chiang, 2003; Wu, Chao, Chen, Chang, & Yu, 2007). These studies all indicate that a facility's IAQ correlates with its ventilation system. Based on these studies, this study hypothesized that the provision of good ventilation is an important indicator for indoor environment quality. As their sense of smell gradually deteriorates after they reach the age of 60 years, the older adult can unconsciously inhale hazardous substances (Ebersole, Touhy, Hess, Jett, & Luggen, 2007).

The deterioration of sense organs in the older adult also hinders them from perceiving changes in temperature. Therefore, it is difficult for them to perceive the danger when their bodies are affected by temperature (Kawahara & Saito, 2005). The Taiwan EPA's recommended temperature value for Type 1 buildings is set at between 15 and 28°C. However, a recommended value for humidity has not yet been provided. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE; 2009) advises that the relative humidity of a general indoor environment should be maintained at between 40% and 60% during the summer and between 30% and 50% during the winter.

Japanese studies have indicated that the favorite summer temperature of the older adult living in LTC institutions is 25 ± 2°C (Jiang, Ryu, & Liu, 2009; Yan et al., 2009). The expected temperature range for hospitalized patients is between 22.0 and 25.9°C, suggesting that hospitalized patients prefer a warmer environmental condition (Hwang, Lin, Cheng, & Chien, 2007). Excessive dampness inside buildings may lead to the growth of mould, which may trigger asthma-related respiratory diseases. As a result, it is necessary to manage buildings' humidity and ventilation aggressively (Krieger & Higgins, 2002; Singh, Yu, & Kim, 2010; World Health Organization, 2009). These studies show that temperature and humidity are the factors most affecting the comfort levels of the frail and of the patients with dementia. Therefore, this study hypothesized that the provision of proper temperature and humidity levels is one of the important factors affecting indoor environment quality.

Taiwan's EPA has defined *noise* as a sound exceeding the control standard. Sounds under 50 dB will allow people to feel comfortable; those between 50 and 70 dB will cause mild discomfort, and those above 70 dB will lead to symptoms such as anxiety, irritability, nervousness, increased blood pressure, and autonomic nervous excitement.

Some studies have indicated that the lighting, noise (e.g., from trolley wheels, monitor beeps, and cell phones), and temperature (i.e., too hot or too cold) of LTC institutions all help to make it difficult for residents to fall asleep (Bephage, 2005; Chiang et al., 2001). Moreover, loud talking, singing, and clapping may trigger the behavioral and psychological symptoms of dementia (BPSD) in the older adult with the disease. Studies have advised care facilities to provide a quiet environment for patients with dementia (Day, Carreon, & Stump, 2000). Therefore, this study hypothesized that the provision of sound control is an important factor in residents' IAQ.

The most frequently seen age-related eye diseases, such as cataracts, glaucoma, and macular degeneration, are triggers for visual impairment (Li et al., 2011). Studies have indicated that an increase in lighting or task lighting is beneficial to the quality of life for patients with visual impairment (Brunnström, Sörensen, Alsterstad, & Sjöstrand, 2004; Copolilloa & Ivanoff, 2011). Light therapy is also beneficial to the physical and psychological health of residents in LTC institutions because it can improve sleep quality, depressive symptoms, and cognitive functions as well as reduce agitation (Dowling et al., 2005; Fetveit & Bjorvatn, 2005). The studies mentioned earlier show that an environment with appropriate lighting can improve residents' living quality and affect their physical and psychological conditions. Therefore, this study

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hypothesized that the provision of proper lighting is one of the important indicators affecting IAQ.

Drawing from the current literature, this study established six indoor environment indicators for LTC institutions: temperature, humidity, natural lighting, lighting, ventilation, and sound. Previous studies have investigated the indoor environment quality of various facility spaces such as bedrooms, bathrooms, and the lounges of facilities (Hoof et al., 2010; Kawahara & Saito, 2005; Kawai, Tsujihara, Hoshoi, & Yasunami, 2008; Tanabe, Kanako, Hideyuki, Kentaro, & Yoshihiro, 2006; Tatehisa, Suzuki, & Iino, 2005; Yan, Ryu, & Wenkun, 2009; Jiang & Ryu, 2010), finding that their indoor environment quality varies. As a result, this study measured the six indoor environment indicators for four different facility spaces: bedrooms, bathrooms, restaurants, and lounges.

