Budget Optimization Model for Cost-Efficient Facility Management and Service Quality

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Abstract- Facility management (FM) is increasingly challenged by rising operational costs, aging infrastructure, stringent regulatory requirements, and growing expectations for service quality and sustainability. Traditional budget allocation methods often rely on incremental adjustments or reactive spending, which can lead to inefficiencies, underfunded priorities, and compromised service delivery. To address these challenges, this study proposes a budget optimization model that integrates cost-efficiency with service quality objectives, providing a systematic approach for resource allocation in FM. The model is designed to minimize the total cost of ownership while ensuring compliance, risk management, and adherence to service-level agreements (SLAs). It incorporates decision variables such as preventive maintenance intensity, vendor selection, energy management strategies, and retrofit investment, with constraints reflecting budget ceilings, regulatory requirements, capacity limits, and sustainability targets. Service quality is quantified through measurable key performance indicators (KPIs), including uptime, mean time to repair, cleanliness scores, and occupant satisfaction, which are modeled as functions of budget allocation. Risk considerations, including asset reliability and contingency planning, are embedded to ensure resilience against disruptions. To enhance adaptability, the model integrates digital tools such as IoT sensors, predictive analytics, and energy management systems for real-time data collection and forecasting. Advanced optimization methods, including mixed-integer linear programming and robust or stochastic approaches, are employed to capture uncertainty in demand, costs, and operating conditions. The proposed framework enables FM teams to allocate budgets strategically, balancing short-term operational efficiency with long-term value creation. Expected outcomes include reduced downtime, optimized preventive maintenance, improved service quality, and enhanced transparency in decision-making. Ultimately, the model supports organizations in achieving cost-efficient facility management while safeguarding service quality, resilience, and stakeholder satisfaction in diverse and dynamic operational contexts.

Index Terms- Budget Optimization, Cost Efficiency, Facility Management, Service Quality, Resource Allocation, Operational Cost Reduction, Predictive Maintenance, Performance Metrics

I. INTRODUCTION

Facility management (FM) has emerged as a critical driver of organizational efficiency, resilience, and sustainability. Once perceived primarily as a support function, FM now encompasses a strategic portfolio of activities that include maintenance, energy management, space utilization, cleaning, security, waste management, and compliance (Lawal and Afolabi; 2015; Nwokediegwu *et al*., 2019). In sectors such as healthcare, manufacturing, education, and corporate real estate, effective FM directly influences operational continuity, user satisfaction, and asset performance (Lawal, 2015; Iyabode, 2015). By ensuring that physical environments are safe, reliable, and efficient, FM contributes to core organizational objectives, from productivity to sustainability, and is therefore increasingly recognized as a key enabler of competitive advantage (Otokiti, 2012; SHARMA *et al*., 2019).

Despite this strategic importance, FM faces a persistent dual challenge: minimizing costs while sustaining or enhancing service quality. Rising operational expenses, aging infrastructure, and increased regulatory scrutiny put pressure on facility budgets, while occupants, regulators, and stakeholders demand higher levels of service, safety, and sustainability (Akinbola and Otokiti, 2012; Lawal *et al*., 2014). For instance, energy and utility costs remain volatile, preventive maintenance competes with short-term corrective fixes, and service-level agreements (SLAs) must be upheld even under resource constraints. Striking the balance between cost containment and service excellence is further complicated by unpredictable variables such as fluctuating occupancy levels, climate-related risks, and evolving workplace expectations (Lawal *et al*., 2014; Otokiti, 2018). As such, traditional budgeting methods, often reliant on incremental adjustments or historical spending, prove inadequate for addressing the complexity and dynamism of modern FM.

This tension provides the rationale for a budget optimization model as a strategic tool. Rather than allocating resources reactively, the model applies quantitative and evidence-based approaches to optimize financial decision-making. It integrates cost considerations with service-level targets, asset reliability, and long-term sustainability (Amos *et al*., 2014; Otokiti, 2017). By systematically evaluating trade-offs—such as preventive versus corrective maintenance, energy efficiency investments versus utility expenditures, or vendor selection versus in-house service delivery—the model enables facility managers to identify allocations that maximize value creation while minimizing risk. Furthermore, embedding digital technologies such as IoT sensors, predictive analytics, and AI-driven forecasting ensures that the optimization process is dynamic, data-driven, and responsive to real-world conditions (Ajonbadi *et al*., 2014; Otokiti and Akorede, 201).

The objectives of the proposed budget optimization model are fourfold. First, it seeks to minimize the total cost of ownership by allocating limited budgets across competing FM functions in the most efficient manner. Second, it aims to safeguard and enhance service quality by ensuring that resource allocation aligns with SLA requirements and user expectations. Third, the model seeks to incorporate risk and resilience considerations, reducing the probability and impact of disruptions through optimized preventive maintenance and contingency planning. Finally, the framework aspires to support long-term sustainability by integrating energy efficiency, emissions reduction, and lifecycle investment strategies into budgeting decisions. Collectively, these objectives position the model not only as a cost-control mechanism but as a strategic enabler of resilient, high-performing, and sustainable facility operations.

The proposed budget optimization model addresses a fundamental tension at the heart of facility management: how to achieve cost efficiency without compromising quality or resilience. By combining advanced optimization techniques, real-time data, and strategic alignment, it provides organizations with a systematic pathway to transform FM from a reactive cost center into a proactive driver of operational excellence (Seshan and Gorain, 2016; Srinivasan, 2016).

II. METHODOLOGY

The PRISMA methodology was applied to systematically review and synthesize evidence relevant to developing a budget optimization model for cost-efficient facility management while maintaining service quality. A structured search was conducted across multidisciplinary databases including Scopus, Web of Science, ScienceDirect, and PubMed, complemented by grey literature from industry reports, policy documents, and professional association publications. Keywords combined terms such as "facility management," "budget optimization," "cost efficiency," "service quality," "resource allocation," and "performance outcomes." Boolean operators and truncation were used to maximize retrieval scope. Studies published between 2000 and 2025 in English were considered to capture both foundational and emerging approaches.

The search identified 2,136 records, from which duplicates were removed, leaving 1,842 unique entries. Titles and abstracts were screened against predefined inclusion criteria, which focused on studies examining models, frameworks, or empirical strategies linking financial optimization to facility management outcomes. Exclusion criteria eliminated articles that addressed unrelated domains such as purely construction budgeting or financial markets without relevance to facility operations. After initial screening, 236 full-text articles were assessed for eligibility. A final set of 74 studies met the inclusion criteria and were subjected to qualitative and quantitative synthesis.

