Availability and Use of Plywood as Finishing Material in Selected Commercial Spaces

Amutha, T

(12PIR002)

Thesis submitted to

Avinashilingam Institute for Home Science and Higher Education for Women,

Coimbatore - 641 043

In Partial Fulfilment of the Requirements for the

Degree of Master of Science in Interior Design and Resource Management

March, 2014

R. Jyagowri

Signature of the Supervisor

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"Gratitude is the most exquisite form of courtesy."

- Jacques Maritan

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"A thankful heart is not only the greatest virtue, but the parent of all other virtues."

- Cicero

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I INTRODUCTION

"Good design combines usefulness with at least one of the following: beauty, comfort, efficiency, economy, or durability."

-Michael Maurer

Interior design discipline involves the arrangement of living space to attain greater functionality and the creation of the perfect atmosphere for the space's intended purpose (Maurer, 2011). Interior design trends change with alarming speed, mirroring the fashion world with new shapes, colours, global influences and finishing material (Davies, 2000). The fascinating study of architecture encompasses a sensitivity to design, skill in drawing techniques and a knowledge of the latest construction materials. It is the combination of these abilities that yields the outstanding architects of today's world. The world of architecture has been one of the major conquests of man to design structures to bring the thrill of lasting beauty of the beholder (Kicklighter, 1984).

The goal of interior decoration is to provide a certain "feel" for the building. It encompasses applying wallpaper, painting walls and other surfaces, choosing furniture and fittings such as lighting fixtures, floor plans, providing other decorations for the area such as paintings, sculptures and carpets. Interior Decoration gives scope to the shop keepers and other members to express their personality, aesthetic taste through selection of finishing material in interior and exterior, furnishings and accessories. Interior design is not just about the looks of the building's interior but it also plays the key role in its functionality. The house's interior must be aesthetically appealing and practical at the same time. The standard architectural plans rarely meet the client's needs completely therefore a good interior designer should be hired to design an interior that will consider the user's needs and lifestyle because the interior of a commercial spaces should not only look good but should also be functional (http://www.transedit.co.uk/).

Bussagli (2006) define that "building" is generally used to indicate a construction intended for habitation or other public or private human activity. Buildings, of course, are not all the same. They can differ not only in material

but also in shape and structure depending on the individual and collective requirements, which are in turn conditioned by the environmental, political, and social context. A commercial building is one that is dedicated to commercial activities. The technical classification of a commercial building for zoning purposes is that it has more than half of its floor space used for commercial activities. A commercial building is a structure that is not used for residential or civic functions. Various retailers and other businesses lease space in commercial buildings in order to operate without buying a property (Kokemuller, 2013).

Commercial buildings are very important to construct they should be user-friendly because different people visit commercial space for different purposes. Such as eating, conducting meetings, entertainment purpose etc. Recently plywood is the common material used for interiors of commercial spaces. Plywoods are available in different varieties such as hardwood plywood, softwood plywood, tropical plywood and special purpose plywood, etc. Use of plywood can change the interior as well as exterior look of the space and it is also eco-friendly material which is easily available and affordable.

Every interior exists within a structure made up of materials organized in a way that provides an envelope and a supporting system of elements having an architectural or engineering basis (Pile, 1995). Interior finishing includes interior wall and ceiling finish and interior floor finish. The exposed floor surfaces of buildings including coverings applied over a finished floor or stair, including risers. The exposed interior surfaces of buildings, including but not limited to: fixed or movable walls and partitions, toilet room privacy partitions, columns, ceilings and interior wainscoting, panelling or other finish applied structurally or for decoration, acoustical correction, surface insulation, structural fire resistance or similar purposes, but not including trim (http://www2.iccsafe.org.pdf).

Fengel and Wegener (1984) says that wood is an important natural resource, one of the few that are renewable. It is prevalent in our everyday lives. Wood and wood products are also a store for carbon, thus, helping to minimize carbon dioxide in the atmosphere. Wood supplies the solid raw

material for products such as lumber, plywood, and wood pallets, and the fiber for paper, paperboard, fiber board panels, rayon, and acetate (see also laminated wood – based composites; paper; pulp). Many wood products can be recovered for reuse or recycling, thus extending our wood supply into the future. In addition, wood residues for lumber, plywood, and pulp mills are recovered and used to make new fiber products or burned to generate energy.

According to Dechiara et al. (2001) Wall finishes are selecting the appropriate partition or wall type is both science and an art. Wood panelling is a wall treatment that can enhance a space and create drama by introducing a rich natural finish with the elements of colour, texture, scale, and modularity. Since wood panelling belongs in the casework and mill work categories, coordination for consistency with other woodwork installations on the project. Almost all wood panelling is veneer, a thin slice of wood cut from a log. The veneer is glued to a substrate such as, "particle board, fiber board or plywood" (www.decoustic.com).

Floor finishes are the single most important interior finish material to be selected since floor is the largest surface in the commercial buildings and subject to excessive wear from large numbers of patron visits. The wooden flooring gives a warm, welcoming and rice look. It generally can be refinished many times and treated with sealers and polyurethane coatings that restore their original beauty. Within the last ten to fifteen years, there has been significant development of "engineered" wood flooring products which are commonly used in commercial installations now and are very suitable for building construction use. These have wood veneer faces bonded to a substrate of a less costly material that is dimensionally stable, like plywood. The veneer face is quite thick, usually 3/8" to 1/2". The heavy – duty commercial grade types also have veneer that is impregnated with acrylic resins that make them much tougher than those that are not treated in this manner (www.expanko.com).

Ceiling systems are the support structure for many functions in a building. They can be functional and essentially unnoticed by the building patrons, such as might occur with the use of a wood plank ceiling system.

There are pre-assembled wood ceiling panels available on the market in different species of wood. Essentially, slat panels are made from wood slats attached to system rails and these panels are attached to a suspension system using clips. The panels are actually open to the underside of the structure above so that air and light can pass through (Tomio et al., 2003)

The slats are kept parallel by the use of inconspicuous wooden dowels. Dowels are available also in a more flexible material like plastic, which allows for curves in the slats. The slats can be thicker, giving the ceiling a more grille-like appearance or flatter, rendering the ceiling plane like a wood surface articulated with reveals (www.vinylbydesign.com).

According to Phillips (2000) wood creates a warm, smooth and attractive surface and has sound and heat- insulation properties. Modern finishes on wood make it easy to maintain, so it is an ideal covering for walls, ceilings and floorings in most rooms in the house and any kind building (wooden panelling in sorts of colours and finishes is specifically manufactured for covering walls, and panelling suitable for both walls and ceilings is sold in board form or as sheets). Wooden boards are easy to fix and can make a good wall surface in rooms. When varnished, sealed or covered with glass paint, they will be impervious to water. We can apply wooden boards vertically, horizontally or diagonally. Panelling often looks its best when run from the floor to dado level, with or wallpaper above.

Wood panelling is an excellent choice for many of today's interiors. It is easy to attach, looks good and is available in a wide range of woods, grains and colours. Wood panelling is also available in many sizes, thickness, qualities, and grades.

Davies (2000) opines that translucent finishes tend to be more traditional method of finishing wooden furniture and fixtures, and are usually used on pieces made from good quality wood as they enhance the luster and colour of the wood without hiding the pattern of the grain. It is also possible to use stains and dyes to make softwoods (which are usually pale) imitate the richer colours of more expensive hardwoods. The more traditional methods of

furnishing wood are known as 'soft finishes' and require great care, skill, time and patience to master.

These are the list of finishes which is used for plywood fixtures and finishes. They are gilt cream over red emulsion, silver transfer leaf in any colour emulsion, blue metallic spray paint, blue wax over white emulsion, satin coloured varnish, coloured woodstain, driftwood wood wash, teak wood stain, shellac button polish, liming wax on hardwood, light oak stain varnish, liming wax on softwood, glass polyurethane varnish on hardwood, oiled finish on hardwood, oiled finish on softwood and glass polyurethane varnish on hardwood (Davies 2000).

Plywood has so many advantages by using plywood as a finishing material in commercial spaces. They are high uniform strength, freedom from shrinking, swelling and warping, non-splitting qualities, availability of relatively large sizes, economical and effective utilization of figured wood, ease of fabrication of curved surfaces, surface dimentional stability, high strength to weight ratio and chemical resistance (www.woodsolutions.com.au).

Due to its advantages plywood is widely used in interior commercial spaces for floors, walls and ceilings. The investigator has a thurst in acquiring knowledge to know more about the use of plywood in interior commercial spaces and thus she has taken up the study entitled **"Availability and Use of Plywood as Finishing Material in Selected Commercial Spaces"** with the following objectives to

- Study the availability of types of plywood in the market.
- Explore the application of plywood as a finishing material for commercial space designing.
- Assess the benefits and problems in using plywood in commercial spaces.
- Examine the measures to maintain plywood used in commercial spaces.

It is hoped that the study would throw light on the use of plywood as a finishing material in commercial spaces and this data would add value to effective and enhanced use of plywood in commercial space designing.

II REVIEW OF LITERATURE

The review of literature pertaining to the study entitled **"Availability and Use of Plywood as Finishing Material in Selected Commercial Spaces"** is discussed under the following headings.

