TCNA
Tile Council of North America, Inc.

Life Cycle Cost Analysis

Floor Coverings Comparison

This copy sponsored by:

nwfa
National Wood Flooring Association

Sponsors

PLATINUM SPONSORS

GOLD SPONSORS

SILVER SPONSORS

Co-branded issues of this publication are marked with the sponsor's logo under the words, "This copy sponsored by." Tile Council of North America, Inc. (TCNA) allows sponsors to customize copies of reports, which may include advertisements showcasing their products, services, or programs and selections relevant to the sponsors' intended audiences. Inclusion of advertisements and other statements or opinions by the sponsors and/or those sponsors' selections of relevant content do not constitute any endorsement, recommendation, approval, or evaluation by TCNA of any sponsor's products, services, programs, statements, or opinions.

Contents

Life-Cycle Costs for Flooring in Commercial Buildings
Floor Covering Comparison Study

Emily Lorenz, PE, F-ACI, is an independent consultant in the areas of life-cycle assessment (LCA), environmental product declarations (EPDs), product category rules (PCRs), green building, and sustainability. She serves as an engineer in the areas of green structures and practices, energy efficiency, thermal properties, and moisture mitigation. Lorenz also specializes in building code and standards work and advocacy. She actively participates as vice-chair of the Envelope Subcommittee developing the commercial provisions of the 2024 International Energy Conservation Code (IECC), and as a voting member of several committees including the 2024 IECC Commercial Committee; the Envelope Subcommittee of ASHRAE 90.1; ASTM International Committee E60, Sustainability; the American Concrete Institute's (ACI's) building code subcommittee on sustainability; ACI Committee 130, Sustainability of Concrete; Joint ACI-TMS Committee 122, Energy Efficiency of Concrete and Masonry Systems; Joint ACI-ASCE Committee 550, Precast Concrete Structures; and several other technical associations and committees. She also serves as an expert to ISO TC59\SC17\WG3 Environmental Declarations of Products. Lorenz received her BS and MS in civil engineering (structural emphasis) from Michigan Technological University, Houghton, MI, USA.

Life-Cycle Costs for Flooring in Commercial Buildings
Floor Covering Comparison Study

The Tile Council of North America commissioned an independent consultant, Emily Lorenz, PE, F-ACI, to conduct a Life Cycle Cost Analysis study.

Introduction

There are several methods available to evaluate and compare the economic performance of products or systems. For this study, life-cycle cost analysis (LCCA) is used to compare 18 flooring types installed in a typical office building. For the purpose of this study, a typical office building is defined according to the commercial building characteristics included in the 2018 Commercial Buildings Energy Consumption Survey from the U.S. Energy Information Administration. The LCCA was conducted according to ASTM E917-17, Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems.

An LCCA is a powerful tool to aid decision makers in evaluating all relevant costs for a given building system. Costs are summed in terms of either present values or annual values over a specified period of time; for this study, present values are used. This allows for comparison of the construction and maintenance costs of alternative building systems that meet the same functional requirements. In this study, the functional requirements of all flooring types are that they are fit for use and provide adequate durability and cleanliness for light to medium commercial use in office space.

This is not to say that all flooring types naturally receive the same soil load, wear pattern, or abrasive conditions, nor is their appearance similar. As such, soil conditions and appearance affect the maintenance cycle and expectations for each product category. For example, marble and other stone flooring are often used in areas where foot traffic and abrasive conditions are frequent (for example, commercial building lobbies), yet are generally expected to have a highly polished finish. Because of this, maintenance for stone flooring is more involved than materials such as carpet, for example, which has a different expected appearance and soil load.

