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Floor Finish Selection in Hospital Design: A Survey of Facility Managers

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ABSTRACT

Flooring materials have a considerable impact on the indoor environment of healthcare facilities. In recent years, flooring options such as vinyl flooring and vinyl composite tiles have emerged as a popular choice in such facilities. They have been preferred extensively because of properties that make them durable, resistant to infections, and easy to maintain with minimum expenditure. However, there is limited literature and research which comprehensively evaluates floor finishes and their selection criteria in healthcare environments and the opinion of facility managers regarding the same.

This study analyzed, identified and systematized literature on selection criteria for flooring in healthcare facilities. It found out the preferences of healthcare facility managers regarding floor finishes and their selection criteria and assigned empirical values to their opinions and carried out further analysis.

This research investigated literature on different types of floor finishes currently used in healthcare facilities and the criteria applied for their selection. The literature review for this study was conducted through search engines using relevant keywords. Peer-reviewed studies and articles published between 2000 and 2016 and consistent with the research design were included. A questionnaire survey was conducted among healthcare facility managers in the state of Texas. Hence, Wilcoxon Rank Sum Test was used for data analysis.

The top five floor finishes used in the healthcare sector were identified: vinyl flooring, vinyl composite tile (VCT), rubber, linoleum, and ceramic flooring. Top five selection criteria that were identified: durability, infection control, ease of maintenance, maintenance cost, and user safety.

Based on specific selection criteria the choice of floor finish may differ because each material exhibits its own properties which are different from other materials. For e.g. vinyl flooring could be preferred due to durability, infection control and low initial and maintenance cost. However, if selection criteria such as the effect on healing and aesthetics are preferred, then carpet flooring could be a better choice. The scope of future research has been provided.

Keywords: Flooring materials, maintenance, healthcare buildings, Environmental, patient safety etc.

INTRODUCTION AND BACKGROUND

Facility design and maintenance are the two phases of a building's lifecycle that have a huge impact on the performance of an organization. However, during decision making in terms of facility design, the topic of facility maintenance of rarely addressed which affects the performance of the organization (Pati et al., 2009). The subsequent sections have analyzed the preferences of healthcare facility managers regarding interior floor finish materials and the criteria applied to select them.

Healing of a patient in a hospital is dependent on its environment. An evidence-base has emerged that supports the designing of healthcare buildings for quality, safety and providing a favorable environment could significantly improve patient outcomes, satisfaction and healing process. It would reduce expenditures and render benefits to healthcare organizations, workers, and patients (Harris & Detke, 2013). Onaran, (2009b) stated that floor finish materials, along with other interior surfaces like the ceiling and wall finishes influence the indoor air quality. Previous studies such as Onaran, (2009a) suggested that the internal environment is most impacted by floor coverings. Color and pattern on the finish materials of a hospital affect the behavior of its users, such as the patients and the hospital staff.

FLOOR FINISHES AND THEIR SIGNIFICANCE IN HEALTHCARE

Facility Management

In a hospital, efficient operations and management procedures are dependent upon the type of interior finish materials put into use (Wilson & Ridgway, 2006). In due consideration with floor finish selection, the decisions made during the architectural design phase of a healthcare building should complement and support its operations and management phase while the facility is occupied. In the healthcare industry, floor coverings with chemically

or heat welded seams have a preferred use because they render infection control properties in the interior environment (Bower, 2006). For spaces, such as operation theaters where hygiene is of paramount importance; flooring types should be seamless, hard and easy to clean. It should withstand strong germicidal and cleaning agents as the floor of likewise areas undergo daily washing with such solutions (Abreu & Potter, 2001).

Floor Finish Materials

The flooring types could be divided broadly into three categories: (1) hard flooring systems; (2) resilient flooring systems; and (3) soft flooring systems (Moussatche & Languell, 2001). Hard flooring systems are defined as those flooring materials that bear rigid and non-scrappable properties and are integral with the building (Robinson, 1996). This classification includes ceramic tiles, quarry tiles, exposed concrete flooring, terrazzo flooring, epoxy flooring, laminated wood flooring, wood plank flooring and others (Moussatche & Languell, 2001). Resilient flooring systems are defined as those which have a fair amount of durability and are resistant to water and stains (Bower, 2006; Tuladhar et al., 2015).

Characteristics of Favorable Floor Finish For Healthcare

Floor finish ideal for application in a healthcare facility should exhibit a wide range of properties (Harris & Fitzgerald, 2015). Its maintenance cost should be low and the service life should be long (Federal Facilities Council, 2001). Criteria for selection of flooring materials also depends upon easy installation and maintenance procedures (Kishk et al., 2007). Studies have suggested that hospital flooring systems should be durable (Noskin & Peterson, 2001) and have good visual characteristics especially in rest areas of the hospital staff (Sadatsafavi et al., 2015). Pattern on the floor is important because it affects absorption and reflection of light and sound through them. Highly polished flooring surfaces are inappropriate for use in healthcare sector as they reflect light and produce additional glare. Strong contrast between the flooring materials should be avoided because it could cause confusion, disorientation or could be interpreted as change in level. (Onaran, 2009).

