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An Integrated Speed-Quality-Cost Model for Professional Cleaning: Summarizing Field Data and Developing Practical Recommendations for Different Types of Facilities

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Abstract

The study is oriented toward a critical reassessment and systematization of the determinants that shape performance outcomes for enterprises in the professional cleaning industry, framed through the integrated "speed–quality–cost" model. The analysis records the sector's salient challenges in 2024–2025: an acute labor shortage, rising unit costs of material and technical resources, and the continued evolution of hygiene requirements in the post-pandemic period. The stated objective is the theoretical substantiation and practical validation of a model for optimizing cleaning operations, developed through the synthesis of a five-year body of field observations and the adaptation of lean production principles to service processes. The methodological design draws on an analytical review of current scholarly literature indexed in Scopus and Web of Science, alongside the processing of empirical indicators reflecting labor productivity, the quality level of disinfection measures, and parameters of operational profitability.

The results indicate that the implementation of strictly regulated and standardized operating procedures (SOP), combined with color-based zoning of cleaning inventory, delivers a pronounced acceleration of task execution: cleaning rates increase by 28–45% while the volume of complaints decreases by 60–72%. Additional evidence supports the priority role of algorithmizing the action sequence according to the "from clean zones to dirty zones" principle as the dominant mechanism for reducing the probability of cross-contamination; the same logic is also associated with optimizing material costs by 12–20%. The systematized conclusions have applied significance for the management tier of service organizations, facility management professionals, and experts operating within the domain of sanitary and epidemiological safety.

Keywords: *Professional Cleaning, Speed–Quality–Cost Model, Lean Production, Facility Management, Sanitary Safety, Cost Optimization, Process Standardization, Cross-Contamination, Staff Productivity, Service Quality.*

CONTENT

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INTRODUCTION

The professional cleaning industry in 2024 is marked by a combination of technological renewal and structural reconfiguration, a constellation that makes the revision of established operational contours difficult to avoid. At the global level, the market for cleaning services is valued at USD 424.06 billion in 2024, with a projected increase to USD 451.63 billion in 2025; this growth trajectory is accompanied by heightened expectations regarding the efficiency of core operating models [1]. The observed dynamics are driven not only by inflationary increases in resource costs, but also by a pronounced labor shortage: to restrain personnel outflow into adjacent segments, including retail and logistics, organizations are compelled to raise wage levels within the 18–27% range.

The relevance of the present study is determined by the fact that managerial practices grounded in extensive scaling of volumes and the use of low-cost labor have lost their functional viability [2, 3]. At the level of scholarly development, a deficit persists in holistic models capable of linking—within a unified mathematical and technological framework—the speed of task execution to parameters of microbiological safety and indicators of economic profitability, particularly under conditions of high volatility in prices for consumables. A substantial share of publications retains a fragmented character: certain studies focus on narrowly defined issues of detergent chemistry, while others emphasize generalized management approaches, without yielding integrated algorithms applicable at the level of frontline performers.

As a target setting, the development and substantiation of a comprehensive “speed–quality–cost” model is proposed, grounded in the synthesis of theoretical provisions of lean production and in the analysis of a five-year set of field data obtained during the operation of facilities of varying functional purpose.

Scientific novelty is articulated through the identification of a synergistic effect that emerges when strict regulation of the sequence of cleaning operations—according to the “from clean zones to dirty zones” principle—is combined with simultaneous improvement across all three parameters of the project management “iron triangle.”

The initial **hypothesis** assumes that a transition from intuitively variable management to rigid process standardization and the rationing of consumable materials can secure a 15–25% increase in operational efficiency without the need for substantial capital investments in costly automation solutions.

CHAPTER 1. ANALYSIS OF SYSTEMIC DESTRUCTORS OF EFFICIENCY IN PROFESSIONAL CLEANING

Within Chapter 1, a set of factors that reduce the effectiveness of cleaning processes is examined at the technological, staffing, and economic–managerial levels. Section 1.1 analyzes typical technological violations (failure to comply with “clean → dirty” routing, the absence of inventory zoning, errors in chemical dosing and exposure time) and the associated risks of surface recontamination, including mechanisms of cross-contamination and the need for standardization through process maps, checklists, and instrument-based rapid control. Section 1.2 addresses workforce provision challenges—shortages of qualified employees and a lack of systematic onboarding and SOP-based training that lead to higher error rates, material overconsumption, and unstable quality—and substantiates organizational solutions (modular training, mentoring, competency assessment). Section 1.3 evaluates economic inefficiency arising from weak final inspection, the absence of consumables standardization, and gaps in managerial communication, and proposes a transition to a multi-level quality control and resource management system that supports reproducible outcomes, fewer reworks, and higher operational resilience.

