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Sustainable Dental Practices: Reducing Waste and Energy

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Abstract

Environmental sustainability is an urgent global challenge, and the healthcare sector, including dentistry, plays a significant role in contributing to ecological burdens through waste generation, high energy consumption, and reliance on single-use materials. Dental practices consume substantial water and electricity, produce hazardous waste such as mercury from amalgam restorations and radiography chemicals, and depend heavily on plastics for infection control, all of which impact the environment. This article reviews sustainable dental practices with a focus on waste reduction, energy conservation, water management, and eco-friendly procurement. Strategies such as digital radiography, amalgam separators, reusable instruments, dry vacuum systems, LED lighting, and biodegradable packaging are discussed as effective approaches to lowering dentistry's environmental footprint. Adoption of these practices not only mitigates pollution and reduces carbon emissions but also offers economic advantages by lowering operational costs, enhancing patient trust, and aligning with global frameworks like the United Nations Sustainable Development Goals (SDGs). Nevertheless, several barriers hinder widespread adoption, including the high cost of transitioning to green technologies, lack of professional awareness, regulatory constraints, and resistance to change among practitioners. The article highlights future directions that emphasize sustainability-focused dental education, policy advocacy, innovation in biodegradable dental materials, and certification programs to encourage eco-friendly practices. Ultimately, sustainable dentistry represents both a professional responsibility and an opportunity to integrate environmental stewardship into oral healthcare, ensuring long-term benefits for patients, practitioners, and the planet.

Keywords: Biodegradable Materials, Dental Waste, Eco-Dentistry, Green Healthcare, Sustainable Development Goals (SDGs).

Introduction

Environmental sustainability has emerged as a major worldwide concern in recent years, affecting not just the energy and industrial sectors but also the healthcare industry. Despite its fundamental goal of enhancing human well-being, the healthcare sector paradoxically contributes to environmental deterioration through waste production, excessive resource use, and high energy use. This also applies to dentistry, a specialist area of medicine. Because of their high energy and water consumption, reliance on disposable materials, and generation of both hazardous and non-hazardous waste, dental clinics and practices contribute significantly to environmental burdens (1).

The extensive use of single-use plastics in dentistry, such as in suction tips, gloves, masks, syringe covers, and packaging materials, is one of the main environmental issues. These products are mostly non-biodegradable and add to the growing issue of plastic pollution, even though they are essential for infection management (2). Furthermore, a lot of electricity and water are needed for dental treatments, especially for heating, ventilation, and air conditioning (HVAC) systems, radiography, lighting, sterilization equipment, and air compressors. Furthermore, if not handled appropriately, the use of radiography chemicals and amalgam restorations, which include mercury, could contaminate the environment (3). According to the FDI World dentistry Federation (2021) asserts that the dentistry industry has a quantifiable ecological impact and needs to adopt more sustainable operational models in order to meet the worldwide call to action (4). Dental practices should be in line with more comprehensive environmental policies, such as the Sustainable Development Goals (SDGs) of the UN, especially Goal 3 (Good Health and Well-Being), Goal 12 (Responsible Consumption and Production), and Goal 13 (Climate Action), according to the FDI.

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The idea of "green dentistry" or "eco-dentistry" has gained popularity as a solution to these environmental problems. Green dentistry advocates for a system that reduces environmental damage while upholding strict guidelines for patient care, security, and operational effectiveness. It promotes a number of tactics, such as waste reduction via digital technologies (such as electronic health records and digital radiographs), energy-efficient practices, like using Energy Star-rated appliances and LED lighting, water conservation methods and the use of biodegradable and environmentally friendly dental materials. Dental practitioners can drastically lessen their ecological footprint without sacrificing clinical effectiveness by rethinking conventional workflows and implementing eco-friendly choices into daily operations. In addition to helping the environment, these sustainability-driven technologies give dentistry clinics long-term financial and reputational benefits (5).

This study aims to explore sustainable dental practices, focusing on waste reduction, energy conservation, and eco-friendly materials, while addressing the growing environmental impact of dental clinics worldwide

Background Study

As awareness regarding pollution, climate change, and the environmental impact of healthcare services has grown over the past few decades, the idea of sustainability in dentistry has gradually changed. Like a large portion of healthcare, dentistry has historically placed a high value on efficiency, sterility, and disposability, frequently without taking the effects on the environment into account. However, dentistry started to recognize and manage its ecological burden as worldwide sustainability movements gained traction.

