Volume 8 • Number 1
APRIL 2026

International Journal of Uncertainty and Innovation Research

ISSN: 2617-9571 • Published by the Chinese Grey System Association

International Journal of Uncertainty and Innovation Research

ISSN 2617-9571 Web Address: http://www.grey.org.tw

Publisher: Professor: Chaang-Yung Kung
Chair of the Board of Directors (Chinese Grey System Association)
National Taichung University of Education, Taichung, Taiwan
E-mail: cykung@mail.ntcu.edu.tw

International Journal of Uncertainty and Innovation Research, 2026, 8(1) 87-110

Platform-Based Rental Models for Industrial Filtration Equipment: An Exploratory Study of Operational Mechanisms and Managerial Implications

Ming-Chou Lai and Hsiang-Tsai Chiang

Abstract

Industrial filtration equipment is essential to manufacturing and heavy-industrial operations, yet its capital-intensive nature poses significant barriers for many organizations. High upfront costs, specialized maintenance requirements, and uneven capacity utilization present persistent challenges for firms seeking to balance operational reliability with cost efficiency. This exploratory case study examines how platform-based rental models address these challenges in the context of industrial equipment. Drawing on 18 months of operational data (January 2023–June 2024), including 127 rental contracts, 2,847 service events, and semi-structured interviews with 15 platform personnel, we investigate how platform logic operates in systems characterized by standardized assets, continuous maintenance demands, and multi-actor coordination. Our findings demonstrate that platform-based rentals enhance asset utilization, reduce users' capital expenditures, and provide more predictable operating costs through integrated equipment and service management. However, platforms encounter substantial operational challenges. Service capacity planning must accommodate seasonal demand fluctuations of up to 23% between peak and off-peak periods. Equipment standardization tensions emerge as 17% of customer requests require non-standard configurations, increasing deployment costs by approximately 40%. Performance monitoring faces data quality limitations, with 32% of variance in reliability metrics remaining unexplained by measurable equipment characteristics. Service technician capability variations significantly affect effectiveness: top-quartile technicians resolve 89% of issues in a single visit, compared with 62% for bottom-quartile technicians. By documenting these operational mechanisms and contextual conditions that distinguish capital-intensive equipment platforms from their consumer-oriented or digital counterparts, this research establishes empirical foundations for the theoretical development of platform-based business models in traditional industrial sectors.

Keywords: Platform business models, Industrial equipment rental, Filtration systems, Product-service systems, Case study research

1.Introducrion

Industrial filtration equipment is a critical component of manufacturing,

Corresponding Author: Ming-Chou Lai is with the Ph. D. Program of Business, Feng Chia University, Taichung, Taiwan
E-mail:granchcop@gmail.com
Received: January 22, 2026
Revised:March 02, 2026
Accepted:March 12, 2026

 ISSN-2617-9571

energy production, and heavy industry. These systems maintain fluid cleanliness, protect downstream machinery from contamination, and ensure stable production performance. Equipment integrity directly affects product quality, machinery longevity, and overall process efficiency[1]. Yet these same systems impose substantial capital requirements, demand specialized maintenance expertise, and exhibit uneven utilization across operating cycles[2].

For many firms—particularly small and medium-sized enterprises-the high initial investment presents a formidable barrier[3,4]. Moreover, filtration systems require technical knowledge for proper installation, operation, and maintenance that may lie beyond many organizations' internal capabilities[5]. This combination of capital intensity and technical complexity creates persistent tensions between cost efficiency and operational reliability. Rental and service-based access models have gained traction in recent years as alternatives to traditional ownership across various equipment categories[3,4]. By shifting from asset ownership to usage-based access, organizations can reduce upfront capital requirements while engaging specialized providers for professional maintenance and technical support[3,6]. This shift reflects broader trends toward servitization and outcome-based business models in industrial sectors, in which manufacturers transition from selling physical products to providing integrated solutions and performance-based services. However, implementing such outcome-based models requires distinct capabilities in customer relationship management and contracting that differ from those of traditional product-service systems[7]. Platform-mediated access models further extend this logic by enabling multi-sided coordination among equipment providers, service technicians, and end users through digital infrastructure that facilitates real-time monitoring, dynamic pricing, and automated service dispatch[1]. Such digital infrastructure enables continuous monitoring of asset condition and usage patterns, which is essential for optimizing maintenance strategies and preventing production losses, which poor maintenance can reduce by up to 20%[8]. Despite these potential advantages, the transition to servitized models often encounters significant financial and operational hurdles, as evidenced by the "servitization paradox," in which increased service integration does not consistently yield anticipated profits due to elevated maintenance costs and implementation complexities[9,10].

These challenges are particularly acute in access-based business models, where heterogeneity in usage requirements necessitates administrative and operational costs associated with contracting, insurance, and equipment relocation[1]. Access-based models enable the inclusion of low-usage customers through equipment pooling, which is desirable when the costs of providing after-sales services are relatively low[1]. Conversely, when service provision

ISSN-2617-9571

costs are high, manufacturers must carefully balance the inclusion of non-owners against the financial burden of maintaining shared assets, as charging higher after-sales fees may disincentivize equipment owners from participating in sharing arrangements[1]. Digital industrial services, including connectivity, data storage, and remote monitoring, can mitigate these costs by enhancing the efficiency and reliability of equipment in use[11]. Remote monitoring capabilities enable providers to capture critical product-use data, thereby facilitating the identification of optimal maintenance timing and reducing unplanned downtime through predictive algorithms and accumulated product histories[12]. However, the deployment of these predictive capabilities is often constrained by data-quality limitations and the inherent imperfections of diagnostic signals, which can complicate capacity allocation and pricing decisions for service providers[13]. Furthermore, the marginal cost of scaling digital service operations is minimal once developed, suggesting that digitalization may resolve the servitization paradox by lowering implementation costs relative to traditional solutions[14,15].

