Facility Managers' Preferred Interior Wall Finishes In Acute-Care Hospital Buildings

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Abstract

Facility managers typically provide a variety of services to their organizations, primarily maintenance, repair, and cleaning, as well as managing budgets. The largest portion of the envelope in a hospital is formed by wall surfaces, which are covered by thousands of square meters of wall finishes. The materials used for interior wall finishes and covering are typically selected by architects and interior designers; after construction is completed, the facility manager takes charge of it for the duration of the building's service life. Clearly, facility managers deal with building finishes more than any other building professionals; as a result, it is assumed that they have their own preferences for what finishes they would choose, based on their experience. This study investigates the preferences of facility managers for interior wall finishes used in hospital buildings in the state of Texas, USA. For the purpose of this study, three hospital units were selected: emergency, surgery, and in-patient departments. Three objectives were specified: (1) to identify the preferences of facility managers for interior wall finish materials used in the three hospital units; (2) to study what characteristics facility managers would consider if they could select interior wall finishes; and (3) to compare the facility managers' preferences for interior wall finishes in the three units. A questionnaire was created, and responses from 48 healthcare facility managers were collected and analyzed using descriptive statistics. A comparison of the preferences was also conducted. The study found that the interior wall finishes most often used in the three hospital departments are vinyl type II (medium-duty vinyl for wall covering), and latex paint. The study also found that the three major characteristics driving the selection of interior wall covering materials are: infection control, gas emission/VOC, and ease of maintenance. The results of this study can be used to enhance the discussion and improve the collaboration between facility managers and designers, in terms of understanding later maintenance needs, in the selection of interior wall finishes.

Keywords: facility management, hospitals, interior wall finishes, survey, USA.

1. Introduction

Healthcare buildings are perhaps the most complex type of building in terms of operations and maintenance management. The construction, operation, and maintenance of a healthcare building require specialized consultations (Milner and Narayan, 2005). The designs of hospitals and the materials used for their construction have considerable effects on both the environment and the health of patients (Vittori, 2000). Since the building envelope covers and safegaurds the valuable building materials contained within, its design is an important phase of the design process. It is focused on keeping the inside space intact by avoiding problems such as moisture penetration and the growth of mold and mildew.

Interior finishes play a vital role in a healthcare facility, as proper wall treatments can contribute to the creation and maintenance of a positive therapeutic environment for patients (Mayer, 2005). A major portion (32%) of the initial budget for a healthcare facility is consumed in interior finishing and interior construction (Shohet *et al.*, 2002). Factors such as durability, easy maintenance, robustness, etc. influence the selection of wall finish in healthcare spaces (Carter and Barr, 1997; Moulavi *et al.*, 1999; Bower, 2006; Parsons *et al.*, 2008; Onaran, 2009). In addition, regulations may affect decision about wall finishes (Schultz, 1979).

Facility managers face a wide range of challenges, from the maintenance, repair, and cleaning of buildings to budget management (Straub, 2003). Architects and interior designers select the materials for wall coverings, and after the construction is completed, the facility managers take charge of them. Facility managers deal with the finishes more than anyone else, and hence, have their own preferences, based on their experience. Although facility managers are the main professionals in charge of operating and maintaining a building for its users, their collaboration with external parties, such as designers, consultants, technicians, and other professionals, is desired for an integrated approach to informed decision-making and building sustainability (Federal Facilities Council, 2001). Dealing with real estate transactions, floor planning, office equipment, transportation, and catering may be included, too, under the umbrella of facilities management (Lav, 2003).

The facility manager's role also includes performing condition assessments of the various components of a building. Maintenance work is then planned and prioritized based on the importance of the task, and the availability of maintenance funds (Straub, 2003). Thus, it can be seen that facility managers often have more experience with building facilities than do architects or designers. It would thus be beneficial to the fields of facilities management and healthcare design to identify their preferences for wall finishes in hospital buildings. This study investigates the preferences of facility managers for wall finishes in acute-care hospitals in the state of Texas, USA. The study will assist architects, interior designers, and owners in selecting interior wall finish based on the experiences of facility managers.

