

**RANKING OF PREFERRED CRITERIA OF
FLOOR FINISHES FOR BATHROOM BY THE
HOUSE OWNER IN EAST COAST OF THE
MALAYSIA**

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**SCHOOL OF CIVIL ENGINEERING
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By

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ABSTRACT

The indoor environment is greatly influenced by the flooring materials, particularly in the bathroom. Bathroom flooring options such as ceramic and porcelain tiles have become more common choices over the years. They are widely preferred due to their qualities that make them long-lasting, water-resistant, and inexpensive to maintain. Nevertheless, a paucity of research and writing thoroughly assesses floor finishes and the factors that should be taken into consideration when choosing a material for bathroom floors. Therefore, this study analysed, compiled, and systematised the literature on bathroom flooring selection criteria. It discovered the selection criteria and preferences of homeowners for floor finishes, gave their opinions empirical values, and conducted the additional analysis. A random sampling technique was employed to select 100 -150 respondents for the investigation. The respondents were derived from residents on the East Coast of Malaysia. The statistical package for the social sciences (SPSS) was used to analyse the data. Results obtained from the case studies show the preference rank of criteria and type of floor finishes material for the bathroom. The conclusion derivable is that the choice of floor finishes is a dependent function of certain variables amongst which is the home ownership.

ABSTRAK

Persekitaran dalaman sangat dipengaruhi oleh bahan lantai, terutamanya di bilik mandi. Pilihan lantai bilik mandi seperti jubin seramik dan porselin telah menjadi pilihan yang lebih biasa selama ini. Mereka lebih disukai kerana kualitinya yang menjadikannya tahan lama, kalis air, dan murah untuk diselenggara. Walau bagaimanapun, kekurangan penyelidikan dan penulisan secara menyeluruh menilai kemasan lantai dan faktor-faktor yang perlu diambil kira semasa memilih bahan untuk lantai bilik mandi. Oleh itu, kajian ini menganalisis, menyusun dan sistematik literatur mengenai kriteria pemilihan lantai bilik mandi. Ia menemui kriteria pemilihan dan keutamaan pemilik rumah untuk kemasan lantai, memberikan pendapat mereka nilai empirikal, dan menjalankan analisis tambahan. Teknik persampelan rawak telah digunakan untuk memilih 100 - 150 responden untuk penyiasatan. Responden adalah berasal daripada penduduk di Pantai Timur Malaysia. Pakej statistik untuk sains sosial (SPSS) digunakan untuk menganalisis data. Keputusan yang diperolehi daripada kajian kes menunjukkan peringkat keutamaan kriteria dan jenis bahan kemasan lantai untuk bilik mandi. Kesimpulan yang boleh diterbitkan ialah pilihan kemasan lantai adalah fungsi bergantung kepada pembolehubah tertentu di antaranya ialah pemilikan rumah.

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CHAPTER 1:

INTRODUCTION

1.1 Introduction

The fact is that humans are spending almost all the time of their life activity in closed spaces such as at home and in non-residential buildings (Neil E. Klepeis, 2001). House play an important role in incorporating interior spaces and all interior elements, as well as promoting the health and well-being of their house owner and making their lives perfect. The floor is one of the most important elements because when compared to other interior elements, our feet come into contact with the floor more frequently. Additionally, slips and falls are frequently brought on by interior floors, making them one of the most crucial interior space elements.

Flooring choices make a big difference in the indoor environment, especially in bathrooms and other wet areas. In recent years, ceramic and vinyl tiles have become common choices for bathroom flooring. They are widely used because of their qualities, which include longevity, infection resistance, ease of maintenance, and low cost. However, there is a deficiency of information in the literature and research that thoroughly assesses floor finishes and their selection criteria for bathroom area.

The term "indoor air quality" refers to the air quality inside of buildings, which has an impact on a person's comfort, health, and productivity. In comparison to the past, with air pollution in the outdoor environment, indoor air quality has received a lot of attention. After being exposed to a pollutant, some health effects, such as eye, nose, and throat irritation, headaches, light headedness, and fatigue, may manifest

immediately. These immediate effects are typically transient and manageable. After some time, the signs, and symptoms of some illnesses, like asthma, may emerge, intensify, or worsen. Effects from long-term exposure can be fatal or severely disabling, including respiratory illnesses, heart conditions, and cancer. It is crucial to choose appropriate floor finishes to enhance indoor air quality even if there are no obvious symptoms.