DATA SOURCES AND SAMPLING

According to the data on registered Taiwanese LTC institutions for December 2009, Taiwan had 1,421 LTC institutions, comprising 1,058 LTC buildings and 363 nursing homes. In compliance with the provisions of Taiwan's regulations for defining and changing buildings' classifications, nursing homes and LTC buildings were classified as health and welfare buildings (Construction and Planning Agency Ministry of the Interior, 2011). This study intended to investigate the indoor environmental quality of facilities. Therefore, it classified nursing homes and LTC buildings under the same category, defining them as LTC institutions. Based on the proportions of LTC buildings and nursing homes, this study used stratified random sampling to determine a confidence level of 95%, a sampling error of ± 5%, and a target sample size of 303.

According to Hung's (2003) research results, when predicting and evaluating an interview success rate in random sampling, expanding the sample size can achieve better results than substituting samples because substitute samples tend to use successful samples and deviate from failing samples; and an increase in substitute samples leads to greater interference deviation. This study followed Hung and mailed its questionnaires. Most investigations concerning LTC institution managers in Taiwan have been quantitative studies or localized and regional interviews (Chao, Ku, Kung, & Hsu, 2007; Li, Wang, Tang, Kuo, & Yin, 2006; Shih, Kao, & Tsai, 2006), which can hardly be used as a reference in evaluations of interview success rates. Hence, after considering the research's funding and duration, this study expanded the target sample 2.5 times to 757 samples. The targets of the questionnaires were LTC institutions registered with Taiwan's county governments. This research was evaluated and approved in October 2009 by the Asia University Medical Research Ethics Committee (No. 1006010).

Randomly selected subjects were used for this research, as described in the research plan approved by the Medical Research Ethics Committee; managers of LTC institutions were contacted by phone, 127 of whom refused to participate after hearing an explanation of the research objectives. In total, 630 were willing to be part of the research and provided their names. The first questionnaire mailing was then carried out, and follow-up phone calls were conducted once every 2 weeks afterward. Nine tracking calls were made, omitting the week of the Chinese New Year holiday. These were used mainly to inquire whether the managers had received the questionnaires, whether they had any questions about them, and when they planned to return them. Investigation team members were sent to pick up the questionnaires from the managers who had trouble returning them. The deadline for sending back the questionnaires was April 30, 2010 because of funding and time limitations. Of the 630 questionnaires sent, 469 (74.4%) could not be collected. The reasons given to the research team during its tracking calls included the following: managers were seldom at the facilities and were hard to contact, the manager had been replaced, and a busy work schedule prevented the managers from filling in the questionnaire. In total, 161 questionnaires were retrieved, of which 151 were effective, giving a return rate of 24%. The sampling error at the 95% confidence level was ± 7.5%. To evaluate the representativeness of the returned questionnaires, a goodness-of-fit test was carried out, showing that the ratio of the types of institutions compared to the total population was not statistically significant ($p = .42$).

MEASURES

This study conducted a questionnaire survey on facility managers by mail to collect its data. It defined *facility managers* as individuals with several subordinates who give orders to other employees (Robbins & Langton, 2000); thus, this group includes the head nurse, supervisor, director, and owners of LTC institutions. The questionnaire had two parts. Part 1 dealt with basic information and the institutional property of facility managers. It queried managers on the degree of importance of the various indoor environment indicators for the four spaces in LTC institutions (bedrooms, bathrooms, restaurants, and lounges). The questions were the following: (a) Do you think it is important to provide a proper temperature in the four spaces? (b) Do you think it is important to provide proper humidity in the four spaces? (c) Do you think it is important to provide natural lighting in the four spaces? (d) Do you think it is important to provide proper lighting in the four spaces? (e) Do you think it is important to provide good ventilation in the four spaces? and (f) Do you think it is important to provide spatial sound control and noise reduction in the four spaces?

These six indicators were measured using a 5-point Likert scale. The scores on the managers' perception of the level of importance for the indoor environment indicators were measured on a scale ranging from 1 (*not important at all*) to 5 (*very important*).

The second part of the questionnaire inquired about the degree of difficulty for managers when implementing the indoor environment indicators of the four spaces in LTC institutions. The questions were the following: (a) What is the degree of difficulty when providing a proper temperature for the four spaces? (b) What is the

degree of difficulty when providing proper humidity for the four spaces? (c) What is the degree of difficulty when providing natural lighting for the four spaces? (d) What is the degree of difficulty when providing proper lighting for the four spaces? (e) What is the degree of difficulty when providing good ventilation for the four spaces? and (f) What is the degree of difficulty when controlling spatial sound and reducing noise for the four spaces?

Again, a 5-point Likert scale was used to measure the scores on the managers' perception of the level of difficulty in implementing the indoor environment indicators; the scale ranged from 1 to 5, where 1 indicated "*very difficult to implement*," 2 as "*difficult to implement*," 3 as "*neutral*," 4 as "*easy to implement*," and 5 as "*very easy to implement*."