A. Types of Plywood

B. Manufacturing Process of Plywood

C. Prospects and Constraints in Using Plywood as a Finishing Material for Interior

D. Application of Plywood in Interiors

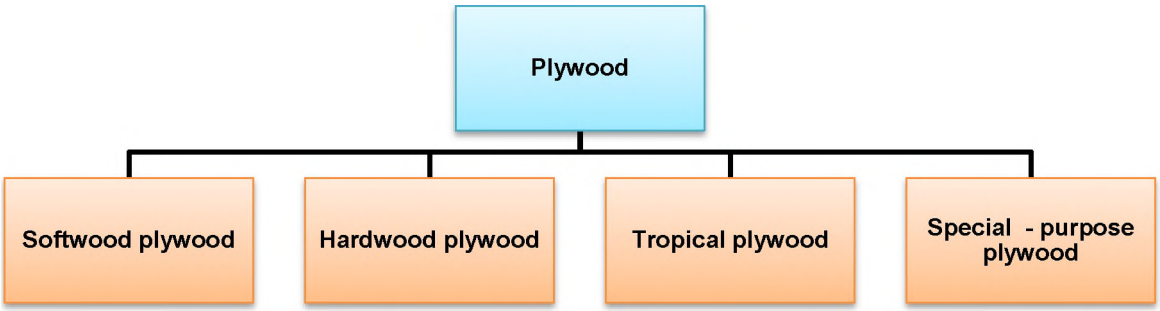
E. Care and Maintenance of Plywood

A. Types of Plywood

According to Bramwell and Martyn (1976) plywood is made of three or more thin layers of wood bonded together with an adhesive. Each layer of wood or ply, is usually oriented with its grain running at right angles to the adjacent layer in order to reduce the shrinkage and improve the strength of the finished piece.

Muller and Norman (2013) points out that all plywoods bind resin and wood fiber sheets (cellulose cells are long, strong and thin) to form a composite material. This alternation of the grain is called cross - graining and has several important benefits. There is usually an odd number of plies, so that sheet is balanced – this reduces warping. Because plywood is bonded with grains running against one another and with an odd number of composite parts, it is very hard to bend it perpendicular to the grain direction of the surface ply. Smaller thinner plywoods and lower quality plywoods may only have their plys (layers) arranged at right angles to each other, though many better quality plywood products will by design have five plys in steps of 45 degrees (0, 45, 90, 135 and 180 degrees), giving strength in multiple axes. The highest quality specialty plywoods often have plys at 30 degrees (0, 30, 60, 90, 120, 150 and 180 degrees) in seven layers with two layers of 45 and 135 degrees in the sandwich.

Types of plywood include



1. Softwood plywood

According to Duncan and Blackwell (1981) softwood panel is usually made either of cedar, Douglas fir or spruce, pine and fir (collectively known as spruce-pine-fir or SPF) or redwood and is typically used for construction and industrial purposes. The most common dimension is 1.2m x 2.4m or the slightly larger imperial dimension of 4ft x 8ft. plies vary in thickness from 1.4mm to 4.3mm. The amount of plies depends on the thickness and grade of the sheet but at least 3/4" (18mm) thick, the thickness depending on the distance between floor joists. Plywood for flooring applications is often tongue and groove; this prevents one board from moving up or down relative to its neighbor, so providing a solid feeling floor when the joints do not lie over joists. T&G plywood is usually found in the 1/2" to 1" (12 – 25mm) range.

2. Hardwood plywood

Gould (1994) defines that the hardwood plywood made from teak wood, or gurjan wood or birch wood. If all the veneers used in making the plywood have been obtained from hardwood trees it will be termed as 100% hardwood plywood and its cost will be higher. Used for demanding end uses. Birch plywood is characterized by its excellent strength, stiffness and resistance to creep. It has a high planar shear strength and impact resistance, which make it especially suitable for heavy-duty floor and wall structures. Oriented plywood construction has a high wheel-carrying capacity. Birch plywood has excellent surface hardness and damage- and wear-resistance.

3. Tropical plywood

Tropical plywood is made of mixed species of tropical wood. Originally from the Asian region, it is now also manufactured in African and South American countries. Tropical plywood is superior to softwood plywood due to its density, strength, evenness of layers and high quality. It is usually sold at a premium in many markets if manufactured with high standards. Tropical plywood is widely used in the UK, Japan, United States, Taiwan, Korea, Dubai and other countries worldwide. It is the preferred choice for construction purposes in many regions due to its low cost. However, many countries' forests have been over-harvested, including the Philippines, Malaysia and Indonesia, largely due to the demand for plywood production and export (http://www.wikipedia.com).

4. Special – purpose plywood

Certain plywoods do not have alternating plies. These are designed for specific purposes. They are as follows *

a. Aircraft plywood

High-strength plywood also known as aircraft plywood is made from mahogany and/or birch and uses adhesives with increased resistance to heat and humidity. It was used for several World War II fighter aircraft. Although the British-built Mosquito bomber, nicknamed "The Wooden Wonder", was constructed of a plywood monocoque, this was formed in moulds from individual veneers of birch, balsa and birch rather than machined from pre-laminated plywood sheets.

Structure aircraft-grade plywood is more commonly manufactured from African mahogany or American birch veneers that are bonded together in a hot press over hardwood cores of basswood or poplar. Basswood is another type of aviation-grade plywood that is lighter and more flexible than mahogany and birch plywood but has slightly less structural strength. All aviation-grade plywood is manufactured to specifications outlined in MIL-P-607, which calls for shear testing after immersion in boiling water for three hours to verify the adhesive qualities between the plies and meets specifications.

b. Decorative plywood (or overlaid plywood)

Usually faced with hardwood including ash, oak, red oak, birch, maple, mahogany, Philippine, Philippine mahogany (often called lauan, luan or meranti and having no relation to true mahogany), rose wood, teak and a large number of other hardwoods. However, , Formica, metal and resin-impregnated paper or fabric bonded are also added on top of plywood at both side as a kind of ready for use in the decoration field. This plywood is a lot easier to dye and draw on than any other plywoods.

c. Flexible plywood

Flexible plywood is very flexible and is designed for making curved parts. In the UK this is sometimes known as "Hatters Ply" as it was used to make stovepipe hats in Victorian times. It is also often referred to as "Bendy Ply" due to its flexibility. However these may not be termed plywood in some countries because the basic description of plywood is layers of veneered wood laid on top of each other with the grain of each layer perpendicular to the grain of the next. In the U.S., the terms "Bender Board" and "Wiggle Board" are commonly used.

d. Marine plywood

Marine plywood is manufactured from durable face and core veneers, with few defects so it performs longer in humid and wet conditions and resists delaminating and fungal attack. Its construction is such that it can be used in environments where it is exposed to moisture for long periods. More recently, tropical producers have become dominant in the marine plywood market. Okoumé from Gabon is now the accepted standard for marine plywood, even though the wood is not very resistant to rot and decay. Each wood veneer will be from tropical hardwoods, have negligible core gap, limiting the chance of trapping water in the plywood and hence providing a solid and stable glue bond. It uses an exterior Water and Boil Proof (WBP) glue similar to most exterior plywoods.

Marine plywood can be graded as being compliant with BS 1088, which is a British Standard for marine plywood. There are few international standards for grading marine plywood and most of the standards are

voluntary. Some marine plywood has a Lloyd's of London stamp that certifies it to be BS 1088 compliant. Some plywood is also labeled based on the wood used to manufacture it. Examples of this are Okoume or Meranti.

Marine plywood is frequently used in the construction of docks and boats. It is much more expensive than standard plywood: the cost for a typical three times as expensive as standard plywood.

e. Other plywoods

Other types of plywoods include fire-retardant, moisture-resistant, sign-grade and pressure-treated. However, the plywood may be treated with various chemicals to improve the plywood's fireproofing. Each of these products is designed to fill a need in industry * (www.wikipedia.com).

B. Manufacturing Process of Plywood

1. Manufacture of Plywood

According to phadke (2013) the trees used to make plywood are generally smaller in diameter than those used to make lumber. In most cases, they have been planted and grown in areas owned by the plywood company. These areas are carefully managed to maximize tree growth and minimize damage from insects or fire. Following are the manufacturing steps of plywood

Step 1: Cutting the logs

The large wooden logs, normally stored under water are cut into pieces according to the production requirement.

Step 2: Processing the logs

The pieces of the logs are then heated at around 70-90 degree C temperature for 12-14 hours either under hot water or in a steam chamber.

Step 3: Debarking

The bark or the thick skin around the log is removed either by hand tools or by using a debarking machine.

Step 4: Veneer making

Veneers are the few millimeters thick layers of wood. The veneers can be made either by peeling or by slicing. The log is to be loaded to a peeling lathe or a slicer machine for making veneers out of it.

Step 5: Wet Clipping

The veneer then cut into pieces of required sizes by using a clipping machine. The clipping machine works like big scissors. Tools/Machinery required: Veneer clipping machine. Drying the veneers are then dried partially by sunlight and partially by a dryer machine. Maintaining required amount of moisture in veneers is very important for producing the good quality plywood.

Step 6: Dry Clipping

After drying again the veneers are clipped using the clipping machine. This step is required to cut the veneers in close tolerance and to remove the drying defects.

Step 7: Resin preparations

Either liquid or the powder resins are used for making glue. Urea formaldehyde (UF) and phenyl formaldehyde (PF) are the two most common types of resins used in plywood manufacturing. In case of liquid resin, the resin is manufactured normally in house by using a resin kettle or resin plant.

Step-8: Gluing and assembly

The correct sized veneers are then glued normally by using a gluing machine. The veneers are passed in between two rollers of the gluing machine. The rollers of the gluing machine are kept wetted by the continuous supply of glue. The odd numbers of veneer layers are assembled such a way that the grain directions of the consecutive layers are perpendicular to each other.

Step 9: Hot pressing

The assembled veneer layers are transferred inside the hot hydraulic press which apply specific pressure and temperature for

specified duration of time to the veneers assembly and convert it to plywood by curing the resins.