Traditional Dental Practices and Environmental Impact

Dental practices were dominated by very resource-intensive materials and technologies in the early and mid-20th century. Due to inappropriate disposal techniques, the extensive use of dental amalgam, which includes the hazardous heavy metal mercury, became a serious environmental concern (6). Likewise, the advent of film-based X-ray imaging brought with it chemical waste, such as developer and fixer solutions that contained silver and other dangerous materials (7).

Furthermore, since the 1980s, there has been a sharp increase in clinical waste due to the growing usage of single-use plastics for infection prevention (such as masks, gloves, and suction tips) (8). For many years, the long-term ecological effects of these activities were mainly ignored, despite the fact that they were put in place to satisfy public health and hygiene regulations.

Emergence of Environmental Awareness in Healthcare (1990s–2000s)

Globally, the healthcare industry began to become more environmentally concerned in the 1990s (9). Organizations started looking into the ways that labs, clinics, and hospitals impacted the environment. Dentistry began to change as healthcare began to incorporate environmental science more into public policy (10).

The rise in popularity of phrases like "green healthcare" and "sustainable medicine" in the early 2000s prompted multidisciplinary research on ways to lower the carbon footprint of healthcare (11, 12). Despite being slower to react than larger medical facilities, dentistry started looking into digital alternatives like digital radiography, which lowered radiation exposure and did away with the need for chemical film processing.

Introduction of Green Dentistry and Formation of Advocacy Groups

The establishment of the Eco-Dentistry Association (EDA) in the US in 2008 marked the beginning of the formalization of green dentistry (13). The EDA gave dentists a forum to exchange ideas about energy efficiency, water conservation, and waste reduction. In order to provide a systematic framework for practices to execute and get recognition for their sustainable initiatives, the association created the GreenDOCTM Dental Office Certification Program (14).

Mercury amalgam separators were created around this time to stop mercury from contaminating wastewater, and autoclaves with energy-saving features and dry vacuum systems that used a lot less water were also used more frequently.

Integration with Global Sustainability Goals

Sustainability was more widely incorporated into health policy in the 2010s, particularly with the 2015 adoption of the Sustainable Development Goals (SDGs) by the UN (15). Dental practitioners and organizations started integrating SDGs into their operations, especially SDG 13 (Climate Action), SDG 12 (Responsible Consumption and

Production), and SDG 3 (Good Health and Well-Being) (16).

Through the release of position papers and toolkits promoting sustainable dental care practices, the FDI World Dental Federation was instrumental in this change (17). In many forward-thinking dental offices, innovations including biodegradable consumables, LED lighting, eco-friendly dental composites, and cloud-based digital recordkeeping have become commonplace. Sustainability efforts suffered during the COVID-19 pandemic (2020–2022) as a result of the increase in disposable personal protective equipment (PPE) and infection-control supplies. On the other hand, it also sped up tele-dentistry and digital transformation, which might eventually lower travel-related emissions and pointless in-clinic visits (18).

These days, dental education, certification programs, and policy-making are all incorporating sustainable dental practices more and more. While dental businesses are creating environmentally friendly dental products, several dental schools are incorporating sustainability into their curricula. Rainwater collection, solar energy, and dental buildings with LEED (Leadership in Energy and Environmental Design) certification are also becoming more popular.

Sources of Environmental Impact in Dentistry

Dentistry, like many other healthcare specialties, considerably contributes to environmental damage through a variety of operational operations. Waste production, high energy needs, water consumption, and the widespread usage of single-use products are the causes of these effects. Developing sustainable treatments requires an understanding of these environmental burdens.

Dental Waste

There are two categories of waste streams produced by dental practices: hazardous and non-hazardous. Toxic, chemical, and biological wastes fall under the hazardous category and need to be handled and disposed of carefully to avoid contaminating the environment.