To verify the validity of the questionnaire, 10 LTC institution operators and scholars were invited to complete the modified Delphi technique questionnaires between October and December 2009, obtain expert consensus, and develop the questionnaires with expert validity. The reliability was determined based on Cronbach's alpha coefficient. The statistical results showed that the values of the measured managers' perception of importance and the levels of implementation were both greater than .94, indicating a high questionnaire reliability.

ANALYSIS

This study used SPSS for Windows 12.0 to conduct its statistical analysis including descriptive statistics, a repeated measures one-way analysis of variance (ANOVA), and an importance-performance analysis (IPA). A statistical analysis was carried out on the 151 effective questionnaires. After a repeated measure of one-way ANOVA is performed, Mauchly's sphericity test is used to ascertain if the assumption of sphericity is violated. If the assumption of sphericity is violated, it is necessary to refer to the Greenhouse-Geisser corrected F value. If the F value is statistically significant, there is a statistical difference between variables.

Martilla and James (1977) propose the IPA mainly to assess the two variables of importance and performance and find the pros and cons of organizations and institutions in service terms. The IPA uses a two-dimensional matrix diagram as a graphical representation, with the matrix diagram divided into four quadrants. In Quadrant I, the attributes are perceived to be important to the respondents, but performance levels are fairly low. This sends a direct message that improvement efforts should "concentrate here." In Quadrant II, the attributes are perceived to be important to respondents, and the organization is seen to have high levels of performance in them; the message here is to maintain this level. In Quadrant III, the attributes have low importance and low performance; although performance levels may be low in this cell, managers should not be overly concerned and should expend only limited resources on this cell's attribute because it is not perceived to be very important. In Quadrant IV, the attributes have high performance and low importance, implying that resources committed to these attributes would be better employed elsewhere; high performance on unimportant attributes indicates the possibility of overkill (Keyt, Yavas, & Riecken, 1994; Martilla & James, 1977).

The IPA has been used in various areas of health research (Lo, Liu, & Lin, 2001; Tsai, Kung, Weng, & Shih, 2004; Yavas & Shemwell, 1996). This study used the IPA method to carry out analyses of the differences between facility managers' perceptions of the importance of the indoor environment indicators and their implementation difficulties for the four LTC institutions' spaces. The IPA uses a two-dimensional matrix diagram as a graphical representation, with the matrix diagram divided into four quadrants. The X-axis represents the degree of difficulty in implementing the indoor environment indicators, whereas the Y-axis represents the perceived importance of the indoor environment indicators. When carrying out two-dimensional analyses and choosing the cutoff points, this research referenced the paper by Hollenhorst, Olson, and Fortney (1992) suggesting that a better evaluation can be performed by using the respective total means of each variable as the cutoff point. Therefore, this method was performed on the 151 effective questionnaires for analyses using the total mean for the degree of difficulty in implementing the indoor environment indicators and that of the perceived importance of the indoor environment indicators as the cutoff points.

RESULTS

Table 1 presents the principal sociodemographic characteristics and the LTC institution characteristics of the study sample. The number of female managers (74.8%) was greater than that of the male ones (25.2%). The average manager age was 45.9 years (SD = 10.8 years). Most of the managers were married (71.5%), and most had college education or higher (72.2%). Most of the managers were titled owners (37.7%); directors were the next most numerous (27.8%), followed by head nurses (20.5%). Most of the facilities were either LTC buildings (91%) or nursing homes (60%). Most of them were private facilities (77.5%); far fewer were public (11.3%). Most of the structures were townhouses (49.0%), with apartment buildings (31.8%) being the next most common type.

Most nursing homes managed as public facilities are apartment buildings, whereas most privately managed nursing homes are townhouses, and the rest are apartment buildings. The Fisher's exact test results did not obtain any statistical significance (p = .15). Eighty percent of the LTC buildings under study are managed privately, and most are townhouses. The Fisher's exact test results showed statistical significance (p = .01), linking LTC institution management styles and building types, with townhouses being the most common building type (see Table 2).