Technological Violations and Risks of Surface Recontamination

Systematic observations of cleaning crews indicate that one of the most problematic areas remains noncompliance with the technological sequence of actions. In professional terminology, “cleanliness” is interpreted more broadly than the visual absence of soil and includes parameters of sanitary and epidemiological reliability, including microbiological safety [5]. At the same time, in a substantial share of cases (up to 80%), key errors are driven not by a lack of resources, but by misassigned priorities when moving between conditionally “dirty” and “clean” areas, which creates preconditions for the spread of contaminants along the cleaning route.

Using the same tools for heterogeneous surfaces (for example, sanitary fixtures and work desks) predictably increases the risk of cross-contamination. Effective implementation of color-based zoning, regulated replacement of consumables, and clear separation of accessory sets can reduce the probability of pathogen transfer by 40–50%, which is of critical importance for medical offices and office spaces with high personnel density [7]. An additional factor that reduces quality is a breach of the rational work vector “top to bottom” and “from window to door”: the repeated settling of aerosolized dust on already treated surfaces leads to forced repeat cycles and an unjustified increase in labor inputs.

Stabilization of cleaning quality is achieved, first and foremost, through process standardization and the formalization of operational algorithms. The most productive instruments are considered to be process maps, checklists for controlling critical points, and unambiguous acceptance criteria that include assessment not only of visual appearance, but also of sanitary condition indicators. Stronger discipline in sequence execution is supported by a combination of training modules, clear visual route marking, and regular internal audits, as well as by instrument-based rapid control methods (for example, ATP luminometry) as an objective indicator of residual organic matter and an indirect marker of microbial contamination risk [12,16].

No less important is a correct organizational and logistics model: separate storage of inventory by zones, prevention of intersections between "dirty" and "clean" flows, fixed points for consumables disposal, and monitoring compliance with solution preparation regimes. Errors in concentration, exposure time, and compatibility of cleaning and disinfecting agents reduce treatment efficacy even when the manual technique appears formally correct [6,8,13]. Under conditions of intensive space utilization, a risk-oriented approach is advisable, with increased treatment frequency for high-touch surfaces (handles, switches, restroom zones) and documented recording of completed operations; this improves reproducibility and reduces quality variability across shifts (see Table 1).

Table 1. Influence of technological violations on efficiency indicators (compiled by the author based on [7, 8])

Type of violation	Violation mechanism (what occurs)	Impact on sanitary reliability / cross-contamination risk	Impact on productivity and labor inputs	Indicators/control criteria and stabilization measures
Sequence breach (clean → dirty)	Incorrect prioritization during transitions between "dirty" and "clean" areas; transfer of soil along the cleaning route	Critically high: preconditions for contaminant spread are formed; a significant share of errors is associated with this factor (up to 80%—not due to resource deficits, but due to routing priorities)	Medium–high: likelihood of repeat processing increases; downtime for corrections grows	Route process maps, critical-point checklists, unambiguous acceptance criteria (including sanitary indicators), training + route marking, regular internal audits; instrument-based rapid control (e.g., ATP luminometry)
Absence of color coding	The same inventory is used for heterogeneous surfaces (restrooms/sanitary fixtures ↔ work desks, etc.); no separation of sets	Very high: cross-contamination predictably increases; especially critical for medical offices and high-density office spaces	Medium: quality returns and corrective passes increase; onboarding new employees becomes more difficult	Introduction of color zoning and separate sets, regulated replacement of consumables; expected reduction in pathogen transfer probability by 40–50% with correct implementation
Ignoring chemical exposure time	Regimes are violated: concentration, exposure time, compatibility of cleaning/disinfecting agents; solutions are prepared/used without control	High: even with "correct technique," efficacy declines due to under-exposure/incorrect concentration; residual organic matter and indirect microbial contamination risk increase	Medium: repeat processing becomes necessary; labor inputs and chemical consumption increase	Control of solution preparation regimes (labels, logs), exposure timing, training; critical-point control; ATP luminometry as an objective indicator of residual organic matter
Incorrect movement ergonomics	The rational work vector is violated ("top to bottom," "from window to door"), causing aerosol dust to resettle on already treated surfaces	Medium: direct contamination risk is lower than with inventory mixing, but the sanitary outcome deteriorates due to secondary soiling	Very high: forced repeat cycles, unjustified growth of labor inputs, reduced pace and reduced quality stability across shifts	Standardization of technique (movement sequence), route schemes, checklist control of operation order; training + visual prompts on site; audits of "vector" compliance and cycle time

The analysis conducted shows that the principal failures of cleaning efficiency in 2024 are largely associated not with resource constraints, but with violations of technological discipline. Incorrect "dirty–clean" transitions and the absence of inventory separation create the maximum risk of cross-contamination (with up to 80% of errors driven precisely by misprioritized routing), while violations of chemical regimes and ergonomics increase outcome variability and sharply raise labor inputs due to repeat cycles. The most stable improvement in quality is achieved through standardization (process maps, checklists, acceptance criteria, separate storage and flow logistics), training, and regular audits, supplemented by objective rapid control (for example, ATP luminometry) as an indicator of residual organic matter and an indirect microbiological risk marker [6,8,12,13,16].