Infection control issues should be prioritised when selecting floor finishes for a bathroom. The design principles used to accommodate infection control procedures would have long-term advantages for up to 30 years (Wilson & Ridgway, 2006). In comparison to other options, floor finishes with sterile qualities, such as sheet vinyl and vinyl composite tile, are a better choice in the United States for infection control (Sherif, 2013). Some indoor building materials, such as volatile organic compounds (VOC), released different gases into the indoor air as a result of their material composition. These materials are widely used in the bathrooms in Malaysia.

The two main sources of VOCs in flooring materials that had a significant effect on a room's indoor air quality were found to be sheet vinyl and plywood flooring (Hodgson, 2000). Vinyl products were still chosen over due to their durability and infection-control capabilities, despite the fact that their use released harmful substances into the indoor air (Sherif, 2013). There are currently no plans to add any bio-based products to the chemistry of vinyl flooring to replace any of its important components. Vinyl flooring does not currently contain any bio-based products. Because of this, manufacturers of flooring materials are unable to eliminate dangerous persistent, bioaccumulative, and toxic (PBT) substances from a vinyl floor type's composition (Lent et al., 2009).

1.2 Problem Statement

One of the most significant elements in any building to make it wonderful and functional is the flooring. The floor is the finishing touch and the material that is most frequently touched by regular users of any building, structure, or home. When you walk into a building, you come into contact with the floor. There is an entire system of layers and parts beneath your feet that work together to create this finished look.

The evaluation and material selection for a particular building's functional space, however, are underwhelming because homeowners prefer to install floors without empirical support, particularly in the bathroom, where moisture levels are more considerably higher. Moreover, other factors such as durability, cost, and ease of installation must also be taken into account. Therefore, the purpose of this study is to give new knowledge for the next house owner.

1.3 Research Aims and Objectives

The aim of this research is to study floor finishing materials for bathrooms most preferable by the house owners. The specific objectives for the research are:

- i. To investigate the preferences of homeowners in terms of material selection criteria.
- ii. To determine the ranking of the preferred choices of floor finishes types among the homeowners.

1.4 Scope of Research

This study was conducted in East Coast of Malaysia. The study focused on respondents who have homes that use floor finishes. The area of focus is the bathroom in which have the damp or wet area. This study was conducted in the form of a questionnaire.

1.5 Respondent and significant of study

The significant of this study. One of it is contemporary and occurring issue meaning is still happening, it is relevant, and it is still significant. Next, it allows us to seek answers regarding the most preferable floor finishes material among house owners, this basically means acquiring new knowledge about an uncharted and new territory in the form of selection criteria of materials. Lastly can provide useful data and information for new house owner.

CHAPTER 2:

LITERATURE REVIEW

2.1 Introduction

Interior floor finishes are very important in interior design. The proper selection of space floor matching can help to create a more sustainable living environment. According to the NFPA 101 Journal (National Fire Protection Association 101 Journal) interior finishes are surfaces that are covered on walls, ceilings, and floors of buildings. Floor finishes are a generic term for a permanent floor covering, the installation of such a covering, and any finish material, such as wood flooring, ceramic tile, stone, terrazzo, and different seamless chemical floor coatings, which are applied over a floor structure to provide a walking surface. Interior floor finishes refer to the visible floor surfaces of structures, including coverings placed over finished floors or stairs, including risers.

Slips and falls incident are also common as a result of the interior floor because residents' step on floor every day compared to other interior space elements such as ceiling and wall. Developers do not pay special attention to the specification of interior floor finishes of affordable houses, which is tricky. Safety issues, such as slips and falls, can occur in the interior space if the floor matching is not appropriate, especially on stairs and in kitchens and bathrooms (Yasser M. El-Sherbiny, 2011). These incidents may have more major impacts, permanent injuries, and, in some

cases, fatalities (ELCOSH-Electronic Library of Construction Occupational Safety Health, 2017). According to The Institute for Public Health's National Health and Morbidity Survey, NHMS 2011, 8.2 percent (0.1 million) of children under the age of seven experienced home injury, while 5.3 percent (0.1 million) of the elderly aged 60 and up experienced home injury. As a consequence, the issue of home injury must be addressed.