2. Criteria for wall finish selection

The proper selection of wall finishes that are functional, cost-effective, and easy to maintain can be valuable for healthcare facilities because of the septic conditions present in hospitals. Wall finish materials can vary from natural products to synthetic materials, e.g., porcelain, natural stone, terrazzo, linoleum, rubber, vinyl, and wood (Milner and Narayan, 2005). Selecting suitable materials for healthcare wall coverings from this extensive list is complicated and requires thorough study. To prevent the spread of microbes in a hospital, it is essential to maintain a hygienic environment by cleaning the medical instruments, clothing, and dressings. All finishes and coverings should be treated for bacterial and fungal infections, as a hospital is vulnerable to the spread of infections due to the presence of sick patients (Hart, 1998).

According to a survey conducted by Rohde (2002), healthcare facility designers consider the following characteristics in the selection of materials for a healthcare facility, in declining order: aesthetics, durability, ease of maintenance, client preference, initial cost, cost of maintenance, infection control, ease of installation, and life cycle cost. Finishes in an acute-care facility should be robust, solid and durable, as these are prone to routine and accidental impacts (Moulavi *et al.*, 1999; Bower, 2006; Parsons *et al.*, 2008; Onaran, 2009). Numerous considerations enter into the decision process. The type and scope of activity in a space is one of the main factors that govern the selection of wall finishes in a healthcare facility (Onaran, 2009). Infection control is another primary criterion to be considered when making decisions on internal finishes in a hospital. An infection control professional must be involved to help clinicians and architects choose appropriate wall covering (Carter and Barr, 1997). Wall finish materials like plastic laminated fire-retardant plywood are more durable, while fiberglass composite substrate and vinyl are aesthetically appealing and easy to maintain, respectively (Moulavi *et al.*, 1999). Additionally, vinyl wall coverings offer variety of colors, textures and patterns for the wall surface, and are available in a range of cost and quality (Bower, 2006).

Also entering the decision process are regulations and voluntary standards that state the type of wall finishes suitable for surgical units in a hospital. All federally funded healthcare facilities must comply with the Hill-Burton Act, as set forth in Minimum Requirements of Construction and Equipment for Hospital and Medical Facilities (Schultz, 1979). Since staff from different departments, representing numerous opinions, is involved in specifying finishes in a hospital, a survey on the preferences of facility managers would be valuable.

3. Wall finish materials

A large variety of wall finishes can be used for any new construction or renovations, including paint, wall coverings, mosaics, and tiles. Healthcare buildings require special attention and scrutiny in the selection of wall finishes for a number of reasons. The most important of these is the health and safety of the patients and the employees.

Wall coverings may affect several measures of quality, including: (a) Relative Humidity (RH) of a room (Mortensen *et al.*, 2005); (b) Indoor Air Quality (IAQ) (Hodgson *et al.*, 2000); and (c) transmission of harmful bacteria (Lankford *et al.*, 2006).

3.1. Wall coverings and Relative Humidity (RH)

Is there any correlation between the wall covering and the RH of a room? In fact, surface materials do play an important role in absorbing moisture when the relative humidity increases, and desorbing moisture when RH decreases. Proper moisture control is essential in order to reduce health risks and Sick Building Syndrome in an enclosed space (Mortensen et al, 2005).

The growth of mildew and mold in walls is caused by moisture in the air. Hygroscopic (absorbing or attracting moisture from the air) materials used as wall coverings keep the indoor relative humidity stable in rooms that are not ventilated frequently. Non-porous materials (i.e., do not absorb water) are generally polycrystalline and are characterized by continuous grain boundaries (Padfield, 1999). Thus, it is seen that moisture control using wall coverings is vital to: (1) reduce health risk and Sick Building Syndrome (Mortensen *et al.*, 2005); and (2) prevent the growth of mildews and molds (Clausen, 2000).

As noted, there is a relationship between the wall covering and relative humidity. When the surface humidity exceeds 80%, drywall and ceramic tiles can harbor mold and mildew, and it is difficult to prevent their growth. Hence, the wall surface should remain dry and clean in order to prevent the growth of fungus (Hodgson *et al.*, 2000).

3.2. Wall coverings and Indoor Air Quality (IAQ)

Patients are susceptible to common environmental microbes present in the air. In addition, chemicals and infectious agents already present in a hospital can affect the indoor air quality (Streifel, 1998). Indoor Air Quality can be affected by the following factors in terms of wall finishes: (1) Volatile Organic Compounds (VOC) emitted by finishes and products used in the room (Burton, 1997); and (2) increase of relative humidity of the room, which may lead to fungal growth (Hodgson *et al.*, 2000).