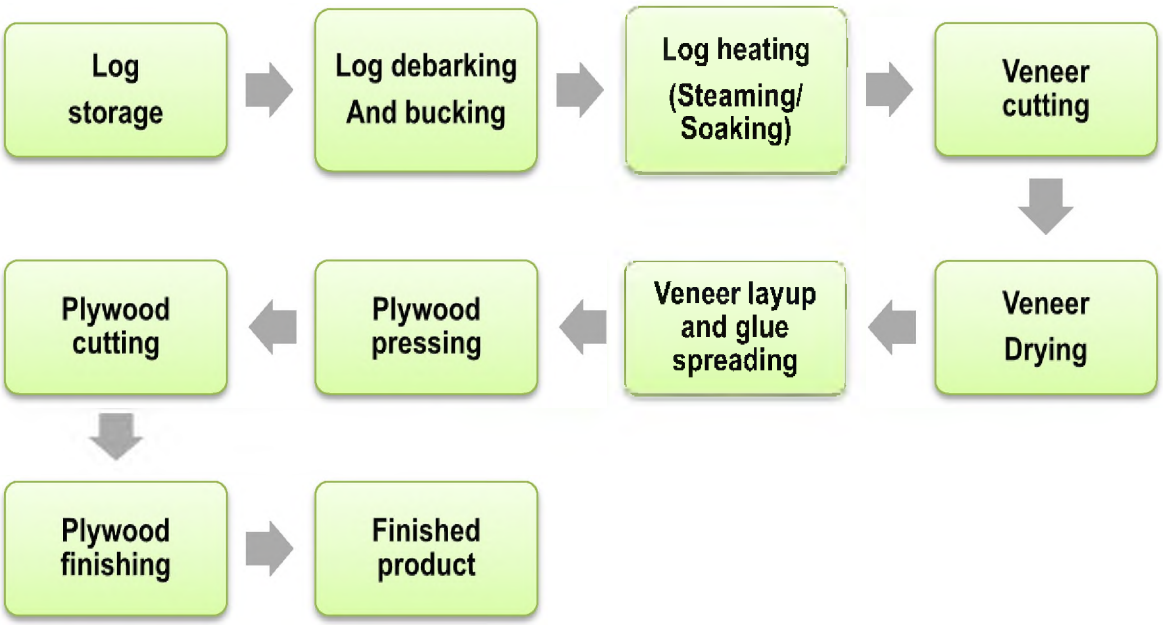
Step 10: Trimming

The circular power saw is used for trimming the plywood boards to give it the required size.

Step 11: Inspection, labeling and dispatching

Inspection is performed to find out the rejected and reparable pieces among the good pieces. The reparable pieces are repaired using putty and colour pastes manually. Finally labeling and dispatching is done (http://blog.mechguru.com).

2. Description Process



Bamesberger and Lee (1999) state that the majority of high temperature (above 100°C or 212°F) veneer dryers depend upon steam as a heat source. The heat is transferred to the air by heat exchangers. However, direct-fired oil and gas dryers are becoming increasingly common in the industry (Baumeister, 1967).

A number of adhesives can be used in the manufacture of plywood. For the purpose of this discussion, distinction is made between protein and phenol-formaldehyde and urea-formaldehyde glues, since these are the

classes of glue most often used in the industry. Protein glue is extracted from plants and animals and typical ingredients are water, dried blood, soya flour, lime, sodium silicate, caustic soda and a formaldehyde donor for thickening while the other two are synthetic, thermosetting glues. Urea-formaldehyde glues are synthetic thermosetting glues and typical ingredients are water, defoamers, extenders (wheat flour) and urea-formaldehyde resin. Phenol-formaldehyde resins are also synthetic thermosetting glues and typical ingredients include additives of caustic soda and soda ash (http://www.epa.gov).

Both protein and urea-formaldehyde are chiefly interior glues (less water resistance) while phenol-formaldehyde is an exterior glue (good water resistance). Urea-formaldehyde is used almost exclusively in the hard plywood industry where panels are used for furniture and indoor panelling (Danielson, 1973).

Piliaris and Alex (1998) said that most plywood manufacturers mix their own glue in large dough-type mixers. The glue is then applied to the veneer by means of a spreader, the most common of which consists of two power driven rollers supplied with the glue. More recently the practice of applying glue by means of sprays and curtain coaters has become common.

After gluing, the layers of veneer are subject to pressure to insure proper alignment and an intimate contact between the wood layers (veneers) and the glue. The glue is allowed to partially cure under pressure. Pressing may be accomplished at room temperature (cold pressing) or at high temperature (hot pressing). Hot pressing equipment is used to cure some protein, some urea-formaldehyde and all of the phenol-formaldehyde glues (http://www.wa.go).

Most pressers are hydraulic and apply pressure from 75 to 250 psi. Cold pressers are operated at room temperatures, while hot pressers are operated at temperature up to 350°F with heat being transferred by means of steam, hot water or hot oil. Plywood pressing time ranges from two minutes to many hours depending upon the temperature of the press, size of plywood and type of glue used. Usually, the hotter the press, the shorter the pressing

time (Hemming,1968). After the pressing operation, any number of a series of finishing steps, depending upon the operation and the product desired, may be taken (Monroe, et al., 1972).

3. Available Sizes in Plywood

According to Gale (2013) the most commonly used thickness range is from 0.14 to 3.0 in (0.36 to 7.6 cm). The sizes of the most commonly used plywood sheets are 4 by 8 ft (1.2 by 2.4 m). Width and length may vary in 1 ft (30 cm) increments. In the United States, the most commonly used size is 4 ft by 8 ft or 5 ft by 5 ft.

Sizes on specialized plywood for concrete forming range from 6 to 21 mm, and a multitude of formats exist, though 15x750x1500mm is very commonly used (Halloran, 2002).

Okrend (1994) state that plywood sheets range in thickness from .06 in (1.6 mm) to 3.0 in (76 mm). The most common thicknesses are in the 0.25 in (6.4 mm) to 0.75 in (19.0 mm) range. Although the core, the crossbands, and the face and back of a sheet of plywood may be made of different thickness veneers, the thickness of each must balance around the center. For example, the face and back must be of equal thickness. Likewise the top and bottom crossbands must be equal.

The most common size for plywood sheets used in building construction is 4 ft (1.2 m) wide by 8 ft (2.4 m) long. Other common widths are 3 ft (0.9 m) and 5 ft (1.5 m). Lengths vary from 8 ft (2.4 m) to 12 ft (3.6 m) in 1 ft (0.3 m) increments. Special applications like boat building may require larger sheets (http://www.answers.com).

4. Grades

According to Joyce (1970) Grading rules differ according to the country of origin. Most popular standard is the British Standard (BS) and American Standard (ASTM). Joyce (1970), however, list some general indication of grading rules as follows.

Grade	Description
A	Face and back veneers practically free from all defects.
A/B	Face veneers practically free from all defects. Reverse veneers with only a few small knots or discolorations.
A/BB	Face as A but reverse side permitting jointed veneers, large knots, plugs, etc.
B	Both side veneers with only a few small knots or discolorations.
B/BB	Face veneers with only a few small knots or discolorations. Reverse side permitting jointed veneers, large knots, plugs, etc.
BB	Both sides permitting jointed veneers, large knots, plugs, etc.
WG	Guaranteed well glued only. All broken knots plugged.
X	Knots, knotholes, cracks and all other defects permitted.
BB/CC	Face as BB, back as CC. BB as very little knots of less than 1/4 inches, slight discoloration, no decay, split and wormholes mended skillfully, matched colours, no blister, no wrinkle. Most popular choice for most applications.

Hornbostel and Caleb (1991) state that there are two broad classes of plywood, each with its own grading system. One class is known as construction and industrial. Plywoods in this class are used primarily for their strength and are rated by their exposure capability and the grade of veneer used on the face and back. Exposure capability may be interior or exterior, depending on the type of glue. Veneer grades may be N, A, B, C, or D. N grade has very few surface defects, while D grade may have numerous knots and splits. For example, plywood used for subflooring in a house is rated "Interior C-D". This means it has a C face with a D back, and the glue is suitable for use in protected locations. The inner plies of all construction and industrial plywood are made from grade C or D veneer, no matter what the rating.

MR grade: Moisture Resistant

According to Phadke (2012) the most common type of plywood used for indoor furniture. Note that moisture resistant does not mean water proof. It

only means that the plywood can resist a certain amount of humidity or dampness (http://blog.positiveindians.in).

BWR and BWP grades

The BWP (Boiling Water proof) grade is generally used to indicate grade of External grade block boards (which are different from plywood and consist of blocks of softwood at the core) and BWR (Boiling Water Resistant) grade is used to indicate External grade plywood. Both these naming conventions BWP and BWR mean almost the same thing in terms of quality. Such types of plywood can be called adequately water-proof for most furniture requirements (Russell, 1992).

FR grade: Fire Retardant

Used in places where fire risks have to be reduced such as in the case of public theatres, malls or shopping complexes, restaurant kitchens and the like. The surface of this type of plywood is treated with chemicals that delay the burning process of wood (hence called fire retardant). Indian standards document number IS: 5509-1980 has detailed quality specifications for this type.

Marine grade: Marine Grade Plywood

Commonly used for marine applications such as in the construction of boats and ships. Has better resistance to water than any other type of plywood. Indian Standard specifications for marine ply are detailed in the IS document.

Termite-Resistant and Borer-proof

As the name suggests, offers protection from external pests that can destroy the wood (http://blog.positiveindians.in).

5. Decoration

Phadke (2013) list the following decoration of plywood and as per log (http://blog.positiveindians.in).

Laminates

According to decorative Laminates such as Sun mica or others (which are actually a blend of paper and plastic) are glued over the plywood surfaces. Laminates are available in a very wide variety of colours, patterns and textures and is the most common way of decorating plywood furniture and panels.

Paints

Paint has for long been a way of protecting wood and increasing its beauty. It is a low-cost alternative to laminates or veneers and a large choice of wood colours are available.

Polish

Wood Polish is usually used on wooden furniture that is made of quality hardwoods such as teak, however polishing plywood is not uncommon. Carpenters often use wood polish (of darker colours) on some parts of furniture (such as the underside of tables and the inside planks of single and double beds).

Veneer

Wood veneers are thin slices/sheets of quality woods such as teak, which can be glued over the plywood surface to increase its beauty and make it look richer. Most casual observers cannot differentiate between a piece of solid teakwood furniture and one that simply has a teak veneer on the outside. Veneers are usually the costliest way of decorating plywood.

