Flooring Maintenance of the Education Built Environment Impacting Occupant Health

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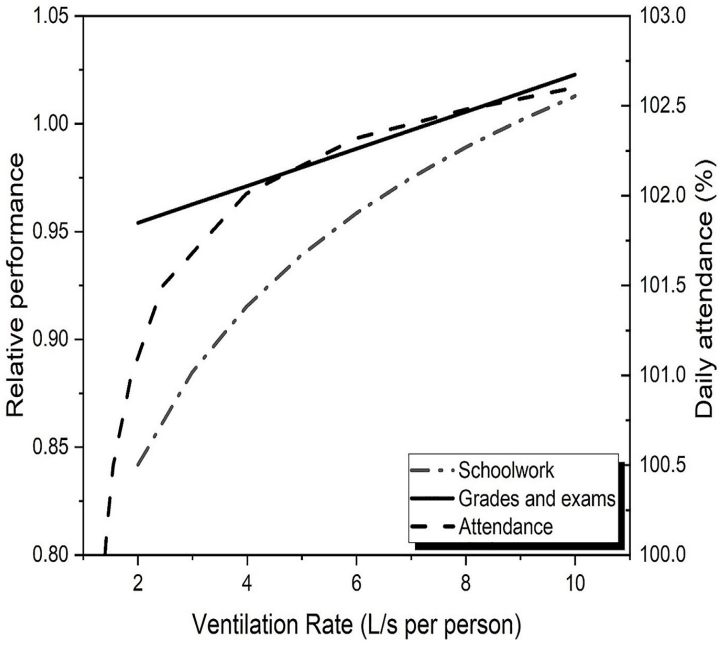
The intention of this research is to establish the correlation between the APPA Center for Facilities Research (CFaR) project, *Measuring the Current Practices of Total Cost of Ownership (TCO) Principles Used in the Procurement of Flooring in Education Environments*, and the implications of flooring maintenance contributions to the performance of the building and occupant health. Dr. Joseph Allen clearly states that *"*Building engineers and facilities managers are the true heroes of our health*."* [i] Dr. Jeffrey Campbell shared in his research, *Cleanliness and Learning in Higher Education*, that students said that the lack of cleanliness affects allergies, spreads germs, increases bug and rodent infestation, and even promotes higher stress levels. In addition, poor facility conditions affect student attendance and teacher retention."[ii] Absenteeism is at crisis levels costing schools more than $11 billion annually where indoor air quality is the number one contributor.[iii]

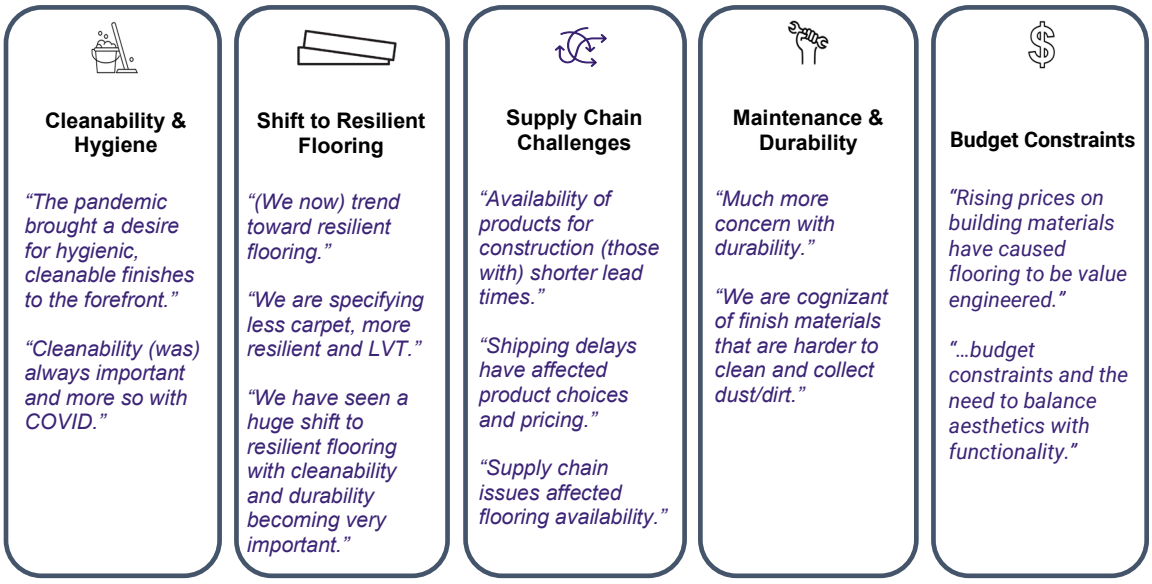
The APPA Productive, Smart Buildings task force survey showed that facilities management has done a great job on managing the high performance of the building while realizing their impact on the health of the occupants.[iv] A JLL survey in 2021 revealed that parents with high school students realized the correlation and importance while elevating indoor air quality campus cleanliness and indoor air quality ranked as the top three most important factors for college or university selection.[v]