Data extraction focused on methodologies employed, optimization techniques applied (e.g., linear programming, cost-benefit analysis, predictive analytics), performance indicators assessed (e.g., operational costs, service quality ratings, user satisfaction, energy efficiency), and contextual variables such as sector, organizational size, and regional practices. Risk of bias was minimized through independent cross-validation by multiple reviewers, and disagreements were resolved through consensus.

The synthesis revealed that integrated optimization approaches—combining financial modeling with quality management frameworks—demonstrated superior performance in balancing cost control with user satisfaction and operational resilience. Evidence highlighted that predictive maintenance, energy management systems, and workforce deployment strategies contributed significantly to efficiency without degrading service quality. The final output of the PRISMA-guided review was the formulation of a conceptual budget optimization model grounded in best practices and validated strategies, providing a cost-efficient pathway to facility management that aligns with both financial sustainability and service excellence.

2.1 Theoretical and Conceptual Foundations

The development of a budget optimization model for facility management (FM) requires a clear theoretical and conceptual grounding. By defining key concepts, drawing on established resource allocation and cost-benefit theories, and integrating insights from quality management frameworks, the model is positioned within a robust intellectual tradition. The foundations also highlight the interconnections between cost-efficiency, service quality, and organizational sustainability, which collectively guide the design and application of optimization strategies (Carayannis *et al*., 2017; Grabowski *et al*., 2017).

Facility management is defined by the International Facility Management Association (IFMA) as "a profession that encompasses multiple disciplines to ensure functionality, comfort, safety, and efficiency of the built environment by integrating people, place, process, and technology." In practice, FM covers a wide range of activities, including maintenance, energy management, security, cleaning, waste management, and compliance, all of which directly influence organizational performance and user experience.

Budget optimization refers to the systematic process of allocating limited financial resources across competing needs and priorities to maximize overall value. Within FM, this involves balancing short-term operational costs with long-term lifecycle considerations, ensuring that expenditure supports not only cost reduction but also service reliability, risk mitigation, and sustainability objectives. Optimization techniques range from linear programming and goal programming to stochastic approaches that address uncertainty.

Service quality is the degree to which a facility or service meets or exceeds the expectations of users and stakeholders. In FM, service quality is typically operationalized through service-level agreements (SLAs) and measured via key performance indicators (KPIs) such as response times, system uptime, cleanliness scores, and user satisfaction. High service quality is not simply about compliance but about ensuring environments that foster productivity, well-being, and organizational reputation (Bisogno, 2016; Avramchuk, 2017).

At its core, budget optimization draws on resource allocation theories that address how scarce resources can be distributed most effectively. Classical economic theories emphasize opportunity cost, where every allocation decision involves trade-offs between competing uses. The cost-benefit principle further provides a decision-making lens, where options are evaluated by comparing the net benefits of investments or expenditures relative to their costs.

In FM, these principles translate into practical dilemmas such as whether to allocate more resources to preventive maintenance (with higher upfront costs but long-term savings) or to corrective maintenance (with lower immediate costs but higher risk of disruptive failures). Optimization models operationalize these trade-offs mathematically, allowing decision-makers to identify allocations that minimize total cost of ownership while maximizing service outcomes.

Modern approaches also integrate risk-adjusted resource allocation, recognizing that cost and benefit must be evaluated alongside risk probabilities and impacts. For example, deferring maintenance may appear cost-efficient in the short term but significantly increase the risk of catastrophic asset failures. Embedding risk functions into optimization models ensures that financial efficiency does not come at the expense of resilience.

The relevance of quality management frameworks is central to aligning budget optimization with service outcomes. Total Quality Management (TQM) emphasizes continuous improvement, customer focus, and process optimization, principles directly applicable to FM services where user satisfaction and operational reliability are critical. Six Sigma, with its emphasis on reducing variability and defects, provides methodological tools for improving FM processes such as maintenance scheduling, energy management, and service delivery (Aldairi *et al*., 2017; Wetzel and Thabet, 2016).

International standards such as ISO 9001 (quality management) and ISO 41001 (facility management systems) further provide structured approaches for integrating quality into FM operations. ISO 45001, focused on occupational health and safety, reinforces the importance of safe, compliant environments as integral to service quality. These frameworks collectively underscore that service quality is not an incidental byproduct but the outcome of systematic processes, measurement, and continuous improvement. Embedding these principles into a budget optimization model ensures that financial decisions are not made in isolation but are tied to measurable, sustainable improvements in service delivery.

The conceptual linkage between cost-efficiency, service quality, and sustainability is at the heart of the proposed model. Cost-efficiency ensures that limited resources are used judiciously, avoiding waste while supporting operational priorities. Service quality ensures that efficiency does not erode user satisfaction or functional performance. Sustainability extends the horizon of decision-making to encompass environmental stewardship, social responsibility, and long-term resilience.

This triadic relationship reflects the broader paradigm of organizational sustainability, which integrates economic, environmental, and social dimensions. For instance, investing in energy-efficient retrofits may involve higher initial costs but delivers long-term savings, reduced environmental impact, and enhanced service reliability. Similarly, prioritizing employee well-being through improved workplace conditions enhances satisfaction and productivity while reducing absenteeism and healthcare costs.

By integrating these dimensions, the budget optimization model moves beyond a narrow focus on financial efficiency to become a strategic tool that aligns FM with broader organizational goals. It positions FM as a critical contributor not only to operational excellence but also to sustainability agendas such as carbon reduction, workplace well-being, and stakeholder trust (Elmualim *et al*., 2017; Dyakova, 2017).

The theoretical and conceptual foundations of the budget optimization model draw on well-established definitions, resource allocation theories, and quality management frameworks to create a robust platform for decision-making. By linking cost-efficiency with service quality and sustainability, the model reframes FM budgeting as a strategic process rather than a routine financial exercise. This integrative perspective provides the intellectual scaffolding necessary to design optimization tools that are rigorous, adaptable, and aligned with organizational resilience and long-term value creation.

2.2 Key Components of the Budget Optimization Model

The proposed budget optimization model for facility management (FM) is structured around four interdependent components: cost analysis and categorization, performance metrics and service quality indicators, optimization techniques and tools, and a structured decision-making framework. Each component contributes to a comprehensive approach that enables organizations to balance financial efficiency with service quality, resilience, and sustainability as shown in figure 1 (Nagel *et al*., 2017; Alibašić, 2018).

