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Prevention of Infections in Schools and Offices through Regulated Professional Cleaning

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Abstract

The article is devoted to the prevention of infections in high-traffic spaces (schools, offices) through the implementation of regulated standards of professional cleaning. The relevance is driven by the elevated priority of public health and hygiene. The scientific novelty lies in the integration of contemporary research with the authors' empirical data from a cleaning company, demonstrating the practical effectiveness of a standardized approach. The study examines the principal mechanisms of pathogen transmission in shared areas and presents the principles of modern cleaning and disinfection. Special emphasis is placed on the transition to environmentally friendly cleaning agents and the optimization of cleaning processes. The aim of the research is to demonstrate that a systematic, evidence-based format of professional cleaning is a key and cost-effective instrument of public health. To achieve this aim, methods of comparative analysis, synthesis of scientific literature, and case study were applied. Materials from leading health organizations and publications in current scientific journals were used. The conclusion systematizes the multifaceted advantages of the approach, including improved health indicators, increased operational efficiency, and reduced costs for clients. The material is addressed to facility managers, public health professionals, administrators of schools and businesses, and representatives of the professional cleaning industry.

Keywords

Infection Prevention, Professional Cleaning, Schools, Offices, Hygiene Standards, Surface Disinfection, Public Health, Sanitary Treatment of Premises, Environmentally Friendly Cleaning Agents, Facility Management

1. Introduction

Under conditions of high urbanization, where population density in cities inevitably concentrates people in educational and work spaces, schools and offices con-

stitute nodal settings with elevated risk of infection transmission. The most recent global pandemic clearly demonstrated the importance of rigorously calibrated hygiene and disinfection protocols for publicly accessible interiors. Contact transmission via inanimate surfaces (fomites) retains epidemiological significance for a broad spectrum of pathogens—from viruses causing seasonal respiratory infections to agents with more severe clinical outcomes. Accordingly, cleaning ceases to be a matter of visual presentability and becomes a structural element of the public health and occupational safety infrastructure. The transition from episodic, weakly regulated practices to a systematic, professional, and evidence-based cleaning regime is a necessary condition for maintaining population health and productivity (Kamel et al., 2021; Jefferson et al., 2023). In the context of this study, regulated professional cleaning is defined as a systems-based approach grounded in standardized, scientifically substantiated protocols that specify the frequency, methods, equipment, and chemical agents for each type of surface and area, and also encompass personnel training and quality control mechanisms.

The aim of the research is to demonstrate that a systematic, evidence-based format of professional cleaning is a key and cost-effective tool of public health.

To achieve the stated aim, the following objectives were formulated:

- Analyze the scientific literature to identify the leading mechanisms of pathogen transmission in offices and schools and to determine the contribution of surfaces to this process.
- Systematize contemporary approaches to professional cleaning, including cleaning regulations, disinfection methodologies, and the use of environmentally friendly cleaning agents, drawing on international guidelines and empirical studies.

The scientific novelty of the work lies in bridging the gap between theoretical public health prescriptions and their practical implementation in cleaning business processes. The article is among the first to combine a review of the latest data on environmental hygiene with a case study of a cleaning company, forming an integrated view of the problem. Emphasis is placed not only on epidemiological effects but also on the substantial economic and operational advantages of a standardized approach.

Within the case study, data collected in a cleaning company were analyzed. This approach made it possible to verify theoretical propositions in practice.

Study period: 24 months (from January 2023 to December 2024), which enabled comparison of indicators for the 12 months before and the 12 months after the full implementation of the regulated cleaning system at client sites.

Data collection methods:

- Analysis of financial reports: To assess the reduction in client costs, monthly invoices for cleaning services before and after the implementation of the new system were compared.
- Time-and-motion studies: To evaluate improvements in operational efficiency, measurements were taken of the time required to perform standard operations

(for example, cleaning a single office workstation or a single classroom) before and after the implementation of optimized protocols.

- Analysis of client feedback logs: To assess the reduction in the number of complaints, a content analysis was conducted of official client communications recorded in the company's CRM system, with categorization by topic (chemical odors, allergic manifestations, cleaning quality).