- **Dental amalgam waste:** About 50% of dental amalgam's weight is elemental mercury, a material with neurotoxic and bioaccumulative qualities. Amalgam particles contribute to mercury pollution in aquatic environments when they get into wastewater systems without being adequately filtered. There is still worry about the incorrect management and disposal of amalgam waste, especially in clinics without amalgam separators (19).
- **Single-Use Plastics:** Dental clinics mostly use disposable items including masks, gloves, suction tips, and plastic instrument coverings to keep infection control. These polymers contribute significantly to landfill bulk and microplastic pollution, and they are frequently non-biodegradable. dentist clinics can generate up to 1.5 kg of solid trash per dentist chair every day (20). A significant amount of this garbage is made up of non-recyclable plastic goods.
- **Chemical Waste from Imaging:** Silver, hydroquinone, and glutaraldehyde are among the hazardous compounds produced by fixer and developer solutions used in conventional radiography procedures. If not disposed of in accordance with environmental rules, these compounds have the potential to contaminate water and soil systems (21).

A considerable percentage of clinics worldwide continue to use antiquated technologies, especially in low- and middle-income nations, despite certain advancements in the reduction of dental waste through digitization and amalgam separators (22).

Energy Consumption

With numerous systems and equipment running concurrently throughout the day, dental clinics are energy-intensive settings. The following are the main causes of excessive energy use in dental settings:

- **Sterilization Equipment:** Although autoclaves, ultrasonic cleaners, and heat sterilizers are essential for preventing infections, they use a lot of water and electricity over time.
- **Imaging and Diagnostic Equipment:** High-power outputs are necessary for digital radiography systems, panoramic X-ray equipment, and cone beam computed tomography (CBCT), particularly in busy multi-chair offices.
- **HVAC and Lighting Systems:** Since most dental offices are located in enclosed or commercial spaces, artificial ventilation and lighting systems are crucial. One of the biggest contributors to a clinic's carbon footprint are HVAC (heating, ventilation, and air conditioning) systems, which are essential for preserving thermal comfort and

air quality. HVAC and lighting systems alone can be responsible for more than half of a dental facility's overall energy use (23).

Although adoption varies by area and resource availability, actions including upgrading to energy-efficient equipment, installing programmable thermostats, and switching to LED lighting can greatly minimize a dental clinic's environmental impact (4).

Strategies for Sustainable Dental Practices Waste Reduction Techniques

In an effort to reduce their environmental impact, contemporary dentistry offices are progressively implementing eco-friendly methods. From material procurement to diagnostic imaging, these tactics cover a broad spectrum of operational areas and all support waste reduction, resource conservation, and long-term sustainability.

- **Waste Reduction and Digital Radiography**

  By replacing traditional film-based X-ray equipment, digital radiography drastically lowers the production of hazardous waste. Developer and fixer solutions, which are used for traditional radiography, contain chemicals including silver, hydroquinone, and glutaraldehyde that are deemed dangerous and should be disposed of carefully. These chemicals are no longer necessary thanks to digital imaging, which lowers exposure in the workplace and the environment.

  Digital radiography is not only environmentally sustainable but also provides faster processing times and reduced radiation exposure, which enhances clinical workflow and patient safety (24, 25). Additionally, it promotes paperless documentation and effective data sharing by enabling smooth integration into digital health records.

- **Mercury control and amalgam separators**

  Mercury, a persistent contaminant found in dental amalgam, can endanger aquatic habitats if it is not disposed of appropriately. Mercury and other heavy metals are captured by amalgam separators, which are devices placed in wastewater lines from dental offices, prior to their entry into municipal sewage systems.

  The adoption of amalgam separators that comply with ISO 11143 and can remove at least 95% of mercury from wastewater is encouraged by the American Dental Association (26). In order to comply with the Minamata Convention on Mercury, an international agreement designed to lower mercury pollution worldwide, this technology is essential (27).

- **Reusable and Autoclavable Instruments**

  The amount of solid clinical waste can be greatly decreased by employing reusable stainless-steel tools rather than disposable ones where clinically suitable. Autoclaves are frequently used to sanitize and safely re-use items like scalers, mouth mirrors, and explorers. Long-term cost-effectiveness and environmental sustainability are two benefits of this strategy, especially when paired with very effective sterilizing techniques (28). However, to guarantee patient safety, strict attention to sterilizing procedures is required.

Energy-Efficient Technologies in Dental Clinics

- **Smart Electrical Systems and LED Lighting**

  A significant amount of the energy used in dental practices is for lighting. Using LED lighting instead of incandescent or fluorescent bulbs can save up to 80% on electricity costs while extending bulb life and reducing heat production (29).