To learn if managers differed in their perceptions of the importance of the indoor environment indicators for the four spaces, this study calculated the total mean for each of the six indicators in each of the four spaces. By looking at the total means in Table 3, one finds that the value for the bedrooms (4.48) was the highest,

TABLE 1. Sociodemographic and Long-Term Care Facility Characteristics of the Study Sample

Characteristic	*N*	Percentage	Characteristic	*N*	Percentage
Gender			Type of institution		
Male	38	25.2	Nursing home	60	39.7
Female	113	74.8	LTC institutions	91	60.3
Job title			Operation style		
Head nurse	31	20.5	Public facilities	17	11.3
Supervisor	9	6.0	Nonprofit	15	9.9
Director	42	27.8	Private facilities	119	78.6
Superintendent	12	7.9	Building type		
Owners	57	37.7	Bungalow	24	15.9
Marital status			Townhouses	74	49.0
No spouse	28	18.5	Apartments building	48	31.8
Marital status	108	71.5	Mixed buildings	5	3.3
Widowed	9	6.0			
Separated/divorced	6	4.0			
Education level					
Junior high school	3	2.0			
Senior high school	27	17.9			
College or above	121	80.1			

Note. LTC = long-term care.

TABLE 2. Cross Analyses of Institution Type, Operation Style, and Building Type

Type of Institution/ Operation Style	Building Type				Total (*N*)
	Bungalow	Townhouses	Apartment Buildings	Mixed Buildings	
Nursing home					
Public facilities	1	5	8	0	14
Nonprofit organization	0	0	3	0	3
Private facilities	2	26	13	2	43
Total (*N*)	3	31	24	2	60
LTC institutions					
Public facilities	0	1	0	2	3
Nonprofit organization	0	7	4	1	12
Private facilities	21	35	20	0	76
Total (*N*)	21	43	24	3	91

Note. LTC = long-term care.

TABLE 3. The Level of Importance of the Six Indoor Environment Indicators for the Four Spaces

	Bedroom		Bathroom		Restaurant		Lounge	
Indoor Environment	Mean (*SD*)	LSD	Mean (*SD*)	LSD	Mean (*SD*)	LSD	Mean (*SD*)	LSD
1. Providing proper temperature	4.50 (0.56)	1 < 5; 1 > 6	4.47 (0.65)	1 < 5; 1 > .3, 6	4.19 (0.72)	1 < 3, 4, 5 ; 1 > 2, 6	4.23 (0.80)	1 < 3, 4, 5; 1 > 2
2. Providing proper humidity	4.21 (0.77)	2 < 1, 2, 3, 4, 5	4.05 (0.96)	2 < 1, 4, 5; 2 > 6	4.00 (0.82)	2 < 1, 3, 4, 5	3.97 (0.84)	2 < 1, 3, 4, 5, 6
3. Providing natural lighting	4.57 (0.58)	3 > 2, 6; 3 < 5	4.15 (0.91)	3 < 1, 4, 5; 3 > 6	4.32 (0.71)	3 < 4, 5; 3 > 1, 2, 6	4.41 (0.73)	3 < 5; 3 > 1, 2, 6
4. Providing proper lighting	4.54 (0.57)	4 < 5; 4 > 2, 6	4.44 (0.63)	4 < 5; 4 > 2, 3, 6	4.43 (0.66)	4 < 5; 4 > 2, 3, 6	4.46 (0.63)	4 < 5; 4 > 1, 2, 6
5. Providing good ventilation	4.78 (0.43)	5 > 1, 2, 3, 4, 6	4.62 (0.57)	5 > 1, 2, 3, 4, 6	4.57 (0.61)	5 > 1, 2, 3, 4, 6	4.60 (0.56)	5 > 1, 2, 3, 4, 6
6. Controlling spatial sound and reducing noise	4.27 (0.78)	6 < 3, 4, 5	3.80 (1.03)	6 < 1, 2, 3, 4, 5	4.01 (0.86)	6 < 1, 3, 4, 5	4.14 (0.83)	6 < 3, 4, 5; 6 > 2
Total Mean (*SD*)	4.48 (0.20)	—	4.25 (0.30)	—	4.25 (0.22)	—	4.30 (0.23)	—

Notes: Bedroom ($F = 27.38$, p = .000; bathroom ($F = 33.60$, p = .000); restaurant ($F = 27.39$, p = .040); lounge ($F = 27.23$, p = .001). One-way ANOVA test with least significant difference multiple comparisons was performed. 1 = providing proper temperature; 2 = providing proper humidity; 3 = providing natural lighting; 4 = providing proper lighting; 5 = providing good ventilation; 6 = controlling spatial sound and reducing noise. LSD = least significant difference.

followed by lounges (4.30), bathrooms (4.25), and restaurants (4.25). The results of the one-way ANOVA tests show that the assumption of sphericity is violated; it is thus necessary to refer to the corrected *F* value ($F = 21.82$, $p = .000$). The *F* value is statistically significant, indicating that there are differences in the levels of importance given to the indoor environments of the four spaces by managers. The post hoc comparison found that the value for bedrooms was statistically significantly greater than that given to lounges, bathrooms, and restaurants, suggesting that the level of managers' perception of the importance of the indoor environment indicators for bedrooms was higher than that of those for the other three spaces.