When compared to the initial cost, the cost of flooring maintenance is substantial. Furthermore, two studies showed that the life cycle costs of the majority of flooring systems were out of proportion to their initial costs. For instance, a low life cycle cost was not always guaranteed by the minimum installation cost (Lozada, 2004). It is significant to mention there are not that many publications that consider at the life cycle costs of different kinds of flooring. The price of installing flooring should not come before other factors. The choice of floor finishes is influenced by a variety of non-financial factors, in addition to cost considerations, including ease of maintenance, durability, user safety, and aesthetics (Bogenstätter, 2000).

2.2 Floor Finishes Material

In general, there are three of flooring types which is hard flooring systems, resilient flooring systems and soft flooring systems (Moussatche & Languell, 2001). Hard flooring structures are described as being made of rigid, scratch-resistant flooring materials that are a vital component of the building (Robinson, 1996). This group of materials includes ceramic tiles, quarry tiles, exposed concrete flooring, terrazzo flooring, epoxy flooring, laminated wood flooring, wood plank flooring, and others (Moussatche & Languell, 2001).

Then, resilient flooring systems are those that have a reasonable amount of durability

and are waterproof and stains (Bower, 2006; Tuladhar et al., 2015). Some examples of resilient flooring systems include linoleum flooring, vinyl composition tiles, vinyl sheets, rubber flooring, and so on (Moussatche & Languell, 2001). Soft flooring systems mainly refer to woven, cut pile, or tufted rugs and carpets with looped designs (Robinson, 1996). As eloquently stated by (Nancy, 2022), the majority of homeowners concentrate on finding an appealing, enduring material that matches their style when choosing flooring for a bathroom however, the bathroom flooring must be waterproof, which is a significant distinction from the flooring in other rooms.

Today's market offers a seemingly limitless selection of bathroom flooring options. It is particularly difficult to find definitive study and design information for operational ranges of floor surface finishes required for bathrooms. There are also no accepted guidelines and design data on operational levels of floor finishes materials for the wet area, especially the bathroom. Therefore, the options have been narrowed slightly by selecting the six best types of bathroom flooring materials.

2.2.1 Porcelain tiles



Figure 2.1: Porcelain tiles in the bathroom



Figure 2.2: Structure composition of porcelain tiles

Porcelain tiles are dense and long-lasting, with a water absorption rate of less than 0.5 per cent. Porcelain tiles are glass tiles made by incorporating elements such as quartz, silica, or feldspar into a clay mixture. This consequences in less porosity and lower water absorption, making the tiles harder and able to withstand greater forces. Walking or standing for long periods of time on tile can be uncomfortable, however, that is true of any hard surface, and the temperature of the floor can be addressed because porcelain works well with flooring systems. Furthermore, porcelain tiles are germ-free because they do not absorb water or germs and clean easily, making them an excellent choice for sterile environments.

On the other hand, a potential disadvantage of tile is that it can be slick when wet, and bathrooms are frequently damp. This is genuine of many different types of hard surfaces, but because porcelain is frequently baked to a smooth finish, people frequently mistakenly believe that it is more slippery than other options. Their surfaces are frequently coloured and glazed, and sometimes different colours are present beneath the surface as shown in figure 2.2. A bathroom floor made of porcelain tiles can become very dangerous because the water will sit on top of the tile, which is very smooth.

2.2.2 Ceramic tiles



Figure 2.3: Ceramic tiles in bathroom



Figure 2.4: Structure composition of ceramic tiles

Ceramic is the most common type of finish and is widely used in bathrooms and kitchens. Sand, organic materials, and clay are the essential components in ceramic tile, which is formed into the desired shape before being fired in a kiln. When compared to other materials used to cover floors and walls, ceramic tiles have a much longer lifespan. The resilience of ceramic tiles to moisture is a major advantage of their durability. The use of ceramic flooring in moist areas is conceivable because of their imperviousness. As ceramic tiles are well recognised for having a lot of resistance. Having said that, ceramics outperform other flooring materials in terms of tread wear

resistance. Additionally, after being coated with an abrasive glaze, ceramic tiles are virtually slip-resistant. Installation of this anti-slip tiles, which have grit baked into their surface during manufacture, will help to lower slips and falls as shown in figure 2.4. Ceramic tiles have a hard, solid surface, that does not attract or hold onto dirt, dust, pollen, or other allergens (Children's Environmental Health Network,2016). Therefore, when such tiny dust particles do manage to land on a ceramic floor, they stand out against the surface and are quickly can be removed with a mop or sponge. This assists in removing irritants from the air that could harm people with asthma and allergies.