C. Prospects and Constraints in Using Plywood as a Finishing Material for Interior

1. Plywood flooring

Many people have a tendency to completely overlook Wooden Flooring, because it is initially more expensive than carpet and linoleum; however, you reap many great prospects which outweigh the initial additional cost (http://www.whittle woods.co.uk)

a. Prospects of wooden flooring

➢ **Character and value**

- Wooden flooring gives warmth, beauty and value to your home
- Wooden floors enhance the decor of any room.
- Homes with wooden flooring sell faster and for higher prices than houses without wooden flooring (National survey).

➢ **Affordable**

- Wood keeps its value and will look beautiful for many years
- It lasts much longer than carpet and lino that will cost to be replaced
- It is inexpensive
- Easy to clean and maintain
- New technology in wood stains and finishes means just minimal sweeping or vacuuming to take care of your wood floor (Mick and McCargar, 1969).

➢ **Ecological and green**

- Wood is a renewable and recyclable natural resource
- Much of the wood used for floors is recycled from old ships, warehouses and barns
- Healthy and hygienic
- Wooden floors do not collect as much dust as carpets and other types of flooring, nor harmful allergens
- Leading health associations agree that wood floors are the perfect choice for a healthier home.

➢ **Variety and choice**

- Different styles and fashions (traditional oak, trendy wenge, rustic pine, exotic bamboo etc).
- Varieties of colours are available in wood
- Different species offer different looks and textures (http://www.woodenfloors trippers.co.uk).

➢ **Other benefits**

- Good quality wooden floors last for decades – Whereas many people find themselves replacing carpet every 5 years, due to stains, holes or shabbiness from everyday wear and tear. A minimum maintenance program, these floors actually look better as the years go by.

- Wood floors are easier to clean than carpets. The reasons for this are fairly obvious. A simple brush or light vacuum keeps your wooden floors looking great. If dogs or children have dragged mud through the house a damp mop removes this muck with ease. Carpet owners at this stage would be screaming.
- Wooden flooring is more hygienic than carpets. There are some fairly horrifying reports out there detailing the parasites that carpets can harbor.
- The aroma of a polished wooden floor is a delight and will make your home more inviting.
- Wood provides a great medium to install under floor heating, which these days is considered by far the most efficient way to heat your house.
- If after a few years your wood floor has been scratched or is a bit damaged due to heavy wear and tear. A simple sand and seal will bring it back to new again. This is a lot less costly than refitting a new carpet.
- Stone and tile floors although as hygienic and easy to maintain as wood, don't have the same warmth and feel that timber floors have (http://www.Whittlewoods. co.uk).

B. Constraints of wooden flooring

- Of course, there are the constraints of having this type of flooring. The biggest constraint is the expense because only natural materials are used and people with a limited budget may not be able to afford hardwooden flooring (Decar, 1972).
- It is time-consuming to install since they have to be laid in strips. Installation cost using professional is expensive.
- Hard wooden flooring can be swept and damp mopped or cleaned with a wood floor cleaner. It needs waxing using a special machine.
- Hard wooden flooring becomes slippery. Hard woods such as oak needs waxing. This type of wood needs extra special care.

- Wooden flooring is very vulnerable to humidity and moisture, which can deteriorate the wood. There is a spill from the floor or do a general cleaning, make sure that the mop is just damp.
- Wearing certain types of shoes can make walking across the hardwood floor noisy (http://www.hardwoodfloortips.net).

2. Plywood walls

According to Kaine (2013) choose wood panelling for sprucing up a home or adding depth and dimension to rooms; using it can also add value to your home. Wood panels come in an array of dimensions and colours. Using wood panels can have certain advantages in nearly any room of the house. Since wood panels come ready to install, almost anyone can install them with ease.

Nadhiroh (2013) states that wooden walls are often found in traditional houses which are located near a beach or at highlands. People in highlands usually use their own wood to construct their house. In contrast, we can only find few traditional houses in a city because of its rarity which makes it so expensive.

a. Prospects of wood panelling and walls

- **Easy to Install**

Wood panelling comes in a variety of styles that are typically easy to install. Tongue-and-groove is a type of panelling in which one end of the board, a small piece called a tongue, sticks out, and on the other side a groove is cut into the wood. The tongue-and-groove pieces are joined together to form a strong and invisible seam. V-joint panelling is a style in which the panels are joined together to form a V-shape. Homeowners can purchase panelling in both tongue-and-groove and V-joint panels that are ready to install.

- **Long-Lasting**

Wood panels can last a long time when cared for properly. You can use a variety of paints, varnishes and stains to seal the wood and protect it for years to come. In addition, you can change the colour by painting over the

existing colour or by adding a different stain, both of which increase the life of the panels. With proper cleaning, routine maintenance like filling holes and painting, staining or varnishing, wood panelling can last 10 to 20 years with ease.

- **Waterproof**

Make wood panels waterproof with the application of a silicone sealant. Install waterproof panels in bathrooms in place of standard ceramic tiles. Since wood panels do not require grout to install, the surfaces can be wiped down or cleaned without using bleach or other harsh chemicals that grout requires. Use mild dishwashing detergent or chlorine-free bleach mixed with a water solution to clean the caulk (Bamesberger and Lee, 1999).

- **Environmentally Friendly**

Bamboo veneer is an environmentally friendly choice for wood panels. Bamboo can be grown to full size in approximately three years and it can be collected and replanted at a much faster rate than trees. Bamboo is less expensive than tree-grown wood. Bamboo offers dimension and style just like ordinary wood, and can be stained or painted to suit any colour palette (http://www.ehow.com).

- Although woods are rare and expensive, some people who have a high taste of home design keeps building houses in wooden walls.
- Today's wooden home designs apply wood panels to cover the walls.
- These wood panels, in fact, bring an attractive impression to the interior atmosphere.
- The wooden walls are able to radiate natural colours which make the house look natural.
- Woods which are installed as the finishing of the exterior walls create the impression of natural and elegant atmosphere.
- To sum up, the advantages of wooden walls are as follows.
- The construction of wooden walls is easy to do and can be designed according to our concept and taste.

- Woods are light and easy to be designed and shaped.
- Wooden walls create a natural and elegant impression to the house (http://www. distrothing.com).

b. Constraints of wooden walls

- Unfortunately, the maintenance is relatively more difficult compared to other wall materials (Cavadeas, 1997).
- Woods are not resistant to heat and cold which means that they are more easily weathered.
- Wooden walls are easily attacked by termites.
- Woods' soft character makes them easily shrink or expand due to weather changes.
- Regardless of the disadvantages wooden walls will endure for years, evolve and become more beautiful and elegant (http://www.distrothing.com).

3. Plywood ceiling

a. Prospects of wooden ceiling

- It provides decorative and artistic look to a room
- It provides better insulation
- It is popular and offer a warm feeling to any room
- It is stylish in design

b. Constraints of wooden ceiling

- It is very expensive.
- It is more prone to termite attack.
- It has weak physical structure.
- It is difficult to clean properly (http://www.gharexpert.com).

D. Application of Plywood in Interiors

According to Joyce and Ernes (1970) plywood is used in many applications that need high-quality, high-strength sheet material. Quality in this context means resistance to cracking, breaking, shrinkage, twisting and warping. On the other hand, subzero conditions don't affect plywood's dimensional or strength properties, which makes some special applications possible.

Plywood is also used as an engineering material for stressed-skin applications. It has been used for marine and aviation applications since. Most notable is the British Mosquito bomber which was primarily made using a moulded sandwich of two layers of birch plywood around a balsa core. Plywood was also used for the hulls in the hard-chine Motor Torpedo Boats(MTB) and Motor Gun Boats (MGB) built by the British Power Boat Company and Vosper's. Plywood is currently successfully used in stressed-skin applications. The American designers Charles and Ray Eames are famous for their plywood-based furniture, as is Finnish Architect Alvar Aalto and his firm Artek, while Phil Bolger is famous for designing a wide range of boats built primarily of plywood. Plywood is often used to create curved surfaces because it can easily bend with the grain. Skateboard ramps often utilize plywood as the top smooth surface over bent curves to create transition that can simulate the shapes of ocean waves (http://www.wikipedia.com).

Joyes and Ernes (1970) list the application of plywood us follows:

1. Softwood plywood applications
2. Hardwood (Birch) plywood applications
3. Tropical plywood applications

1. Softwood plywood applications

a. Typical end uses of spruce plywood are:

- Floors, walls and roofs in house constructions
- Wind bracing panels
- Vehicle internal body work
- Packages and boxes
- Fencing

b. Coated plywoods

There are coating solutions available that mask the prominent grain structure of spruce plywood. For these coated plywoods there are some end uses where reasonable strength is needed but the lightness of spruce is a benefit e.g.:

- Concrete shuttering panels
- Ready-to-paint surfaces for constructions

2. Hardwood (Birch) plywood applications

a. Phenolic-film Coated birch plywood

It is typically used as a ready-to-install component e.g.:

- Panels in concrete form work systems
- Floors, walls and roofs in transport vehicles
- Container floors,
- Floors subjected to heavy wear in various buildings and factories,
- Scaffolding materials
- ("Wire" or other styles of imprinting available for better traction)

b. Birch plywood

It is used as a structural material in special applications e.g.:

- Wind turbine blades
- Insulation boxes for Liquefied Natural Gas (LNG) carriers

Smooth surface and accurate thickness combined with the durability of the material makes birch plywood a favorable material for many special end uses e.g.:

- High-end loud speakers
- Die-cutting boards
- Supporting structure for parquet
- Playground equipment
- Furniture
- Signs and fences for demanding outdoor advertising
- Musical instruments
- Sports equipment

c. Tropical plywood applications

Tropical plywood is widely available from the South-East Asia region, mainly from Malaysia and Indonesia. Tropical plywood boasts premium quality, and strength. Depending on machinery, tropical plywood can be made with high accuracy in thickness, and is a highly preferable choice in America, Japan, Middle East, Korea and other regions around the world.