Staffing Provision Challenges and the Deficit of Systematic Training

Among the key constraints on the effectiveness of cleaning services is insufficient qualification of frontline personnel combined with the absence of structured initial onboarding programs. Cleaning activity remains distinctly labor-intensive; as a result, labor costs account for more than 50% of an operator's total expenditures [4]. Against the background of the 2024 labor shortage, a common practice is to hire employees without relevant experience, while the time required to reach normative productivity typically equals 2–3 weeks [2]. This expands operational risk and intensifies variability in service quality.

A deficit of systematic instructions and standardized regulations leads to work execution being anchored in subjective skills and everyday representations, which often conflict with professional requirements for safety and surface preservation. "Hidden losses" emerge, expressed in overconsumption of cleaning and disinfecting agents due to incorrect dosing (18–27% above normative values), as well as in damage to expensive finishes when chemistry and inventory are selected incorrectly. Empirical data indicate that structured SOP-based training (Standard Operating Procedures) makes it possible to reduce the preparation period for new hires to 5–7 days and to secure reproducible quality already in the first week of work [10, 11].

Effective onboarding in professional cleaning should be treated as a managed technological process, comparable in rigor to production safety briefings: with clearly defined goals, control points, and criteria for admission to independent work. Practically significant is a modular approach that includes basic chemistry and agent compatibility with materials, dosing and exposure rules, cleaning route logic, principles of inventory zoning, and occupational safety and infection prevention requirements [6,8,13]. Skill consolidation increases when demonstration of reference operations is combined with drill-based practice on typical zones and with mentoring by an experienced employee; this reduces the probability that incorrect habits become fixed in the first days.

A stability contour is supported not only by training, but also by an embedded system of competency and quality control: initial attestation via checklists, selective audits of work shifts, documentation of deviations, and corrective measures. An additional effect is provided by unification of working tools and visual standardization (labels, dosing schemes, concise operation cards), which reduce cognitive load and the probability of errors under conditions of high staff turnover. As a result, direct costs related to chemicals and finish restoration decrease, as do indirect costs tied to complaints and repeat cleaning cycles, which shifts staff preparation from a cost line to an instrument of managed productivity growth (see Fig. 1).

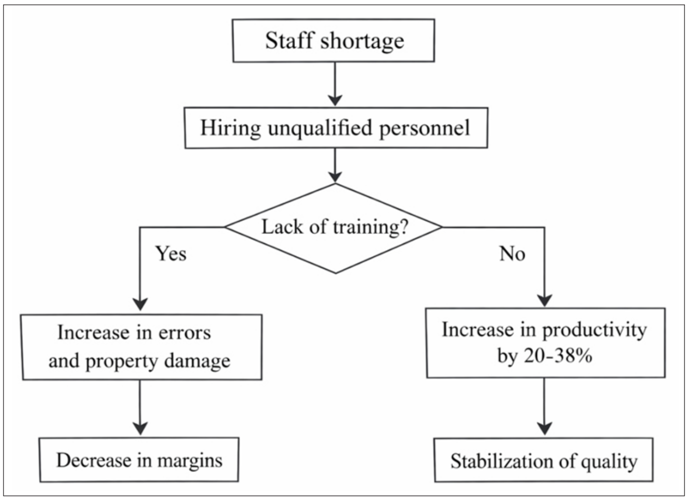

Fig. 1. Cause-and-effect linkage between the training system and operational outcomes (compiled by the author based on [9]).

Thus, the staffing shortage in cleaning services in 2024 amplified the dependence of operational results on the quality of initial onboarding: under conditions of forced hiring of employees without relevant experience, the absence of systematic training is directly transformed into higher error rates, wider quality variability, and elevated operational risks. Since labor costs account for more than half of an operator's total cost base, the extension of the time-to-normative productivity to 2–3 weeks and the early consolidation of incorrect practices in the first days of work reduce margin not only through time losses, but also through "hidden losses"—overconsumption of chemicals due to improper dosing (18–27% above the norm), as well as damage to finishes caused by incorrect selection of agents and tools.

The presented data confirm that shifting onboarding into the format of a managed technological process (SOPs, a modular structure, mentoring, drill-based practice, and checklist-based admission) constitutes a key condition for service stability under high turnover. Structured training reduces the preparation period for new hires to 5–7 days and delivers reproducible quality already within the first working week, lowering the probability of complaints, repeat cleaning cycles, and costs associated with surface restoration [10]. Consequently, the training system and the embedded competency-control contour should be treated not as an auxiliary function, but as a basic mechanism for managing productivity and quality, enabling a transition from the scenario "error growth → margin decline" to the scenario "standardization → productivity growth (20–38%) → quality stabilization," which is logically reflected in Fig. 1 [9].