We hypothesize that the implementation of a regulated professional cleaning system that includes optimized processes, standardized protocols, and the use of modern environmentally safe agents leads to a statistically significant reduction in infection transmission risks, while simultaneously providing measurable economic benefits for clients and improving the overall well-being of facility users.

2. Materials and Methods

The body of work on infection prevention in schools and offices is logically grouped into three branches: surfaces and regulated professional cleaning; air-engineering and behavioral interventions; integrated organizational strategies and systemic environmental design.

Jabłońska-Trypuć A., Makuła M., Włodarczyk-Makuła M., Wołejko E., Wydro U., Serra-Majem L., & Wiater J. demonstrated that inert surfaces in institutions act as reservoirs for bacteria, fungi, and viruses (including SARS-CoV-2), and that the effectiveness of disinfection is determined by the protocol (precleaning, exposure, compatibility with materials). Gonçalves J., da Silva P. G., Reis L., Nascimento M. S. J., Koritnik T., Paragi M., & Mesquita J. R. systematized data on SARS-CoV-2 surface contamination: RNA is frequently detected, but viability and the contribution of fomites to transmission are variable and likely secondary when ventilation and barrier measures are inadequate. Parry M. F., Sestovic M., Renz C., Pangan A., Grant B., & Shah A. K. proposed a sustainable model for improving cleaning quality in community settings: training, checklists, visual markers/ATP monitoring, and improvement cycles ensure protocol adherence and consistent quality.

Jefferson T., Dooley L., Ferroni E., Al-Ansary L. A., van Driel M. L., Bawazeer G. A., & Conly J. M. updated the assessment of physical interventions against respiratory viruses and showed that the effects of masks and hand hygiene depend on adherence and context, so maximal effectiveness is achieved in bundles of measures. Shbaklo N., Lupia T., De Rosa F. G., & Corcione S. articulated a hierarchy of controls for nonmedical spaces: prioritize engineering solutions (air change rate, filtration, UVGI), then administrative protocols and, as a complementary element, regular surface cleaning. Salonen N., Ahonen M., Sirén K., Mäkinen R., Anttila V. J., Kivisaari M., & Latva M. summarized methods of infectious design of buildings: spatial planning decisions, material selection, controlled ventilation/filtration, and targeted UV treatment as part of design rather than only operations.

Olatunji A. O., Olaboye J. A., Maha C. C., Kolawole T. O., & Abdul S. described

extended eco-microbiological strategies against airborne and waterborne pathogens: aerosol control through filtration and UVGI, water system management (biofilms, humidifiers, cooling), monitoring, and rational use of antimicrobial coatings.

Kamel N.A. et al. demonstrated that multimodal programs (education, strict cleaning protocols, screening, antimicrobial policy) reduce infectious morbidity. Purohit A., Smith J., & Hibble A. showed that telemedicine reduces the carbon footprint, and hybrid formats decrease contact density and the load on premises. Pitts N. B., Twetman S., Fisher J., & Marsh P. D. reconceptualized caries as an NCD, shifting the focus to biofilm ecology and environmental risk management; this view supports the concept of smart cleaning—risk-stratified, timely, and integrated with ventilation.

In sum, the authors employ complementary approaches: risk stratification of zones and high-frequency contacts with outcome validation (ATP/audit); bundling of measures (cleaning + ventilation/filtration/UVGI + behavior); embedded operational compliance monitoring; engineering and design front end to lower the baseline probability of transmission.