  Furthermore, energy-efficient regulation of HVAC systems, which are frequently the biggest energy users in healthcare facilities, is made possible by smart thermostats and occupancy sensors. These devices minimize wasteful energy use during off-peak hours and maximize temperature regulation (23).

- **Equipment with an Energy Star rating**

  Choosing dental equipment with Energy Star certification, such as compressors, X-ray machines, and sterilizers, guarantees reduced energy use without sacrificing performance. These appliances drastically lower the operational carbon footprint of dental offices and adhere to stringent energy-efficiency standards established by environmental organizations.

Water Conservation Strategies

- **Dry Vacuum Systems with Low-Flow Valves**

  Water is essential to dental operations, particularly for suction and equipment cleaning. Water waste during daily operations can be significantly decreased by installing foot pedal-activated taps, auto-off faucets, and low-flow valves (30). Additionally, compared to conventional wet-ring vacuums, dry vacuum

systems are a more environmentally friendly option. In busy clinics, dry vacuums can save hundreds of gallons of water every day because they don't need a constant water supply to generate suction (13).

Sustainable Procurement and Eco-Friendly Materials

- **Biodegradable Packaging and Food Items**
  The use of recyclable, compostable, or biodegradable materials is emphasized in sustainable dentistry practices. This includes environmentally friendly packing materials, patient bibs, and sterilizer wraps made from plants, which lessen the need for petroleum-based plastics and ease the strain on landfills.
- **Dental Products from Ethical Sources**
  By collaborating with suppliers who follow moral manufacturing standards, such as lower emissions, equitable labor methods, and the sourcing of eco-friendly materials, clinics can advance their sustainability objectives. Product lifecycle evaluations can help purchase decisions prioritize materials with less of an impact on the environment (1).

Benefits of Sustainable Dentistry

Beyond only lessening environmental damage, sustainable dentistry practices benefit practitioners and the community at large in a number of ways, including financial, legal, and reputational ones. Adopting sustainable practices in dentistry settings offers multifaceted benefits as the world's attention turns more and more toward climate responsibility and environmentally conscious healthcare.

Environmental Benefits

The fact that sustainable dentistry helps preserve the environment is one of its main benefits. Conventional dentistry frequently uses a lot of energy, water, single-use plastics, and dangerous materials like chemical-based radiography agents and amalgam. By switching to green dentistry practices, clinics can significantly reduce plastic waste by using fewer disposables and choosing biodegradable materials, carbon emissions by using energy-efficient equipment and digital communication techniques, which reduce physical travel and paper usage, air and water pollution by using amalgam separators, dry vacuum systems, and digital radiography.

The FDI World Dental Federation (2021) states that by putting in place sustainable waste and energy management procedures, dental offices all around the world may considerably reduce their ecological effect (4). The top three factors contributing to dentistry's carbon footprint were power consumption, waste disposal, and travel-related emissions. Sustainability solutions can address each of these factors (31).

Economic Savings

Sustainable technology changes, such energy-efficient HVAC systems, LED lighting, or dry suction systems, may seem expensive at first, but they save money over time by improving operational efficiency and lowering utility costs. For example: Reusable equipment lessens the need for repeated repurchasing of disposable materials, digital radiography removes recurring charges for film, processing chemicals, and hazardous waste disposal, and efficient water systems reduce water use and related costs.

Healthcare facilities that implement sustainability frequently see a gradual decrease in operating costs of up to 30% (32). Dental clinics can reinvest savings into patient care or the adoption of new technology by efficiently managing waste and energy.

Improved Patient Satisfaction and Public Image

Patients are placing a higher value on healthcare professionals that exhibit environmental responsibility in today's eco-aware culture. Sustainable dental clinics frequently report higher levels of patient satisfaction, loyalty, and trust, especially among younger and environmentally conscious populations.

According to the Eco-Dentistry Association (EDA), dental clinics can stand out in a competitive market by demonstrating a clear commitment to environmentally friendly practices, such as plant-based dental materials, paperless billing, or clearly marked recycling bins (13).

Furthermore, clinics can fit with corporate social responsibility (CSR) concepts, which are increasingly impacting patient choice and healthcare marketing strategies, by being transparent about sustainability activities (2).