2.2.3 Vinyl flooring

Vinyl makes a great flooring option for bathrooms due to its general water resistance. PVC (polyvinyl chloride), a man-made plastic made of carbon, hydrogen, and chlorine, made vinyl flooring a truly practical flooring material. The flooring material in conventional sheet vinyl or vinyl tiles is a composite product made of a PVC framework requires to a fibrous core, which is then covered with a printed design surface and a durable, clear wear layer. The thickness of the products and the tensile strength of the wear layer serve as indicators of high and low quality. The material comes into several forms such as sheets vinyl, planks vinyl and tiles vinyl.

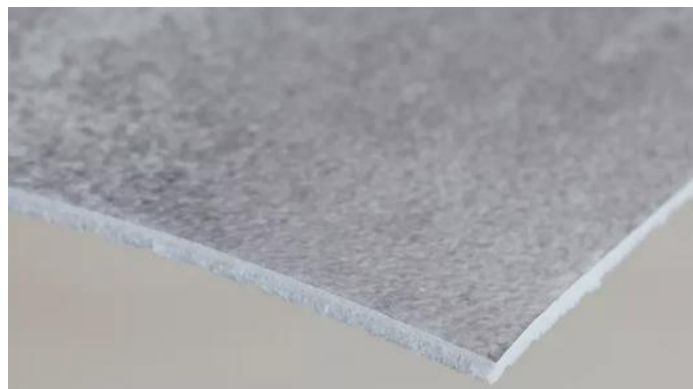


Figure 2.5: The composition of sheet vinyl

The sheet vinyl flooring is installed in one continuous piece. Generally, a base layer

of fibrous material is adhered to a PVC film layer created using digital graphics to give the flooring its pattern and colour as shown in figure 2.5. To safeguard the PVC layer, there is a layer of protective outerwear on top. It is one of the best flooring materials for water repellency due to its wide width, which enables a room to be covered with few or no seams at all. Sheet vinyl is actually somewhat more versatile when it comes to design since it also works well with random patterns that do not repeat (Joeseph,2020).



Figure 2.6: The composition of vinyl tiles

In contrast, vinyl tile is a blend of natural limestone that has been finely ground, filler materials, thermoplastic binders, and colour pigments as in figure 2.6. It is created by joining these components to form solid sheets, which are then cut into tiles. However, this floor will not be as moisture resistant as sheet vinyl because of the numerous seams that frequently exist between the tiles. The base layer may become loose as a result of water leaking through the seams. It can be regarded as the most reasonable or low-cost type of vinyl flooring, and since the individual pieces are very manageable cause the installation is quite simple.

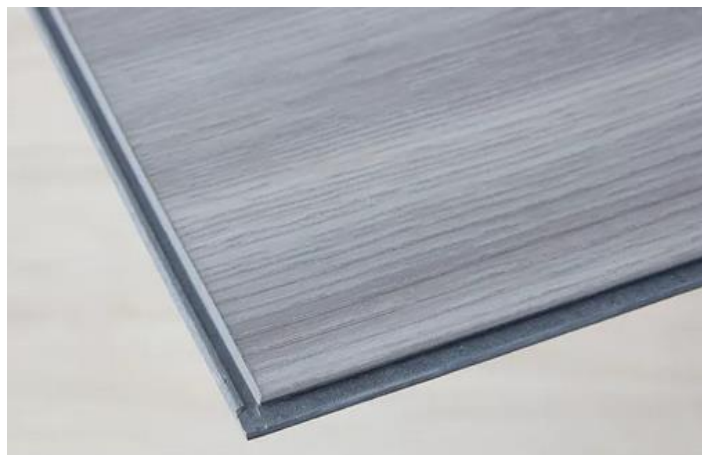


Figure 2.7: The composition of plank vinyl

While plank vinyl is vinyl flooring in the form of long strips, or planks, is available. Although plank vinyl flooring is much simpler to install than sheet vinyl, it is also slightly less water-resistant because it has more seams than the vinyl sheets. It is formed from materials based on limestone and PVC composites. Since there is no fibre layer, the entire thickness of this material is solid. The individual tiles or planks are connected together using a modified tongue (figure 2.7) and groove system, making plank vinyl flooring also quite simple to install. Overall, there are many different types of vinyl flooring for bathrooms. Considering that it is accessible in almost every colour, pattern, and design.