To see if managers experienced different levels of difficulty in implementing the indoor environment indicators in the four spaces, this study calculated the total mean for each of the six indicators in each of the four spaces. By looking at the total means in Table 4, one sees that implementing the indicators in the lounges was easiest (3.52), followed by restaurants (3.47), bedrooms (3.42), and bathrooms (3.40). The results of the one-way ANOVA tests show that the assumption of sphericity is violated; it is thus necessary to refer to the corrected *F* value ($F = 3.29$, $p = .030$). The *F* value is statistically significant, indicating that there is a difference in the level of perceived difficulty in the implementation of the indoor environments of the four spaces. A post hoc comparison found that the value for the lounges (3.52) was greater than that for the bedrooms (3.42), showing that managers believed implementing the indoor environment indicators was easier in the lounges than in the bedrooms.

Additionally, to discover whether there were differences between the perceived importance and difficulty of implementing the indoor environment indicators, this study subtracted the degree of difficulty in implementing the indoor environment indicators from the perceived importance of the indoor environment indicators for the four respective spaces and then calculated the total mean for each case. The results show that the widest difference between perceived importance and implementation difficulty occurs in the bedrooms (1.06), followed by bathrooms (0.85), restaurants (0.78), and lounges (0.78). The results of the one-way ANOVA tests show that the assumption of sphericity is violated; it is thus necessary to refer to the corrected *F* value ($F = 8.15$, $p = .000$). The *F* value is statistically significant, indicating that there is a difference between the level of the indoor environment index and the difficulty of implementation for the four spaces as perceived by managers. The post hoc comparison found that the difference for the bedrooms was larger than that for the restaurant and the lounges. Hence, from the management's perspective, the space with the widest difference between perceived importance and difficulty of implementation for the indoor environment indicators was the bedroom.

Table 3 summarizes the level of importance of the six indoor environment indicators for each of the four spaces (bedrooms, bathrooms, restaurants, and lounges). The results of the one-way ANOVA tests show that the assumption of sphericity is violated; it is thus necessary to refer to the corrected *F* value (bedroom: $F = 27.38$, $p = .000$; bathroom: $F = 33.60$, $p = .000$; restaurant: $F = 27.39$, $p = .000$; and lounge: $F = 27.23$, $p = .000$). The *F* value is statistically significant, indicating that there is a statistical difference in the level of the six indoor environment indices for the four spaces as perceived by the managers. A post hoc comparison found that the perceived level of importance for the ventilation in the four spaces was statistically significantly higher than that for the other five indicators. Moreover, there were differences in the managers' perceptions of the importance of the six indoor environment indicators for each of the four spaces. For the bedroom, management gave greater importance to two indoor environment indicators, natural lighting and proper lighting, which were ranked right after proper ventilation. However, the perceived importance of two indicators, humidity and sound, was ranked lower than that of the others. For the bathroom, management gave greater importance to two indicators, temperature and proper lighting, but perceived least importance in the indicator for sound control. Furthermore, management perceived a similar level of importance in the indoor environment indicators for both restaurants and lounges, perceiving both indicators as having greater importance while perceiving less importance in the humidity indicator.

Table 4 summarizes the level of implementation of the six indoor environment indicators for the four spaces. The results of the one-way ANOVA tests show that the assumption of sphericity is violated; it is thus necessary to refer to the corrected *F* value (bedroom: $F = 23.62$, $p = .000$; bathroom: $F = 20.53$, $p = .000$; restaurant: $F = 25.04$, $p = .000$; and lounge: $F = 20.21$, $p = .000$). The *F* value is statistically significant, indicating that there is a statistical difference in the level of the difficulty of implementing the six indoor environment indices of the four spaces as perceived by managers. A post hoc comparison found that, from management's perspective, the most easily implemented indoor environment indicators for the four spaces were proper lighting, ventilation, and natural lighting, whereas the most difficult indicators to implement were humidity and temperature. This shows that degrees of difficulty for the six indoor environmental indicators were similar in each of the four spaces, with lighting and ventilation being the easiest to implement and humidity and temperature the most difficult.