Eighteen Flooring Types of the Study	
CSI Designation	**Flooring Types**
09 30 13	Ceramic Tile
09 30 13	Quarry Tile
09 30 13	Porcelain Tile
09 62 19	Laminate
09 63 40	Marble
09 63 40	Granite
09 63 40	Travertine
09 63 40	Limestone
09 64 19	Engineered Wood
09 64 29	Solid Wood
09 65 16.23	Sheet Vinyl
09 65 19.19	Vinyl Composition Tile (VCT)
09 65 19.23	Flexible Luxury Vinyl Flooring (LVF/LVP)
09 65 19.43	Rigid Core Flooring (RCB, SPC, WPC, etc.)
09 66 13	Epoxy Terrazzo
09 67 23	Poured Epoxy
09 68 13	Carpet Tiles/Carpet Squares
09 68 16	Nylon Broadloom Carpet

Table 1

Although this study was based on flooring use in light to medium commercial applications, many of the results would be applicable to residential applications as well. Differences in wear and cleaning routines between residential and light to medium commercial applications are similar for the eighteen flooring types studied, with the primary difference being an increased loading for commercial applications attributed to more frequent rolling of carts and higher pedestrian traffic.

A note about conservative assumptions: This study was primarily funded by the Tile Council of North America (TCNA) although with financial and technical support from several industry associations representing other

WOOD FLOORING'S CARBON FOOTPRINT ESTABLISHED

Environmental Product Declarations (EPD)

for solid and engineered wood flooring are now available to eco-conscious architects, specifiers, and end-users.

To download the full reports, and view a comparison of wood flooring's Global Warming Potential (GWP) to other flooring categories, visit NWFA's website today.

nwfa
National Wood Flooring Association

NATIONAL WOOD FLOORING ASSOCIATION
NWFA.ORG | 800.422.4556

flooring types. While the selection of engineering parameters was made by the author without influence from TCNA or others, as a condition of undertaking this report and to avoid any suggestion of bias favoring the source of primary financial support, in the evaluation of any data ambiguities, any reasonable choices that could potentially favor the selection of flooring types other than ceramic, porcelain, and quarry tile were preferred. These choices are identified and referred to as conservative assumptions within the author's full report available at http://bit.ly/3UBUPHF.

The 18 types of flooring considered in this LCCA are listed in **Table 1**, ordered by their CSI designation.

For this study, annual 2020 costs were chosen because they represented the most-current values that were not influenced by COVID-19 pandemic-related fluctuations. When cost data were not available in the RS Means database, online searches of cost data from big-box retailers were used or industry sources were consulted to approximate cost data in relation to available RS Means data.

Basic LCCA Criteria

As consumers look toward more-sustainable and durable products, it is common to consider the impacts and costs over the full life cycle of a building. When evaluating the environmental impact of a material, both the International Green Construction Code (IgCC) and ASHRAE 189.1, Standard for the Design of High-Performance Green Buildings, use a 75-year period of analysis. In keeping with those standards, a 75-year study period was used for this analysis. To check the sensitivity of the analysis however to this study period, additional analyses were run with a study period of 40 years.

To compare future costs, such as maintenance and replacements, occurring at different times over the life of a building, such future costs are "discounted" back to their net present value. That is, the discount rate reflects what a dollar today will be worth in the future with interest, and conversely, what an expense in the future would cost today if those dollars today were saved and interest earned on them. Per ASTM E917, "The discount rate is used to convert costs occurring at different times to equivalent costs at a common point in time."

A real discount rate of 3% was used for this study, which is expressed in terms net of general price inflation. This means whatever cost increases occur in the future due to inflation, this study assumes the rate of interest to be three percentage points greater than that inflation.

The 3% real discount rate was chosen based on Lavappa and Kneifel (2018), which set the real discount rate based on "long-term Treasury Bond rates averaged over 12 months and the general inflation rate." In its Technical Note 2032 rev 2, the National Institute of Standards and Technology notes that average discount rates range from -0.5% to 7% (NIST 2021). To check the sensitivity of this LCCA analysis to this discount rate, additional analyses were run at discount rates of 0%, 5%, and 7%.