Compliance with Regulations and Global Goals

Regulations are changing quickly as the global healthcare industry comes under more scrutiny for its effects on the environment. Hazardous material reduction in clinical settings is required by national and international rules, including the Minamata Convention on Mercury (33).

Clinics can keep ahead of regulatory requirements and prevent fines, harm to their reputation, and expensive retrofits by implementing sustainable dentistry practices. Additionally, dental clinics are positioned as proactive participants in global health and sustainability initiatives by aligning with more general frameworks such as the Sustainable Development Goals (SDGs) of the UN, especially SDG 3 (Good Health and Well-Being), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) (4).

Barriers to Implementation of Sustainable Dental Practices

Even while environmental responsibility in healthcare is becoming more widely acknowledged, a number of obstacles stand in the way of the broad adoption of sustainable dentistry practices. The shift to eco-friendly dentistry is complicated by these obstacles, which vary from financial and educational to legal and cultural, particularly for small or resource-constrained clinics.

Cost of Transition

The substantial initial outlay needed for environmentally friendly infrastructure and technologies is one of the biggest obstacles to adopting sustainable practices. It costs a lot of money to replace traditional equipment with energy-efficient substitutes including mercury separators, digital radiography, dry vacuum systems, and LED operatory lighting.

These expenses could be unaffordable for small dental practices or those in underdeveloped nations, particularly in the absence of government grants or incentives. Although the long-term benefits of lower utility costs and waste management are widely known, many dentists are still put off by the initial capital outlay (31).

Lack of Awareness and Education

The environmental impact of their work and the availability of sustainable alternatives are not completely understood by many dentists. Dental curricula rarely place any emphasis on sustainability, and continuing professional education courses frequently don't include any information about environmentally friendly practices.

More than 60% of dentists were ignorant of the effects that amalgam disposal and water waste from wet suction systems had on the environment (34). Clinicians may feel unprepared to make knowledgeable recommendations regarding eco-friendly goods and procedures if they are not given enough training.

Regulatory Constraints

Adoption of sustainable practices may be unintentionally hampered by infection control laws intended to safeguard the public's health. For instance, in order to avoid cross-contamination, single-use disposable goods are frequently required. Despite its negative effects on the environment, mercury amalgam is nevertheless used lawfully in many nations; strict sterilisation regulations may preclude the use of biodegradable or reusable substitutes.

Although the Minamata Convention on Mercury (UNEP, 2017) aims to reduce mercury usage worldwide, country implementation has been uneven (33). Dental offices may be deterred from trying out novel, environmentally friendly techniques by unclear regulations or too strict procedures.

Resistance to Change

Another issue is behavioural rigidity among dental teams. Adopting sustainable practices may be hampered by ingrained behaviours, mistrust of new items, and discomfort with digital tools.

According to research on health behaviour change, one of the hardest obstacles to overcome in work settings is habitual behaviour (35). Dental professionals may believe that sustainable practices are pointless, time-consuming, or disruptive to day-to-day operations in the absence of strong leadership, employee training, and explicit incentives. Furthermore, doctors may question the dependability, safety, or affordability of eco-friendly options in the absence of clear peer adoption or industry-wide norms.

Future Directions in Sustainable Dentistry

Dentistry is experiencing a revolutionary era when sustainability is increasingly seen as a professional obligation rather than an optional value as knowledge of environmental challenges in healthcare develops. Future developments in green dentistry will rely on how well systemic changes, technical breakthroughs, and cooperative policymaking are integrated. The following are important future paths that can direct long-term change in the dentistry industry:

Education and Training

Integrating environmental sustainability into dentistry education is a critical first step in attaining sustainable dental practice. Nowadays, the majority of dental schools place a strong emphasis on clinical and procedural skills, frequently ignoring the ecological elements of dentistry. Future dental professionals can be better prepared to reduce their environmental effect by including sustainability into their curricula.

Sustainability principles ought to be taught in undergraduate and graduate programs, with an emphasis on resource-efficient clinical procedures, waste management, and sustainable procurement (31). Courses for continuing professional development (CPD) can help current practitioners update their methods in accordance with changing green standards.

Policy Advocacy and Regulation

Policymakers and professional dental associations are essential in establishing sustainable practice guidelines. Evidence-based policies and regulations are required in order to encourage ecologically conscious behaviour without endangering patient safety.