Regarding the binary matrices of the perceived level of importance and the level of implementation of the six indoor environment indicators, we calculated the total mean for each of the indicators in each of the four spaces (Figure 1). The "temperature" indicator in the bedrooms and bathrooms was in the "concentrate here" region. The indicators in the "low priority" region included humidity and controlling spatial sound in the bedrooms; humidity and natural lighting in the bathrooms; temperature and humidity in the restaurant; and temperature, humidity, and controlling spatial sound in the lounges. The indicators of the four spaces in the "maintain level" region were mainly natural lighting, proper lighting, and ventilation. The indicator for

TABLE 4. The Level of Implementation of the Six Indoor Environment Indicators for the Four Spaces

Indoor Environment Indicators	Bedroom		Bathroom		Restaurant		Lounge	
	Mean (*SD*)	LSD	Mean (*SD*)	LSD	Mean (*SD*)	LSD	Mean (*SD*)	LSD
1. Providing proper temperature	3.20 (1.12)	1 < 3, 4, 5, 6; 1 > 2	3.25 (1.06)	1 < 4, 5, 6; 1 > 2	3.27 (1.02)	1 < 3, 4, 5, 6; 1 > 2	3.38 (1.03)	1 < 3, 4, 5; 1 > 2
2. Providing proper humidity	2.97 (1.08)	2 < 1, 2, 3, 4, 5, 6	2.95 (1.07)	2 < 1, 3, 4, 5, 6	3.04 (0.94)	2 < 1, 3, 4, 5, 6	3.15 (0.97)	2 < 1, 3, 4, 5, 6
3. Providing natural lighting	3.54 (1.34)	3 < 4; 3 > 1, 2	3.32 (1.29)	3 < 4, 5; 3 > 2	3.57 (1.21)	3 < 4, 5; 3 > 1, 2	3.62 (1.21)	3 < 5; 3 > 1, 2, 6
4. Providing proper lighting	3.76 (1.17)	4 > 1, 2, 3, 6	3.79 (1.13)	4 > 1, 2, 3, 5, 6	3.72 (1.18)	4 > 1, 2, 3, 6	3.79 (1.14	4 > 1, 2, 3, 6
5. Providing good ventilation	3.66 (1.25)	5 > 1, 2, 6	3.54 (1.18)	5 < 4; 5 > 1, 2, 3	3.71 (1.15)	5 > 1, 2, 3, 6	3.74 (1.18)	5 > 1, 2, 6
6. Controlling spatial sound and reducing noise	3.40 (1.10)	6 < 4, 5; 6 > 1, 2	3.54 (1.15)	6 < 4; 6 > 1,2	3.52 (1.08)	6 < 4, 5; 6 > 1, 2	3.46 (1.10)	6 < 3, 4, 5; 6 > 2
Total Mean (*SD*)	3.42 (0.29)	—	3.40 (0.29)	—	3.47 (0.26)	—	3.52 (0.24)	—

Notes: Bedroom ($F = 23.62$, p = .000; bathroom ($F = 20.53$, p = .000); restaurant ($F = 25.04$, p = .000); lounge ($F = 20.21$, p = .000). One-way ANOVA test with post hoc Dunnett's T3 multiple comparisons was performed. 1 = providing proper temperature; 2 = providing proper humidity; 3 = providing natural lighting; 4 = providing proper lighting; 5 = providing good ventilation; 6 = controlling spatial sound and reducing noise. LSD = least significant difference.