[1] The authors acknowledge the helpful comments from Cameron Christensen during the writing of this report and Dr. Jeffrey Campbell's influence on starting this work in 2017.

A research study, including indoor air quality of a space, also pointed to cognition increasing by as much as 101% with cleaner air.[vi] In APPA's *Operational Guidelines for Educational Facilities – Custodial 4th Edition* (Chapter 8: Scientific Measurement of Cleaning), "studies repeatedly show that students and employees perform better in facilities that are orderly and look clean." Relying on appearances alone is not enough. Rather, cleaning for health and providing a sanitary environment are also critically important. Students and staff will perform much better in facilities that are truly clean and sanitary experiencing fewer sick days.[vii] Asthma and allergies affect more than 4.6 million (or one out of 12 school students) each year.[viii] Nine percent, 1.6M, of college students also suffer from asthma and allergies. Many research excerpts indicate that flooring can be a source contributing to the transmission of infection and be a landing place for particulate matter.[ix]



Building maintenance has a direct impact on user health, and the flooring is the largest horizontal surface in a building, which can be a sequester soil, particulate matter, and any spills. As a part of this CFaR research project we conducted a survey of more than 340 institutional respondents and asked, "How has COVID-19 impacted the choices, decisions, or procedures about flooring at educational institutions?"[x] It revealed the need for maintenance-related proof, evidence, and training. The most commonly used words from respondents in order of frequency were Cleanability, Hygiene, Resilient flooring, Supply chain, Maintenance, Durability, Budget constraints, Availability, and Easy-to-clean.



Flooring Maintenance impacting Occupant Health

Flooring is one of the largest surfaces of any building and is used in education facilities as an interactive medium for all ages of students especially for students at younger ages. A higher percentage of particulate matter travels lower to the floor[xi] as lower school grades frequently use the floor as a play and learning surface and students of all ages are also seen sitting on the floor as a community and engagement space. Indoor Air Quality research by the University of Tulsa points to the fact that well-maintained flooring has a direct impact on occupant health and safety.[xii]

One of the underlying issues facing the health component of flooring is the need to clean before you can sanitize and disinfect. Unintended consequences can surface when rushing to solve the spread of germs by spraying chemicals to disinfectants into buildings. This can do more harm to indoor air quality of the environment and not even solve the problem.[xiii] Cleaning surfaces first allow the removal of bacteria or live energy molecules where subsequent sanitization can then be effective.[xiv] The CDC does not recommend disinfecting flooring but does give a list of high touch surfaces such as doorknobs to achieve sanitization.[xv] Flooring surface can easily be cleaned with a neutral cleaner. Sanitization is the reduction of general microbial pathogens to safe levels whereas disinfection inactivates the pathogens

still present on the surfaces.[xvi] Inadequate cleaning leads to the accumulation of particulate matter, which can prolong the persistence of live molecules.