- Common plywood
- Concrete panel
- Floor base
- Structure panel
- Container flooring
- Laminated board
- Laminated Veneer Lumber (LVL) (http://www.wikipedia.com)

E. Care and Maintenance of Plywood

1. Care and Maintenance of wooden flooring

Wooden flooring – especially reclaimed, old-growth wooden flooring – is one of the most durable flooring options available. With proper care and maintenance, wooden flooring can provide generations of use and beauty. With today's advances in wooden flooring stains and finishes, cleaning our wood floors has never been easier. Regular maintenance requires little more than sweeping with a soft bristle broom and vacuuming with a soft floor attachment if our wood floor includes a beveled edge that could collect debris. We also should clean our floors periodically with a professional wood floor cleaning product recommended by a wooden flooring professional (http://woodfloors.org).

Knowing how to clean hardwood floors is very important. Gravel and dirt is the bane of hardwood floors. Even fine dirt such as indoor plant soil can scratch and mark the floor if not removed promptly. Hardwood floor care may be more work but if someone in our household has allergies, then hardwood floors makes life much more breathable. Therefore, sweeping and dusting is a regular once a week routine or after any event that leaves dirt and grit behind (http://www.armstrong.com).

- **Steps to minimize maintenance and maintain the beauty of your wood floors as well.**

  - Wipe up spills immediately with a slightly dampened towel.
  - Do not over-wax a wood floor. If a wax floor dulls, try buffing instead. Avoid wax buildup under furniture and other light traffic areas by applying wax in these spots every other waxing session.

  - We can't be used sheet vinyl or tile floor care products on wood floors. Self-polishing acrylic waxes cause wood to become slippery and appear dull quickly.
  - Use throw rugs both inside and outside doorways to help prevent grit, dirt and other debris from being tracked onto your wood floors. This will prevent scratching.
  - Do not wet-mop a wood floor. Standing water can dull the finish, damage the wood and leave a discoloring residue.
  - Avoid walking on your wood floors with cleats, sports shoes and high heels.
  - When moving heavy furniture, do not slide it on wooden flooring. It is best to pick up the furniture completely to prevent scratches.
  - For wooden flooring in the kitchen, place an area rug in front of the kitchen sink.
  - Use a humidifier throughout the winter months to minimize gaps or cracks (http://woodfloors.org).
  - Use Armstrong or Bruce furniture leg protector pads under all furniture legs.
  - Keep the relative humidity in your home between 35% and 55%.
  - Protect your floor from direct sunlight.

- Use any of the following products (or products similar in nature) on your floor: ammonia based cleaners, acrylic finishes, wax based products, detergents, bleach, polishes and oil soaps, abrasive cleaning soaps or acidic materials such as vinegar.
- Allow water to stand on your floor for any length of time – wipe up immediately.
- Use rubber, foam back or plastic mats as they may trap moisture and possibly discolour.
- Do not use vacuums with beater bars or hard heads (http://www.armstrong.com).

2. Care and Maintenance of wooden walls and ceiling panels

- Panels are finished with a commercial finish which is durable and resistant to moisture. Allowing moisture to accumulate on, or stay in contact with, any wood surface, regardless of how well finished, will cause damage. Prevent direct contact with moisture wipe and dry immediately should any occur.
- With the exception of true oil-rubbed surfaces, modern finishes do not need to be polished, oiled or waxed. In fact, applying some polishing oils, cleaning waxes or products containing silicone may impede the effectiveness of touch-up or refinishing procedures in the future.
- No abrasives or chemical or ammonia cleaners should be used to clean fine woodwork surfaces.
- Routine cleaning is best accomplished with a soft, lint-free cloth lightly dampened with water or an inert household dust attractant. Allowing airborne dust, which is somewhat abrasive to build up will tend to dull a finish over time.
- Remove oil or grease deposits with a mild flax soap.
- Avoid excessive or repetitive impact, however lightly applied. The cellular structure of the wood will compact under pressure. Many

modern finishes are flexible and will show evidence of impact and pressure applied to them.

- Avoid localized high heat, such as a hot pan or plate or a hot light source, close to or in contact with the finished surface. Exposure to direct sunlight will alter the appearance of fine woodwork over time.
- Maintain the relative humidity around the woodwork in accordance with the guidelines published by the Architectural Woodwork Institute, every hour of every day to minimize wood movement.
- Do not apply masking tape or other adhesive products to the face of finished woodwork. Adhesive products may damage custom finishes (www.rulonco.com).

III. METHODOLOGY

The methodology adopted for the study on **"Availability and Use of Plywood as Finishing Material in Selected Commercial Spaces"** comprised the following phases:

Phase 1: Market Survey

Phase 2: Commercial Space Survey

Phase 1: Market Survey

A market survey is an objective and systematic collection, recording, analysis and interpretation of data about existing or potential markets for a product/ service. It is a valuable tool to help minimize risks and increase the probability of success (http://www.ediindia.org). Market survey was conducted by the investigator to know the availability of various types of plywood in the market and their thickness, common sizes, qualities and the price of plywood. This data would be more helpful for the Interior designers and commercial space planners to plan the finishing materials for their interiors.

A. Selection of the Area
B. Selection of the Sample
C. Selection of the Method
D. Selection of the Tool
E. Conduct of the Study and
F. Consolidation and Analysis of the Data

A. Selection of the Area

Coimbatore, also known as Kovai is the second largest city in the Indian state of Tamil Nadu and one of the fastest growing cities in India. Recently in Coimbatore the commercial buildings are constructed in main shopping areas of the city with good interior finishing materials.

The most famous and popular twenty five shops which deals only with Plywood located at Saibaba Colony, R.S.Puram, Cross cut road and Mettupalayam road in Coimbatore city were chosen to collect the required details. These areas were selected by the investigator due to the availability of

innovative types of plywood in the market with varied sizes, thickness, price and qualities of plywood.

B. Selection of the Sample

A sample is selected from a sampling frame. This sample is the group from which measurements will be sought. In many cases, the sample will be only a very small fraction of the sampling frame and therefore, of the target population (Groves, 2011). Twenty five famous shops which are mainly dealing with plywood were purposively selected by using purposive sampling method. They are selling these plywoods mostly in large quantity.

The investigator specially chose for the survey only those shops that were

- Focusing only on plywood
- Located in the main shopping centres and easily accessible to the investigator
- Popular.

C. Selection of the Method

Interviewing is a meeting of two persons to exchange information and ideas through questions and responses resulting in communication and joint construction of meaning about a particular topic (http://www.slideshare.net). Personal interview cum observation method was adopted by the investigator for conducting the survey. Interview method of collecting data, involves a face to face contact with people from sample. The interviewer asks them questions pertaining to the problems and collects the desired information (Gupta, 2009). Malhotra and Dash (2008) notify observation as the potential to provide valuable information when properly used.

D. Selection of the Tool

An interview schedule is a written list of questions open ended or close prepared for use of collecting information based on their needs by an interviewer. Interview schedule is a research tool for collection of data whereas interviewing is a method of data collecting (Ranjitkumar, 2011). The schedule (Appendix I) consists of the following information such as the

general information of the shop, types of plywood under the categories of thickness, sizes, quality, grades and brands.

E. Conduct of the Study

According to Panneerselvam (2005) data are the basic input in any decision making process. Direct Personal Interview cum Observation method was considered advantageous for collecting data. In the Direct Personal Interview method there is a face to face contact with the people from whom the information is to be obtained. The interviewer asks them questions pertaining to the survey and collects the desired information. The information obtained from this method is likely to be more accurate because the interviewer can clear up doubts of the informants about certain questions and thus obtain correct information. In case the interviewer apprehends that the informant is not giving accurate information, he may cross examine him and thereby try to obtain the information (Sharma, 2005).

The famous and popular shops which have plywood were chosen for conducting the survey. Twenty five shop keepers who are having plywood as the product in their shops were contacted by the investigator. The shopkeepers extended their fullest cooperation and helped the investigator in collecting the data after establishing good rapport with them. The necessary information's were collected for the study as per the schedule.

F. Consolidation and Analysis of the Data

Interpretation of collected data is not only necessary but unavoidable in research (Reddy, 2004). The data collected are generally in an unintelligible form and need to be classified and tabulated before they are analyzed (Puri, 2000).The data thus collected were consolidated, tabulated and then analyzed. Jain (2000) considers that the purpose of a table is to simplify the presentation and to facilitate comparison. The tabulated data were analyzed, discussed and presented under Chapter IV Results and Discussion.

Phase 2: Commercial Space Survey

Groves et al. (2011) avows that a 'Survey' is a systematic method of gathering information from (a sample of) entities for the purpose of constructing quantitative descriptors of the attributes of a large population of

which the entities are members. A commercial space survey was conducted to gather information about the plywood used in their shops for the flooring, walls and ceiling from the user. The survey included the following aspects:

A. Selection of the Area

B. Selection of the Sample

C. Selection of the Method

D. Selection of the Tool

E. Conduct of the Study and

F. Consolidation and Analysis of the Data

A. Selection of the Area

Coimbatore is known for its peaceful atmosphere, cosmopolitan outlook and private enterprise. The city is home to more than 25,000 small, medium, large and tiny industries and textile mills, hosiery units and engineering industries. No wonder it is rightly called the "Manchester of South India".

Coimbatore is a major commercial centre and is famous for Schools, Universities, Engineering Colleges, Medical, Management Schools, Textiles - Yarn, Knitted Garments, Handlooms, Textile Machinery, Motors, Pumps, Industrial goods, Cotton, Tea and Software. It is also famous for the mall's construction also. The construction of mall is increased in Coimbatore. For example fun mall, McDonalds' and Brookefields (http://www.articlesbase.com).

Areas namely Saibaba colony, Gandhipuram, 100 ft road, R.S. Puram and Race Course were selected for the study in the city. There are many commercial spaces which use plywood as a finishing material for their interiors – floors, walls and ceilings. These areas were chosen by the investigator to gather information due to easy accessibility and cooperation extended by the respondents.