2.2.4 Wooden flooring



Figure 2.8: The wooden flooring for bathroom.

Wood bathroom flooring has created a stunning foundation for homes all over the world. Timber's timeless elegance and natural characteristics continue to make it a popular choice for your bathroom ideas (Amelia Thorpe,2022). Solid wood flooring and engineered wood flooring are two basic types of this type of flooring. Solid wood is created from a single piece of timber, whereas engineered wood is created by layering solid wood over layers of plywood to produce a stable and durable product. Solid woods would need to be flawlessly installed and moisture-sealed in order to function in a bathroom. Otherwise, the water will seep in, and they will eventually rot.

Additionally, they will require more frequent resealing with a polyurethane-type coating than if they were in a different room without the moisture issues a bathroom presents. Moreover, even though engineered wood has real wood layers on top, must ensure that it is completely sealed. The substance beneath the wood layers is frequently neither waterproof nor even water-resistant. This kind of flooring can be considered a fairly pricey option, and it has another drawback in that it is vulnerable to damage and can only be sanded frequently without cutting through the veneer layer. Even so, it is a reasonable chance to succeed with great caution.

2.2.5 Marble



Figure 2.9: The marble flooring for bathroom.

One of the most exquisite flooring options for the bathroom is the marble flooring (figure 2.9). The natural stone that is extracted in large slabs from the mountain's core before being cut into smaller pieces and refined into the individual tiles, slabs, and mosaic sheets that are used in common construction procedures, such as floor and wall tiles and countertop slabs. It is a metamorphic rock that results from the transformation of a sedimentary stone, such as limestone, into a harder stone with gorgeous colour and veining that produces under heat and pressure.

Even though it can be attractive with its appearance it has a lot of disadvantages such as being more costlier and low slip resistance as the surfaces are dangerously slick and slippery. However, this can be reduced by using grout patterns and finishes that are added after the surface has been roughed. As certain stone products need periodic sealant applications to maintain the stone finish and stop the infiltration of dirt and debris as well as moisture absorption, it may also require more frequent maintenance than other options.

2.2.6 Carpet flooring



Figure 2.10: The carpet flooring for bathroom

Carpet made of synthetic materials such as olefin and polyester perform only

marginally better in damp areas than wool. Due to its ease in capturing moisture and abundance of favorable conditions for its growth, the carpet is extremely hospitable to mould. Even if the bathroom has a running fan and adequate ventilation in the bathroom, one prolonged shower can result in the growth of more mould. The carpet feels softer underfoot as its stack height increases but leaving it in the bathroom is a bad idea because it makes the room smell bad. Additionally, slipping on the carpet can result in accidents. The best course of action is, simply put, to avoid installing carpet.

2.2.7 Terrazzo tiles



Figure 2.11: Terrazzo tiles for bathroom



Figure 2.12: The composition of terrazzo tiles

Terrazzo has completely taken off in the tile world over the past couple of years, with new interpretations elevating the time-honored design idea. By definition, terrazzo is a composite material that is precast or poured in place and is typically used for countertops, backsplashes, and wall treatments in addition to flooring. Specks of marble, granite, glass or even shell chips are combined with a cement or epoxy binder to create terrazzo tiles (figure 2.12). The end result is a smooth surface with interchangeable glittering chips that can be used to match the aesthetic of the surroundings. Terrazzo flooring has the advantage of requiring incredibly little maintenance. A lovely terrazzo bathroom floor requires very little routine maintenance because it is water, stain, and bacteria resistant. The modern manufacturing process and the high demand for terrazzo have turned it into one of the priciest flooring options available, despite the fact that it was designed with affordability in mind. Thus, there is a reason why terrazzo is used in so many luxurious bathrooms as it looks amazing and is extremely durable.