The National Center for Education Statistics (NCES) Planning Guide for Maintaining School Facilities notes custodial responsibilities include cleaning floors.[xvii] The guide offers suggestions both for flooring specifications and cleaning routines. Proper preventive maintenance routines, and chemical-free cleaning products directly impact performance and life cycle of a product, which also impact the health of occupants.[xviii] The simple maintenance guidelines for both soft surface flooring and resilient flooring are in the footnotes.[xix]

The Federal Economic Relief for COVID-19 created an opportunity on how education organizations could use funding through "*Repairing and Improving School Facilities to Reduce Risk of Virus Transmission and Exposure to Environmental Health Hazards.*"[xx]

Healthcare considered flooring not to be a high-touch surface for the transmission of infection.[xxi] Examples of high-touch surfaces include pens, counters, shopping carts, tables, doorknobs, light switches, handles, stair rails, elevator buttons, desks, keyboards, phones, toilets, faucets, and sinks. Environmental Services (EVS) technicians within healthcare are directed to clean high-touch surfaces at least once a day or as often as determined is necessary.[xxii] Reducing the risk of virus transmission and exposure are highly impacted by simple daily maintenance.[xxiii] If students do use the floor as an interactive medium, then maintenance of the floor should be considered as a strategy to ensure the best possible health outcomes. The following are research-based recommendations that align with the Federal Economic Relief impacting floor cleanliness and health.

- Flooring needs to be non-porous or non-flow through surfaces where surface soiling and spills can travel to the subfloor.[xxiv]
- Smoother surfaces were less effectively cleaned and/or more likely to transmit infection to hands. Therefore, provide a much better transmission surface for hands.[xxv]
- According to the American Lung Association, vacuuming often with a high efficiency particle air (HEPA) filter and annual steam cleaning can help manage settled dust and particles.[xxvi]
- Bonnet cleaning should be avoided due to it kicking up particulates. This

process lacks deep cleaning that removes asthmagens and the addition of cleaning chemicals to the surface.

- Harsh cleaning materials can result in allergic reaction, skin and respiratory irritation, and headaches. To reduce chemical exposure for custodial staff, students, and educators, the U.S. EPA provides guidance for green cleaning through Green Seal, Ecologo, BioPreferred Program, and Safer Choice. Additionally, in the 2021 Integrated Pest Management Toolkit, the EPA suggests sealing any openings in floors and cleaning floor drains weekly.
- Asthma and Allergy Friendly Certified flooring products provide the lowest TVOC for transparency and material health exposure, which highly reduces any asthmatic or allergy triggers.[xxvii]
- According to the EPA, Antimicrobials are a health risk and highly contribute to antibiotic resistance. There is no evidence that products treated with antimicrobial chemistry prevent the spread of infection. [xxviii]
- Soft surface and wood flooring deliver the best results in terms of reducing the life of the virus. Research also indicated that carpet does not pose additional hazard for viral transmission from the surface [xxix]
- Moisture trapped below a traditional carpet (flow-through allows spills and moisture to pass through the material and at the seams) can result in mold growth and the release of mold spores and mold metabolic products (microbial VOCs or MVOCs) into indoor air. Effective moisture control is critical to protect all building systems from the potential for mold growth. It is essential that concrete be sufficiently cured and dry before carpet is installed over it.[xxx]

Impact and Prevention of Particulates and Contaminates at the Entry

Flooring contributes to the health of occupants which can begin at the entrance of each educational facility. Managing a building particulates and soil, or soil localization, starts at the entry but can also be leveraged throughout the building. The first four steps taken inside the front door of a building bring in close to 85% of the outdoor contaminants found inside.[xxxi] Any entry system should include a high-performance entry flooring strategy. According to the International Sanitary Supply Association (ISSA), most dirt within a building is tracked in through occupants' shoes. As a result, entry flooring can remove up to 85% of tracked-in dirt if properly designed and maintained.

The following benefits can be provided by entry flooring system

1. Highly reducing particulates, soil, and contaminates at the entry
2. Localizing soil movement throughout the building
3. Extending the life of flooring throughout rest of the building
4. Reducing the risk of slips and falls from wet shoes

The combination of materials, textures, and lengths of your entry flooring selection may vary depending on climate and location and outcome.[xxxii] The ISSA also recommends up to 36' of indoor matting to remove up to 99% of soil and contaminants. Entry system flooring of at least 6' can remove 40% of soil and contaminants, 12 feet can remove 80% and 36 feet of matting can remove 99%. The estimated minimum cost to remove 1lb of dirt from a building is $600. When the daily occupancy is more than 1,000 students per day, approximately 24 pounds of soil will be tracked in over a 20-day period, yielding $14,400 per month of removal costs.