Economic Inefficiency and the Absence of Quality Control

Insufficient final inspection at task completion is treated as one of the leading sources of client claims: according to available estimates, up to 70% of complaints are formed precisely at the result acceptance stage. The prevailing "completed—left the site" practice effectively excludes a verification procedure, and under conditions of limited self-control among frontline performers predictably generates rework and returns. Each return increases total labor inputs on a site by an average of 50% [9], which not only raises service cost, but also reduces crew throughput, disrupting shift planning and work routing.

A distinct layer of losses is formed due to suboptimal consumption of material resources—wipes, mops, disposable attachments, and chemical agents—which is directly linked to the absence of rationing and transparent rules for inventory renewal. Analytical data show that without automated dosing systems and regulated replacement schedules for consumables, operating expenses may exceed the potentially achievable level by 12–20% [4]. A further amplifier of inefficiency is the presence of communication gaps between management and executors: when priorities are unclear in complex or nonstandard scenarios, downtime increases, secondary operations are performed instead of critical ones, and controllability of the outcome deteriorates.

To eliminate these dysfunctions, a transition is required from episodic acceptance toward a multi-level quality control system embedded into the production cycle. In practical terms, it is justified to define a mandatory post-control procedure via a checklist with documentation of critical points (restrooms, high-touch surfaces, food intake areas, glass surfaces), as well as to introduce selective inspections based on statistical control principles, allowing recurring defects to be identified without disproportionate growth of administrative load. In parallel, the use of measurable quality criteria is advisable (visual standards, streak control, absence of residual soil, compliance with agent exposure time), supplemented by instrument-based methods on higher-risk sites; this increases the evidentiary strength of acceptance and reduces conflict intensity in interactions with the client [6,13,16].

Resource rationing should rely on process maps that connect room type, area, contamination class, and the work regulation to calculated limits for consumables and cleaning agents, as well as to their replacement frequency. The introduction of automated dosing, inventory labeling, and consumables write-off procedures reduces cost variability and removes overconsumption as a compensatory response to uncertainty among personnel [8,13]. At the same time, managerial communication is critically important in the form of short operational instructions and decision-making scenarios (including cases of nonstandard contamination, incidents, and time deficits), which ensures uniform prioritization and minimizes downtime, moving control and resource management into the category of reproducible processes rather than individual, ad hoc practices.

CHAPTER 2. EMPIRICAL ANALYSIS OF THE EFFECT OF REGULATION ON KEY PERFORMANCE INDICATORS (KPIS)

Chapter 2 provides an applied assessment of how formalized regulations, standardized routes, and an embedded control contour reshape the performance of professional cleaning processes. Section 2.1 examines the acceleration of operations and the reduction of cycle-time variability across facility types (offices, healthcare settings, residential stock, retail areas) through the elimination of "hidden losses" and the synchronization of planning–execution–control. Section 2.2 considers the effect of standardization on quality and sanitary reliability, including fewer complaints, lower recontamination risk under a correct work vector and under zoning/microfiber use, and a shift toward more objective acceptance methods (checklists, periodic instrument-based measurements). Section 2.3 clarifies the economic effect of regulation via the standardization of dosing and inventory handling, reduced overconsumption of chemicals and materials, lower operating costs, and fewer losses from returns and rework—an aggregate outcome that increases profitability and moves expenditure into a controllable, predictable category.

Transformation of Speed Characteristics Across Facility Types

The introduction of an integrated management model grounded in formalized algorithms and reproducible technological schemes ensures a meaningful acceleration of cleaning operations while preserving the completeness of the technological cycle. Generalization of a five-year set of observations makes it possible to state a stable productivity gain in the 28–45% range. The spread is predictably determined by facility typology and operating characteristics: in residential stock, where cleaning is complicated by individualized layouts, high levels of cluttering, and variability of soils, acceleration is constrained to 25–32% [2]. Under such conditions, the decisive efficiency factor is not maximum time compression as such, but the reduction of nonproductive movement and the standardization of repeated operations without sacrificing quality.

The most pronounced effect is recorded in healthcare organizations (up to 45%), which is associated with the high structuring of sanitary protocols and regulations that minimize unnecessary transitions, duplicated actions, and ambiguity in procedure choice [6,13]. The office environment demonstrates stable growth within 30–40% due to the introduction of cyclical routes and the fixation of constant work logistics, which makes it possible to rationalize the sequence of zone processing and to optimize staff loading. These results reflect a basic regularity: the higher the initial share of process variability and "hidden losses," the more visible the contribution of managerial standardization to productivity growth.