The materials like carpets, paints, wallpaper and PVCs can emit VOCs, which can have a negative effect on indoor air quality. These can cause irritation and odor annoyance and could have behavioral, neurotoxic, hepatoxic and genotoxic effects (Meininghaus *et al.*, 2000; Hoskins, 2003; Hodgson *et al.*, 2000). According to Hoskins (2003), VOCs could be carcinogenic depending upon the compound. To reduce the effect of VOCs in hospital rooms, low VOC content paints, low-emitting carpet systems, and low VOC content wall finishes should be used.

3.3. Risk of transmission of bacteria from walls

The transmission of bacteria from walls and floors is minimal unless the surfaces have residual moisture. In order to keep wall finishes from transmitting harmful bacteria, they should be easy to

clean and able to withstand repetitive wear and frequent germicidal decontamination, and have the ability to repel moisture (Lankford *et al.*, 2006). The risk of infection in hospital patients can be minimized via the participation of infection control professionals who specialize in facility design. By doing this, the issues of infection control can be identified early and the design and planning can be conducted accordingly (Noskin and Peterson, 2001). As such, the task of specifying wall finishes for a hospital is not a simple one that can be handled by the owner or designer. It requires the opinions of professionals who are familiar with hospital finishes and materials.

4. Wall covering material selection in healthcare

The primary material for wall finishes in public healthcare spaces is vinyl type II due to their aesthetics (Burns, 2002). Vinyl wall coverings may look costlier than paint when they are not, they clean far easier, and they retain their appearance far longer, which may make them more efficient in the long run (Jacob, 2006). Characteristics of vinyl: (1) easy to maintain Indoor Air Quality (Borrelli, 2007); (2) an easy-care product (Nussbaumer, 2006); and (3) aesthetically pleasing (Jacob, 2006).

Conventional water-based latex paints use solvents and additives, which contain volatile organic compounds (VOCs) (Turner and Bentley, 1997). Low-VOC latex paint emits considerably less VOC and performs equal to or better than conventional latex paint. Additionally, latex paint is much more environmentally friendly, non-toxic, and non-flammable than oil paints (Chang *et al.*, 1999).

4.1. Wall finishes used for surgery units

The wall finishes of a surgery unit should be: a) hard; b) non-porous; c) free from joints and crevices; d) easy to wash; and e) able to withstand repeated contact with strong cleaning agents (Abreu and Potter, 2001; Fogg, 1999). Walls with ceramic tiles are not recommended in surgery units because the joints are difficult to clean, non-resistant to wear, and not durable. Lime wash (lime putty) is not suitable for any wall surfaces in operating rooms because it is water-soluble and therefore, dissolves when washed. Cement paint also is not appropriate for surfaces in the surgery unit because its rough finish easily harbors dirt and therefore makes cleaning difficult (Abreu and Potter, 2001). Latex paint (Turner and Bentley, 1997) and vinyl (Jacob, 2006) are suitable for a surgery unit.

4.2. Wall finishes used for emergency units

The function of the emergency unit is to care for critically sick patients who may have an increased risk of infection. Thus, a high level of care and hygiene is required in the emergency unit (Takrouri, 2004). Guidelines concerning surfaces and finishes in emergency rooms are based on common sense and well-established infection control principles. Paint and wall coverings should be washable, durable, and able to resist accidental impacts of trolleys and other objects. Wall finishes such as paint, sprayed plastic skins, and plastic sheets with welded joints have been found to satisfy these requirements (O'Connell and Humphreys, 2000).

4.3. Wall finishes used for in-patient units

For in-patient units, paint is considered the most versatile material due to the wide range of colors and textures. Textured and easy to clean paints are preferred because they diminish glare and facilitate acoustical control (Piotrowski and Rogers, 2007).

In summary, for surgery, emergency, and in-patient units, cleanliness is of utmost concern. The wall finishes of all these units should resist the effects of cleaning agents like acids, and should be durable. Proper selection of wall finishes can also be beneficial for healthcare facilities by decreasing maintenance costs. Wall coverings have a direct impact on the relative humidity of a room, indoor air quality, and the transmission of bacteria. In order to control the relative humidity, suitable wall finishes that can absorb or desorb moisture according to the humidity should be used. The indoor air quality depends to a great extent on the emission of harmful gases from the wall covering. Hence, proper care should be taken that hospital finishes have low levels of gas emission. In order to avoid the transmission of bacteria, wall finishes should be regularly cleaned and maintained.