A well-designed entry flooring system can create significant savings and time for custodians and is their first line of defense in flooring maintenance.[xxxiii] Additionally, soil and particulate matter localization was identified not only at the entry but throughout the building. Research from the University of Tulsa showed that hybrid carpet (VCTT) effectively sequestered 2.5x more particulate matter vs a flow through carpet or carpet with seams (carpet where spills have opportunity to reach the subfloor). This sequestration evidence helps to not only control airborne particulate movement but localize it only in areas where there is foot traffic lending itself to custodial attention only in those areas. More research could be done here to allocate custodial resources in certain traffic areas in the building instead of wall-to-wall flooring maintenance.

Concerns with a soft surface floorcovering and the ability to remove contaminants.

Not all "carpets" perform the same or respond to maintenance the same. One way to scientifically measure cleanliness outcomes is through an Adenosine Triphosphate (ATP) device. This measures the live energy molecules on surfaces which can be done before and after cleaning detecting presences such as bacteria, mold, mildew, or viruses present. Live energy molecules have a better survival rate if particulates are present or uncleaned surfaces. This can either be in settled form or airborne particulates. Those sequestered on the floor can

be recovered through maintenance and those that are airborne rely on building filtration systems.

Research done by Shari Solomon at Clean Health Environmental used the ATP meter in two separate locations on a hybrid carpet to illustrate the effective removal of bioburden (bacteria and microbials). One was a 55-year-old installation in Denver, CO and the other was in a housing facility in Merced, CA where Emotional Support Animals (ESAs) were permitted to live in the facility. Both revealed strong resemblance of contamination before cleaning. After using the manufacturers recommendation for cleaning both surfaces revealed a reduction between 85% to 99% of contaminate bioburden with a reading under 100. (Hybrid carpet is manufactured in 6' width rolls and is bonded at the seam for a wall-to-wall moisture barrier which allows all stains and particulates to be removed. A hybrid carpet is a soft surface flooring material that is engineered with a closed cell resilient base and bonded with a low fiber pile height tufted wear layer.)[xxxv] For comparison, "pass rates" for non-porous surfaces in public spaces in healthcare settings, where our most sensitive population resides, range from 50 to100 Relative Light Units (RLUs).[xxxvi] ATP is commonly used in healthcare environments to determine the impact and effectiveness of the EVS team.[xxxvii] An ATP meter is commonly used on surfaces both smooth and soft to determine live energy molecule loads and touch transmission.

The Asthma and Allergy Certification Program test flooring products to a pass or fail rate of removing a high percentage of asthmagen particulates due to the impact on human health if it is airborne.[xxxviii] Some concerns with a soft surface floorcovering and the ability to remove contaminates on "carpets" come up frequently. Not all carpets have the same durability outcomes, nor do they all create a custodian's ability to address removal outcomes effectively or efficiently when it comes to removing settled particulate matter or spills.

Education spaces do not require the same rigor or illustrate the same levels of live pathogens, but this process is a measurable data point as the education environment has used healthcare as a benchmark on occasion. Education spaces, except kitchens and bathrooms, do not require sanitization. However, simply achieving a consistent and proper cleaning on flooring can significantly reduce transmission rate as proven by Clean Health Environmental. The education industry does not require sanitization or disinfecting spaces for learning environments as they do encourage it only after influenza or COVID case.[xxxix]

Conclusions:

- The facilities management role has a direct impact on occupant health
- Proper maintenance on flooring has a positive impact on indoor air quality
- Poor Indoor air quality negatively impacts student cognition and absenteeism
- The current recommendation from the CDC is to clean learning environments and not sanitize or disinfect unless there is an incident
- You must properly clean before you can sanitize or disinfect surfaces
- Implementing a consistent cleaning strategy should be a requirement
- Using a non-porous and non-flow through flooring reduces opportunity to remove live molecules with a neutral cleaner
- Using a high performance entry flooring reduces maintenance cost and containment at entry point
- All soft surface floorcoverings do not have the same health outcomes after cleaning
- Flooring that has welded seams can enhance effective contaminate removal
- A hybrid-carpet can also be cleaned to healthcare common area cleaning levels
- Transmission of infection on soft flooring is no higher than hard or smooth surface flooring
- Training custodian on how to properly maintain flooring for health is a priority.

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