At the organizational-mechanism level, the gain is produced through the coupling of three contours: planning, execution, and control. Planning includes the standardization of time and resources for typical operations, load forecasting with allowance for peak traffic, and the identification of critical zones that require a higher processing frequency. The execution contour is supported by regulated routes, inventory unification, and separate zoning, which reduces the number of task switches and eliminates returns to already completed areas. The control contour records deviations and supports regulation updates, preventing standard degradation under staff turnover and differences in employee training levels.

From a practical standpoint, the integrated management model increases not only speed, but also the predictability of the result: the dispersion of execution time between shifts and crews declines, the number of repeat cycles and the overconsumption of materials decreases, and client experience becomes more stable. It is especially important that acceleration is achieved primarily through the elimination of nonproductive expenditure—waiting, excessive movement, suboptimal operation sequencing, and reprocessing of surfaces—rather than by reducing mandatory stages. In this way, managerial standardization functions as an instrument for simultaneously improving operational efficiency and service quality, a point of particular importance for facilities with heightened sanitary reliability requirements and regulated acceptance procedures.

Table 2. Comparative dynamics of cleaning speed by facility type (compiled by the author based on [4])

Facility type	Speed gain range in text, %	Adopted for table (mean), %	Conditional cycle time BEFORE = 100	Conditional cycle time AFTER (calculated)
Office premises (B2B)	30–40	35	100	74.1
Medical offices	up to 45	45	100	69.0
Residential apartments (deep clean)	25–32	29	100	77.5
Retail areas	not specified directly in text	32 (estimate, within the general 28–45 band)	100	75.8

Note: the “conditional cycle time” is calculated using the formula Tafter = 100 / (1 + p/100), where p is the productivity gain.

The indicated values are consistent with empirical conclusions reported in Lean Service studies: optimization of the spatial organization of work, combined with operation standardization, is associated with efficiency gains on the order of 27% [9]. Within this logic, improvements are achieved not through labor intensification as such, but through the redistribution and ordering of actions that reduce the share of auxiliary and repetitive operations that previously “hiddenly” consumed time and resources.

Speed characteristics in this context function as a derivative of systematic waste elimination in processes—nonproductive movement, waiting, unnecessary switching between tasks, and returns to already treated areas. The most pronounced contribution is typically made by reduced distances and fewer transitions, optimized operation sequencing, leveled workloads, and standardized points for preparing inventory and materials. As a result, a higher pace becomes the consequence of a more rational process configuration, while quality and compliance with technological requirements are retained through the fixation of performance standards and control criteria.

Quality Indicators and the Reduction of Complaint Risks

Quality in professional cleaning represents a multi-component category that integrates visual-aesthetic characteristics, parameters of sanitary and hygienic reliability, and the client’s overall evaluation. Deployment of a consistent quality control system yields a pronounced reduction in claim levels (by 60–72%), while a key determinant of effectiveness is not only the presence of control per se, but also the technological correction of the work route: a stable result is formed when movement proceeds from conditionally “clean” zones to conditionally “dirty” ones [7,13]. This logic reduces the probability of secondary contamination of treated surfaces and decreases the volume of forced returns, thereby increasing result reproducibility across shifts and individual performers.

The use of objectified control methods, in particular ATP luminometry as a rapid assessment of residual organic matter, shows that compliance with sanitary regulations can reduce cross-infection risk by 45–60% [7,12,16]. A substantial contribution to lowering microbial migration is provided by the correct selection of consumables: the use of high-absorption microfiber in combination with color separation (blue for dry soils and dust, red for restroom zones, yellow for disinfection procedures) reduces the probability of bacterial transfer by 35–48% compared with conventional practices [8]. The effect is driven by the simultaneous strengthening of mechanical soil removal and the reduction of the likelihood that the same material will be mistakenly used across zones with different epidemiological risk profiles.

An additional condition for stable quality is a shift from predominantly subjective assessments of “visible cleanliness” toward a risk-oriented model in which priority is assigned to high-touch surfaces and to zones with higher contamination likelihood. In such schemes, control is built on a combination of visual acceptance, regulated checklists, and periodic instrument-based measurements, which increases the evidentiary strength of the result and reduces variability of interpretations between the client and the contractor [13,16]. At the same time, standardization of quality criteria should include not only the end-state appearance of the surface, but also the correctness of technological parameters: dosing, exposure time, stage sequencing, and compliance with inventory zoning [6,8].

No less important is the management of feedback and corrective actions: documentation of defects, causal analysis (routing error, incorrect chemistry selection, consumable replacement violations), and subsequent updating of regulations to prevent deviation recurrence. At facilities with heightened sanitary safety requirements, it is advisable to implement a work-frequency matrix linked to the intensity of space utilization; this supports rational resource allocation without reducing the level of protection [13]. Collectively, such measures move quality from a declarative characteristic to a measurable and controllable indicator supported both by technological standards and by a system of monitoring their execution (see Fig. 2).