Summary and Results

The following chart summarizes the installed cost for each flooring type, the lifetime cost in net present dollars for each flooring, the reference service life for each flooring, and the cost per year averaged over the full building life. Costs associated with daily cleaning practices common to all flooring types, whether regular dusting, mopping, or vacuuming, were assumed to be the same and were equally applied to each material's life cycle cost. For those flooring types that did not have an estimated service life that was a multiple of the study period, a residual value was calculated at the end of the study period and subtracted from the net present value. The residual value is calculated as a percentage of the initial cost discounted back to the net present value from 75 years.

Compared to costs presented above using a 3% discount rate, a higher discount rate decreases the impact of future costs on the net present value. Conversely, a lower discount rate increases the impact of future costs.

Shortening the building life from 75 years to any lesser number puts greater emphasis on the cost of the initial installation and eliminates the impact of maintenance and replacements beyond the study period (in this case 40 years). However, the cost per foot per year for all floorings goes up as the costs are not amortized over the longer building lifetime.

Is it Real Wood? Is it Refinishable?

REAL WOOD · REFINISHABLE · CERTIFIED

nwfa
National Wood Flooring Association

The hard surface maketplace is full of confusion. The NWFA Engineered Wood Flooring Refinishable Program cuts through the clutter and identifies real wood flooring products with wear layers thick enough to be sanded & refinished.

LEARN MORE ABOUT THE PROGRAM AND VIEW THE COMPLETE LIST OF CERTIFIED MANUFACTURERS

NWFA.ORG/MANUFACTURING/
800.422.4556

Life-Cycle Costs for Flooring in Commercial Buildings				
Material Type	**Initial Installation Cost[1] (per sq.ft.)**	**Life Cycle Cost[2] (per sq.ft.)**	**Estimated Useful Life**	**Cost Per Year[3] (per sq. ft.)**
Quarry Tile	$9.53	$71.31	75 years	$0.95
Ceramic Tile	$11.03	$72.81	75 years	$0.97
Porcelain Tile	$11.38	$73.16	75 years	$0.98
Solid Wood	$8.92	$75.78	75 years	$1.01
Engineered Wood	$7.92	$78.76	25 years	$1.05
Limestone	$24.30	$101.68	75 years	$1.36
Travertine	$24.30	$101.68	75 years	$1.36
Granite	$26.65	$102.69	75 years	$1.37
Marble	$26.65	$104.03	75 years	$1.39
Nylon Broadloom Carpet	$5.86	$125.41	5 years	$1.67
LVF	$4.56	$131.66	15 years	$1.76
Carpet Tile	$5.25	$132.57	5 years	$1.77
Rigid Core	$6.36	$136.13	15 years	$1.82
Epoxy Terrazzo	$13.66	$137.22	75 years	$1.83
Laminate	$8.49	$138.45	20 years	$1.85
Poured Epoxy	$11.49	$155.91	15 years	$2.08
VCT	$3.09	$159.48	15 years	$2.13
Sheet Vinyl	$7.10	$169.46	15 years	$2.26

Table 2
Costs calculated for light to medium commercial use in office space.
[1] Initial installation costs are the addition of the material and labor costs for each respective material type.
[2] Life cycle costs are expressed as net present values (NPVs).
[3] Costs per year are the life cycle costs for each respective material divided by the length of the study period (75 years).

In total eight analyses were performed

- 3% Discount rate with a 75-year study period (presented in **Table 2**)
- 7% Discount rate with a 75-year study period
- 5% Discount rate with a 75-year study period
- 0% Discount rate with a 75-year study period
- 7% Discount rate with a 40-year study period
- 5% Discount rate with a 40-year study period
- 3% Discount rate with a 40-year study period
- 0% Discount rate with a 40-year study period

In all cases, quarry tile, ceramic tile, porcelain tile, solid wood and engineered wood cost less per year than all other floorings. Also, in all cases, poured epoxy, VCT, and sheet vinyl cost more than all other floorings.