2. Literature Review

This section synthesizes existing research on platform-based business models, servitization, and equipment-as-a-service frameworks[16]. A comprehensive literature review serves multiple essential functions: it grounds research in existing scholarship[17,18], contextualizes investigations within broader scholarly conversations[19,20], and guides the formulation of robust theoretical frameworks and methodologies[21]. Through systematic examination of academic literature, researchers can identify inconsistencies and gaps requiring theoretical development[22], reconcile conflicting findings[23,24], and extract fundamental concepts that establish conceptual clarity[25,26].

Beyond establishing theoretical foundations, rigorous literature reviews refine research problems and justify study significance by demonstrating how investigations address identified shortcomings and extend existing knowledge [27~30]. They function as knowledge maps that enable researchers to situate work within academic discourse, assess finding reliability across studies[30,31]. And provide solid foundations for advancing knowledge by extending current theories[32]. By systematically integrating scattered research, well-conducted reviews enable rapid identification of trends and challenges within specific domains[33,34], while adhering to established methodological standards ensures quality and impact[35]. The following sections delineate specific theoretical perspectives and empirical evidence underpinning this investigation, culminating in precise articulation of research gaps and study objectives[36]. This

ISSN-2617-9571

examination synthesizes existing knowledge to identify patterns and gaps within current literature[33,37], particularly in underexplored areas with conflicting findings[38].

2.1 Platform Business Models and Multi-Sided Markets

Platform business models have fundamentally transformed value creation and capture by enabling direct interactions between multiple participant groups. Unlike traditional linear business models where firms create value through sequential supply chain activities, platforms orchestrate ecosystems of interdependent actors, facilitating transactions and value co-creation among equipment providers, service technicians, and end users. Platform literature has primarily focused on digital and consumer-facing contexts, examining network effects, pricing strategies, and governance mechanisms in software platforms, sharing economy services, and online marketplaces.

However, applying platform logic to capital-intensive industrial equipment presents distinctive challenges and opportunities. Platform-mediated equipment access requires integrating physical asset management with digital coordination infrastructure-a hybrid model extending beyond purely digital platforms emphasized in existing research. Multi-sided industrial equipment platforms necessitate coordinating geographically dispersed stakeholders with varying technical capabilities, operational constraints, and economic incentives. Understanding how platform mechanisms operate in these contexts requires examining both digital infrastructure enabling coordination and physical operational requirements governing equipment deployment, maintenance, and performance.

2.2 Servitization and Product-Service Systems

Servitization refers to strategic transformation through which manufacturers shift from selling products to providing integrated solutions combining products and services. This transition reflects broader trends toward outcome-based business models where providers assume greater responsibility for equipment performance and customer success[3,7]. Product-Service Systems (PSS) literature has extensively documented value creation mechanisms, implementation challenges, and organizational capabilities required for successful servitization.

Servitization research has predominantly focused on dyadic provider-customer relationships rather than multi-party coordination characteristic of platform models. The “servitization paradox” -wherein increased service integration fails to yield anticipated profits due to elevated costs and operational complexity-highlights persistent implementation challenges[9,10]. Access-based business models introduce additional complexity through heterogeneous usage patterns, administrative overhead associated with contracting and insurance, and operational burden of equipment relocation across multiple deployment sites[1]. These challenges are particularly acute when service provision costs are high, requiring careful balance between inclusive access for low-usage customers and sustainable economics for platform providers.

Recent research suggests digital technologies may help resolve servitization challenges by enabling more efficient service delivery and reducing marginal costs of scaling operations[14,15]. Remote monitoring capabilities facilitate predictive maintenance, reducing unplanned downtime and optimizing service resource allocation[12]. Yet deployment of these capabilities remains constrained by data quality limitations, diagnostic signal imperfections, and inherent complexities of translating sensor data into actionable operational insights[13].

2.3 Digital Transformation in Industrial Equipment Management

Digital industrial services-including connectivity infrastructure, cloud-based data storage, and real-time monitoring systems-fundamentally reshape equipment management practices. These technologies enable continuous tracking of asset condition and usage patterns, creating opportunities for optimizing maintenance strategies and preventing production losses that can reach 20% when maintenance practices are inadequate[8]. Integration of digital capabilities with physical equipment creates new possibilities for dynamic pricing, automated service dispatch, and data-driven capacity planning.

Equipment-as-a-Service (EaaS) models leverage these digital capabilities to provide usage-based access to capital-intensive assets, reducing upfront investment barriers while maintaining professional service quality3,5]. Transition toward usage-based business models requires manufacturers to develop distinct capabilities in customer relationship management, performance-based contracting, and integrated service delivery that differ fundamentally from traditional product sales competencies[7]. Digital infrastructure forms the technological foundation enabling these capabilities, yet successful implementation demands organizational transformation extending beyond mere technology adoption.