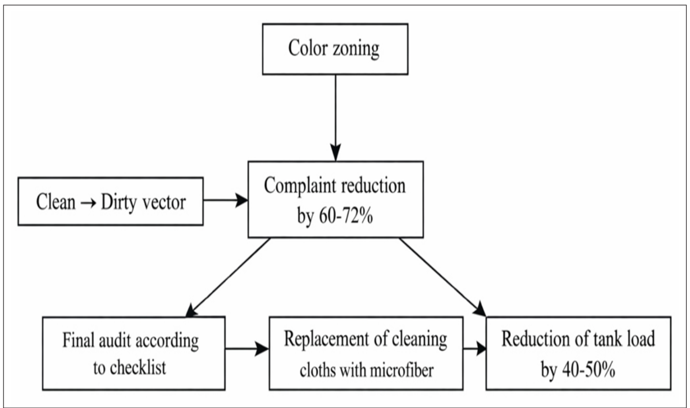

Fig. 2. Factors that increase quality and sanitary safety (compiled by the author based on [7]).

Thus, the quality of professional cleaning can be treated as a composite indicator that brings together the visual–aesthetic outcome, sanitary and hygienic reliability, and the client's evaluation. In this frame, the introduction of systematic control and a technologically correct work route (movement from conditionally "clean" zones to "dirty" ones) provides stable reproducibility of results and reduces the level of claims by 60–72% by limiting secondary contamination and the number of forced returns [7,13]. A shift toward objectified control methods, including ATP luminometry, further confirms that compliance with sanitary regulations lowers cross-infection risk by 45–60% [7,12,16], while the correct selection of consumables (high-absorption microfiber) and their color-based zoning additionally reduces the probability of bacterial transfer by 35–48% compared with conventional practices [8]. Quality stability is also achieved by moving the emphasis away from subjective "visible cleanliness" toward a risk-oriented model that prioritizes high-touch surfaces and uses combined control (visual acceptance, checklists, periodic instrument-based measurements); this increases the evidentiary strength of the outcome and reduces variability in interpretations between the client and the contractor [13,16]. In parallel, standardization should cover not only the final appearance of the surface, but also compliance with technological parameters (dosing, exposure time, stage sequencing, and inventory zoning) [6,8]. Finally, the manageability of complaint risks is supported by a regulated feedback contour (defect documentation, causal analysis, corrective actions, and updates to instructions), and—at facilities with elevated requirements—by the implementation of a work-frequency matrix linked to utilization intensity, enabling rational resource allocation without lowering sanitary protection levels [13].

Process Economics: Cost Optimization and Profitability

The economic effect of implementing an integrated management model manifests in three interrelated dimensions: reduced material intensity, lower labor inputs, and an extended service life of inventory. Standardizing the dosing of cleaning and disinfecting agents ensures a reduction in chemical consumption by 18–27% [4]. This result is achieved through the use of pump dispensers and regulated concentrate dilution schemes, which eliminates the practice of "insurance" overuse—an approach that does not improve quality, yet increases unit cost and accelerates finish degradation through chemical overloading.

In parallel, a decrease in total operating expenses is recorded, averaging 12–20%, reflecting the effect of route synchronization, the elimination of returns, and the stabilization of work-cycle duration [4,9]. A meaningful component of savings is the reduction in wear of consumable inventory (cloths, mops, attachments) by 22–35% due to the establishment of correct practices for washing, drying, and storing materials, as well as compliance with zoning rules for their use [8]. In the 2024 context—when the cost of professional equipment increased under logistics constraints—reducing the frequency of inventory replacement acquires the character of a strategic factor of competitiveness and supply resilience [2,4].

From the perspective of managerial accounting, the observed effects are appropriately interpreted as a transformation of costs from variable and weakly predictable into standardized and controllable categories. Material savings generate a direct reduction in service cost, while reduced labor inputs produce a broader effect through increased crew throughput and a lower need for overtime or additional shifts. Extending inventory service life decreases depreciation pressure and reduces the frequency of unplanned procurement, which is particularly important for facilities with high utilization intensity and strict continuity-of-service requirements.

An additional financial result is formed in the domain of prevented losses, which in conventional practice are weakly reflected in reporting, yet materially shape margins: returns, complaints, forced repeat cycles, and localized downtime caused by missing consumables or by solutions not being prepared. Standardization of dosing and inventory-handling procedures reduces the risk of surface damage, decreases the volume of restorative work, and increases result reproducibility across shifts, thereby stabilizing contract performance indicators and lowering the probability of penalty deductions [6,8,13]. Taken together, these mechanisms move the economic effect from a one-off "optimization" into a sustainable model grounded in process controllability and cost predictability.