5. Research methods

The primary objective of this study is to identify the preferences of facility managers for wall finishes used in acute-care hospitals. For this study, the opinions of facility managers were obtained by administering a survey that included relevant questions. The questionnaire consisted of 22 questions that covered these topics. The emphasis of the study is on identifying the preferences of facility managers for wall finishes in emergency, surgery, and in-patient units of acute-care hospitals in the state of Texas, USA. For each of these units, the survey questions addressed the following information: (1) wall finishes preferred by facility managers; and (2) characteristics upon which the facility managers based their preferences and selections.

5.1. Data collection

The sample population for this study is composed of facility managers in metropolitan, for-profit hospitals in the state of Texas, USA. Non-metropolitan and non-profit hospitals are not expected to have as high-quality specialized staff or as expensive technology as metropolitan for-profit hospitals (Wang *et al.*, 2001); therefore, they were excluded from the study. Moreover, it is assumed that material selection for an institution depends on local availability, traditional selection, and type of design. It is assumed that the materials available for hospital design are the same throughout the entire state of Texas. According to the Hospital Survey Unit, Center for Health Statistics, the local Department of State Health Services, there are 210 for-profit, metropolitan acute-care hospitals in the state of Texas. In order to collect data for this study, the facility managers of these hospitals were sent a web-based survey. Follow-up phone calls were made if no responses were received within a week.

A pilot survey was administered to three of the total 210 for-profit acute-care hospitals, which resulted in two responses. As a result of this pilot, no further modifications were made to the survey questionnaire. The survey was distributed to the remaining 207 respondents. Of these, 54 responses were collected. Only 48 of the 54 responses were complete; incomplete responses were not included

in this study. This results in a response rate of 23.2%. The designations of the respondents were: Plant Managers, Directors of Facilities Management, Plant Operations Directors, and Facility Managers.

5.2. Data analysis

The analysis of the data collected online utilized descriptive statistics methods, such as graphical displays of the data and tabular descriptions. As an ordinal scale was used, the responses represented the scale of the opinions of the respondents. As these scales were not quantitative, they cannot be analyzed using standard parametric statistical analysis.

6. Findings

6.1. Wall finish materials

The results collected from the survey are summarized in Tables 1, 2 and 3. Table 1 indicates the responses for the top wall finish materials, as obtained from the respondents' rankings. The respondents were asked to rank these materials on an ordinal scale from 1 through 10, with "1" and "10" indicating the most preferred and least preferred, respectively. Table 1 shows the number of responses received for the top five rankings (out of 10) for each of the wall finish materials, per unit. As mentioned earlier, 48 responses were collected in this survey; however, since the number of responses obtained for rankings 6 through 10 is not included in Table 1, the total number of responses presented in this table may be less than 48 for each building material in each unit. The results in this table suggest vinyl type II very clearly as the most preferred wall finish material in all three healthcare units. It is rated as most preferred by 25, 32 and 33 respondents in the emergency, surgery and in-patient units, respectively. The second most preferred wall finish material is paint – water-based or latex, with 18, 27 and 27 respondents in emergency, surgery and in-patient units ranking it, respectively, as second most preferred material. Rigid fiberglass panels are third most preferred wall finish in all three units. As these data represent the rank of the materials in the opinion of respondents, mean values could not be assumed as appropriate central tendency. Mean values can be calculated only when actual values, such as scores or weights (not ranks) are being analyzed, which is not the case in this survey. Hence, the mode (maximum number of occurrences) is considered as the central tendency and the greatest number of occurrences is considered for determining the top three preferred materials. Following vinyl type II, latex paint and fiberglass in the list of top six materials preferred by the facility managers are: paint – solvent/oil, acoustical tiles, and wallpaper. Interestingly, the pattern of preference for wall finishes is similar, yet not identical, in the three spaces studied. The other four wall finish materials of vinyl types I and III, ceramic tiles, and wood paneling are ranked lower in the order of priorities of facility managers.