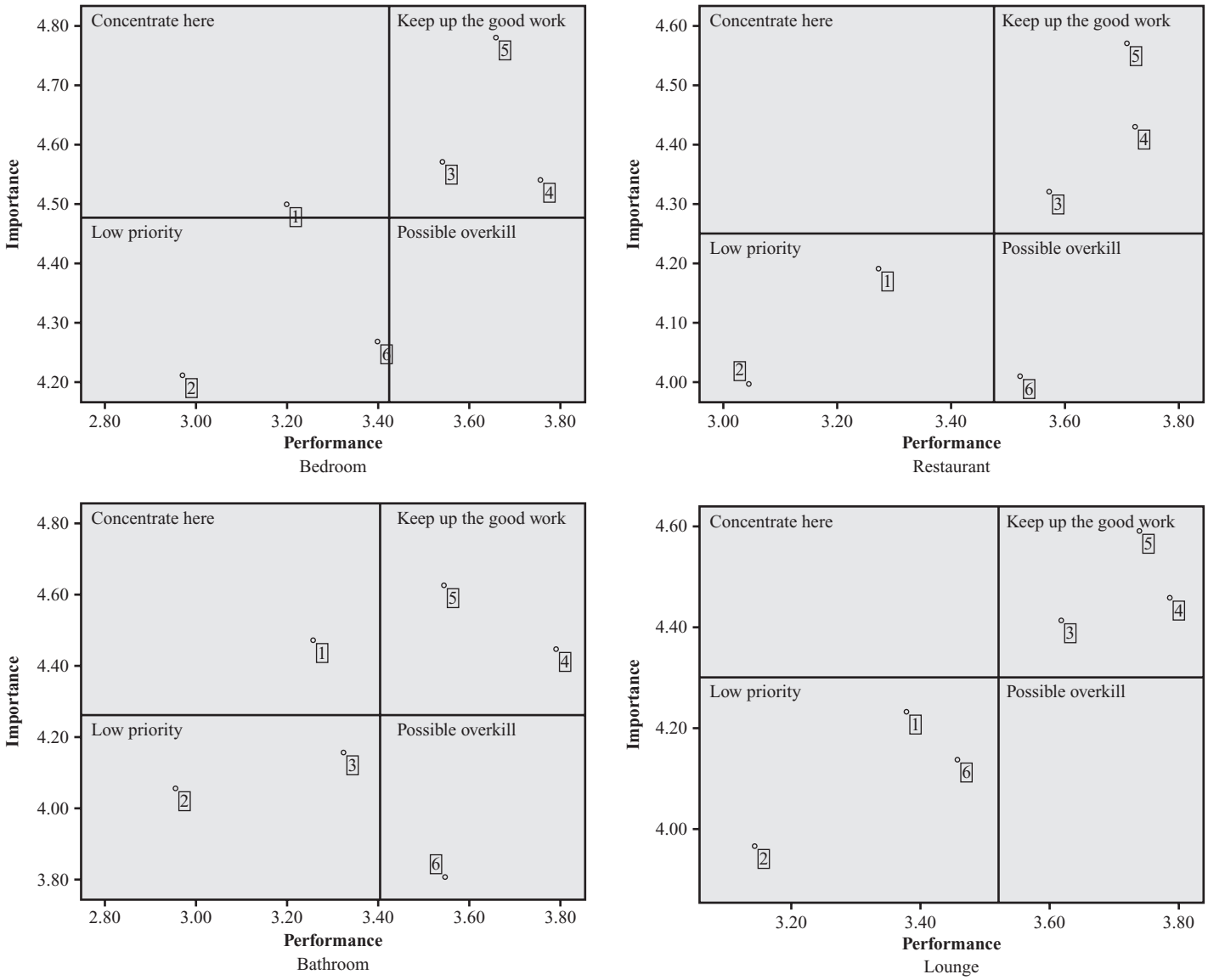

Figure 1. The comparison of the matrices of the perceived level of importance and the level of performance of indoor environment indicators for the four spaces.

the bathroom and restaurant in the "possible overkill" region was controlling spatial sound.

DISCUSSION

We investigated the level of LTC managers' perceptions of the importance of the indoor environment indicators in LTC institutions and the level of difficulty in implementing them. Via binary matrices, this study delineated the relationship between the levels of managers' perceptions of the importance of the indoor environment indicators and their implementation difficulty levels.

The findings of this study show that the score for the perceived importance of the indoor environment indicators was higher than the score for the implementation difficulty. For all four spaces (bedrooms, bathrooms, restaurants, and lounges) of the facilities, the difference between the perceived importance and the implementation difficulty

of the indoor environmental indicators was greatest in the bedroom. In Taiwan, two- to eight-bed multiple occupancy rooms are common (Hsieh, 2010; Tzeng & Wang, 2002). This high density of residents may easily lead to IAQ issues such as the transmission of infectious diseases (Chen et al., 2008; Fang et al., 2010; Hu et al., 2007; Shen, 2009). As a result, managers should pay special attention to the indoor environment quality of multiple occupancy dormitories.

Moreover, the level of the management's perception of the importance of ventilation and the level of ventilation's implementation were both high. This result was consistent with the current literature. Relevant studies on the care quality indicators of LTC institutions in Taiwan have indicated that facilities pay special attention to odors and attach great importance to ventilation (Chang, 2009; Lin, 2009). However, the results of some empirical studies on the IAQ of LTC institutions in Taiwan have shown that the air quality-related values measured in public facilities are higher than what is recommended for IAQ (Fang et al., 2010; Shen, 2009; Wu et al., 2007). Many factors such as the types of ventilation components in air conditioning systems, the number of indoor personnel, space allocation, building materials and furniture, the age of the building, and the maintenance and cleaning of air conditioning systems (Fang et al., 2010; Kuo, 2007; Singh et al., 2010; Yin, 2005) all affect IAQ. Taiwan implemented independent IAQ management regulations in 2007, hoping that organizations would maintain a high degree of care and conscientiousness regarding indoor workplace air quality through education and training (Taiwan Architecture & Building Center, n.d.). Therefore, managers should participate in similar kinds of training to learn the methods of controlling indoor environmental quality.