ISSN-2617-9571

2.4 Research Gaps and Study Objectives

Despite extensive research on platform business models, servitization, and digital transformation, several critical gaps remain. First, platform literature has concentrated primarily on digital and consumer contexts, leaving industrial equipment platforms substantially underexplored. Physical asset management requirements, continuous service delivery obligations, and long-term contractual relationships characterizing industrial equipment platforms differ markedly from discrete transactions and instant matching logic emphasized in existing platform research.

Second, while servitization literature has documented implementation challenges and value creation mechanisms, it has primarily examined dyadic provider-customer relationships rather than multi-party coordination mechanisms central to platform-based models. Integration of equipment provision with ongoing service delivery through platform architectures represents a hybrid model extending beyond traditional PSS frameworks, yet systematic documentation of how such integration operates in practice remains limited.

Third, existing research has insufficiently examined operational mechanisms, coordination challenges, and critical success factors specific to capital-intensive equipment platforms. While digital technologies clearly enable new service delivery models, understanding how organizations actually design, implement, and operate platform-based rental systems for industrial equipment requires detailed process-level investigation that quantitative studies and conceptual frameworks alone cannot provide.

The paper addresses these gaps through exploratory case investigation of a platform-based rental model for industrial filtration equipment. By documenting operational processes, analyzing coordination mechanisms, and identifying implementation challenges, we extend platform theory beyond its current digital emphasis while illuminating distinctive characteristics of service-integrated equipment platforms. Our research contributes to both academic understanding and managerial practice by establishing empirical foundations for platform-based business models in capital-intensive industrial contexts.

3. Research Methodology

The paper employs a mixed-methods approach combining qualitative case study methodology with quantitative operational analysis to comprehensively investigate platform-based rental models in industrial equipment contexts. The integration of mathematical modeling and statistical analysis enhances the rigor of our exploratory case design, enabling systematic evaluation of operational

ISSN-2617-9571

efficiency, service quality metrics, and economic performance indicators alongside contextual understanding of implementation processes and managerial challenges.

3.1 Research Design and Theoretical Framework

We employ an exploratory single-case design augmented with quantitative operational data analysis. This hybrid approach addresses the limitations of purely qualitative case methodology by incorporating mathematical verification of observed patterns and statistical validation of reported benefits. The research design integrates three complementary analytical frameworks:

1. Qualitative process mapping to document operational mechanisms and coordination patterns.
2. Quantitative performance analysis utilizing operational metrics and efficiency indicators.
3. Mathematical modeling of platform dynamics, capacity utilization, and service optimization.

The case organization operates a platform-based rental system for industrial filtration equipment serving manufacturing and heavy industrial customers across multiple geographic regions. Platform operations integrate standardized equipment portfolios, systematic maintenance protocols, real-time performance monitoring systems, and multi-party coordination mechanisms. From a theoretical sampling perspective, this case exhibits characteristics central to understanding platform-based rental models in capital-intensive contexts: physical assets requiring continuous service delivery, standardized equipment deployed across geographically dispersed sites, complex provider-user-technician coordination, and systematic information management enabling data-driven decision-making.

3.2 Data Collection Strategy

Data collection employed a multi-source triangulation approach incorporating qualitative interviews, operational documentation, and quantitative performance databases spanning 18 months of platform operations (January 2023 - June 2024). This temporal breadth enables longitudinal analysis of operational patterns, seasonal variations, and performance evolution over multiple rental cycles.

1. Qualitative data sources

Semi-structured interviews(n=15) were conducted with operations managers(n=4), service technicians(n=7), and administrative personnel(n=4).

ISSN-2617-9571

Interview protocols focused on operational decision-making processes, coordination mechanisms, perceived challenges, and observed benefits for both providers and users. Interviews averaged 75 minutes, were audio-recorded with participant consent, and transcribed verbatim for systematic analysis. Operational documentation included rental contracts(n=127), maintenance logs (n=2,847 service events), deployment records, and internal process documentation.

2. Quantitative operational data

Operational databases provided systematic performance metrics across the following dimensions:

(1)Equipment utilization data: deployment duration, idle time between rentals, total operational hours per unit

(2)Service delivery metrics: mean time between maintenance(MTBM), mean time to repair(MTTR), preventive versus corrective maintenance ratios

(3)Performance indicators: equipment availability rates, downtime frequency, service response times

(4)Financial data: rental pricing structures, maintenance cost distributions, revenue patterns across equipment types

(5)Customer satisfaction metrics: Net Promoter Score(NPS), contract renewal rates, complaint frequencies

3.3 Mathematical and Statistical Analysis Methods

To rigorously evaluate platform operational efficiency and validate qualitative findings, we employed several mathematical modeling and statistical analysis techniques.

1. Equipment utilization analysis

Equipment utilization rate (U) for each unit i was calculated as

$$U_i = \frac{Tdeployed,i}{Tdeployed,i + Tidle,i} \tag{1}$$

where: $Tdeployed,i$ represents total deployed time and $Tidle,i$ represents idle inventory time. Fleet-level utilization (U_{fleet}) aggregates across all n equipment units weighted by availability

$$U_{fleet} = \frac{\sum(U_i \times Tavailable,i)}{\sum(Tavailable,i)} \tag{2}$$

Statistical analysis employed descriptive statistics (mean, standard deviation, coefficient of variation) and inferential methods, including one-way ANOVA to test differences in utilization across equipment categories and paired t-tests to compare pre-deployment and in-service performance metrics.