Durability and Resilience

Floor coverings which are resilient have broad applications in the healthcare industry. They are popular due to durability, comfort, ease of cleaning and routine maintenance, low cost and an availability of broad range designs (Lent et al., 2009). Resilience and durability renders water resistant properties to floor finishes (Noskin & Peterson, 2001). It is important for finishes used in a hospital to be smooth and resist water, especially around plumbing fixtures because dampness might support microbial growth (Ninomura et al., 2006).

Underfoot Comfort and Fatigue Reduction

Environmental stressors like fatigue, stress and physical injury walk a fine line between the efficiency of an organization and facility design that bolsters the processes of a health care institution (Harris, 2015). They negatively impact mood, alertness and cognitive performance of healthcare employees (Hales & Pronovost, 2006; Reason, 2000; Shojania et al., 2001).

Safety, Impact and Slip Resistance and Prevention of Fall and Injury

National Council on Aging states that 30% of fall incidents in a hospital or acute healthcare facility results in a serious injury (Harris & Detke, 2013). Also, falls occur frequently in hospitals and cost about \$3.6 billion annually (Gulwadi & Calkins, 2008). They are epidemic and account for the highest number of nonfatal injuries occurring during hospitalization of patients (Agency for Healthcare Research and Quality, 2008b). Flooring material types and shock absorbing floor tiles could prove to be important for injury prevention in hospitals (Drahota et al., 2007).

Favorable Acoustical Properties and Noise Cancellation

Excessive noise and poor acoustics in healthcare facilities can obstruct the healing process of patients (Hagerman et al., 2008; Parthasarathy & Tobin, 2004), cause tension (Morrison et al., 2003), contribute to poor communication levels (Blomkvist et al., 2005), which could result in errors. Nurses have reported fatigue, headaches and irritation due to noise at workplace. Moreover, hearing loss due to noise has been a cause of concern for orthopedic surgeons (Kracht et al., 2007; Love, 2003).

Ease of Maintenance

While facility design is playing a defining role in strategizing organizational objectives, concerns related to maintenance of a facility have typically been overlooked during the process of design related decision-making.

Emission of Volatile Organic Compounds into The Indoor Air

Flooring materials were found to be responsible for the release of emissions, such as VOCs into the indoor air of a building (Rossi & Lent, 2006). Upon the measurement of secondary degradation emission rate of flooring products; it was concluded that adhesives used in a flooring system decomposed in an alkaline environment and hence, gave rise to alarming rates of secondary emission (Sjöberg & Ramnäs, 2007).

Infection Control and Resistance to Bacterial and Mold Growth

Bacteria found on environmental surfaces in a hospital was found to be associated with infections acquired in such facilities. Especially, in in-patient environments, those surfaces have the potential to host pathogens ranging from a few hours to months (Harris et al., 2009). Diseases were caused due to bacterial or mold build up when the floor remained moist or dirty (Berry et al., 2002).

Sustainability

Sustainability was found to be one of the most important considerations in the building industry in the present-day scenario (Onaran, 2009). To close the loop, a product must be designed in such a way that after its usable life it is recycled back into such materials which can be used to manufacture items of similar grade.

Life Cycle Cost

Finish materials play a significant role in the determination of construction costs whether in initial or operation and maintenance costs. However, the selection decisions should always evaluate and compare the cost of the finish material with its efficiency, durability and required cleaning methods (Shafie & Sherif, 2010).

SUMMARY

Based on this literature study, it was found that mostly 10 different types of floor finishes are used in the healthcare facilities. Namely, rubber flooring, carpet flooring, sheet vinyl flooring, vinyl composition tiles (VCT), linoleum flooring, ceramic tiles, concrete flooring, hardwood flooring, laminated hardwood flooring, and mosaic flooring. Along with the flooring types, 16 different selection criteria were identified. They are initial cost, ease of installation, maintenance cost, ease of maintenance, durability, noise cancellation, ease of movement, underfoot comfort, impact resistance, flame resistance, indoor air quality, infection control, sustainability, aesthetics, glare, and effect on healing.

Key Findings of The Literature Review

The literature study revealed 11 different types of floor finishes used in the healthcare facilities investigated in the referred studies. These finishes included rubber flooring (Harris & Detke, 2013), carpet flooring (Harris, 2009), vinyl flooring (Sherif, 2013), vinyl composition tiles-VCT (Blakey and Rohde, 2002), linoleum flooring (Lent et al., 2010), ceramic tiles (Harris & Fitzgerald, 2015), concrete flooring (Gulwadi & Calkins, 2008), hardwood flooring (Tuladhar et al., 2015).