An indicator requiring improvement as soon as possible, from the perspective of management, was obtained from the binary matrices; this was found to be the indicator for temperature in the bedrooms and bathrooms. Numerous Japanese studies have investigated the temperatures of various spaces in LTC institutions, the results indicating that these temperatures are uneven. For example, the difference in bathroom temperature between the summer and winter is 10°C. In winter, the temperature difference between the bedroom ceilings and floors is 2–4°C, which is related to the installation of air conditioning equipment, the location of the air conditioning equipment, and the ventilation design of the building (Kawai, Tsujihara, Hoshoi, & Yasunami, 2008; Matsuura & Saito, 1999). Moreover, a survey on the bathing behaviors of the older adult revealed that the temperatures perceived by the older adult vary with the humidity, temperature, and seasonal differences experienced in the bathroom, the physical condition of the older adult, and his or her bathing behavior (Takanori, Murakawa, Nishina, & Takaaze, 2008; Tatehisa et al., 2005; Yan et al., 2008). Although the climate in Japan is different from Taiwan's, these results show that to control the temperature of the bedrooms and bathrooms, one must take notice of the relevant factors such as architectural conditions, air-conditioning conditions, bathing behavior, and the seasons. Therefore, when managers seek to improve the temperature indicators for the bedrooms and bathrooms, they must take notice of the temperature factor if they are to achieve their improvements.

The indicators for temperature and humidity in the four spaces were mostly in the low priority region. Moreover, the sound indicator for the bedrooms and lounges was in the low priority region, whereas that of the restaurant and bathroom was in the "possible overkill" region, revealing that the level of the managers' perception of the importance of sound was low, and that the difference among spaces affects the implementation of indicators.

The bedroom-related literature has pointed out that disturbances among residents can easily develop in multiple occupancy dormitories, driven by such issues as television and radio usage and inconsistent bed times and sleeping lengths (Foltz-Gray, 1995; Hsieh, 2010). When a facility holds numerous activities in the lounge, such as video and television viewing, group therapy, or singing (Yin, 2005), excessively loud sounds may trigger BPSD symptoms in the older adult with dementia (Day et al., 2000). Therefore, when there are residents with dementia living in facilities, more importance should be placed on sound control in the lounges. Managers should regard the sound control indicator as one of the objectives in the improvement of indoor environment quality.

The indicators for lighting and ventilation of the four spaces were in the "maintain level" region, suggesting that managers should pay special attention to these indicators and implement them carefully. This result is consistent with the results in the current literature, which have indicated that the ventilation indicator is one of the important care quality indicators (Chang, 2009; Lin, 2009). Moreover, studies on residential space planning for the older adult have also shown the importance of lighting (Ding, 2006; Liao, 2009; Tzeng, 2008). The results of this study similarly demonstrate the importance of the lighting indicator. Therefore, managers should continuously maintain the ventilation and lighting indicators.

LIMITATIONS OF THE STUDY

This study has some limitations. First, it was designed to reduce the interview rejection rates and thus carried out sample size expansion and phone tracking, with research team members going to various institutions to collect completed questionnaires. However, the rate of return remained low. The response rate is consistent with Baruch (1999) in which the questionnaire return rate was lowest when the investigated subjects were high-level management or organization representatives. Thus, the methods by which questionnaires are provided to management personnel should be reconsidered. Second, indoor environmental qualities are often limited by factors such as the physical constraints of a building's architecture; the specifications of an organization (e.g., motivation for improving the indoor environment and the cost of the equipment used for improving indoor environment quality or maintenance systems); and the methods used by management, staff, or residents to take care of the indoor environment. This research did not

contain any of these confounding factors. It approached the subject mainly from the perspective of the service quality management of LTC institutions to investigate the perceived importance and implementation difficulty of the indoor environment indicators during the self-management of these institutions.

CONCLUSIONS

This research investigated the levels of the LTC institution managers' perceptions of the importance of indoor environment indicators for four LTC spaces (bedrooms, bathrooms, restaurant, and lounges) and the levels of difficulty in implementing them. The results indicate that management tended to place great importance on the indoor environment indicator of ventilation, that it was easiest to implement the indoor environment indicators of lighting and ventilation, and that it was most difficult to implement the temperature and humidity indicators. The two-dimensional matrix diagram shows that management perceived the lighting and ventilation indicators for the four spaces to be important and easy to implement, suggesting the perception that these areas needed only to be maintained at their current levels. Moreover, the current status of the indicators in the maintain level region should be continuously maintained. The indicator for the four spaces in the concentrate here region was the temperature indicator for the bedrooms and bathrooms, suggesting that managers should aggressively manage the air conditioner ventilation systems and management methods. Furthermore, to improve the indoor environment quality of LTC institutions, priority should be given to the indicators for temperature, humidity, and sound, all in the low priority region.

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