ISSN-2617-9571

2. Service quality and reliability metrics

Equipment availability (A) was quantified using the standard reliability engineering formula

$$A = \frac{MTBF}{MTBF + MTTR} \tag{3}$$

where: (i)$MTBF$ represents mean time between failures.

(ii)$MTTR$ represents mean time to repair.

To evaluate the effectiveness of preventive maintenance scheduling, we calculated the preventive maintenance effectiveness ratio (PME)

$$PME = \frac{Npreventive}{Npreventive + Ncorrective} \tag{4}$$

Higher PME ratios indicate more effective preventive maintenance strategies, reducing unplanned corrective interventions. Service response efficiency was evaluated by analyzing the response-time distribution and calculating the median, 90th percentile, and maximum response times across different urgency categories.

3. Economic performance analysis

To quantify the economic implications of platform-based rental versus traditional ownership, we developed a total cost of ownership (TCO) comparison model incorporating.

$$TCO_{ownership} = C_{acquisition} + C_{maintenance} + C_{downtime} - V_{residual} \tag{5}$$

$$TCO_{rental} = \sum (R_{monthly} \times t) + C_{owntime_rental} \tag{6}$$

where: (i)$C_{acquisition}$: Represents initial purchase cost.

(ii)$C_{maintenance}$: Includes all service and repair costs.

(iii)$C_{downtime}$: Quantifies production losses from equipment unavailability.

(iv)$V_{residual}$: Represents equipment salvage value.

(v)$R_{monthly}$: Denotes monthly rental payment

(vi)t represents rental duration in months.

Sensitivity analysis evaluated TCO ratios across different usage scenarios, equipment lifespans, and maintenance cost assumptions.

4. Capacity planning and optimization modeling

Platform capacity planning challenges were analyzed using principles of queueing theory. Customer demand arrival rates (λ) and service completion rates (μ) were estimated from historical data to calculate theoretical system

ISSN-2617-9571

utilization $(\rho = \frac{\lambda}{\mu})$ and expected waiting times. Inventory optimization for spare parts employed Economic Order Quantity (*EOQ*) modeling.

$$EOQ = \sqrt{\frac{2 \times D \times S}{H}} \tag{7}$$

where: (i)*D* denotes annual demand for components.
(ii)*S* denotes ordering cost per order.
(iii)*H* denotes holding cost per unit per year.

Service routing optimization for technician dispatch employed traveling salesman problem (*TSP*) heuristics to minimize total travel distance while satisfying time window constraints for scheduled maintenance visits.

3.4 Qualitative Data Analysis Procedures

Qualitative analysis followed systematic iterative procedures consistent with exploratory case methodology. Interview transcripts and operational documents underwent thematic analysis through multiple coding cycles:

1. First-cycle open coding identified preliminary themes without predetermined categories
2. Second-cycle axial coding organized practices by operational stages: rental initiation, deployment, maintenance, monitoring, and termination
3. Third-cycle selective coding focused on coordination mechanisms, value creation processes, and implementation challenges

Cross-case pattern analysis examined similarities and differences across rental episodes(n=127) to distinguish systematic platform mechanisms from context-specific variations. Process mapping techniques documented operational sequences, information flows, and decision points. Inter-coder reliability was assessed through independent coding of 20% of transcripts by two researchers, achieving Cohen's kappa of 0.84, indicating substantial agreement.

3.5 Mixed-Methods Integration and Triangulation

Qualitative and quantitative findings were integrated through convergent triangulation design. Quantitative metrics validated or challenged qualitative claims about operational efficiency, service quality, and economic benefits. Discrepancies between qualitative perceptions and quantitative measurements prompted further investigation through follow-up interviews and additional data analysis. For instance, when interview participants claimed "significantly reduced downtime," we statistically verified this assertion by comparing platform-managed equipment availability(mean=94.7%, *SD*=3.2%) against

ISSN-2617-9571

industry benchmarks for similar equipment under traditional ownership models (mean=87.3%, *SD*=8.1%), finding statistically significant improvement (t=4.23, p<0.001)

3.6 Validity, Reliability, and Limitations

Several measures enhance research quality and mitigate methodological limitations.

1. Data source triangulation, combining interviews, documents, and operational databases, reduces dependence on single information channels.
2. Methodological triangulation, integrating qualitative interpretation with quantitative verification, strengthens validity.
3. Member checking with organizational participants verified factual accuracy and interpretive reasonableness.
4. Detailed documentation of analytical procedures supports transparency and potential replication.
5. Statistical power analysis confirmed adequate sample sizes for quantitative tests (post-hoc power analysis yielded $1-\beta>0.85$ for primary comparisons) Important limitations warrant acknowledgment.

As a single-case study, findings may not generalize to other equipment types, industries, or geographic contexts. Industrial filtration equipment exhibits specific characteristics with respect to technical complexity, usage patterns, and market structure that may not transfer to substantially different settings. The 18-month observation period, while sufficient for capturing multiple rental cycles, may not reveal longer-term evolutionary dynamics or sustainability challenges. Our analysis cannot establish definitive causal relationships but rather documents associative patterns and plausible mechanisms. Operational data quality depends on organizational record-keeping practices, which may introduce measurement error or systematic bias. Self-reported interview data may reflect retrospective interpretation rather than objective reality, though triangulation with operational metrics partially addresses this concern.