For flooring products between these least and most expensive categories, some of the relative rankings moved slightly depending on the discount rate and study period. As an example, using a 0% discount rate and a 40-year study period, the only changes from the table above using a 3% discount rate and 75-year study period were that granite had a lower life-cycle cost than limestone and epoxy terrazzo had a lower life-cycle cost than LVF. To see all the analyses, refer to the author's full report available at http://bit.ly/3UBUPHF.

For specific projects using a building lifetime different than those above, or for different discount rates, or different installed costs and maintenance costs, please contact IPALaboratories at **info@IPALaboratories.com** for a project-specific lifecycle cost analysis.

YOU'LL BE FLOORED AT THE VALUE

Nearly 80% of homeowners believe wood floors add the most value to their home. Plus, the life span of a wood floor can exceed 100 years.

EVERY WOOD FLOOR HAS A STORY. WHAT WILL YOURS BE?

REAL WOOD. REAL LIFE.

Read about the ROI of real wood at woodfloors.org

nwfa
National Wood Flooring Association

real wood
Real Life℠

Specify Quality Assurance

COUNT ON NWFA CERTIFIED PROFESSIONALS

The National Wood Flooring Association (NWFA) is a not-for-profit trade organization that creates worldwide standards for the hardwood flooring industry. When seeking a professional craftsman, installer, sand & finisher, or inspector, shouldn't that person be qualified by the organization that creates and maintains these rigorous standards?

What is an NWFA Certified Professional?

NWFA Certified Professionals are trained specifically in their area of expertise. NWFA Certified Professionals set themselves apart by attending training and earning certifications through the NWFA.

The NWFA Certified Professional Difference:

- Services meet the highest level of quality
- Up-to-date training and proven expert technical knowledge
- Above-and-beyond customer service and ethics
- Adherence to strict Code of Conduct

TESTIMONIAL

As a Claims Administrator/Technical Advisor, NWFA University and NWFA hands-on training helped me improve my skills and broaden my wood flooring expertise. The knowledge I gained led to my NWFA certifications in sales and inspections, which helped improve my business.

– Dannie Marx, CWFI, CSA
Hallmark Floors, Inc.

CERTIFIED SALES ADVISOR

NWFA Certified Sales Advisors have the necessary knowledge to educate customers about wood floors and help guide them to the floor that best suits their needs.

CERTIFIED INSTALLER AND/OR SAND & FINISHER

NWFA Certified Installer and/or Sand & Finishers have the education and skill set to establish themselves as continuous learners and give customers confidence that they are hiring a skilled professional.