Figure 1: Key Components of the Budget Optimization Model

Accurate cost analysis and categorization provide the foundation of any optimization model. In facility management, expenditures are diverse, spanning daily operations, long-term investments, and indirect or hidden costs.

Operational costs constitute the bulk of FM expenditures, encompassing utilities, routine maintenance, consumables, and workforce expenses. Utilities, such as energy and water, are not only significant cost drivers but also critical levers for sustainability performance. Maintenance costs, both preventive and corrective, directly influence asset reliability and lifecycle performance. Workforce expenses, including salaries, training, and outsourcing contracts, represent essential inputs into the quality and consistency of service delivery.

Capital expenditures (capex) include equipment purchases, infrastructure upgrades, and large-scale retrofits. These investments often demand careful financial planning due to their high upfront cost, but they also yield long-term value in the form of improved efficiency, extended asset life, and reduced operational risk. Examples include HVAC system replacements, renewable energy installations, and digital FM infrastructure such as building automation systems.

Hidden or indirect costs are often overlooked yet critical to capturing the full economic impact of FM decisions. These include downtime costs from equipment failures, inefficiencies in resource use, safety incidents, regulatory penalties, and reputational damage. Quantifying these costs enables organizations to recognize the true value of preventive and proactive measures, reinforcing the rationale for optimization beyond visible line items (Eldenburg *et al*., 2016; Bell and Orzen, 2016).

Performance metrics provide the basis for linking budgetary decisions to service outcomes. In the proposed model, metrics are categorized into key performance indicators (KPIs) and service quality benchmarks.

Key performance indicators (KPIs) are quantifiable measures that track operational performance. Common FM KPIs include energy efficiency (measured in kWh/m^2), response times to service requests, maintenance backlog levels, and asset uptime percentages (Robinson *et al*., 2016; Photovoltaic *et al*., 2018). These indicators provide tangible evidence of how effectively resources are being used and where optimization can deliver improvements.

Service quality benchmarks capture the broader user and stakeholder experience. These include user satisfaction surveys, reliability ratings for critical systems, and compliance rates with regulatory or industry standards. Service quality benchmarks are essential because they address the intangible dimensions of FM that impact occupant productivity, safety, and well-being.

A critical aspect of the model is maintaining a balance between cost reductions and quality thresholds. Aggressive cost-cutting without regard for service quality risks creating false economies, where short-term savings generate long-term inefficiencies, dissatisfaction, or safety issues. By embedding thresholds—such as minimum acceptable SLA compliance rates or uptime percentages—the model ensures that cost optimization does not compromise essential service outcomes.

The optimization engine of the model applies advanced quantitative and digital tools to identify the most efficient allocation of resources.

Linear and dynamic programming models provide structured mathematical approaches for solving allocation problems under constraints. Linear programming is effective for relatively stable cost and performance functions, while dynamic programming allows sequential decision-making over multiple time periods, capturing lifecycle considerations such as asset replacement planning.

Predictive analytics enhance optimization by leveraging historical and real-time data to forecast demand, resource requirements, and potential disruptions. For example, predictive models can estimate maintenance needs based on asset condition data, enabling more precise allocation of preventive maintenance budgets.

Simulation models enable scenario testing, allowing managers to explore the consequences of different budget strategies under varying assumptions. For instance, simulations can assess the impact of energy price fluctuations, occupancy shifts, or deferred maintenance on costs and service levels. This scenario-based analysis strengthens resilience by preparing organizations for uncertainty.

Digital solutions provide real-time data and automation capabilities that strengthen the optimization process. Internet of Things (IoT) devices enable continuous monitoring of building systems, identifying inefficiencies and risks in real time. Building Information Modeling (BIM) supports digital twin applications, integrating spatial, asset, and operational data for informed decision-making. Artificial intelligence (AI)-driven maintenance scheduling automates preventive interventions based on predictive analytics, reducing downtime and optimizing workforce deployment (Gupta *et al*., 2018; Pentyala, 2018). Together, these digital tools transform optimization from a static planning exercise into a dynamic, adaptive process.

The final component of the model is the decision-making framework, which ensures that optimization results are translated into actionable strategies aligned with organizational priorities.

Prioritization strategies provide a structured means of determining which projects or services receive funding. A risk-based approach prioritizes investments that reduce the likelihood or severity of critical failures, while cost-benefit analysis prioritizes those with the highest return on investment. In practice, a hybrid approach often proves most effective, ensuring both resilience and financial efficiency.

Trade-off analysis is essential to reconcile the tension between cost efficiency and service quality. The framework employs sensitivity analysis to highlight how budget changes affect key outcomes, enabling decision-makers to understand the implications of underfunding or overfunding specific services. This transparency fosters informed decision-making and stakeholder consensus.

Multi-criteria decision-making (MCDM) approaches formalize trade-offs by integrating multiple objectives and stakeholder preferences. Techniques such as the Analytic Hierarchy Process (AHP) or Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) allow decision-makers to rank budget scenarios according to criteria such as cost, risk reduction, user satisfaction, and sustainability. By capturing diverse perspectives, MCDM ensures that optimization decisions are not purely financial but strategically balanced.

The key components of the budget optimization model—cost analysis, performance metrics, optimization tools, and decision-making frameworks—form a cohesive system for aligning financial efficiency with service excellence (Marcelo *et al*., 2016; Consigli *et al*., 2016). Cost categorization ensures that all direct and hidden expenditures are captured; performance metrics provide quantifiable links between budgets and outcomes; optimization techniques identify efficient allocation strategies; and structured decision-making frameworks reconcile trade-offs in a transparent and strategic manner. Together, these components operationalize the model, enabling organizations to transform facility management from a cost-driven function into a strategic driver of resilience, sustainability, and long-term value creation.

2.3 Mechanisms for Cost Efficiency without Quality Loss

Achieving cost efficiency in facility management without compromising service quality requires a balanced approach that integrates strategic planning, technological innovation, and data-driven decision-making. While budget optimization has traditionally been viewed as a trade-off between cost savings and service outcomes, modern facility management demonstrates that these objectives can be mutually reinforcing when guided by targeted mechanisms. Key strategies include preventive and predictive maintenance, energy management systems, workforce optimization, procurement innovations, and advanced technological integration as shown in figure 2(Basri *et al.*, 2017; Selcuk, 2017). Together, these mechanisms enable organizations to minimize waste, reduce operational disruptions, and sustain high-quality service delivery.