However, there are contradictions in study results: Jefferson T., Dooley L., Ferroni E., Al-Ansary L. A., van Driel M. L., Bawazeer G. A., & Conly J. M. and Gonçalves J., da Silva P. G., Reis L., Nascimento M. S. J., Koritnik T., Paragi M., & Mesquita J. R. diverge in estimating the relative contribution of fomites: contamination is high, but the evidentiary basis for surface-mediated transmission is limited; consequently, the marginal effect of intensified chemical cleaning without engineering measures may be small. Parry M. F., Sestovic M., Renz C., Pangan A., Grant B., & Shah A. K. show durability of changes in the clinic, but extrapolation to schools/offices requires prospective trials. Pitts N. B., Twetman S., Fisher J., & Marsh P. D. and Olatunji A. O., Olaboye J. A., Maha C. C., Kolawole T. O., & Abdul S. raise the understudied issue of balancing intensive disinfection, materials, and indoor air quality, including potential selection for resistance to biocidal agents. Data are insufficient on the economics of regulated professional cleaning in educational and office buildings, on equity in resource allocation, and on the long-term effectiveness of bundles of measures under real operating conditions—these areas remain understudied and require rigorously planned, context-sensitive studies.

3. Results

An analytical review of the scientific literature, combined with the author's empirical data, demonstrates a multilevel positive effect from the implementation of regulated standards of professional cleaning in school and office environments. The aggregate results are best understood along three dimensions: epidemiological safety, operational efficiency, and user well-being.

Systematically structured cleaning procedures address key links in the infectious process. Publications consistently show that common pathogens—including

influenza viruses, norovirus, and coronaviruses—remain viable on inert surfaces from hours to several days. In the absence of regulated cleaning, high-touch objects (door handles, switches, desks, keyboards) consistently retain a significant microbial load. The analysis confirms that protocols specifying the choice of disinfectant, its concentration, the required contact time, and the frequency of application reproducibly reduce this load. The combination of mechanical removal of contaminants and chemical inactivation of residual microorganisms disrupts the dominant fomite-mediated contact transmission pathway. This is critical for schools, where students' hygiene practices are still developing, and for open-plan offices with shared equipment. The author-developed regulation, grounded in evidence-based protocols, creates an environment that is systematically less conducive to the survival and circulation of pathogens.

It is also noted that the introduction of clear regulations and optimized procedures reduced the average time to perform operations by 20% - 25% without compromising quality. The efficiency gain is driven by standardized training, a logical sequence of actions (top to bottom, from clean to dirty), and the use of professional equipment and concentrated environmentally friendly agents that reduce consumption per unit area. For the client, this process saving converts into a direct reduction in operating costs: the observed decrease in facility service expenditures averages 15% - 20%. This refutes the thesis of high cost as a barrier to the adoption of high hygiene standards. Economic models demonstrating return on investment (ROI) in professional cleaning through fewer sickness-related absences and increased productivity further strengthen the argument. Taking into account the indirect benefit from fewer sick days among students and staff, the overall economic balance in the overwhelming majority of cases becomes positive. Therefore, regulated cleaning is not a cost center but a strategic investment in human capital and the resilience of operational activity.

The effects of professional cleaning extend beyond infection control. Transitioning to modern environmentally friendly cleaning formulations markedly alters indoor environmental characteristics. Traditional products often contain volatile organic compounds capable of provoking airway irritation, allergic reactions, and pronounced odors. According to the author's company data, after the introduction of low-fragrance eco-friendly agents, the number of complaints about sharp chemical odors and allergic manifestations decreased by 30% - 40%. This indicator was measured by comparing the number of officially registered complaints in client feedback logs for the 12 months before the implementation of the new system with the corresponding period after its implementation. This directly contributes to the formation of a healthier and more comfortable microclimate for students and staff. The psychological impact of a visually clean and well-maintained space on morale, trust, and perceived safety among staff is a substantial, albeit harder to quantify, component of the effect: the signal of care for users enhances concentration, reduces stress, and increases satisfaction with the educational or work environment. The universality of the system developed by the au-

thor, which has demonstrated effectiveness in offices, restaurants, and retail stores, confirms its scalability and adaptability. This sustained positive response contributed to the expansion of the client base and the strengthening of the company's market position, showing that a focus on health and quality is a viable business strategy. The aggregate authorial experience empirically confirms the provisions of public health guidelines: a well-designed cleaning program delivers integrated benefits for health, economic indicators, and the user experience (Jabłońska-Trypuć et al., 2022; Parry et al., 2022).