B. Selection of the Sample

In this method the choice of sample items depends exclusively on the purpose of the investigator. In other words, the investigator exercises her judgment in the choice and includes those items in the sample which she thinks are most typical of the universe with regard to the characteristics under investigation (Gupta, 2008). Fifty commercial spaces which dealt only Plywood as a finishing material for Interiors were selected by purposive sampling method. The investigator specially chose for the survey, only those commercial spaces that were dealing only plywood as a finishing material for floors, walls and ceilings.

Out of fifty commercial spaces chosen for the study ten each included textiles, jewellery, cosmetics, hotels and shops in malls respectively. The use of plywood for commercial space is increasing. Recently Interior Designer started using for walls, floors and ceilings also, because plywood is eco-friendly material and also it is inexpensive compared to solid wood. It is very light in weight, portable, easy to install, durable and aesthetic too.

C. Selection of the Method

Singh (2009) affirms that survey is the process of collection of data and this first step for any statistical enquiry. The survey method is the technique of gathering data by asking questions from people who are thought to have the desired information (Bhattacharyya, 2006). 'Survey' refers the method of securing information, concerning a phenomenon under study from all or selected number of respondents of concerned universe (Kothari, 2008).

The interview schedule is a proforma containing a set of questions and is very useful in gathering information (Sharma and Jain, 2004). Observation means viewing or seeing (Krishnaswami and Ranganatham 2005). A pilot or feasibility study, is a small experiment designed to test logistics and gather information prior to a larger study, in order to improve the latter's quality and efficiency. A pilot study can reveal deficiencies in the design of a proposed experiment or procedure and these can then be addressed before time and resources are expended on large scale studies (Lancaster et al., 2004).

The prepared schedule was pretested in ten commercial shops for its ambiguity based on the pilot study, the schedule was modified with necessary correction. The modified schedule for the study is presented in Appendix II.

D. Selection of the Tool

The detailed interview schedule was prepared to gather information on general information about the shops and other details of plywood as a finishing material for the interiors of the selected shops. The details include place of use of plywood- floors, walls and ceilings, types, thickness, cost, any other finishing material used above the plywood, care and maintenance, reasons for selecting, advantages and disadvantages.

E. Conduct of the Study

The investigator approached the selected shops' owners at their commercial spaces. The purpose of the study was explained to them, permission was sought and the survey was conducted. The investigator created a friendly ambience while interacting with the shop owners which is very conducive for obtaining desired data.

The observation method was also used as a complement to the interview method for data collection as the respondents may not be able to spare a lot of time, which is required to answer every division of the schedule. The investigator therefore made a note of all the important things by observation so that valuable time is not wasted on asking of and answering of obviously visible things. Thus the investigator personally visited all the selected fifty commercial spaces and collected the necessary information.

F. Consolidation and Analysis of the Data

The information thus collected were consolidated, analyzed and presented under the Chapter IV.

IV RESULTS AND DISCUSSION

The findings of the study on **"Availability and Use of Plywood as Finishing Material in Selected Commercial Spaces"** are discussed under the following headings:

Phase 1: Findings of the Market Survey

Phase 2: Findings of the Commercial Space Survey

Phase 1: Findings of the Market Survey

The availability of types of plywood, finishes and finishing materials for plywood which have come to the market in Coimbatore city shops is discussed below.

A. Details on the Availability of Plywood

B. Finishes Used on Various Types of Plywood

C. Surface Finishing Materials for Plywood

A. Details on the Availability of Plywood

It includes various types of plywood based on the nature of wood and special purpose plywood based on the special manufacturing techniques

1. Availability of plywood

It includes various types of plywood which is analyzed in terms of cost, brands and grades, size, thickness and sheet of veneer or pile used.

a. Availability of types of plywood

It includes various types of plywood such as hardwood, softwood, tropical and other plywoods (marine plywood, artcraft plywood, MDF- Medium Density Fiber Board, Particle Board, etc) and their cost are discussed under the following Table 1, Figure1 and Plate 1.

Table 1: Types of Plywood

Types of plywood	Percentage of shops (N=25)	Amount in `
Hardwood plywood	100	45-125
Softwood or semi-hard plywood	100	38-45
Tropical plywood	100	95 above
Other plywood	84	80-120
Special plywood	68	80-150

It was revealed from the table that all the selected shops were selling different types of plywoods such as hardwood, softwood or semi-hard and tropical plywood. The other plywoods which were dealt by the shops were marine plywood, artcraft plywood, Medium Density Fiber Board (MDF), Particle Boards (84 per cent) and special plywood (64 per cent).

The cost of the plywood ranged from `45 to 150. The rate of hardwood is `45-125, softwood (`38-45), tropical plywood (`95 and above), special plywood (`80-150), and other plywood such as Medium Density Fiber Board (MDF) and particle boards (`80-120).

b. Availability of various brands and grades of plywood

All the selected shops were having all these brands in various types of plywood such as century ply, kid ply, green ply, sanic ply, sharon ply, uni ply, mayur ply and Trojan. Each brand was having various grades such as commercial, termite proof, BWR (Boiling Water Resistant), BWP(Boiling Water Proof), and marine proof.

c. Availability of various sizes

The availability of various sizes of plywood in the selected shops is given in Table 2, Figure 2 and Plate 2.

Figure 1

Plate 1

Table 2: Various Sizes of Plywood

Sizes in feet	Percentage of shops (N=25)
8'x4'	100
8'x3'	80
7'x4'	90
7'x3'	85
6'x4'	100
6'x3'	90

In all the selected shops 8'x4' and 6'x4' sizes of plywood were available. While 90 per cent of the shops were having 7'x4' and 6'x3' sizes, 7'x3' sizes were available in 85 per cent and 8'x3'sizes were available in 80 per cent of the shops.

d. Availability of various thickness

Availability of plywood in various thicknesses is given in Table 3, Figure 3 and Plate 2.

Table 3: Plywood Available in Relation to its Thickness

Thickness in mm	Percentage of shop (N=25)
2	90
4	85
6	90
8	100
9	75
12	100
18	100
25	70
30	60

All the selected shops were having 8mm, 12mm and 18mm thickness of plywood, whereas 90 per cent of the shops were having 2mm and 6mm thickness. While 85 per cent of the shops were selling 4mm thickness. The other sizes of plywood sold by the shops were 9mm (75 per cent), 25mm (70 per cent) and 30mm (60 per cent).

Figure 2

Plate 2

Figure 3

2. Availability of special purpose plywood

It includes special purpose plywoods such as decorative plywood, rubber wood, Gurjan plywood and flexible plywood. These are classified based on special manufacturing techniques. The availability of special purpose plywood was discussed under the following Table 4, Figure 4 and Plate 3.

Table 4: Details of Special Purpose Plywood

Types of special purpose plywood	Percentage of shops (N=25)
Flexible plywood	92
Gurjan plywood	68
Decorative plywood	64
Rubber wood	56

A maximum of 92 per cent of the shops were selling flexible plywood. The other plywoods dealt by the shops were gurjan plywood (68 per cent), decorative plywood (64 per cent) and rubber wood (56 per cent).

B. Finishes Used on Various Types of Plywood

Finishes used on various types of plywood is depicted in Table 5, Figure 5 and Plate 4.

Table 5: Finishes Used on Plywood

Plywood	Percentage of Finishes used (N=25 each)				
	Oil	Wax	Paints	Polish	Laminates
Hardwood plywood	70	90	90	100	100
Softwood or semi-hardwood plywood	60	80	80	100	100
Tropical plywood	65	85	80	100	100

Figure 4

Plate 3

Figure 5

Plate 4

Above 80 per cent of the shopkeepers mentioned that lamination, polish, paints and wax were used as finishes on plywood. More than 60 per cent of them stated that oil was used as a finish on plywood.

C. Surface Finishing Materials for Plywood

All the selected shops were having veneer and mica, these two plywoods which were given surface finishing to make it more attractive, aesthetic, easy to maintain and produce rich look like solid wood. It is available in various colours and textures. These plywoods are durable for 3-5 years (veneer) and 1-2 years (mica). The surface finishing materials for plywood was displayed in Plate 5.

Phase 2: Findings of the Commercial Space Survey

This phase of the findings present the data obtained from the selected 50 commercial spaces. They are presented under the following topics:

A. General Background of the Shops
B. Details of Plywood Used in Commercial Space
C. Preference of Plywood in Interiors
D. Finishes Applied on Plywood
E. Surface Finishing Materials for Plywood
F. Effect of Plywood on the Inmates
G. Care and Maintenance of Plywood
H. Benefits Accrued in Using Plywood
I. Problems Faced in Using Plywood

A. General Background of the Shops

This includes the general details about the commercial shops which dealt with plywood finishes in interiors. Seventy per cent of the commercial spaces were bought by the owners which are independent building whereas 30 per cent of them rented the building in the malls and commercial complexes for three to five years on lease agreement.

They modified the interiors with various types of plywood whether it is owned or rented building to make it more aesthetic, attractive and to create a rich look. Those who were on rented building know that they vacate the shops

Plate 5

after the lease period they did not mind spending money on decorating the interiors with plywood since it is not very expensive.

B. Details of Plywood Used in Commercial Space

The details of plywood used in commercial spaces include the types of plywood in interiors, the thickness and sizes of plywood used in commercial spaces are discussed under this heading.

1. Types of plywood used

Table 6 and Figure 6 display the types of plywood used in floors, walls and ceilings of commercial spaces.

Table 6: Types of Plywood Used in Floors, Walls and Ceilings

Types of plywood	Percentage* (N=50)		
	Floors	Walls	Ceilings
Hardwood	66	72	40
Softwood	64	76	38
Tropical	70	88	40
Decorative plywood	-	60	30
Flexible plywood	-	68	36
Rubber wood	56	42	26

*Multiple responses

Floors

Tropical plywood was used in 70 per cent of the shops whereas hardwood in 66 per cent, softwood in 64 per cent and rubber wood in 56 per cent in the floors of the selected commercial spaces.