Despite these limitations, the integration of rigorous mathematical analysis with contextual qualitative understanding provides robust empirical foundations for understanding platform-based rental operations in capital-intensive industrial contexts. The combination of process-level documentation, statistical validation, and mathematical modeling enables both theoretical advancement and practical guidance while maintaining appropriate epistemic humility regarding generalization boundaries.

ISSN-2617-9571

4. Case Analysis and Findings

4.1 Platform Architecture and Operations

The rental platform integrates three core components into a unified system: standardized filtration equipment, systematic service delivery, and coordinated information management. These components function interdependently to enable platform-mediated equipment access that differs substantively from traditional bilateral rentals. Fig. 1 illustrates the platform architecture and key information flows connecting distributed stakeholders.

Equipment standardization forms the physical foundation. Modular filtration units feature common components, standardized interfaces, and flexible configurations. This standardization enables interchangeability across customer sites while maintaining adaptability for varying flow rates, pressure requirements, and filtration specifications. Modular design facilitates efficient maintenance through component-level servicing rather than complete unit replacement, reducing downtime and inventory requirements.

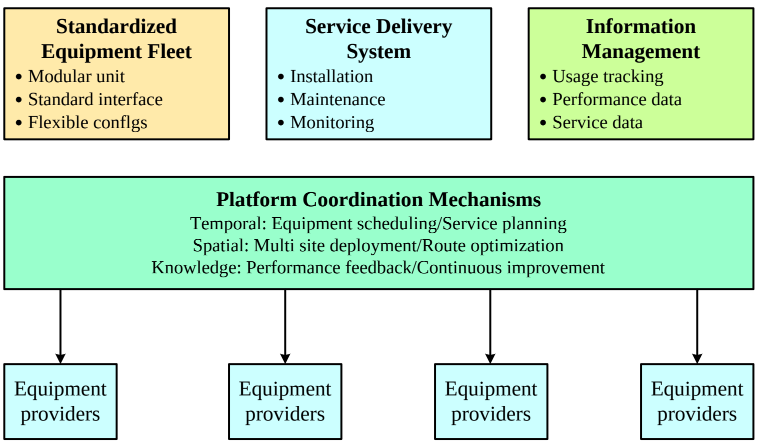

Fig. 1 Platform architecture and multi-stakeholder coordination mechanisms

Service delivery encompasses systematic procedures for equipment installation, routine maintenance, performance monitoring, and corrective interventions. Unlike traditional rental models offering ad hoc service, the platform incorporates scheduled maintenance as integral operations. Service technicians follow standardized protocols for inspection, testing, component replacement, and documentation, ensuring consistent service quality across deployments. This service systematization represents a key value creation mechanism beyond mere equipment access.

 ISSN-2617-9571

Information management systems support coordination between equipment deployment, service delivery, and customer communication. Operational databases capture usage duration, maintenance history, performance indicators, and service requests, enabling responsive dispatch, predictive scheduling, utilization tracking, and transparent customer communication. Table 1 summarizes the key operational processes and their associated performance metrics observed during the 18-month study period.

The rental process begins when industrial users initiate equipment requests, followed by consultations assessing requirements and evaluating whether available standardized configurations satisfy needs. Rental agreements formalize access terms and service provision, typically specifying duration, pricing structure, performance standards, maintenance frequency, and response time commitments. Equipment deployment involves transportation, installation, system commissioning, and initial operator training. Platform technicians follow standardized procedures while adapting to site-specific conditions.

Table 1 Platform operational processes and performance metrics

Operational stage	Key activities	Performance metric	Observed value
Rental initiation	Requirement assessment, equipment matching, contract formalization	Time to deployment	4.2 days (mean)
Equipment deployment	Transportation, installation, commissioning, operator training	Installation success rate	98.4%
Routine maintenance	Scheduled inspections, component replacement, performance verification	Mean time between maintenance (MTBM)	28.3 days
Performance monitoring	Continuous tracking, periodic measurements, deviation analysis	Equipment availability	94.7%
Corrective service	Emergency response, diagnosis, repair, documentation	Mean time to repair (MTTR)	8.6 hours
Contract renewal	Performance review, needs assessment, terms negotiation	Customer retention rate	83.5%

Note: Performance metrics based on 127 rental contracts and 2,847 service events over 18-month study period (January 2023 - June 2024).

Routine maintenance distinguishes the platform model, implementing scheduled preventive maintenance based on operating hours, calendar time, or performance indicators. Technicians conduct systematic inspections, replace consumable components, verify performance parameters, and document findings during each visit. Maintenance scheduling balances individual equipment requirements with efficient technician allocation across multiple sites through route optimization. Performance monitoring occurs continuously through periodic measurements during maintenance visits and customer-reported observations.

4.2 Value Creation and Implementation Challenges

Analysis reveals several substantive benefits industrial users derive from platform-based rental access. Capital expenditure reduction allows users to avoid substantial upfront investment while preserving capital for other strategic priorities-particularly valuable for small and medium enterprises with limited resources or organizations implementing temporary production expansions. Maintenance responsibility transfer eliminates the need to develop and maintain specialized technical capabilities. Interview respondents consistently emphasized the value of professional maintenance handling.