2.3 Criteria Selection of Floor Finishes for Bathroom

A bathroom floor finish should have a diverse set of properties. Its service life should be prolonged, and its maintenance costs should be minimal (Federal Facilities Council, 2001). The ease of installation and maintenance procedures are also important considerations when choosing flooring materials (Kishk et al., 2007). The floor's design is significant because it affects how water, light, and sound are absorbed and reflected. Because they are cold and slippery, highly polished flooring surfaces shouldn't be used in bathrooms. It should be able to reduce user fatigue, increase underfoot comfort (Reiling et al., 2008), and lessen the impact of accidents involving falls (Drahota et al., 2007). The floor ought to be simple to navigate and walk on (Harris & Detke, 2013). Additionally, it should have noise-cancelling capabilities (Okcu et al., 2011) and be flame-resistant (Onaran, 2009).

Before a flooring type is installed, the potential health and environmental impacts also must be evaluated. Considerable consideration should be given to the material's durability, safety (traction and effect on falls, slips, and trips), comfort, strain, and fatigue; glare; acoustics; installation, including an assessment of the installation procedures and the toxicity of sealants and adhesives advised for use with the floor materials; time constraints; and cleaning, use, and maintenance (Lent et al., 2009).

2.3.1 Safety and Slip Resistance

Flooring materials and shock-absorbing floor tiles may be important for injury prevention in the bathroom. Porcelain is a member of the general ceramic tile family, with the exception of a slight difference in water absorption rate. The Porcelain Tile Certification Agency (PTCA) certifies tile as "porcelain" if it absorbs less than 0.5 percent of water rate. Vinyl flooring may be used to avoid injuries (Donald et al., 2000; Tse, 2005); however, the use of absorbent materials, such as linoleum sheets and carpet flooring, may help avoid injury or other negative physical effects brought on by falls (Lange, 2012; Tse, 2005). Hence, the preferred bathroom floor finishes should be associated with an element of safety.

2.3.2 Durability and Resilience

Resilient floor coverings have numerous uses, particularly in wet areas. They are well-liked for their solidity, comfort, simplicity in cleaning and routine maintenance, affordability, and wide range of designs (Lent et al., 2009). Because of their toughness and longevity, floor finishes offer water resistance (Noskin & Peterson, 2001). Since moisture can lead to slippery surfaces and support microbial growth, it is essential that more grouts be used in bathroom finishes and that the grout functions as a non-skid surface, especially around the shower area. One of the most durable types of floor tiles was found to be ceramic (Wallender, 2021). Vinyl flooring has replaced ceramic tiles as the best option for bathrooms, especially in western homes.

2.3.3 Initial Cost

The initial costs for various floor materials vary. Costs may rise as well as with quality and durability. However, the choice of flooring material is made depending on a number of variables, including the estimated total cost of the building, the type of building, how the floor will be used, and others. According to the results of earlier studies, these design independent variables have a significant financial impact on the overall costs of any building construction. This is due to the fact that these differences in design variables, once they are given careful consideration during the design of every building project, can go a long way in preserving a good amount of materials and encouraging constructability (Ainomugisha Safiki,2015). As a result, these considerations should be used to determine the initial cost.

2.3.4 Ease of Installation

Renting a professional to install the flooring can be just as expensive as purchasing the flooring itself. The simplest flooring to install is probably carpet tiles, but vinyl planks or sheets are also very simple to do. Literally anyone with a minimal level of DIY skills can install carpet tiles. Typically, carpet tiles have a peel-and-stick backing that can be removed. They can also be anchored using carpet tabs or double-sided carpet tape. The bottoms of them can be taped together to keep them together if you want to float them rather than attach them to your subfloor. It is also not too difficult to cut them to size. While some thicker, more expensive tiles might need to be cut with a utility knife along the side of a straight edge like a ruler, some thinner, less expensive tiles can be cut with scissors. Instead of using carpeting, vinyl sheets are frequently installed in bathrooms, laundry rooms, kitchens, and other areas that require waterproof flooring.