Walls

Tropical plywood (88 per cent), softwood (76 per cent), hardwood (72 per cent), decorative and flexible plywood (68 per cent each) and rubber wood (42 per cent) were used in the walls of various selected commercial spaces.

Figure 6

Ceilings

Hardwood and tropical plywood (40 per cent each), softwood and flexible plywood (36 per cent each), decorative plywood (30 per cent) and rubber wood (26 per cent) were used in the ceilings of the selected commercial spaces.

2. Thickness of plywood used in commercial spaces

Table 7 and Figure 7 present the thickness of plywood used in commercial spaces.

Table 7: Thickness of Plywood Used in Commercial Spaces

Commercial spaces (N=10 each)	Percentage* Thickness of plywood in mm						
	2mm	4mm	6mm	8mm	12mm	18mm	25mm
Textiles	60	40	10	10	30	20	10
Jewellery	20	10	20	10	30	20	10
Cosmetics	40	50	50	40	60	30	20
Hotels	20	30	30	40	80	40	40
Shops in malls	30	40	60	60	70	60	70

*Multiple responses

Plywood was available in the thickness of 2mm, 4mm, 6mm, 8mm, 12mm, 18mm and 25mm in the selected commercial spaces. A maximum of textile shops used 2mm (60 per cent), cosmetics shops used 4mm (50 per cent), shops in malls used 6mm and 8mm (60 per cent each), hotels used 12mm (80 per cent) and shops in malls used 18mm (60 per cent) and 25mm (70 per cent) thickness of plywood in their interiors of commercial spaces.

Figure 7

3. Standard sizes of plywood used in commercial spaces

Table 8 and Figure 8 present the sizes of plywood used in selected commercial spaces.

Table 8: Standard Sizes of Plywood Used in Commercial Spaces

Commercial spaces (N=10 each)	Percentage* Size of plywood in feet					
	8' x 4'	8'x3'	7'x4'	7'x3'	6' x 4'	6'x3'
Textiles	20	20	30	20	30	20
Jewellery	20	10	30	10	40	20
Cosmetics	20	10	20	10	40	30
Hotels	40	30	20	20	50	40
Shops in malls	40	20	10	10	20	30

*Multiple responses

Plywood was available in the sizes of 8'x4', 8'x3', 7'x4', 7'x3', 6'x4' and 6'x3' in the selected commercial spaces. A maximum of hotels and shops in malls used 8'x4' (40 per cent each), hotels used 8'x3' (30 per cent), textile shops and jewellery shops used 7'x4' (30 per cent each), textile shops and hotels used 7'x3' (20 per cent each) and hotels used 6'x4' (50 per cent) and 6'x3' (40 per cent) sizes of plywood in their interiors of commercial spaces.

C. Preference of Plywood in Interiors

This heading deals with the preference of plywood in commercial spaces such as textile shops, jewellery shops, cosmetics shops, hotels and shops in malls. The difference among the various selected shops in the use of plywood is dealt in Table 9, Figure 9 and Plate 6.

Table 9: Preference of Plywood in Commercial Spaces

Use of plywood	Percentage of shops (N=10 each)				
	Textiles	Jewellery	Cosmetics	Hotels	Shops in malls
Floors	30	20	40	60	100
Walls	100	30	70	50	80
Ceilings	30	10	20	30	50
Wall panelling	80	50	30	80	60

Figure 8

Figure 9

Plate 6 (a)

Plate 6(b)

Plate 6 (c)

All the selected textile shops and shops in malls used plywood for walls and floors. While 50 and 80 per cent of them used for wall panelling in jewellery shops and hotels respectively. A maximum of 70 and 80 per cent used plywood for walls in cosmetics shops and in shops in malls respectively. Fifty (shops in malls) and 30 per cent of them (hotels) used plywood for ceilings.

D. Finishes Applied on Plywood

Table 10 and Figure 10 demonstrate the use of finishes applied on plywood.

Table: 10 Finishes Applied on Plywood

Finishes	Percentage of shops (N=10 each)				
	Textiles	**Jewellery**	**cosmetics**	**Hotels**	**Shops in malls**
Oil	10	-	10	10	30
Wax	10	20	20	20	10
Polish	20	30	20	20	10
Paints	-	-	10	-	20
Laminates	60	50	40	50	40

Oil, wax, polish, paints and laminates were finishes applied on plywood by the selected commercial spaces. A maximum of 60 per cent of the shops applied laminates over the plywood surfaces to provide glossy effect. Wax (20 per cent) and polish (30 per cent) were applied on plywood by the selected shops. A minimum of 10 per cent of the shops applied oil and paint finishes for plywood.

Figure 10

E. Surface Finishing Materials for Plywood

Table 11 and Figure 11 give the use of finishing materials for plywood.

Table: 11 Surface Finishing Materials for Plywood

Finishing materials	Percentage of shops (N=10 each)				
	Textiles	Jewellery	Cosmetics	Hotels	Shops in malls
Veneer	70	60	30	60	40
Mica	10	30	40	20	40

Above 60 per cent of the selected textile shops used veneer as surface finishing material for textiles, jewellery and hotels whereas above 40 per cent used mica for cosmetics shops and shops in malls.

F. Effect Plywood on the Inmates

Effect of plywood on the inmates is discussed in Table 12.

Table: 12 Effect of Plywood on the Inmates

Effect of plywood	Percentage (N=50)
Eco-friendliness	100
Warmth	80
Welcoming	70
Relaxing	60
Spaciousness	40

All the selected shops experienced the eco-friendliness of plywood. Eighty per cent of them expressed that the plywood created warmth feeling and the welcoming effect was felt by 70 per cent. The other effects experienced by the inmates by using plywood were relaxing (60 per cent) and spaciousness (40 per cent).

Figure 11

G. Care and Maintenance of Plywood

Table 13 and Figure 12 depict the care and maintenance of plywood in commercial spaces.

Table: 13 Care and Maintenance of Plywood

Details	Percentage (N=50)
Easy	100
Medium	80
Difficult	60
Costly	50
Cheap	90

All the selected shops agreed that the care and maintenance of plywoods were easy. They also expressed that the care was medium (80 per cent) and difficult (60 per cent) by the selected shops. Ninety per cent of them stated that maintenance of plywood was very cheap but 50 per cent did not agree with this statement and they felt that it is a costly affair in maintaining the plywood interiors.

H. Benefits Accrued in Using Plywood

Benefits accrued in using plywood are discussed in Table 14.

Table: 14 Benefits Accrued in Using Plywood

Benefits	Percentage (N=50)
Plywood absorbs noise	90
Plywood is easy to maintain	80
Plywood is strong and durable	80
Plywood is comfortable	70
Plywood gives customers more flexibility	60
Plywood is fire resistant	50

Figure 12

A maximum of 90 per cent of the selected shops assured that the plywood absorbs noise. The other benefits experienced were strong, durable and easy to maintain (80 per cent) and gave customers more flexibility (70%) to use. Fifty per cent of them accepted that plywood was fire resistant.

I. Problems Faced in Using Plywood

The problems faced in using plywood of commercial spaces were discussed in Table 15 and Plate 7.

Table 15: Problems Faced in Using Plywood

Problems faced	Percentage (N=50)
Non- resilient	70
Wear and Tear	70
Slippery	60
Expensive	50
Non availability	40

Seventy per cent of the selected shops agreed that using plywood was non- resilient and wear and taer. The other problems expressed in using plywoods by the selected respondents were slippery (60 per cent), expensive (50 per cent) and non availability (50 per cent).

Plate 7

V SUMMARY AND CONCLUSION

Human has a strong urge to express his creative and aesthetic instincts in visual form. A comfortable commercial space has proper composition of natural elements and manmade elements where the man can perform various functions in the best possible ways and feel pleasant. Commercial space should satisfy the customers for which he is visiting the place and it should be aesthetically good so that customer will feel to visit again. With the use of plywood for interiors in commercial spaces one can create a functional environment with the beauty and character. The study entitled "**Availability and Use of Plywood as Finishing Material in Selected Commercial Spaces**" was chosen.

A market survey was conducted in 25 shops by purposive sampling method in Coimbatore city by the investigator to know the availability of various types of plywood in the market and their thickness, common sizes, qualities and the price of plywood. This data would be more helpful for the Interior designers and commercial space planners to plan the finishing materials for their interiors.

A commercial space survey was conducted in 50 shops of which each ten shops from textiles, jewellery, cosmetics, hotels and shops in malls in Coimbatore city by purposive sampling method to analyze the use of plywood as a finishing material. This survey was conducted to gather general information about the shops and other details of plywood as a finishing material for the interiors of the selected shops. The details include place of use of plywood- floors, walls and ceilings, types, thickness, cost, any other finishing material used above the plywood, care and maintenance, reasons for selecting, advantages and disadvantages.

The Highlights of the Study are summarized below:

Phase 1: Findings of the Market Survey

A. Details on the Availability of Plywood

- The different types of plywoods such as hardwood, softwood or semi-hard and tropical plywood were available in all the selected shops. The

other plywoods which were dealt by the shops were Medium Density Fiber Board (MDF), Particle Boards (84 per cent) and special plywood (64 per cent). The cost of the plywood ranged from Rs 45 to 150. The rate of hardwood is Rs 45-125, softwood (Rs 38-45), tropical plywood (Rs 95 and above), special plywood (Rs 80-150), and other plywoods such as marine plywood, artcraft plywood, Medium Density Fiber Board (MDF) and Particle Boards (Rs 80-120).