Dental associations can set the standard by publishing "green dentistry" toolkits, advocating for ecologically friendly product labelling, and providing member clinics with sustainability checklists. Examples of these include the FDI World Dental Federation and national dental councils. Furthermore, extended producer responsibility (EPR), which requires manufacturers to lessen environmental impacts across product lifecycles, can be enforced by governments in dental supply chains (36).

Innovation in Materials and Technologies

Reducing environmental harm will require innovation in dental materials that are recyclable, biodegradable, or low-impact. The creation of non-toxic substitutes for mercury amalgam, plant-based or biodegradable personal protective equipment, low-energy autoclaves, and environmentally friendly disinfectants should be the top priorities of future research.

For example, the increasing interest in bioresorbable polymers and sustainable bioceramics for dental restorations, which present viable substitutes for conventional, resource-intensive materials (2). At the same time, digitization, such as cloud-based records and CAD/CAM systems, will keep cutting down on wasteful travel, chemical use, and paper waste.

Green Certification and Incentive Programs

Formal certification programs can encourage dental offices to make sustainability a priority, which can lead to significant change. Dental settings can benefit from customised certification models based on frameworks such as ISO 14001 (Environmental Management Systems) or LEED (Leadership in Energy and Environmental Design). As an illustration, consider the Eco-Dentistry Association's (EDA) GreenDOCTM Certification Program, which honours dental practices that satisfy particular sustainability standards in areas like waste minimisation, energy efficiency, and environmentally friendly purchasing (37). Clinics may be further encouraged to embrace ecologically friendly techniques by offering incentive programs like tax breaks, lowered licensing costs, or insurance reductions for certified green operations.

Conclusion

In an era characterised by expanding ecological crises, resource depletion, and climate change, it is more important than ever for all areas of healthcare, including dentistry, to adopt sustainable methods. Although dental offices are typically thought of as having less of an impact than bigger medical facilities, they really produce a lot of trash, use a lot of energy, and pollute the environment by using single-use goods and dangerous materials (38).

Therefore, sustainable dentistry is an essential part of providing responsible healthcare, not just a fad. Dental clinics can lower their carbon footprint and enhance environmental results by using waste reduction techniques, switching to energy-efficient equipment, conserving water, and using eco-friendly, biodegradable products (5, 34). The United Nations Sustainable Development Goals (SDGs), in particular SDG 3 (Good Health and Well-Being), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action), are among the global sustainability frameworks that these interventions not only protect but also align dental practices with FDI World Dental Federation, 2021 (4).

Nevertheless, there are still obstacles to implementation, such as the upfront expenses of green technology, dental professionals' ignorance or lack of training, and legal restrictions that could prevent the use of reuse or substitute materials (36). A multifaceted strategy is needed to overcome these obstacles, including advocacy and incentives at the policy level to support green certification and investment in eco-friendly infrastructure, constant research and innovation to develop sustainable materials and resource-efficient dental technologies and strong education and training to instill environmental consciousness in dental students and practitioners.

Crucially, sustainable methods give dental offices long-term financial and reputational benefits in addition to helping the environment. Due to their dedication to moral, forward-thinking care, environmentally conscious clinics frequently see financial benefits from lower energy and waste management expenses as well as increased patient satisfaction and confidence (39).

Sustainability needs to be ingrained in the dentistry profession's operational, clinical, and ethical framework as it develops. The transition to eco-dentistry is a practical and moral opportunity to make sure that the provision of oral healthcare is in line with more general environmental stewardship objectives, ultimately leading to healthier individuals on a healthier world.

In conclusion, dental clinics contribute significantly to global environmental pollution due to the widespread use of single-use plastics, excessive energy consumption, and hazardous waste management. More global studies should be referenced to highlight the broader impact of these practices.

Abbreviations

EDA: Eco-Dentistry Association, FDI: World Dental Federation, HVAC: Heating, Ventilation, and Air Conditioning, ISO: International Organization for Standardization, LEED: Leadership in Energy and Environmental Design, PPE: Personal Protective Equipment, SDGs: Sustainable Development Goals.

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Author Contributions

Saubhagya S. Agrawal: Conceptualization, Methodology, Writing - Original Draft, Supervision, Mohammad Zanul Abedeen: Data Curation, Formal Analysis, Writing - Review and Editing.

Conflict of Interest

The authors declare no conflict of interest.

Ethics Approval

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