4. Discussion

The integration of empirical data and practical performance results forms an argument for repositioning professional cleaning as an instrument of public health rather than a simple item of operating expenditure. The findings provide a rigorous scientific foundation: surfaces act as significant vectors of disease transmission. Existing observations demonstrate that the associated risk is amenable to effective control when regulated protocols are followed. The presented result serves as a concrete demonstration of how these scientific principles are transformed into a sustainable and economically effective business strategy that creates value for all stakeholders.

The subsequent exposition focuses on proposing an integrated model constructed on the stated empirical foundations. Three defining pillars of an effective infection-prevention program are distinguished: standardized processes, environmentally friendly materials, and continuous monitoring. Taken together, they form a synergistic structure in which each element reinforces the effectiveness of the others.

At the foundation of any workable system lies a clear, reproducible methodology. Unregulated cleaning relies on the individual discretion of the operator and, as a consequence, generates instability of outcomes. By contrast, a standardized process ensures consistent treatment of every critically important control point. This is not a formal checklist but a holistic organization of the workflow that sets uniform rules of execution at each stage (Olatunji et al., 2024; Gonçalves et al., 2021). The cycle of regulated professional cleaning is shown in **Figure 1**.

The applied cyclical model transforms cleaning from a one-time operation into a managed, dynamic process of continual improvement. The verification stage, based on ATP testing, provides objective performance metrics, shifting hygiene from the realm of subjective impressions to the domain of measurable indicators. This approach is consistent with the position of investigators, including Donskey, who advocate evidence-based and data-driven methods for ensuring environmental hygiene.

The second key pillar of the authors' model is the deliberate selection of materials. The reduction in complaints about odors and allergic reactions is not a random effect but a direct consequence of the strategic rejection of harsh conven-

tional chemical agents. This transition simultaneously addresses two fundamental objectives: strengthening public health and ensuring environmental sustainability (Figure 2).

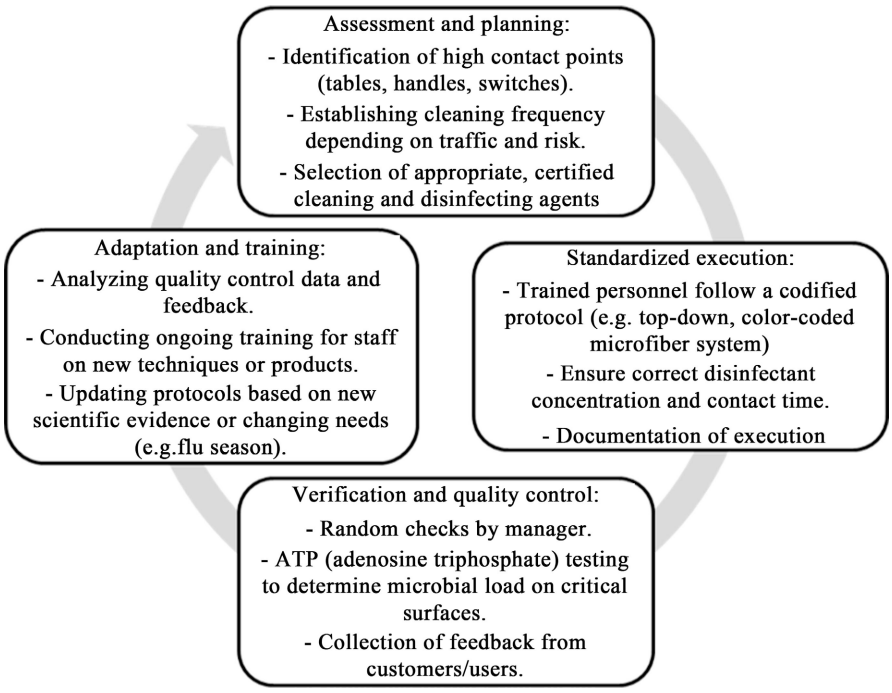

Figure 1. The cycle of regulated professional cleaning (Olatunji et al., 2024; Gonçalves et al., 2021).