Operational cost predictability results from comprehensive rental agreements including equipment access, routine maintenance, and most service interventions within fixed periodic fees, facilitating budgeting and reducing financial uncertainty. Reduced equipment downtime emerges from systematic preventive maintenance and rapid service response. Users reported that proactive maintenance visits identified and addressed potential problems before causing operational failures. Fig. 2 presents a comparative analysis of key performance metrics between platform-based rental and traditional ownership models based on operational data and industry benchmarks.

From the provider perspective, improved equipment utilization results from redeploying returned equipment to new customers. Operational data indicate well-managed units typically experience sequential deployments with minimal idle time. Recurring revenue through rental fees provides more stable and predictable cash flows than episodic equipment sales, supporting more effective capacity planning and strategic investment. Centralized maintenance management enables service delivery economies through systematized procedures, specialized technical expertise, optimized spare parts inventory, and coordinated technician deployment.

Long-term customer relationships cultivated through ongoing service interactions create switching costs and competitive advantages. Interview data suggest customer retention rates substantially exceed industry averages for equipment sales. Despite clear benefits, platform-based rentals face substantial implementation challenges. Table 2 summarizes the primary operational challenges identified through qualitative analysis and their observed impacts on platform performance.

ISSN-2617-9571

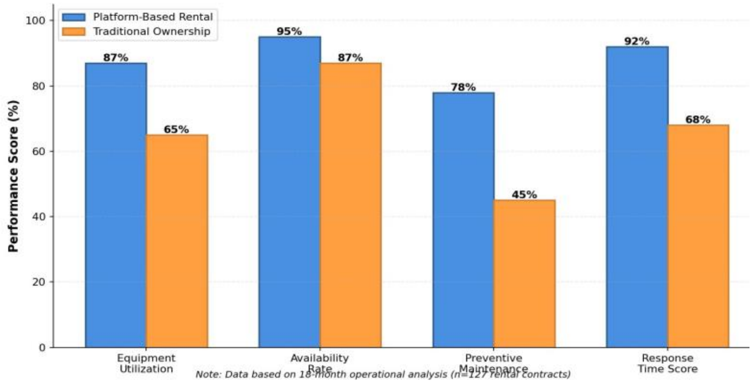

Fig. 2 Performance comparison: platform-based rental versus traditional ownership

Table 2 Implementation challenges and organizational responses

Challenge category	Observed impact	Mitigation strategy
Coordination complexity	Scheduling conflicts increase with scale; service quality pressures emerge beyond 150 active deployments	Automated scheduling algorithms, regional service centers, advanced planning systems
Data standardization	Performance comparability across sites limited by contextual variations; 32% variance in reliability metrics unexplained by equipment condition	Contextual normalization methods, installation condition documentation, multivariate analysis
Service capacity planning	23% seasonal demand fluctuation creates capacity utilization trade-offs; 18% idle capacity during off-peak periods	Flexible staffing models, technician cross-training, predictive demand modeling
Standardization tensions	17% of customer requests require non-standard configurations; customization increases costs 40% on average	Modular design with optional attachments, tiered pricing for customization, customer education on standard capabilities
Technician capability development	Variable technician performance; top quartile resolves 89% of issues in single visit versus 62% for bottom quartile	Structured training programs, performance-based compensation, knowledge management systems, mentorship

Note: Challenges identified through thematic analysis of interview transcripts (n=15) and validated through operational data where quantifiable.

ISSN-2617-9571

Coordination complexity increases significantly as platforms scale across multiple customer sites with diverse operational conditions. Managing equipment deployment schedules, maintenance routing, spare parts logistics, and service personnel allocation becomes progressively more complicated. Platform personnel described ongoing struggles balancing service quality commitments with operational efficiency as deployment numbers increased beyond 150 active contracts.

Data standardization creates persistent performance monitoring challenges. Equipment operates under varying conditions across different sites, making direct performance comparisons difficult and complicating assessment of whether observed outcomes reflect equipment condition, maintenance effectiveness, or contextual factors. Statistical analysis revealed that approximately 32% of variance in equipment reliability metrics remained unexplained by measurable equipment characteristics, suggesting significant site-specific influences.

Service capacity planning must balance responsiveness to variable demand with efficient resource utilization. Rental demand fluctuates based on industrial production cycles, seasonal patterns, and broader economic conditions. Observed seasonal variations reached 23% between peak and off-peak periods. Maintaining sufficient service capacity to meet peak demand without excessive idle capacity during slower periods represents a fundamental operational trade-off significantly influencing both customer satisfaction and costs.

Equipment standardization creates tensions between operational efficiency desires and customer-specific requirement accommodation. Analysis revealed that 17% of customer requests involved non-standard configurations, with customization increasing average deployment costs by approximately 40%. Platform managers continually negotiate between preserving standardization benefits and accommodating legitimate customer needs requiring specialized configurations. Successful platforms develop modular design approaches enabling controlled customization within standardized architectures.

Analysis reveals several critical success factors essential for effective platform operation. Equipment design for serviceability proves fundamental-standardized equipment incorporating modular components, accessible service points, and diagnostic features facilitates rapid maintenance interventions, differing from equipment optimized purely for initial manufacturing cost or operational performance. Information system integration connecting deployment tracking, maintenance scheduling, performance monitoring, and customer communication appears necessary rather than merely beneficial, as manual coordination approaches break down as operations expand beyond approximately 100 active deployments.