Table 1: No. of occurrences of each of the wall finish materials in the top five rankings, by unit

	Emergency unit					*Surgery unit*					*In-patient unit*				
Preference / Material	*1*	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*
Vinyl type II	*25*	*15*	*5*	*1*	*1*	*32*	*10*	*1*	*2*	*1*	*33*	*11*	*1*	*0*	*3*
Paint – water/latex	*18*	*18*	*5*	*2*	*1*	*10*	*27*	*4*	*2*	*0*	*12*	*27*	*4*	*1*	*2*
Rigid fiberglass panel	*2*	*4*	*18*	*5*	*2*	*3*	*3*	*17*	*5*	*5*	*0*	*6*	*15*	*7*	*2*
Paint – solvent/oil	*1*	*4*	*6*	*6*	*6*	*2*	*1*	*12*	*6*	*3*	*1*	*2*	*10*	*5*	*3*
Acoustical tiles	*0*	*0*	*3*	*9*	*8*	*1*	*0*	*2*	*12*	*7*	*0*	*0*	*3*	*9*	*8*
Wall paper	*0*	*1*	*3*	*9*	*11*	*1*	*0*	*1*	*9*	*10*	*0*	*0*	*6*	*8*	*11*
Vinyl type III	*2*	*3*	*3*	*5*	*6*	*1*	*0*	*5*	*3*	*9*	*2*	*1*	*0*	*9*	*9*
Ceramic tiles	*1*	*0*	*2*	*3*	*5*	*3*	*1*	*0*	*2*	*7*	*0*	*1*	*6*	*3*	*3*
Wood paneling	*0*	*0*	*2*	*5*	*5*	*1*	*1*	*2*	*2*	*1*	*1*	*0*	*2*	*2*	*1*
Vinyl type I	*0*	*2*	*3*	*2*	*4*	*2*	*3*	*2*	*3*	*3*	*1*	*1*	*2*	*4*	*6*

6.2. Wall finish materials: selection criteria

The respondents were asked to rank the selection criteria for choosing wall finish material on a five point Likert Scale, ranging from "Most important" to "Least important." The responses collected for this question are summarized in Table 2, which presents only higher ranks in the categories of important and most important, while other categories are not included in the table. As seen in the results, most of the respondents ranked all of these criteria as either "Most important" or "Important" for their selection of wall finish materials. The top criterion for selecting wall finishes in all three healthcare units is infection control, with 10, 10, and 12 "Most important" responses in emergency, surgery, and in-patient units, respectively. It seems natural to get this response particularly in healthcare facilities, which usually face major concerns of infection control (Carter and Barr, 1997). The second most considered selection criterion in both emergency and inpatient units is ease of maintenance, while for the surgery unit, the three criteria--ease of maintenance, gas emission, and IAQ--received similar rankings on the Likert scale. The difference among the responses to the IAQ, ease of maintenance, and gas emission is just one, which seems to be insignificant. The durability and cost of maintenance criteria are not ranked among top three in any of the spaces, similar to findings reported in the literature review (Moulavi *et al.*, 1999; Bower, 2006; Parsons *et al.*, 2008; Onaran, 2009). The gas emission, cost of maintenance, and aesthetics received similar responses to be the third most preferred criterion in in-patient units; however, cost of maintenance and aesthetics received much lower ranks in any of the other two spaces studied. It seems convincing that aesthetics is ranked so high in in-patient units, as the majority of healthcare customers (patients) stay most of their time in this unit.

Table 2: Perceived highest levels of importance of each criteria for selecting wall finish materials, by unit

	Emergency unit		*Surgery unit*		*In-patient unit*	
Criteria	*Most important*	*Important*	*Most important*	*Important*	*Most important*	*Important*
Infection control	*10*	*38*	*10*	*38*	*12*	*36*
Ease of maintenance	*6*	*41*	*6*	*41*	*9*	*38*
Gas emission	*4*	*41*	*6*	*38*	*4*	*41*
IAQ	*3*	*41*	*6*	*42*	*2*	*45*
Sound resistance	*3*	*42*	*5*	*39*	*2*	*44*
Durability	*3*	*43*	*4*	*41*	*3*	*42*
Cost of maintenance	*2*	*42*	*3*	*42*	*4*	*41*
Flame resistance	*2*	*43*	*4*	*41*	*2*	*45*
Aesthetics	*1*	*45*	*2*	*40*	*4*	*41*
Initial cost	*0*	*40*	*1*	*43*	*2*	*41*
Ease of installation	*0*	*38*	*1*	*39*	*1*	*39*