2.3.5 Maintenance Convenience

Facility maintenance considerations are frequently disregarded during the design decision-making process, despite the fact that facility design is crucial for strategizing organisational objectives. It was mainly caused by the lack of a clear strategy for deliberately representing facility maintenance information during the building design stage (Pati et al., 2009). When selecting a floor finish, the convenience of cleaning is crucial (Warren & Hanger, 2012). It was found that users or new homeowners made an effort to select floor finishes that were simple to maintain, but the knowledge needed to make an educated decision on this matter is limited. According to the Borrelli, 2007. Vinyl, one of the most useful plastics in contemporary society, is frequently used as resilient flooring in the bathroom since it is both aesthetically pleasing and useful. Most people preferred vinyl composition floor surfaces over others because they were simple to clean up spills on (Harris, 2000).

2.3.6 Appearance

The materials' appearance is another deciding factor. The majority of homeowners are more likely to choose floor finish materials based on appearance than on other factors. When a homeowner decides to install new flooring, they may choose a style that appeals to them with an appealing design or pattern because aesthetic appeal is the primary factor that influences someone to make a purchase.

2.3.7 Indoor Air

Most air pollution indoors comes from within the building's sources. For example, the emitting of volatile organic materials (VOCs), including formaldehyde, may include adhesives, carpeting, polished products, wood products made, machines, pesticides, and cleaners. Environmental tobacco smoke contributes to a high level of VOCs and other toxic compounds. Research has shown that certain VOCs can have

high concentrations of chronic and acute health effects. Small to medium levels of several VOCs can also cause acute reactions. The open air entering a building can cause air pollution indoors. For example, exhaust pollutants; plumbing vents and building exhaust for example bathrooms and kitchens may enter the building by means of air vents, windows and other air openings which are poorly located.

2.3.7.1 Emissions of Volatile Organic Component (VOC)

Flooring materials were discovered to be responsible for the release of emissions such as VOCs into a building's indoor air (Rossi & Lent, 2006). The secondary degradation emission rate of flooring products was measured, and it was concluded that adhesives used in a flooring system decomposed in an alkaline environment, resulting in alarming rates of secondary emission (Sjöberg & Ramnäs, 2007). Ceramic tile, glass tile, linoleum, bamboo, and cork are all VOC-free in the bathroom. VOCs are sometimes found in adhesives used for installation rather than the products themselves. Vinyl plank flooring with low VOCs is appropriate for every room in the house, including wet areas like the bathroom. Choose low VOC adhesives with care to ensure excellent air quality. Volatile organic compounds released into the indoor environment due to off-gassing of the floor finish material, degrade the quality of air (Baker, 2006).

Organic compound is the chemical compound that contains at least one carbon and a hydrogen atom in its molecular structure. They are classified into different categories as shown in table below (table 2.1).

Table 2.1: Classification of indoor organic compounds by volatility (WHO, 1989)

Description	Abbreviation	Boiling point range, °C
Very volatile (gaseous) organic compounds	VVOC	0 to 50-100
Volatile organic compounds	VOC	50-100 to 240-260
Semi volatile organic compounds (pesticides, polynuclear aromatic compounds, plasticizers)	SVOC	240-260 to 380-400
Non-volatile organic compounds	NVOC	

The high vapor pressure of VOCs is usually between 50 and 260 ° C in normal room temperature environments (Maroni et al. 1995). VOC-containing materials and similar types show the desirable features that are affordable, good insulation properties, fire-resistant and easy to install. These features promote their use in the construction sector (Burton, 1997). A list of familiar indoor VOCs is displayed in Table 2.2. Indoor air is measured at concentrations above 1 ppb in 350 VOCs of approximately 900 chemicals and biological substances, (Brooks et al.1991).

Table 2.2: Sources of common VOC in indoor air (Maroni et al., 1995)