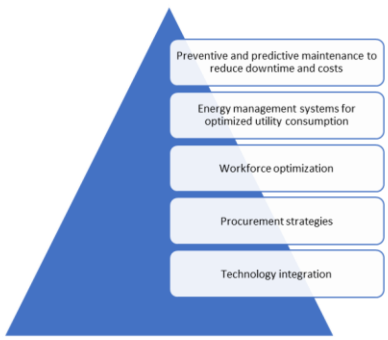

Figure 2: Mechanisms for Cost Efficiency without Quality Loss

One of the most effective mechanisms for reducing costs without eroding quality is the implementation of preventive and predictive maintenance systems. Preventive maintenance involves scheduled inspections and servicing to avoid breakdowns, thereby reducing downtime and extending equipment life cycles. Predictive maintenance advances this approach through data-driven monitoring, using sensors and algorithms to forecast when a system or component is likely to fail. By addressing potential issues before they escalate into costly failures, organizations avoid unplanned downtime, lower repair costs, and enhance safety. This approach not only reduces financial burdens but also ensures continuity of service quality, as equipment operates reliably and user disruptions are minimized.

Energy consumption constitutes a significant share of facility operational costs. Energy management systems (EMS) provide a structured approach to monitor, control, and optimize energy use across buildings and processes. By leveraging real-time monitoring, automation, and analytics, EMS enables organizations to reduce utility expenditures without compromising comfort or performance standards. For example, automated lighting and HVAC systems adjust resource use based on occupancy and demand, ensuring efficiency while maintaining user satisfaction. Additionally, EMS supports sustainability by reducing greenhouse gas emissions, aligning cost optimization with broader environmental goals. Long-term energy savings contribute not only to financial efficiency but also to enhanced organizational reputation in meeting ESG commitments (Kotsantonis *et al.*, 2016; Grove and Clouse, 2018).

Human resources are central to facility management, but labor costs often represent one of the largest expenditures. Workforce optimization focuses on aligning skills with tasks, outsourcing non-core functions, and leveraging automation to enhance productivity. Skill alignment ensures that staff are trained and deployed in roles that maximize their expertise, minimizing inefficiencies and error rates. Strategic outsourcing allows organizations to tap into specialized expertise and scale services more cost-effectively, while maintaining service quality benchmarks. Automation—ranging from robotics for repetitive tasks to AI-driven scheduling—frees employees for higher-value activities, improving both efficiency and job satisfaction. The outcome is a leaner, more agile workforce that sustains high-quality outcomes while reducing operational costs.

Procurement is another area where cost efficiency and quality intersect. Traditional procurement practices often prioritize upfront savings, but lifecycle costing offers a more holistic view by evaluating the total cost of ownership, including maintenance, operation, and disposal. This approach prevents false economies by ensuring that assets deliver long-term value rather than short-term savings. Supplier partnerships further enhance efficiency by fostering collaboration, innovation, and reliability in supply chains. Long-term contracts with trusted suppliers can reduce transaction costs, stabilize pricing, and ensure consistent quality. Collaborative procurement strategies also enable organizations to benefit from economies of scale and shared expertise, aligning financial optimization with sustained service performance.

Technology plays a pivotal role in driving cost efficiency without compromising service quality. Smart sensors embedded within building systems provide continuous, real-time data on temperature, air quality, equipment performance, and occupancy levels. This data is analyzed to identify inefficiencies, detect anomalies, and optimize resource allocation. For example, predictive algorithms can automatically adjust HVAC output based on occupancy patterns, reducing energy waste while maintaining comfort. Data-driven monitoring also enhances transparency and accountability, enabling managers to make evidence-based decisions and quickly respond to emerging issues (Tuli *et al*., 2018; Custer *et al*., 2018). Beyond cost savings, technology integration improves service reliability and user satisfaction by ensuring facilities remain adaptive, responsive, and resilient.

Mechanisms such as preventive and predictive maintenance, energy management systems, workforce optimization, innovative procurement, and smart technology integration collectively demonstrate that cost efficiency and service quality are not mutually exclusive. Instead, when implemented strategically, they reinforce one another by reducing waste, preventing disruptions, and enhancing operational resilience. These mechanisms create a framework in which financial optimization directly supports service excellence, enabling organizations to maintain competitiveness, align with sustainability objectives, and deliver long-term value. As facility management evolves in an era of increasing resource constraints and performance expectations, these approaches will be critical to ensuring that organizations achieve efficiency without sacrificing the standards upon which their success depends.

2.4 Expected Outcomes of the Model

The budget optimization model for facility management (FM) is designed not only to achieve cost efficiency but also to deliver sustainable service quality, resilience, and stakeholder value. By integrating systematic cost analysis, performance metrics, advanced optimization tools, and structured decision-making frameworks, the model generates tangible and strategic outcomes that extend beyond immediate financial savings (Bertoni, 2017; Salama and Eltawil, 2018). These outcomes can be grouped into five main dimensions: enhanced budget control, service quality assurance, operational resilience, stakeholder satisfaction, and sustainability alignment.

A central expected outcome of the proposed model is greater budgetary discipline and minimized financial waste. Traditional FM budgeting often suffers from reactive spending, redundant contracts, and misaligned resource allocation. By incorporating rigorous cost categorization—covering operational, capital, and indirect costs—the model ensures that all expenditures are visible and accounted for. Optimization techniques such as linear programming and predictive analytics identify inefficiencies, enabling FM teams to reallocate resources toward higher-value activities.

For example, preventive maintenance can be prioritized over costly corrective interventions by leveraging predictive analytics and IoT data. Similarly, scenario simulations highlight hidden costs of downtime or regulatory penalties, allowing managers to justify strategic investments in resilience. This shift from reactive to proactive spending creates greater transparency, reduces cost overruns, and enhances financial predictability, strengthening the organization's overall fiscal health.

Another significant outcome is the ability to sustain or improve service quality despite tighter budgetary constraints. The model links financial inputs directly to service quality indicators such as asset uptime, response times, and user satisfaction levels. By embedding quality thresholds into optimization processes, the model prevents the pursuit of cost savings at the expense of safety, comfort, or compliance (Polygerinos *et al*., 2017; Iemma *et al*., 2018).

For instance, minimum acceptable standards for energy efficiency, cleanliness, or system reliability can be coded as constraints, ensuring that service outcomes remain within acceptable ranges. This protects organizations from the false economy of short-term cuts that degrade long-term performance. The result is a facility management system that aligns financial efficiency with consistent delivery of high-quality services, ultimately safeguarding occupant productivity, health, and well-being.