6.3. Selection criteria ratings

Table 3 supplements the information presented in Table 2, as the respondents were also asked to rank the eleven criteria on an ordinal scale of 1 through 11, with "1" and "11" being the highest and lowest ratings, respectively. Table 3 summarizes the top five rankings as suggested by the survey respondents. The rankings for the emergency unit demonstrate that the top three rated criteria are: infection control, gas emission, and IAQ, with ease of maintenance and sound resistance not too far behind. However, this rating pattern is not similar to the surgery units, with infection control, gas emission, and sound resistance criteria tanked as the top three. The results for the in-patient units demonstrate that infection control and gas emission received the top two rankings, followed by ease of maintenance, IAQ, and sound resistance. Interestingly enough, the top two criteria rated in all three units are infection control and gas emission, where the following criteria for wall finish material selection are IAQ, ease of maintenance, and sound resistance, in different order, based on the function of the space. The other six criteria of durability, cost of maintenance, flame resistance, aesthetics, initial cost, and ease of installation are ranked lower in the order of priority of wall finish material selection by facility managers.

The respondents were not asked directly to make a link between their opinion on wall finish materials and the criteria for selecting wall finish materials. Hence, the relationship between the most preferred wall finish materials and the top ranked criteria in any given space needs some analysis and further validation that could be a part of a future research effort.

Table 3: No. of occurrences of each of the criteria for selecting wall finish materials in the top five rankings, by unit

	Emergency unit					*Surgery unit*					*In-patient unit*				
Preference / Criteria	*1*	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*
Infection control	*36*	*10*	*0*	*1*	*1*	*34*	*11*	*0*	*1*	*1*	*37*	*7*	*0*	*0*	*3*
Gas emission	*1*	*17*	*12*	*6*	*5*	*2*	*16*	*13*	*5*	*3*	*2*	*17*	*11*	*5*	*7*
IAQ	*0*	*8*	*14*	*4*	*5*	*1*	*8*	*8*	*14*	*4*	*0*	*8*	*12*	*9*	*4*
Ease of maintenance	*8*	*10*	*6*	*8*	*8*	*8*	*7*	*9*	*10*	*4*	*7*	*12*	*1*	*12*	*7*
Sound resistance	*0*	*0*	*9*	*14*	*5*	*1*	*2*	*13*	*8*	*9*	*0*	*2*	*11*	*10*	*9*
Durability	*0*	*2*	*3*	*3*	*4*	*1*	*0*	*2*	*1*	*3*	*1*	*1*	*1*	*2*	*0*
Cost of maintenance	*0*	*0*	*3*	*1*	*2*	*0*	*1*	*1*	*1*	*4*	*0*	*0*	*3*	*1*	*5*
Flame resistance	*0*	*0*	*4*	*0*	*3*	*0*	*0*	*2*	*3*	*3*	*0*	*0*	*3*	*3*	*6*
Aesthetics	*1*	*1*	*0*	*2*	*2*	*1*	*0*	*1*	*0*	*5*	*3*	*0*	*1*	*1*	*1*
Initial cost	*0*	*2*	*1*	*3*	*6*	*0*	*2*	*1*	*6*	*4*	*0*	*0*	*5*	*2*	*4*
Ease of installation	*1*	*0*	*2*	*4*	*6*	*0*	*1*	*0*	*4*	*7*	*0*	*1*	*1*	*2*	*5*

As seen in Tables 1 and 3, the respondents were given two lists to work with: one was a list of 10 wall finish materials, and a second list included 11 selection criteria, and they were asked to rank all of the items within each of these two groups. Therefore, responses were collected based on the rankings of wall finish materials compared to each other, and the same was done for the selection criteria of these materials. Instead, a performance score could have been obtained for each of the items within each of these two groups individually. The problem associated with the alternative method (performance scores obtained) is the possibility of not being able to differentiate between two or more items in the responses, similar to the results presented in Table 2, where it is clear that the respondents feel that all of the criteria presented to them are either “Most important” or “Important” in their selection process. From examining the results presented in Table 2, it is obvious what the top criterion for selection of wall finish materials is; however, it is almost impossible to identify the order of importance for the following criteria in that list. As a result of the method in which data was collected, and since there was no foundation based on which a probabilistic distribution of the data could have been assumed, it was inappropriate to use parametric statistical analysis methods; thus, non-parametric statistical analyses methods were considered. Out of the variety of possible statistical models and tests that are available, there are no more than a few that deal with ranking problems, and therefore, the following were considered in this study: Friedman test, Kendall’s tau test, Kruskal-Wallis test, and Spearman’s rank correlation coefficient. All of these methods were found to be inappropriate for the purpose of this study; hence, the authors would like to recommend that further research is needed in order to study whether the selection of wall finish materials is similar or different in emergency, surgery, and in-patient units, and whether leading criteria considered for the selection of wall finish materials are similar or different in these three units.