Sources	Examples of Typical Contaminants
Consumer and commercial products	Aliphatic hydrocarbon (n-decane, branched alkanes), aromatic hydrocarbons (toluene, xylenes), halogenated hydrocarbons (methylene chloride), alcohols, ketones (acetone, methyl ethyl ketone), aldehydes (formaldehyde), esters (alkyl ethoxylate), ethers (glycol ethers), terpenes (limonene, alpha-pinene).
Paint and associated supplies	Aliphatic hydrocarbons (n-hexane, n-heptane), aromatic hydrocarbons (toluene), halogenated hydrocarbons (methuene chloride, propylene dichloride), alcohols, ketones (methyl ethyl ketone), esters (ethyl acetate), ethers (methyl ether, ethyle ether, buthyl ether).
Adhesives	Aliphatic hydrocarbons (hexane, heptane), aromatic hydrocarbons, halogenated hydrocarbons, alcohols, amines, ketones (acetone, methyl ethyl ketone), esters (vinyl acetate), ethers.
Furnishings and clothing	Aromatic hydrocarbons (styrene, brominated aromatics), halogenated hydrocarbons (vinyl chloride), aldehydes (formaldehyde), ethers, esters.
Building materials	Aliphatic hydrocarbons (n-decane, n-dodecane), aromatic hydrocarbons (toluene, styrene, ethylbenzene), halogenated hydrocarbons (vinyl-chloride), aldehydes (formaldehyde), ketones (acetone, butanone), ethers, esters (urethane, ethylacetate).
Combustion appliances	Aliphatic hydrocarbons (propane, butane, isobutane), aldehydes (acetaldehyde, acrolein).
Potable water	Halogenated hydrocarbons (1,1,1-trichloroethane, chloroform, trichloroethane).

According to (Wallace, 1991a), indoor VOC concentrations are usually five times greater than outdoor air, however the values are still well below the odour threshold limit. Indoor air VOCs contains a wide range of chemicals with various

concentrations, depending on indoor conditions (Brown et al., 1994; Mølhave, 1979; Schah and Singh, 1988). The Total Volatile Organic Compounds (TVOC) are therefore commonly used instead of individual VOC concentrations in most Guidelines and reports (ECJRC, 1997).

Chapter 3:

Methodology

3.1 Introduction

Research methodology is a process used to obtain information and data to fulfil the objective of this research. This chapter is going to review the methods applied in collecting the data in order to determine the floor finishes materials for bathroom most preferable by house owners.

3.2 Research Method

This study was conducted in four step method to investigate the preferences of bathroom regarding floor finish choices and their selection criteria. The steps were reviewing related literature, next, developing questionnaire survey, then, conducting a questionnaire survey and collecting data. Lastly, analyzing and interpreting collected data. The following figures 3.1 describe these steps.

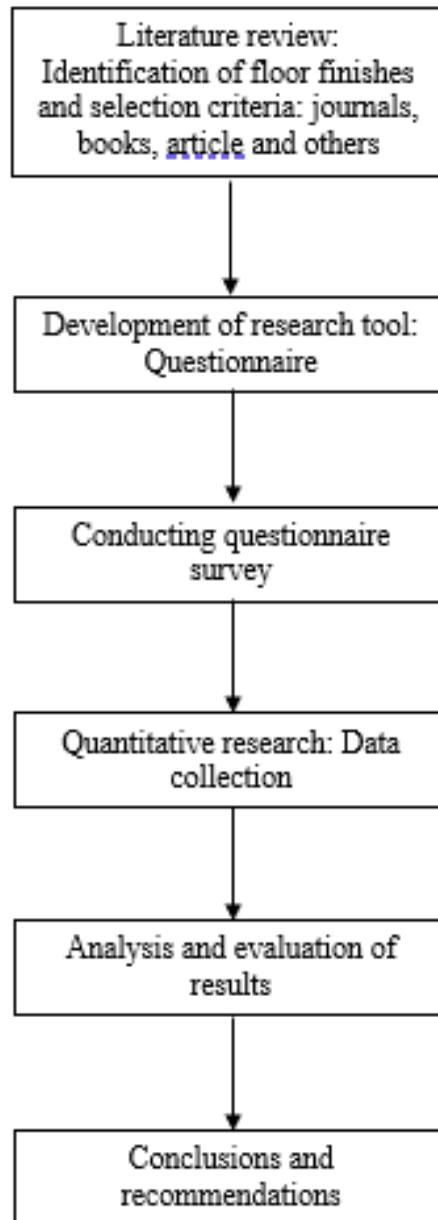


Figure 3.1: Flow chart of the research method

3.2.1 Literature Review

A literature review was used to demonstrate an author's knowledge of a particular field of study. It was including vocabulary, theories, key variables and phenomena and its methods and history (Justus, 2009). The literature review included reading and evaluation of what others wrote about the subject of the dissertation. In order to describe and analyses what they have written, material relevant to the subject of the