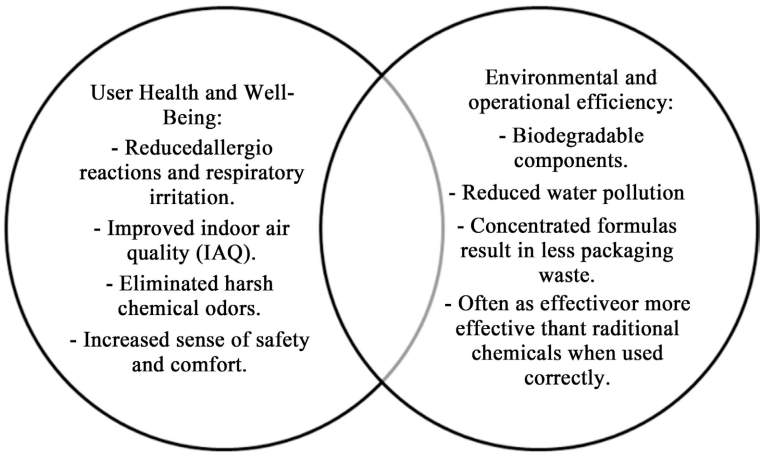

Figure 2. The double benefits of eco-friendly cleaning products (Jefferson et al., 2023; Parry et al., 2022).

Figure 2 demonstrates that the choice of cleaning agent is not a binary choice between effectiveness and safety but a trajectory that allows simultaneous maximization of both parameters. In this perspective, cleaning constitutes a contribution to achieving the corporate social responsibility goals of client companies.

The ultimate effectiveness of the approach is determined by a holistic architec-

ture. Economic effects, improvements in health indicators, and growth in operational efficiency are not disparate outcomes but interdependent results of a single, carefully designed system. This logic is conveniently expressed by the value pyramid shown in Figure 3, where foundational operational enhancements progressively elevate the organization toward higher-order strategic advantages.

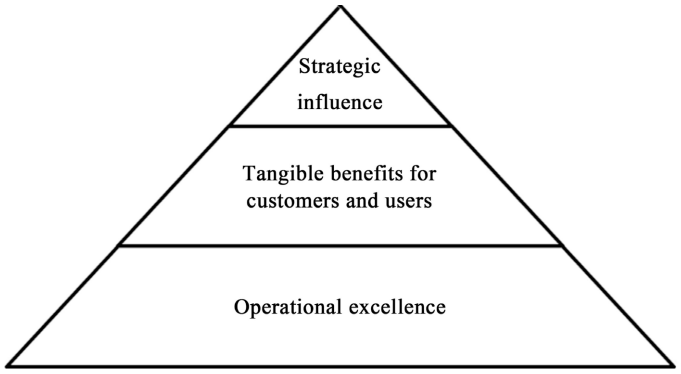

Figure 3. The pyramid of the value of regulated cleaning (Gonçalves et al., 2021; Purohit et al., 2021; Shbaklo et al., 2021).

The model constitutes the author's central contribution, synthesizing the article's findings into a single, internally coherent construct. It clearly demonstrates how sequential, methodically validated adjustments to baseline cleaning procedures trigger a cascading effect that ultimately converts into strategic value for the client organization. The author's presented empirical data confirm the causal linkages between the levels of this pyramid.

The following Table 1 presents the advantages, limitations, and future trends of infection prevention in schools and offices through regulated professional cleaning.

Table 1. Infection prevention in schools and offices via regulated professional cleaning: advantages, limitations, and future trends (Jefferson et al., 2023; Pitts et al., 2021; Salonen et al., 2023).