- All the selected shops were having all these brands in various types of plywood such as century ply, kid ply, green ply, sanic ply, sharon ply, uni ply, mayur ply and Trojan. Each brand was having various grades such as commercial, termite proof, BWR (Boiling Water Resistant), BWP (Boiling Water Proof), and marine proof.
- In all the selected shops 8'x4' and 6'x4' sizes of plywood were available. While 90 per cent of the shops were having 7'x4' and 6'x3' sizes, 7'x3' sizes were available in 85 per cent and 8'x3'sizes were available in 80 per cent of the shops.
- All the selected shops were having 8mm, 12mm and 18mm thickness of plywood, whereas 90 per cent of the shops were having 2mm and 6mm thickness. While 85 per cent of the shops were selling 4mm thickness. The other sizes of plywood sold by the shops were 9mm (75 per cent), 25mm (70 per cent) and 30mm (60 per cent).
- Regarding special purpose plywood, ninety two per cent of the shops were selling flexible plywood. The other plywoods dealt by the shops were gurjan plywood (68 per cent), decorative plywood (64 per cent) and rubber wood (56 per cent).

B. Finishes Used on Various Types of Plywood

- Above 80 per cent of the shopkeepers mentioned that lamination, polish, paints and wax were used as finishes on plywood. More than 60 per cent of them stated that oil was used as a finish on plywood.

C. Surface Finishing Materials for Plywood

- All the selected shops were having veneer and mica, these two plywoods which were given surface finishing to make it more attractive, aesthetic, easy to maintain and produce rich look like solid wood. It is available in various colours and textures. These plywoods are durable for 3-5 years (veneer) and 1-2 years (mica).

Phase 2: Commercial Space Survey

A. General Background of the Shops

- This includes the general details about the commercial shops which dealt with plywood finishes in interiors. Seventy per cent of the commercial spaces were bought by the owners which are independent building whereas 30 per cent of them rented the building in the malls and commercial complexes for three to five years on lease agreement. They modified the interiors with various types of plywood whether it is owned or rented building to make it more aesthetic, attractive and to create a rich look. Those who were on rented building know that they vacate the shops after the lease period they did not mind spending money on decorating the interiors with plywood since it is not very expensive.

B. Details of Plywood Used in Commercial Space

- Tropical plywood was used in 70 per cent of the shops whereas hardwood in 66 per cent, softwood in 64 per cent and rubber wood in 56 per cent in the floors of the selected commercial spaces.
- Tropical plywood (88 per cent), softwood (76 per cent), hardwood (72 per cent), decorative and flexible plywood (68 per cent each) and rubber wood (42 per cent) were used in the walls of various selected commercial spaces.
- Hardwood and tropical plywood (40 per cent each), softwood and flexible plywood (36 per cent each), decorative plywood (30 per cent) and rubber wood (26 per cent) were used in the ceilings of the selected commercial spaces.

- Plywood was available in the thickness of 2mm, 4mm, 6mm, 8mm, 12mm, 18mm and 25mm in the selected commercial spaces. A maximum of textile shops used 2mm (60 per cent), cosmetics shops used 4mm (50 per cent), shops in malls used 6mm and 8mm (60 per cent each), hotels used 12mm (80 per cent) and shops in malls used 18mm (60 per cent) and 25mm (70 per cent) thickness of plywood in their interiors of commercial spaces.

- Plywood was available in the sizes of 8'x4', 8'x3', 7'x4', 7'x3', 6'x4' and 6'x3' in the selected commercial spaces. A maximum of hotels and shops in malls used 8'x4' (40 per cent each), hotels used 8'x3' (30 per cent), textile shops and jewellery shops used 7'x4' (30 per cent each), textile shops and hotels used 7'x3' (20 per cent each) and hotels used 6'x4' (50 per cent) and 6'x3' (40 per cent) sizes of plywood in their interiors of commercial spaces.

C. Preference of Plywood in Interiors

- All the selected textile shops and shops in malls used plywood for walls and floors. While 50 and 80 per cent of them used for wall panelling in jewellery shops and hotels respectively. A maximum of 70 and 80 per cent used plywood for walls in cosmetics shops and in shops in malls respectively. Fifty (shops in malls) and 30 per cent of them (hotels) used plywood for ceilings.

D. Finishes Applied on Plywood

- Oil, wax, polish, paints and laminates were finishes applied on plywood by the selected commercial spaces. A maximum of 60 per cent of the shops applied laminates over the plywood surfaces to provide glossy effect. Wax (20 per cent) and polish (30 per cent) were applied on plywood by the selected shops. A minimum of 10 per cent of the shops applied oil and paint finishes for plywood.

E. Surface Finishing Materials for Plywood

- Above 60 per cent of the selected textile shops used veneer as surface finishing material for textiles, jewellery and hotels whereas above 40 per cent used mica for cosmetics shops and shops in malls.

F. Effect of Plywood on the Inmates

- All the selected shops experienced the eco-friendliness of plywoods. Eighty per cent of them expressed that the plywood created warmth feeling and the welcoming effect was felt by 70 per cent. The other effects experienced by the inmates by using plywood were relaxing (60 per cent) and spaciousness (40 per cent).

G. Care and Maintenance of Plywood

- All the selected shops agreed that the care and maintenance of plywoods were easy. They also expressed that the care was medium (80 per cent) and difficult (60 per cent) by the selected shops. Ninety per cent of them stated that maintenance of plywood was very cheap but 50 per cent did not agree with this statement and they felt that it is a costly affair in maintaining the plywood interiors.

H. Benefits Accrued in Using Plywood

- A maximum of 90 per cent of the selected shops assured that the plywood absorbs noise. The other benefits experienced were strong, durable and easy to maintain (80 per cent) and gave customers more flexibility (70 per cent) to use. Fifty per cent of them accepted that plywood was fire resistant.

I. Problems Faced in Using Plywood

- Seventy per cent of the selected shops agreed that using plywood was non- resilient. The other problems expressed in using plywoods by the selected respondents were slippery (60 per cent), expensive (50 per cent) and non availability (50 per cent).

Conclusion

Interiors of commercial spaces played an important role in owners as well as customers life. Good interiors will create a good welcoming atmosphere for the customers. Though various interior materials are available in the market plywood is widely used recently as finishing material for interiors of commercial spaces due to its various advantages such as availability in various colours and sizes, resilient effect, inexpensive, easy to install and easy to care and maintain and the most notable and important point is that everyone likes plywood.

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APPENDIX – I

INTERVIEW SCHEDULE TO ELICIT INFORMATION FROM SHOPKEEPER ABOUT PLYWOOD IN SELECTED SHOPS

1. Name of the interviewer:
2. Name of the interviewee:
3. Shop name:
4. Location:
5. E-mail ID:
6. Contact no:
7. Is plywood available in your shop?

   Yes ☐ no ☐

8. List out the types of plywood which are available in your shop

   ---

   ---

9. Any innovative type of plywood is available
   a. ----------
   b. ----------
   c. ----------
   d. ----------
10. What kind of plywood is frequently sold by the customer?
    a. Hardwood plywood
    b. Softwood plywood
    c. Tropical plywood
    d. Special purpose plywood

       If you have special purpose plywood, mention which kind of special plywood

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       ---

11. Mention the name of finishing material which are used on plywood

    a. ----------

    b. ----------

12. Details about plywood which is available in your shop

Types of plywood	Common sizes (LXB)	Thickness	Brand	Grade	Quality	Price
Hardwood plywood						
Softwood plywood						
Tropical plywood						
Special purpose plywood						

APPENDIX - II

INTERVIEW SCHEDULE TO ELICIT INFORMATION FROM OWNERS OF COMMERCIAL SPACES ABOUT THE USE OF PLYWOOD

1. Name of the interviewer:
2. Name of the interviewee:
3. Shop name:
4. Location:
5. E-mail ID:
6. Contact no:
7. Plywood is used as a finishing material for floors, walls and ceilings in your shop?

   Yes ☐ no ☐

8. Which are the places are used in your shop?

Flooring	Walls	Ceiling

9. What kind of plywood used for flooring in your shop?

Type of wood	Flooring
Hardwood plywood	
Softwood plywood	
Tropical plywood	

10. What kind of plywood used for walls in your shop?

Type of wood	Walls
Hardwood plywood	
Softwood plywood	
Tropical plywood	

11. What kind of plywood finishes used for walls in your shop?

Type of wood	Ceiling
Hardwood plywood	
Softwood plywood	
Tropical plywood	

12. Any other special kind of plywood used in your shop?
    a. Aircraft plywood
    b. Decorative plywood
    c. Flexible plywood
    d. Marine plywood
    e. Other plywood
13. Are the used plywood can be recycled or reusable?

    Yes ☐ no ☐
14. What is the thickness of plywood used in your shop?

    a) 4mm b)6mm c)8mm d)12mm
15. What is the size of the plywood used in your shop?

    a) 8”-10” b) 12”-18” c) 6”-10” d)----------
16. Have you applied any finishes over the plywood finishes?

    Yes☐ No ☐

    If yes, mention the name of which are used ----------
17. Reasons for selecting this plywood as a finishing material?
    a. For cost reduction
    b. Innovative material
    c. Aesthetic look
    d. Easy maintenance
18. What is the cost of single piece of plywood?

    a)40 b) 60 c) 80 d)-------

19. When did you inlay this plywood?
    a. Before 1 year
    b. Before 10 months
    c. Before 11/2 year
    d. Before ----------

20. What kind of care given for this plywood finishing?

Types of plywood				
Hardwood plywood				
Softwood plywood				
Tropical plywood				

21. What are the maintenance techniques have you applied for taking care of this material?

    _____

    _____

    _____

22. Mention the advantages of using this plywood as a finishing material?
    a. Easy maintain
    b. Cost wise it is cheap
    c. Easy to install or construct
    d. Many varieties are available

23. Mention the disadvantages of using this plywood as a finishing material?

    _____

    _____

    _____

24. Can this kind of plywood finishing material be used in interiors- Floors, walls, ceilings

    Yes☐ no ☐

25. Durability period of this plywood

    a) 3 years b) 4 years c) 5 years d) above 5 years

26. Is the plywood finishing material better than other tiles?

_____

_____

_____