Operational resilience—defined as the capacity to absorb shocks, adapt to disruptions, and maintain continuity—is increasingly vital in today's volatile environments. The model enhances resilience by integrating risk-based prioritization into budg*et al*location. Investments in preventive maintenance, redundancy, and emergency preparedness are justified not only as safety imperatives but also as cost-optimized strategies that reduce long-term liabilities.

Simulation and scenario analysis further prepare FM teams for uncertain futures, such as energy price volatility, supply chain disruptions, or extreme weather events. By stress-testing different budget scenarios, organizations can identify vulnerabilities and adopt preemptive strategies that secure continuity of critical services. As a result, the model delivers not just cost efficiency but also robustness against disruptions, a critical differentiator in competitive and risk-prone markets.

The proposed model also strengthens stakeholder trust and satisfaction. Employees benefit from safer, well-maintained, and ergonomically optimized workplaces, which reduce stress, enhance morale, and support productivity (Groves and Marlow, 2016; Lööw *et al*., 2018). Clients experience reliable service delivery and improved user satisfaction scores, reinforcing confidence in organizational competence. Regulators, in turn, observe higher compliance rates with occupational health and safety (OHS), environmental, and quality standards, reducing the risk of sanctions or reputational damage.

By transparently linking budgets to outcomes, the model also enhances accountability in decision-making. Multi-criteria decision-making (MCDM) approaches ensure that diverse stakeholder priorities—ranging from cost control to user experience—are considered in allocation strategies. This participatory and transparent process fosters trust, reduces conflicts, and builds alignment around shared performance objectives.

Finally, the model supports organizational alignment with sustainability and environmental, social, and governance (ESG) imperatives. Energy efficiency, waste reduction, and compliance with green building standards can be directly embedded into optimization objectives. For example, investments in renewable energy, smart energy management systems, or water conservation technologies are evaluated not just as environmental add-ons but as cost-efficient strategies that yield long-term financial and reputational returns.

Moreover, social dimensions of ESG—such as employee well-being, inclusivity, and safety—are explicitly recognized through service quality benchmarks and stakeholder satisfaction metrics. Governance is reinforced through transparent decision-making and accountability in budg*et al*location. By integrating these ESG elements, the model ensures that facility management contributes to broader organizational sustainability strategies while meeting the rising expectations of investors, clients, and communities.

The expected outcomes of the budget optimization model are multifaceted, extending beyond immediate financial efficiency. Enhanced budget control reduces waste and increases transparency, while embedded service quality benchmarks ensure sustained performance. Risk-based prioritization and scenario analysis strengthen operational resilience, and stakeholder-focused strategies foster trust and satisfaction. Finally, alignment with sustainability and ESG imperatives positions facility management as a strategic contributor to long-term organizational resilience and value creation. Together, these outcomes demonstrate the transformative potential of the model, reframing facility management as a proactive, data-driven, and sustainability-aligned function.

2.5 Implementation Considerations

The success of a budget optimization model for cost-efficient facility management and service quality is contingent not only on the theoretical soundness of its design but also on the rigor of its implementation. Translating strategic intentions into measurable outcomes requires a deliberate approach that aligns leadership, organizational culture, workforce capacity, and monitoring systems (Swensen *et al*., 2016; Jabbar and Hussein, 2017). Four critical considerations underpin this process: leadership and governance structures for financial accountability, phased rollout through pilot testing and scaling, training and capacity-building for facility management teams, and robust monitoring, evaluation, and continuous improvement cycles.

Effective implementation begins with leadership commitment and sound governance structures. Senior leaders play a pivotal role in setting priorities, allocating resources, and establishing a culture of accountability. Governance mechanisms such as steering committees or oversight boards ensure that financial decisions align with organizational goals and compliance requirements. Clear lines of accountability, defined roles, and transparent reporting frameworks mitigate risks of misallocation and enhance trust among stakeholders. Leadership also sets the tone for balancing cost efficiency with service quality, ensuring that optimization efforts do not devolve into short-term cost-cutting measures that undermine long-term resilience. Furthermore, embedding financial accountability within governance structures fosters credibility with external stakeholders, including regulators, investors, and clients.

Given the complexity of facility management operations, implementation is most effective when approached in phases. Pilot testing enables organizations to trial the budget optimization model on a smaller scale, generating empirical evidence on its feasibility and impact. This stage allows for the identification of unforeseen challenges, such as system integration issues, resistance from staff, or data gaps. Feedback loops—incorporating insights from managers, employees, and end-users—inform iterative refinements. Once validated, the model can be scaled gradually across facilities or departments, ensuring lessons learned are incorporated into wider deployment (Turetken *et al*., 2017; Ståhl *et al*., 2017). This phased approach mitigates risks, builds confidence, and enhances stakeholder buy-in, all while preserving service quality throughout the transition.

A central determinant of implementation success is the capability of facility management teams. Training ensures that staff understand the principles of budget optimization, the tools employed, and their role in sustaining cost efficiency without compromising quality. Capacity-building programs should extend beyond technical training to include financial literacy, data analysis, and change management. Equipping staff with these skills empowers them to contribute proactively to optimization efforts, rather than viewing the model as an externally imposed directive. Furthermore, cross-training fosters flexibility, allowing teams to adapt quickly to evolving operational needs. Investment in workforce development not only enhances model adoption but also strengthens employee morale and retention, creating a virtuous cycle of capability and performance.

Implementation is not a one-time exercise but an ongoing process that demands regular monitoring and evaluation. Key performance indicators (KPIs) such as cost savings, service reliability, user satisfaction, and energy efficiency provide measurable evidence of progress. Evaluation frameworks should balance quantitative data with qualitative feedback, capturing both financial outcomes and experiential dimensions of service quality (Sputore and Fitzgibbons, 2017; Mbama *et al*., 2018). Importantly, monitoring systems must be designed to detect deviations early, enabling corrective action before inefficiencies escalate. Continuous improvement cycles institutionalize learning, ensuring that the model evolves alongside technological advancements, regulatory changes, and organizational priorities. Benchmarking against industry standards and peer organizations further supports adaptive refinement, positioning the organization as a leader in facility management excellence.

The implementation of a budget optimization model requires more than technical design; it demands strategic leadership, phased deployment, empowered teams, and robust monitoring systems. Leadership and governance structures ensure financial accountability, while phased rollout strategies minimize risks and maximize stakeholder engagement. Training and capacity-building equip facility management teams with the skills needed to sustain efficiency and quality, and continuous monitoring ensures adaptability and resilience. Taken together, these considerations form an integrated approach to implementation that not only optimizes budgets but also safeguards service quality, operational continuity, and organizational sustainability. By embedding these practices, organizations can transition from conceptual frameworks to operational realities, achieving enduring value in facility management.