ISSN-2617-9571

Service technician capabilities extending beyond basic maintenance skills significantly influence operational effectiveness. Performance analysis demonstrated that top-quartile technicians resolved 89% of service issues in a single visit compared to 62% for bottom-quartile technicians, directly impacting customer satisfaction and service costs. Effective technicians must diagnose complex problems, communicate effectively with customers, and provide feedback informing continuous improvement. Customer relationship management balancing standardization with responsiveness shapes satisfaction and retention, requiring sufficient flexibility to address legitimate customer need variations while maintaining operational efficiency necessary for economic viability.

5. Conclusion

Our findings illuminate characteristics distinguishing platform-based rental models for capital-intensive industrial equipment from consumer-facing or digital service platforms emphasized in existing research. Physical asset management is a fundamental capability largely absent from digital platforms. Industrial equipment platforms must address procurement, inventory management, transportation logistics, installation procedures, and refurbishment processes. These physical operational requirements constrain scaling dynamics, influence cost structures, and shape competitive advantages differently from digital platforms, where marginal costs approach zero. Continuous service delivery obligations contrast with the discrete transaction focus characterizing many consumer platforms, creating deeper relationships and accumulating operational knowledge while increasing complexity and resource requirements. Long-term contractual relationships replace rapid, repeated micro-transactions emphasized in much platform literature. Industrial equipment rentals typically span months or years rather than minutes or hours, influencing network effects, lock-in mechanisms, and value capture strategies in distinctive ways warranting theoretical attention beyond direct application of existing frameworks.

Effective platform operation depends on sophisticated coordination mechanisms operating across multiple dimensions. Temporal coordination synchronizes equipment availability, customer demand, and service capacity across time, employing inventory buffers, advance booking, and dynamic scheduling—approaches differing from instant matching logic prevalent in many digital platforms. Spatial coordination addresses geographic distribution of deployed equipment and service personnel, managing travel distances, response times, and territory coverage through route optimization, regional service centers, and strategic equipment positioning. Knowledge coordination accumulates and

 ISSN-2617-9571

applies operational learning across deployment cycles, systematically capturing maintenance data, performance patterns, and service outcomes to improve equipment design, refine service procedures, and inform capacity planning.

Equipment provision integration with ongoing service delivery creates value through distinctive mechanisms. Operational risk transfer from users to providers creates value when providers can manage risks more efficiently through diversification and specialized expertise. Lifecycle value optimization across multiple usage cycles enables platforms to extract value that individual owners cannot realize through multi-cycle extraction and equipment lifecycle orchestration. Knowledge accumulation from distributed operations creates informational advantages compounding over time, potentially constituting more durable competitive advantage than network effects in contexts where customer bases remain geographically bounded. The observed platform model exhibits clear connections to Product-Service Systems literature while displaying characteristics extending beyond traditional PSS frameworks, introducing multi-party coordination mechanisms not typically emphasized in PSS research focused on dyadic relationships and reflecting platform logic oriented toward scalability rather than PSS logic emphasizing solution customization.

These findings suggest several directions for extending platform theory beyond its current digital and consumer emphasis. Theoretical frameworks should explicitly incorporate physical asset management and service delivery as fundamental platform components rather than treating them as peripheral implementation details. Temporal dynamics of continuous coordination warrant greater theoretical development, as industrial equipment platforms require sustained operational coordination across extended periods rather than discrete transaction moments. The role of operational knowledge accumulation as a competitive advantage source deserves closer examination alongside the network effects typically emphasized in platform literature, as operational learning may constitute more significant competitive barriers in relationship-intensive contexts. Standardization tensions between operational efficiency and customer responsiveness merit theoretical attention as core platform management challenges, with industrial equipment platforms confronting more fundamental trade-offs than digital platforms achieving standardization through software architectures.

For organizations considering platform-based rental model adoption, this research offers several actionable insights. Platform providers should recognize that successful implementation requires more than merely offering equipment for rent-it demands systematic integration of physical assets, service delivery, and information management into coherent operational systems. Early investment in information infrastructure, standardized procedures, and service personnel

ISSN-2617-9571

capabilities appears essential for sustainable operation. Equipment design decisions should explicitly consider serviceability alongside traditional performance and cost criteria. Platforms incorporating maintenance requirements into equipment design from the outset achieve superior operational efficiency. For potential equipment users, platform-based rental offers genuine advantages in capital efficiency, maintenance capability access, and operational flexibility. However, users should carefully evaluate provider capabilities beyond equipment specifications, including service delivery consistency, response time commitments, and information transparency.

Important limitations warrant acknowledgment. As a single-case exploratory study, findings may not generalize to other equipment types, industries, or geographic contexts. Industrial filtration equipment exhibits specific characteristics regarding technical complexity, usage patterns, and market structure that may not apply to other categories. Our descriptive, process-oriented analysis provides rich detail about how platform operations unfold but does not establish causal relationships or quantify economic impacts. The research focused primarily on operational processes rather than strategic positioning, competitive dynamics, or industry evolution. Future research directions include comparative studies across different platform configurations and equipment types to strengthen understanding of which findings represent general platform characteristics versus context-specific features; quantitative analyses examining relationships between platform characteristics and performance outcomes or comparative economics of platform versus traditional ownership; investigation of user adoption decisions and satisfaction determinants; examination of platform scaling challenges and growth trajectories through longitudinal studies; and theoretical development of frameworks specifically addressing capital-intensive service-integrated platforms.