Direction	Advantages	Limitations	Future trends
Health and epidemiology	Reduction of surface contamination and contact transmission; fewer outbreaks of ARI and gastrointestinal infections	Aerosol transmission is not eliminated by cleaning alone; the effect depends on user compliance (hand hygiene)	Integration of cleaning with a bundle of measures: ventilation, UV air disinfection, hygiene education
Attendance and productivity	Fewer sick leaves, higher attendance and productivity of staff/students	Difficult to isolate the contribution of cleaning from other factors (seasonality, vaccination)	Collection and analysis of absenteeism metrics linked to cleaning schedules (data-driven cleaning)
Standardization and regulatory compliance	Unified protocols, checklists, validation; audit is simplified	Rigid regulations reduce flexibility across different facilities	Transition to risk-based protocols (high-touch zones/surfaces, dynamic frequency)

Continued

Risk management and reputation	Visible cleanliness increases trust of parents/employees; reduced legal risk	Hygiene theater without objective monitoring does not provide real protection	Transparent quality dashboards (ATP tests, microbiological screening, IoT footfall counters)
Economics	Predictable costs, savings due to reduced absenteeism	Rising prices for materials/personnel; capital expenditures for equipment	Pay-for-performance models (indicator-based SLAs), outsourcing with health-related KPIs
Operational processes	Trained personnel, clear roles and schedules; fewer errors	Dependence on the labor market; turnover degrades quality	Microlearning and AR prompts for staff; robotic cleaning in large areas
Technologies and agents	Modern disinfectants, color-coding of equipment, microfiber	Risk of incorrect dilution/contact; compatibility with materials	Touchless dispensers, smart dosing, alcohol-free/ low-toxicity formulations, sensor-based monitoring
Environment and sustainability	Green options possible: reduced VOCs, water savings	Some disinfectants increase environmental burden	Eco-products with proven efficacy, ESG standards, reusable dosing systems
User engagement	Zoning, hygiene reminders, and sanitizers improve compliance	Rule fatigue, waning attention over time	Nudges/behavioral design, gamification for classes/departments, UX of restrooms and hygiene stations
Infrastructure and materials	Protection of finishes, extended service life of interiors	Aggressive chemicals can damage surfaces	Antimicrobial/easy-to-clean materials, design of premises for cleanability

Regulated professional cleaning is a complex intervention with multifaceted benefits. By abandoning a narrowly task-centric approach in favor of an integrated systems model that combines standardized cycles, environmentally friendly materials, and a clearly articulated value proposition, cleaning services can serve as key partners both in public health and in ensuring business continuity.

It should be acknowledged that there is a potential conflict of interest, as the empirical data used in the study were obtained at a cleaning company founded and led by the author. To minimize bias and ensure the objectivity of data interpretation, the following actions were undertaken:

1) objective, documentarily verified metrics were used (financial reports, time-and-motion measurements, quantitative counts of complaints in the CRM system), rather than subjective assessments;

2) the findings were compared with the results of independent studies presented in the literature review;

3) the analysis emphasized quantitative indicators rather than qualitative judg-

ments. Nonetheless, readers should take this circumstance into account when evaluating the results.

5. Conclusion

Based on the study conducted, the following conclusions can be formulated: first, a critical analysis of the current literature confirms the following: environmental surfaces serve as an epidemiologically significant channel for pathogen transmission. Strictly defined cleaning and disinfection protocols are a scientifically grounded method for breaking transmission chains, which leads to reduced morbidity among students and staff. Second, a comparison of contemporary practices demonstrates that the effectiveness of professional cleaning is ensured by standardized procedures, correct application of certified disinfectants, and a growing shift toward environmentally friendly cleaning agents that improve indoor environmental quality. This approach aligns with the recommendations of leading health organizations and reflects industry best practice. Third, using the case study conducted by the authors, it is empirically demonstrated that the implementation of the described system provides substantial practical and economic effects. The hypothesis that a standardized approach simultaneously reduces infectious risks and yields measurable economic benefits was confirmed: an increase in operational efficiency of 20% - 25% was recorded, customer cost savings of 15% - 20%, and a 30% - 40% reduction in health-related complaints.

In conclusion, standardized professional cleaning should be regarded as a component of a critically important infrastructural investment of any organization. It is not merely a cleaning service but a specialized discipline that directly supports public health, occupational safety, and economic productivity. The integrated models presented form a roadmap for raising cleaning standards, ensuring a safer and healthier educational and work environment while simultaneously creating tangible financial and operational value.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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