7. Conclusions

This paper explores the preferences of facility managers for wall finish materials and for their selection criteria in three hospital spaces: emergency, surgery, and in-patient units. Facility managers are primarily responsible for promoting the organization's productivity and for providing a safe quality of life to its users--employees and customers. Wall finishes of hospital buildings play a major role in not only making the space look appealing to the patients, but they also assist in the healing process. Wall finishes could affect the level of microbial infection in a healthcare facility, as they could harbor germs and eventually transmit diseases. Furthermore, it was found that facility managers are concerned about selecting a wall finish material that is primarily effective in infection control and offers lower gas emission, where secondary criteria include Indoor Air Quality concerns, ease of maintenance, and being sound resistant. Yet, most respondents rated most of the criteria as either "Most important" or "Important" when making such a decision, and therefore, the ranking question revealed their order of preferences.

The choice of wall finish materials was found to be similar for all three healthcare units chosen for this study; however, in other spaces this could differ, depending upon activities and usage. From this study, it can be concluded that the facility managers' most preferred choices for wall finish materials in hospitals are vinyl type II, paint – water or latex based, and rigid fiberglass panels, in this order. A relationship is possible between the most preferred materials and the top criteria for material selection. This, however, needs further analysis of the data and additional research effort.

References

Abreu E and Potter D (2001) "Recommendations for renovating an operating theater at an emergency obstetric care facility." *International Journal of Gynecology and Obstetrics* **75**: 287-294.

Borrelli F E (2007) "Vinyl meeting today's and tomorrow's indoor air quality requirements." *The Vinyl Institute*, **13**: 138-142.

Bower S B (2006) "Dialysis facility design – Part IV: color, sound and materials." *Dialysis & Transplantation*, November 2006, 1-5.

Burns T (2002) "Vinyl news focus material selection in health care." *Journal of Vinyl and Additive Technology*, **8**(3): 169-170.

Burton B T (1997) "Volatile Organic Compounds" in *Indoor Air Pollution and Health*, Bardana E J and Montanaro A (eds.). Portland, OR, USA, Informa Healthcare.

Carter C D and Barr B A (1997) Infection control issues in construction and renovation, *Infection Control and Hospital Epidemiology*, **18**(8): 587-596.

Chang J C, Fortman R, Roache N and Lao H C (1999) “Evaluation of low-voc latex paints.” *Indoor Air*, **9**: 253–258.

Clausen C A (2000) “Recognize, remove, and remediate mold and mildew”, *Proceedings of the 2nd Annual Conference on Durability and Disaster Mitigation in Wood-Frame Housing*, Madison, WI, USA, Forest Products Society, November 6-8, 2000, 231-234.

Federal Facilities Council (2001). Sustainable Federal Facilities: A Guide to Integrating Value Engineering, Life-Cycle Costing, and Sustainable Development, Washington DC, USA, National Academies Press.

Fogg D M (1999) “Pagers in the OR; pacemakers; OR renovation; draping; flash sterilizers records”, *AORN Journal*, **69**(1): 272-276.

Hart K (1998) “Wall-to-wall protection”, *The Journal for Healthcare Design and Development*, **29**(8): 45-48.

Hodgson A T, Rudd A F, Beal D and Chandra S (2000) “Volatile organic compound concentrations and emission rates in new manufactured and site-built houses”, *Indoor Air,* **10**: 178-192.

Hoskins J A (2003) “Health effects due to indoor air pollution”, *Indoor Built Environment*, **12**(6): 427-433.

Jacob J (2006) *Design & Durability with Vinyl Wall coverings*, (available online http://www.greenbuildingsolutions.org/s_greenbuilding/doc.asp?TRACKID=&CID=555&DID=1855 [accessed on October 15, 2008]).