CERTIFIED INSPECTOR

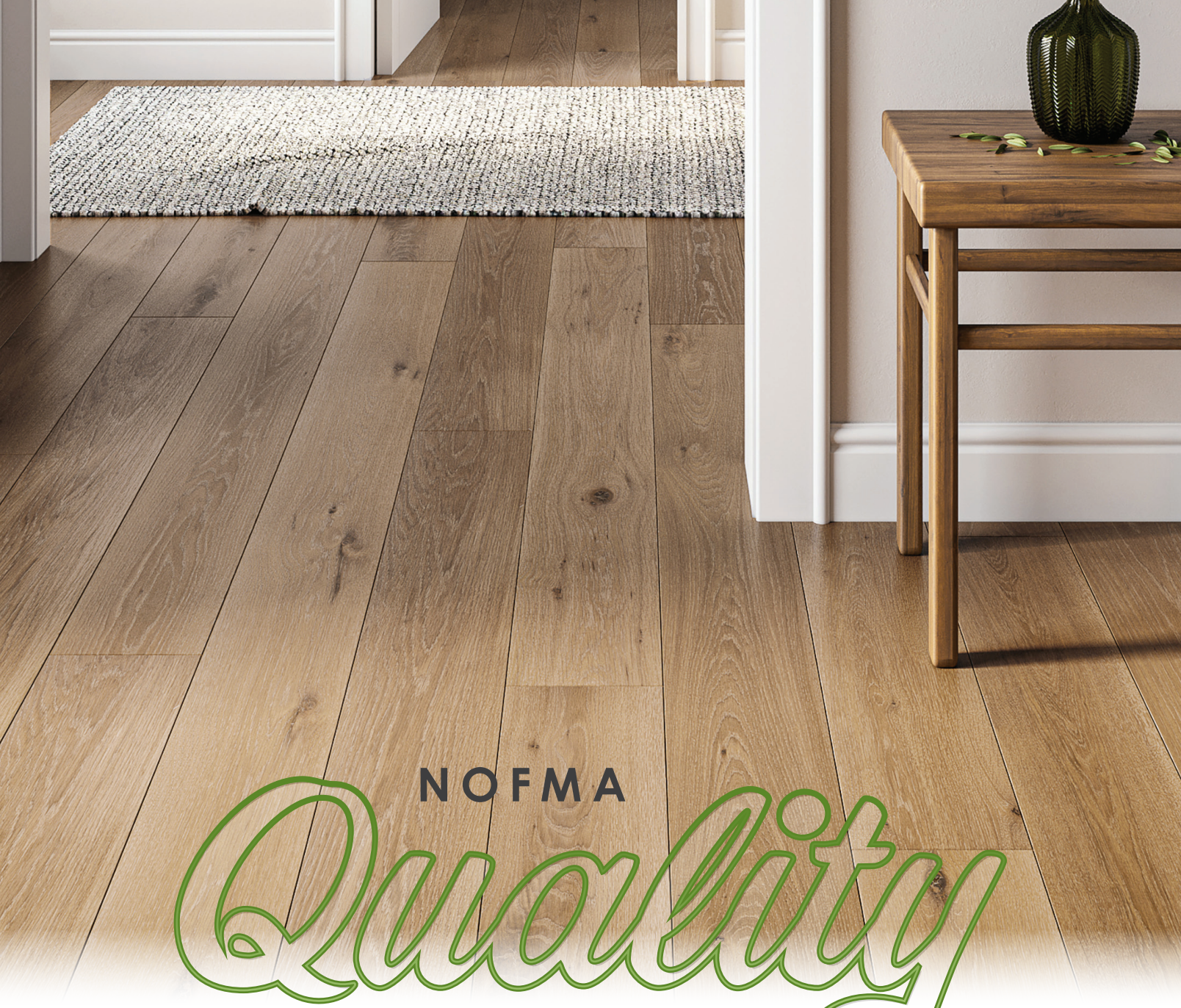
NWFA Certified Wood Flooring Inspectors have the knowledge to ensure a floor is installed successfully, and are able to help others prevent and identify failure of a wood floor.

CERTIFIED CRAFTSMAN
CERTIFIED MASTER CRAFTSMAN

NWFA Certified Craftsman or Master Craftsman have the confidence and capability to offer customers a truly one-of-a-kind floor and experience. They have achieved the highest level of recognition with the NWFA Certified Professional program.

The money spent on wood floors is an investment. It is crucial to choose a highly trained professional who has the knowledge and skills to do the job right. In fact, many NWFA-member manufacturers recommend hiring NWFA Certified Professionals.

>> Learn more at woodfloors.org/find-a-professional



NOFMA

Quality

WOOD FLOORING

SINCE 1909

NOFMA HAS BEEN CERTIFYING WOOD FLOORING FOR MORE THAN 100 YEARS.

The only standard in the industry that assures wood flooring has been properly kiln dried, manufactured, and graded.

NWFA/NOFMA CERTIFIED WOOD FLOORING

WHEN QUALITY MATTERS, CONTACT AN NWFA/NOFMA MANUFACTURER.
NWFA.ORG/MANUFACTURING/ • 800.422.4556

100 Clemson Research Blvd. Anderson, SC 29625 | 864.646.8453 | www.TCNAtile.com