RESEARCH DESIGN AND METHODOLOGY

RESEARCH METHODOLOGY

Problem Statement

In the healthcare construction industry, preferences of facility managers for floor finish choices and their selection criteria have not been well understood. Hence, an investigation of opinions of such professionals, who play a significant role during the life cycle of a facility; is important.

RESEARCH OBJECTIVES

The objective of this study was: (1) to review the existing literature and developing a preferred list of floor finishes and their selection criteria in healthcare, (2) to conduct a survey of healthcare facility managers for identifying the most preferred floor finish and selection criteria, and (3) to investigate the similarity in ranking of floor finishes and their selection criteria across different healthcare units using non-parametric statistical methods.

Limitation and Delimitation

The questionnaire survey for this study was limited to not-for-profit hospitals located in metropolitan regions (Wang et al., 2001). This study is delimited to the healthcare facility managers working in the state of Texas, USA.

Assumptions

It was assumed that the respondents of the questionnaire survey would answer the questions without any bias and that they had sufficient knowledge and expertise to participate. It was also assumed that for a healthcare facility, the material selection depended on the design type, availability of the material locally and traditional selection procedures. For the state of Texas, it was assumed that similar floor finish materials were available for installation in healthcare.

Research Methods

This study was conducted in four step method to investigate the preferences of healthcare facility managers regarding floor finish choices and their selection criteria. The steps were: (1) reviewing related literature, (2) developing questionnaire survey, (3) conducting a pilot study, administering questionnaire survey and collecting data, (4) analyzing and interpreting collected data.

SUMMARY

This study was conducted to find out the opinion of healthcare facility managers regarding floor finish choices and their selection criteria. Using statistical methods empirical values were assigned to their preferences. The Wilcoxon Rank Sum Test which was used to analyze the collected data was an appropriate non-parametric statistical method to study a data set which does not follow a normal distribution. However, when the responses across all

three healthcare units were combined for a cumulative analysis, the central limit theorem allowed the calculation of mean values after a defensive approximation of the Likert scale as an interval scale (Gupta & Kapoor, 2000).

RESULTS

In the questionnaire survey, all questions were designed using multiple matrices to collect different data sets in relation to the identified healthcare units: (1) emergency units, (2) surgery units, and (3) inpatient units. Questions 1 and 2 aimed at collecting data regarding floor finish choices of healthcare facility managers, while, questions 3 and 4 aimed at exploring their preferences for floor finish selection criteria .

FLOOR FINISH MATERIALS

Data specific to floor finish materials such as: (1) information on types of floor finishes currently installed in the healthcare facility that the respondents were working with at the time of participation in the questionnaire survey, and (2) the ranking of identified floor finish choices based on their experience in the field of healthcare facility management, were collected via questions 1 and 2.

SELECTION CRITERIA FOR FLOOR FINISH MATERIALS

Data specific to the selection criteria of floor finish materials were collected via questions 3 and 4, for e.g.: (1) information on the preferred ranking of identified criteria for selection of floor finishes based on the experience of facility managers in healthcare and (2) opinion of the respondents on significance of each selection criteria for floor finishes in different healthcare units.

DISCUSSION

According to the literature review it was found that the top five floor finish materials preferable for use in healthcare facilities are vinyl composition tile, vinyl, rubber, carpet, and linoleum flooring, and the top five selection criteria for floor finishes are indoor air quality, patient safety, infection control, recyclability and ease of maintenance. However, with respect to the questionnaire survey conducted among the healthcare facility managers, it was found that the results were not entirely identical to the findings of the literature review. According to the questionnaire survey, the top five preferences for floor finishes of healthcare facility managers were vinyl, vinyl composition tile, rubber, linoleum and ceramic flooring, and the top five selection criteria for floor finishes were durability, infection control, ease of maintenance, maintenance cost, and user safety. These results are based on observation of Tables 11 and 16 which present a cumulative data for all healthcare units. A difference was observed when individual units were investigated.

CONCLUSIONS

Floor finishes in healthcare played a significant role in maintaining an environment free of infection, along with accelerating the rate of healing of patients. It provided comfort to its users, especially the hospital staff who worked for longer hours. The literature review established that there was a difference in the opinion of the design decision makers and facility managers. The designer's point of view was driven majorly by high-level project perspectives such as design concepts and budget. However, the opinion of the healthcare facility managers was driven primarily by the building functionality related aspects which played a significant role in the operations and maintenance stage of a facility. After extensively analyzing related literature, this study focused on conducting a questionnaire survey among the healthcare facility managers in the state of Texas to collect data regarding their preferences for floor finish choices and selection criteria. Their responses were statistically analyzed and empirical values were assigned to their preferred choices. The intention was not to undermine the ideas or viewpoints of the designers. The main objective of this research was to make the design team aware of the choices of the respondents based on their experience in the field of facility management.

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