2.6 Challenges and Mitigation Strategies

The implementation of a budget optimization model for facility management (FM) promises significant advantages, from improved cost efficiency to enhanced service quality and sustainability alignment. However, the model is not without challenges as shown in figure 3. Complex trade-offs, human and organizational resistance, technological hurdles, and cost-related barriers can all impede successful adoption. To ensure practical viability, it is essential to anticipate these challenges and design robust mitigation strategies.

A core challenge lies in balancing cost efficiency with the maintenance of service quality standards (Guillén *et al*., 2016; Wirtz and Zeithaml, 2018). Efforts to reduce costs may unintentionally erode critical aspects of facility performance, such as safety, comfort, or compliance. For example, underfunding preventive maintenance might lower short-term expenditures but lead to equipment failures, costly downtime, or safety incidents in the long run. Similarly, aggressive workforce reductions may compromise service delivery, leading to diminished user satisfaction.

Mitigation Strategy, this challenge can be addressed by embedding minimum service quality thresholds directly into the optimization framework. By defining non-negotiable performance benchmarks—such as response times, energy efficiency ratings, or compliance with ISO and OHS standards—managers can prevent cost-cutting from undermining essential outcomes. Scenario-based simulations and sensitivity analyses can further test the consequences of different cost-saving strategies, ensuring that decisions optimize both efficiency and resilience.

Figure 3: Challenges and Mitigation Strategies

Introducing a budget optimization model often requires cultural and behavioral shifts across an organization. Stakeholders—including employees, service providers, and management—may resist new processes that disrupt established routines. Resistance can stem from skepticism about the model's benefits, fear of job insecurity, or reluctance to rely on data-driven decision-making tools (Blissinga and McIntyreb, 2017; Arkhipova and Bozzoli, 2017). Such pushback risks slowing adoption and limiting the model's effectiveness.

Mitigation Strategy, change management strategies are critical. Engaging stakeholders early through participatory decision-making and transparent communication fosters trust and reduces resistance. Training programs should emphasize the model's benefits not only for the organization but also for employees' working conditions and professional development. Aligning performance incentives with optimized outcomes—such as rewarding compliance with efficiency and safety goals—can further motivate stakeholders to embrace new approaches. Leadership commitment is particularly important, as visible support from top management signals the model's strategic relevance.

The model relies heavily on accurate, real-time data to guide optimization. However, many organizations struggle with fragmented data systems, incomplete records, or inconsistent reporting practices. Integrating diverse datasets—covering costs, asset performance, energy consumption, and user satisfaction—can be technically complex and resource-intensive (Hasan *et al*., 2018; Kitchens *et al*., 2018). Without reliable data inputs, optimization tools may generate flawed insights, undermining trust in the model.

Mitigation Strategy, a phased approach to data management is recommended. Organizations should begin with a baseline assessment of available data, followed by targeted efforts to close gaps in accuracy and coverage. Investments in integrated facility management (IFM) platforms, cloud-based systems, and IoT-enabled devices can centralize data collection and improve interoperability. Establishing standardized data governance protocols—covering ownership, validation, and security—ensures long-term reliability. Additionally, applying AI and machine learning to clean and harmonize disparate datasets can reduce complexity and enhance predictive accuracy.

Although digital technologies such as IoT sensors, Building Information Modeling (BIM), and AI-driven maintenance tools offer significant optimization potential, their adoption often involves high upfront costs. Budget-constrained organizations may hesitate to invest in these technologies, particularly when return on investment (ROI) is not immediately visible. The perceived financial burden can deter decision-makers from pursuing transformation initiatives.

Mitigation Strategy, to address this challenge, organizations can adopt a staged investment approach, prioritizing high-impact, low-cost technologies before scaling up to more advanced solutions. Pilot projects demonstrating measurable savings in energy consumption or reduced downtime can build the business case for broader adoption. Lifecycle cost analyses, which highlight the long-term savings and risk mitigation benefits of digital investments, can further justify expenditures to stakeholders and boards. Moreover, exploring public–private partnerships, leasing models, or vendor-financing schemes can spread initial costs and make digital adoption more financially manageable.

While the budget optimization model offers transformative potential for facility management, its successful implementation requires proactive navigation of significant challenges. Trade-offs between cost and quality, resistance to change, data integration issues, and upfront technological costs are recurring barriers. However, these challenges are not insurmountable. Embedding service thresholds into optimization tools, fostering stakeholder buy-in through change management, investing in reliable data infrastructure, and adopting staged approaches to digital transformation can collectively ensure that the model delivers sustainable value (Omopariola and Lead, 2016; Dorgbefu, 2018). Ultimately, addressing these barriers not only secures the model's success but also enhances its role as a strategic enabler of resilient, efficient, and high-performing facility management systems.

CONCLUSION

The development of a budget optimization model for facility management demonstrates significant value in reconciling financial sustainability with service excellence. By systematically aligning cost-control measures with quality assurance mechanisms, such a model offers organizations a structured pathway to reduce inefficiencies, safeguard resources, and ensure the continuity of essential services. The framework's strength lies in its ability to provide financial discipline without compromising operational reliability, thereby enabling organizations to remain competitive while fulfilling their social and environmental responsibilities.

A critical contribution of the model is the recognition that cost-efficiency and service quality are not mutually exclusive, but complementary goals. Traditional perceptions often equated cost reduction with diminished service outcomes; however, evidence suggests that strategic approaches such as predictive maintenance, workforce optimization, lifecycle costing, and technology integration simultaneously lower expenditures and improve performance. By reframing optimization as a dual pursuit of efficiency and quality, organizations create conditions for long-term resilience, stakeholder trust, and user satisfaction.

The implications for future research and practice are substantial. Further empirical validation across diverse sectors and regions is needed to test the adaptability of budget optimization models in varied operational contexts. Comparative studies could identify best practices, while longitudinal analyses may reveal how optimization strategies influence organizational sustainability over time. For practitioners, the model underscores the importance of leadership, phased implementation, capacity-building, and continuous improvement cycles in translating theoretical design into operational success.

Ultimately, the budget optimization model advances the discourse on sustainable facility management by bridging financial stewardship with service reliability. By treating cost-efficiency and quality as synergistic rather than competing imperatives, it lays the groundwork for organizations to achieve both immediate savings and enduring value creation in an increasingly resource-conscious and performance-driven environment.