CHAPTER 3. DEVELOPMENT OF AN INTEGRATED MODEL AND PRACTICAL RECOMMENDATIONS

Chapter 3 presents an applied managerial construct that shifts professional cleaning into the mode of a stably reproducible service. In Section 3.1, an integrated "Speed–Quality–Cost" algorithm is formed, grounded in a technological hierarchy of zones (a movement logic from lower-risk areas toward functionally critical ones), the elimination of returns, and visual standardization through color-based zoning of inventory; this configuration simultaneously reduces time losses and the probability of methodological errors. In Section 3.2, the necessity of control digitalization and predictive management is substantiated (Demand-Based Cleaning based on IoT and Predictive Maintenance, mobile audits, dashboards, and digital checklists), where the key condition of effectiveness is a mature data architecture and management by SLA/OLA metrics, alongside tightened requirements for information security. In Section 3.3, a "human capital" development contour is proposed via microlearning in the work environment, ergonomic training, mentoring, and regular competency assessment; this shortens time-to-normative productivity, reduces turnover, and embeds standards as an everyday practice, thereby maintaining a stable KPI balance across the "speed–quality–cost" triad.

The Integrated "Speed–Quality–Cost" Algorithm

The developed model rests on five basic principles intended for implementation in day-to-day practices of both frontline performers and the managerial tier. Of primary importance is the principle of a technological hierarchy of zones, which assumes a strict sequence of space processing: work begins in areas with the lowest probability of contamination (living rooms in apartments, workstations in offices) and ends in functionally most critical zones (restrooms, kitchen blocks, entrance groups). This logic determines not only sanitary reliability, but also operational efficiency: eliminating returns to already treated areas reduces repeated movement and makes it possible to save up to 15% of working time by minimizing duplicated operations [9].

The second principle is visual standardization implemented through a stable color code for inventory and consumables. The formation of an automated association "color—purpose" reduces cognitive load, accelerates on-site decision-making, and decreases the probability of methodological errors when selecting clothes, mops, and solutions. The most critical effect is the prevention of situations in which agents and materials intended for restroom zones are used on delicate surfaces of office furniture or interior finishes, a pattern that simultaneously degrades quality and increases the risk of material damage. Under visual standardization, the frequency of errors associated with incorrect chemical application decreases by 70–80% [4].

Control Digitalization and Predictive Management

In the 2025 operating context, the "speed–quality–cost" triad is difficult to balance in a stable manner without reliance on digital tools for process management [14,15,18,21]. The concept of predictive maintenance, implemented on the basis of IoT sensors, shifts planning from rigid calendar schedules toward cleaning based on actual demand. For example, sensors in restroom zones can register visit intensity and generate a service signal at the moment a specified threshold is reached, which allows resources to be redistributed more precisely across zones and reduces the share of nonproductive site visits [14,18, 24].

The use of mobile solutions for audits and digital control panels increases work transparency and accelerates the feedback contour between the client, management, and performers. Final acceptance through a digital checklist standardizes "readiness" criteria for a zone, lowering the probability of omissions and subjective interpretation; as a result, complaint risk decreases by more than twofold due to mandatory self-check in the controller logic immediately before shift completion [16]. The embedding of digital verification into the operational contour effectively closes the PDCA cycle, supporting continuous quality improvement on the basis of data rather than episodic remarks [9].

Technological effectiveness of digitalization is determined not only by the presence of sensors and applications, but also by the data architecture: the correctness of trigger thresholds, the quality of zone labeling, the uniformity of defect classifiers, and the comparability of indicators across sites. Practically significant is the transition toward metrics-based management (SLA/OLA), where servicing frequency, response time, return share, and material consumption are linked to room type and utilization intensity [21, 23]. Integration of quality dashboards with request and incident accounting systems reduces transaction losses spent on approvals and supports traceability—from the deviation cause to a corrective action and to subsequent verification of its effectiveness.

Additional effects are produced when Demand-Based Cleaning is coupled with building asset and infrastructure management: digital logs, resource mapping, and compliance monitoring allow more accurate consumables planning and reduce cost variability [15,21]. At the same time, the importance of information security and access management requirements increases, since traffic and space utilization data represent sensitive organizational parameters. With competent role configuration, access protocols, and verification procedures, digital tools function not as a superficial add-on, but as the core of a controllable service in which speed and quality are secured through lower uncertainty, automated control, and disciplined execution of standards [15,18].

Below, Fig. 3 will be used for clarity to present the digital cycle of managing cleaning efficiency.