Lankford G M, Collins S, Youngberg L, Rooney D M, Warren J R and Noskin G A (2006) “Assessment of materials commonly utilized in health care: Implications for bacterial survival and transmission”, *American Journal of Infection Control*, **34**(5): 258-263.

Lav R (2003) *Changing role of facility manager*, (available online http://www.businessgyan.com/ [accessed on June 4, 2008]).

Mayer P (2005) *Costs: Wall finishes in healthcare buildings*, (available online http://www.building.co.uk/story.asp?storyCode=3045192 [accessed on October 15, 2008]).

Meininghaus R, Gunnarsen L and Knudsen H N (2000) “Diffusion and sorption of volatile organic compounds in building materials-impact on indoor air quality”, *Environmental Science & Technology*, **34**(15): 3101-3108.

Milner S and Narayan C (2005) “Material/matters”, *Health Facilities Management*, **18**(10): 27-30.

Mortensen L H, Rode C and Peuhkuri R (2005) "Full scale tests of moisture buffer capacity of wall materials", *Proceedings of the 7th Symposium on Building Physics in the Nordic Countries*, Reykjavik, Iceland, June 13-15, 2005, 662-669.

Moulavi D, Bushy A, Peterson J and Stullenbarger E (1999) "Factors to consider when buying a mobile health unit", *Journal of Nursing Administration*, **29**(2): 34-41.

Noskin G A and Peterson L R (2001) "Engineering infection control through facility design", *Emerging Infectious Diseases*, **7**(2): 354-357.

Nussbaumer L L (2006) *MCS: Interior finishes*, (available online http://agbiopubs.sdstate.edu/articles/ExEx14098.pdf [accessed on November 15, 2009]).

O'Connell N H and Humphreys H (2000) "Intensive care unit design and environmental factors in the acquisition of infection", *The Hospital Infection Society*, **45**, 255-262.

Onaran B S (2009) "Sustainable therapy room surfaces in acute mental health hospitals", *WSEAS Transactions on Environment and Development*, **5**(2): 219-228.

Padfield T (1999) *Humidity buffering of interior spaces by porous, absorbent insulation: part of hygrothermal properties of alternative insulation materials*, (available online http://www.conservationphysics.org/altisol/woolbuff.pdf [accessed on November 15, 2009]).

Parsons S A, Hussey R, Abbott G and Jager P D (2008) "Hospital design to accommodate multi-and extensively drug-resistant TB patients", *Proceedings of the 20th Congress of the International Federation of Hospital Engineering*, Barcelona, Spain, October 19-22, 2008.

Piotrowski C M and Rogers E A (2007) *Designing commercial interiors*, New York, NY, USA, John Wiley and Sons.

Rohde J (2002) *Survey outlines materials selections in healthcare design*, Arlington, VA, USA, JSR Associates Inc.

Schultz J K (1979) "OR wall material: is there any choice?", *AORN Journal*, **29**(7): 1222-1223.

Shohet I M, Lavy-Leibovich S and Bar-on D (2002) "Integrated Maintenance Management of Hospital Buildings in Israel", *Proceedings of the 17th International Symposium of the international Federation of Hospital Engineering*, Bergen, Norway, May 12-16, 2002.

Straub A (2003) "Using a condition-dependent approach to maintenance to control costs and performances", *Journal of Facilities Management*, **1**(4): 380-395.

Streifel A J (1998) "A holistic approach to indoor air quality in health care", *Heating/Piping/Air Conditioning*, **4**(2): 69-70.

Takrouri M S (2004) “Intensive care unit”, *The Internet Journal of Health*, **3**(2): 2-4.

Turner G P and Bentley J (1997) *Introduction to paint chemistry and principles*, New York, NY, USA, Chapman and Hall.

Vittori G (2000) *Green and healthy buildings for the healthcare industry White Ppaer*, Setting Healthcare’s Environmental Agenda, October 16, 2000, (available online http://www.cmpbs.org/publications/PE1.1-Green_Healthy.pdf [accessed on November 15, 2009]).

Wang B B, Thomas W, Falk J A and Goodwin D (2001) “Management strategies and financial performance in rural and urban hospitals”, *Journal of Medical Systems*, **25**(4): 241-255.