REFERENCES

[1] Ajonbadi, H.A., Lawal, A.A., Badmus, D.A. and Otokiti, B.O., 2014. Financial control and organisational performance of the Nigerian small and medium enterprises (SMEs): A catalyst for economic growth. *American Journal of Business, Economics and Management*, *2*(2), pp.135-143.

[2] Akinbola, O.A. and Otokiti, B.O., 2012. Effects of lease options as a source of finance on profitability performance of small and medium enterprises (SMEs) in Lagos State, Nigeria. *International Journal of Economic Development Research and Investment*, *3*(3), pp.70-76.

[3] Aldairi, J., Khan, M.K. and Munive-Hernandez, J.E., 2017. Knowledge-based Lean Six Sigma maintenance system for sustainable buildings. *International Journal of Lean Six Sigma*, *8*(1), pp.109-130.

[4] Alibašić, H., 2018. Sustainability and resilience planning for local governments. *The Quadruple Bottom Line Strategy. Springer, New York*.

[5] Amos, A.O., Adeniyi, A.O. and Oluwatosin, O.B., 2014. Market based capabilities and results: inference for telecommunication service businesses in Nigeria. *European Scientific Journal*, *10*(7).

[6] Arkhipova, D. and Bozzoli, C., 2017. Digital capabilities. In *CIOs and the digital transformation: A new leadership role* (pp. 121-146). Cham: Springer International Publishing.

[7] Avramchuk, A.S., 2017. The conceptual relationship between workplace well-being, corporate social responsibility, and healthcare costs. *International Management Review*, *13*(2), pp.24-31.

[8] Basri, E.I., Abdul Razak, I.H., Ab-Samat, H. and Kamaruddin, S., 2017. Preventive maintenance (PM) planning: a review. *Journal of quality in maintenance engineering*, *23*(2), pp.114-143.

[9] Bell, S.C. and Orzen, M.A., 2016. *Lean IT: Enabling and sustaining your lean transformation*. CRC Press.

[10] Bertoni, M., 2017. Introducing sustainability in value models to support design decision making: A systematic review. *Sustainability*, *9*(6), p.994.

[11] Bisogno, M., 2016. Corporate social responsibility and supply chains: contribution to the sustainability of well-being. *Agriculture and agricultural science Procedia*, *8*, pp.441-448.

[12] Blissinga, T.E. and McIntyreb, J., 2017. Adoption of big data in the Southeast Asian (SEA) insurance industry: an organizational change perspective. *Knowing Enough to Be Dangerous: The Dark Side of Empowering Employees with Data an d Tools*, p.113.

[13] Carayannis, E.G., Grigoroudis, E., Del Giudice, M., Della Peruta, M.R. and Sindakis, S., 2017. An exploration of contemporary organizational artifacts and routines in a sustainable excellence context. *Journal of Knowledge Management*, *21*(1), pp.35-56.

[14] Consigli, G., Kuhn, D. and Brandimarte, P., 2016. Optimal financial decision making under uncertainty. In *Optimal financial decision making under uncertainty* (pp. 255-290). Cham: Springer International Publishing.

[15] Custer, S., King, E.M., Atinc, T.M., Read, L. and Sethi, T., 2018. Toward Data-Driven Education Systems: Insights into Using Information to Measure Results and Manage Change. *Center for Universal Education at The Brookings Institution*.

[16] Dorgbefu, E.A., 2018. Leveraging predictive analytics for real estate marketing to enhance investor decision-making and housing affordability outcomes. *Int J Eng Technol Res Manag*, *2*(12), p.135.

[17] Dyakova, M., 2017. Investment for health and well-being: a review of the social return on investment from public health policies to support implementing the Sustainable Development Goals by building on Health 2020.

[18] Eldenburg, L.G., Wolcott, S.K., Chen, L.H. and Cook, G., 2016. *Cost management: Measuring, monitoring, and motivating performance*. John Wiley & Sons.

[19] Elmualim, A., Czwakiel, A., Valle, R., Ludlow, G. and Shah, S., 2017. The practice of sustainable facilities management: Design sentiments and the knowledge chasm. In *Design management for sustainability* (pp. 91-102). Routledge.

[20] Grabowski, Z.J., Matsler, A.M., Thiel, C., McPhillips, L., Hum, R., Bradshaw, A., Miller, T. and Redman, C., 2017. Infrastructures as socio-eco-technical systems: five considerations for interdisciplinary dialogue. *Journal of Infrastructure Systems*, *23*(4), p.02517002.

[21] Grove, H. and Clouse, M., 2018. Focusing on sustainability to strengthen corporate governance. *Corporate Governance and Sustainability Review*, *2*(2), pp.38-47.

[22] Groves, K. and Marlow, O., 2016. *Spaces for innovation: The design and science of inspiring environments*. Frame Publishers.

[23] Guillén, A.J., Crespo, A., Gómez, J.F. and Sanz, M.D., 2016. A framework for effective management of condition based maintenance programs in the context of industrial development of E-Maintenance strategies. *Computers in Industry*, *82*, pp.170-185.

[24] Gupta, S., Sharma, A. and Abubakar, A., 2018, September. Artificial intelligence–driven asset optimizer. In *SPE Annual Technical Conference and Exhibition?* (p. D012S045R001). SPE.

[25] Hasan, U., Whyte, A. and Al Jassmi, H., 2018. Life-cycle asset management in residential developments building on transport system critical attributes via a data-mining algorithm. *Buildings*, *9*(1), p.1.

[26] Iemma, U., Pisi Vitagliano, F. and Centracchio, F., 2018. A multi-objective design optimisation of eco-friendly aircraft: the impact of noise fees on airplanes sustainable development. *International Journal of Sustainable Engineering*, *11*(2), pp.122-134.

[27] Iyabode, L.C., 2015. Career development and talent management in banking sector. *Texila International Journal*.

[28] Jabbar, A.A. and Hussein, A.M., 2017. The role of leadership in strategic management. *International Journal of Research-Granthaalayah*, *5*(5), pp.99-106.

[29] Kitchens, B., Dobolyi, D., Li, J. and Abbasi, A., 2018. Advanced customer analytics: Strategic value through integration of relationship-oriented big data. *Journal of Management Information Systems*, *35*(2), pp.540-574.

[30] Kotsantonis, S., Pinney, C. and Serafeim, G., 2016. ESG integration in investment management: Myths and realities. *Journal of Applied Corporate Finance*, *28*(2), pp.10-16.

[31] Lawal, A.A., Ajonbadi, H.A. and Otokiti, B.O., 2014. Leadership and organisational performance in the Nigeria small and medium enterprises (SMEs). *American Journal of Business, Economics and Management*, *2*(5), p.121.