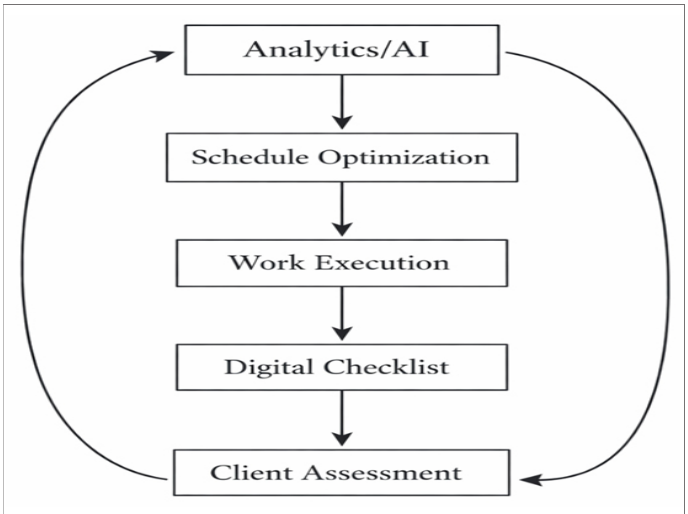

Fig. 3. Digital cycle for managing cleaning efficiency (compiled by the author based on [17-20]).

The section demonstrates that, under 2025 conditions, stable management of professional cleaning through the "speed–quality–cost" triad becomes nearly impossible without digitalization: IoT sensors and Predictive Maintenance shift servicing into a Demand-Based Cleaning mode, enabling resource redistribution in line with actual load and reducing nonproductive site visits, while mobile audits, dashboards, and digital checklists standardize acceptance and close the PDCA contour through rapid feedback and built-in self-control, which noticeably lowers complaint risk [14,18]. At the same time, the determining factor of effectiveness is not the mere presence of technologies, but a mature data architecture (threshold logic, zone labeling, defect classifiers, and metric comparability), a transition toward SLA/OLA-based management, and the integration of quality control with request/incident tracking, which together provide traceability of corrective actions and reduce transactional losses [15,21, 22]. An additional effect is generated by coupling with asset and inventory management while simultaneously tightening information security requirements; as a result, digital tools evolve from a managerial "overlay" into the core of a controllable service.

Recommendations for Training and "Human Capital" Development

Given that professional cleaning remains distinctly human-centered, investments in competency development function as one of the most economically effective instruments for cost reduction. The most applied format is microlearning directly within the work environment: short video modules lasting 1–2 minutes and clear infographic materials placed on carts and in inventory-preparation zones [10]. Such a model narrows the gap between instruction and action, supports rapid transfer of knowledge into practice, and makes it possible to stabilize operation quality within 5–7 days through frequent reinforcement of critical rules (zoning, dosing, sequencing, wiping technique).

Systematic training in ergonomics and correct use of professional tools improves employees' subjective well-being and reduces turnover by 20–30%, which directly affects service cost through lower recruitment expenses and fewer productivity losses during adaptation. In the 2024 context, retaining a qualified worker is estimated to be 3–4 times less costly than searching for and training a new employee [2], which makes personnel development programs financially justified even under constrained budgets. An additional advantage appears in production metrics: trained performers demonstrate productivity 20–38% higher than that of newcomers operating without standardized instructions and fixed algorithms [4].

CONCLUSION

The research conducted, together with the processing of a five-year body of field observations, indicates that the effectiveness of professional cleaning in the 2024–2025 economic environment is determined primarily not by the adoption of capital-intensive technologies as an end in itself, but by systemic, structural optimization of the operating contour. Within the integrated "speed–quality–cost" model, the attainability of a 25–45% productivity gain is confirmed through the formalization of regulations (SOPs), procedure unification, and strict compliance with the technological sequence "from clean to dirty". This approach increases cycle predictability, reduces outcome variability across shifts, and decreases the share of repeat operations, producing a stable effect without degrading sanitary parameters [6,7,16].

The hypothesis regarding the possibility of materially improving operational indicators without large-scale capital expenditures receives empirical support: standardization of consumables use and the elimination of "hidden losses" provide savings of 12–20% while simultaneously reducing complaint levels and increasing client satisfaction by 60–72%. The findings presented form an applied toolkit suitable for replication and scaling of service models, and for strengthening sanitary reliability across sectors with different facility utilization intensities.

From a theoretical and methodological standpoint, the results support treating professional cleaning as a controllable production system in which quality functions as a measurable consequence of correct work organization rather than exclusively as a function of individual performer skill. The evidence-based linkage between regulations, routing, and resource rationing and efficiency indicators substantiates the rationale for process management, where target KPI values are maintained through critical-point control rather than through situational "push" at the end of a shift. In this way, a foundation is formed for further standardization of industry practices, including the development of typical operating models for facilities of different purposes and sanitary risk classes.

The practical significance of the material is expressed in the possibility of integrating the proposed model into active contracts without service stoppage and without a substantial increase in administrative burden. A particularly promising direction of development is digital process support: a shift toward data as the basis for planning, implementation of audit and feedback tools, and risk-oriented allocation of resources in accordance with actual zone utilization intensity. Taken together, this supports simultaneous growth in the competitiveness of the service business and the strengthening of sanitary safety standards, a priority that becomes especially relevant under cost uncertainty and heightened service quality requirements in 2024–2025.

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