[32] Lawal, A.A., Ajonbadi, H.A. and Otokiti, B.O., 2014. Strategic importance of the Nigerian small and medium enterprises (SMES): Myth or reality. *American Journal of Business, Economics and Management*, *2*(4), pp.94-104.

[33] Lawal, C.I. and Afolabi, A.A., 2015. Perception and practice of HR managers toward talent philosophies and its effect on the recruitment process in both private and public sectors in two major cities in Nigeria. *Perception*, *10*(2).

[34] Lawal, C.I., 2015. Knowledge and awareness on the utilization of talent philosophy by banks among staff on contract appointment in commercial banks in Ibadan, Oyo State. *Texila International Journal of Management*, *3*.

[35] Lööw, J., Johansson, B., Andersson, E. and Johansson, J., 2018. *Designing ergonomic, safe, and attractive mining workplaces*. CRC Press.

[36] Marcelo, D., Mandri-Perrott, C., House, S. and Schwartz, J., 2016. Prioritizing infrastructure investment: a framework for government decision making. *World Bank Policy Research Working Paper*, (7674

[37] Mbama, C.I., Ezepue, P., Alboul, L. and Beer, M., 2018. Digital banking, customer experience and financial performance: UK bank managers' perceptions. *Journal of Research in interactive Marketing*, *12*(4), pp.432-451.

[38] Nagel, S., Hiss, S., Woschnack, D. and Teufel, B., 2017. Between efficiency and resilience: The classification of companies according to their sustainability performance. *Historical Social*

Research/Historische Sozialforschung, pp.189-210.

[39] Nwokediegwu, Z. S., Bankole, A. O., & Okiye, S. E. (2019). Advancing interior and exterior construction design through large-scale 3D printing: A comprehensive review. IRE Journals, 3(1), 422-449. ISSN: 2456-8880

[40] Omopariola, M. and Lead, C.D., 2016. *Zero-Trust Architecture Deployment in Emerging Economies: A Case Study from Nigeria* [online]

[41] Otokiti, B.O. and Akorede, A.F., 2018. Advancing sustainability through change and innovation: A co-evolutionary perspective. *Innovation: Taking creativity to the market. Book of Readings in Honour of Professor SO Otokiti*, *1*(1), pp.161-167.

[42] Otokiti, B.O., 2012. *Mode of entry of multinational corporation and their performance in the Nigeria market* (Doctoral dissertation, Covenant University).

[43] Otokiti, B.O., 2017. A study of management practices and organisational performance of selected MNCs in emerging market-A Case of Nigeria. *International Journal of Business and Management Invention*, *6*(6), pp.1-7.

[44] Otokiti, B.O., 2018. Business regulation and control in Nigeria. *Book of readings in honour of Professor SO Otokiti*, *1*(2), pp.201-215.

[45] Pentyala, D.K., 2018. AI-Driven Decision-Making for Ensuring Data Reliability in Distributed Cloud Systems. *International Journal of Modern Computing*, *1*(1), pp.1-22.

[46] Photovoltaic, B.I., Heating, V., House, P.P., Package, P.P.H.P., Vote, P.P.M. and Dissatisfied, P.P.P., 2018. NZEB Case Studies and Learned Lessons. *Net Zero Energy Buildings (NZEB): Concepts, Frameworks and Roadmap for Project Analysis and Implementation*, p.303.

[47] Polygerinos, P., Correll, N., Morin, S.A., Mosadegh, B., Onal, C.D., Petersen, K., Cianchetti, M., Tolley, M.T. and Shepherd, R.F., 2017. Soft robotics: Review of fluid-driven intrinsically soft devices; manufacturing, sensing, control, and applications in human-robot interaction. *Advanced engineering materials*, *19*(12), p.1700016.

[48] Robinson, R.A.J., Townsend, P., Steen, P., Barron, H., Abesser, C.A., Muschamp, H., McGrath, I. and Todd, I., 2016. *Geothermal Energy Challenge Fund: the Guardbridge Geothermal Technology Project*. The Scottish Government.

[49] Salama, S. and Eltawil, A.B., 2018. A decision support system architecture based on simulation optimization for cyber-physical systems. *Procedia Manufacturing*, *26*, pp.1147-1158.

[50] Selcuk, S., 2017. Predictive maintenance, its implementation and latest trends. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, *231*(9), pp.1670-1679.

[51] Seshan, A. and Gorain, B.K., 2016. An integrated mining and metallurgical enterprise enabling continuous process optimization. In *Innovative Process Development in Metallurgical Industry: Concept to Commission* (pp. 203-242). Cham: Springer International Publishing.

[52] SHARMA, A., ADEKUNLE, B.I., OGEAWUCHI, J.C., ABAYOMI, A.A. and ONIFADE, O., 2019. IoT-enabled Predictive Maintenance for Mechanical Systems: Innovations in Real-time Monitoring and Operational Excellence.

[53] Sputore, A. and Fitzgibbons, M., 2017. Assessing 'goodness': A review of quality frameworks for Australian academic libraries. *Journal of the australian library and information association*, *66*(3), pp.207-230.

[54] Srinivasan, V., 2016. *The intelligent enterprise in the era of big data*. John Wiley & Sons.

[55] Ståhl, D., Hallén, K. and Bosch, J., 2017. Achieving traceability in large scale continuous integration and delivery deployment, usage and validation of the eiffel framework. *Empirical Software Engineering*, *22*(3), pp.967-995.

[56] Swensen, S., Gorringe, G., Caviness, J. and Peters, D., 2016. Leadership by design: Intentional organization development of physician leaders. *Journal of Management Development*, *35*(4), pp.549-570.

[57] Tuli, F.A., Varghese, A. and Ande, J.R.P.K., 2018. Data-driven decision making: A framework for integrating workforce analytics and predictive HR metrics in digitalized environments. *Global Disclosure of Economics and Business*, *7*(2), pp.109-122.

[58] Turetken, O., Stojanov, I. and Trienekens, J.J., 2017. Assessing the adoption level of scaled

agile development: a maturity model for Scaled Agile Framework. *Journal of Software: Evolution and process*, *29*(6), p.e1796.

[59] Wetzel, E.M. and Thabet, W.Y., 2016. Utilizing Six Sigma to develop standard attributes for a Safety for Facilities Management (SFFM) framework. *Safety science*, *89*, pp.355-368.

[60] Wirtz, J. and Zeithaml, V., 2018. Cost-effective service excellence. *Journal of the Academy of Marketing Science*, *46*(1), pp.59-80.