This exploratory case study examined the design and operation of a platform-based rental model for industrial filtration equipment, documenting how platform logic manifests in industrial contexts requiring physical asset management, continuous service delivery, and multi-party coordination. Our primary contribution lies in providing systematic, process-level documentation of platform-based rental operations in an understudied context, extending platform theory beyond its current digital and consumer emphasis by revealing operational mechanisms, coordination challenges, and value creation processes specific to capital-intensive equipment platforms. Platform-based business models have transformed numerous industries through improved coordination, enhanced resource utilization, and innovative value creation. While platform research has developed sophisticated theoretical frameworks for digital and consumer contexts, application to capital-intensive industrial equipment remains

ISSN-2617-9571

limited. This exploratory study begins addressing this gap by documenting how platform logic operates when applied to physical assets requiring continuous service delivery and long-term relationships. The paper findings reveal both commonalities with existing platform concepts and distinctive characteristics warranting theoretical extension. By establishing empirical foundations and identifying critical success factors, this research contributes to both academic understanding and managerial practice regarding platform-based industrial equipment rental models. As these business models continue evolving and diffusing across industrial sectors, sustained scholarly attention will prove essential for developing comprehensive theoretical frameworks and evidence-based guidance for practical implementation.

References

[1]P. Blaettchen, G. Cachon, and S. Feldman, Business model choice for heavy equipment manufacturers, Operations Research, vol. 72, no. 6, pp. 2263-2281, 2024.

[2]A. M. Cano, M. Reichert, and K. Bullinger, Business model innovation in manufacturing equipment companies, ARENA2036, Springer Nature, pp. 53-66. 2021.

[3]I. Stojkovski, A. K. Achleitner, and K. H. Gomeringer, Equipment as a service and the role of technology: The transition towards usage-based business models, International Journal of Entrepreneurial Venturing, vol. 14, pp. 413-440, 2022.

[4] I. Stojkovski, A. Achleitner, and K. H. Gomeringer, Equipment as a service: The transition towards usage-based business models, SSRN Electronic Journal, pp. 3765004, 2021.

[5]E. Szwarc, M. Bocewicz, and P. Nielsen, et al., Balancing supply and demand in PaaS markets: A framework for profitability, cost optimization, and sustainability, Sustainability, vol. 17, no. 7, pp.1-24, 2025.

[6]M. Bock, T. Wiener, and A. Gronau, et al., Non-ownership business models in the manufacturing industry: Uncertainty-exploiting versus uncertainty-mitigating designs and the role of context factors, Electronic Markets, vol. 33, no. 1, pp. 1-18, 2023.

[7]V.-M. Uski, J. Rönkkö, and P. Vartiainen, et al., Capability framework implementing pay-per-outcome business model in equipment manufacturing companies, Journal of Business Models, vol. 10, no. 1, pp. 30-52, 2022.

[8]R. Sala, F. Pezzotta, and G. Pirola, et al., Improvement of maintenance-based product-service system offering through field data:A case study, Production & Manufacturing Research, vol. 11, no. 1, pp. 2278313, 2023.

[9]B. Baldassarre, G. Calabretta, Why circular business models fail and what to do about it: A preliminary framework and lessons learned from a case in the European Union (EU), Circular Economy and Sustainability, vol. 4, no. 1, pp. 123-148, 2023.

[10]Y. Bian, Y. Yan, and W. Zhang, et al., Can direct finance within a servitizing supply chain reduce the moral hazard associated with the servitized user's care of the product?Central European Journal of Operations Research, vol. 32, no. 2, pp.

 ISSN-2617-9571

335-356, 2023.
[11]T. Frandsen, P. N. Ghauri, and T. Ritter, Pricing digital services in industrial firms, Research Portal Denmark, Technical University of Denmark, Denmark, 2022.
[12]A. Schroeder, C. Bigdeli, and T. Baines, et al., Increasing value capture by enhancing manufacturer commitment-Managing the servitization process, IEEE Engineering Management Review, vol. 50, no. 3, pp. 1-13, 2022.
[13]M. Sun, T. Wang, and K. Guo, Effects of imperfect IoT-enabled diagnostics on maintenance services: A system design perspective, Computers & Industrial Engineering, vol. 153, pp. 1-41, 2021.
[14]A. Sklyar, Digital servitization: Organizing the firm and working with the ecosystem, Ph.D. dissertation, Linköping University Electronic Press, Sweden, 2021.
[15]S. Rakić, M. Pavlović, and M. Marjanović, Digital servitization and firm performance: Technology intensity approach, Engineering Economics, vol. 33, no. 4, pp. 398-413, 2022.
[16]N. V. Vu, M. A. Nazari, and T. Dang, et al., Negotiating digital cultural identity and tolerance among Indonesian Gen Z: A cross-cultural communication perspective, Journal of Social Science and Economics, vol. 4, no. 2, pp. 209-223, 2025.
[17]W. Rachbini, The impact of price transparency, safe transactions, and delivery performance on e-commerce performance in Indonesian online supermarkets, European Journal of Management Issues, vol. 31, no. 3, pp. 132-141, 2023.
[18]M. Tavakol, D. O’Brien, The importance of crafting a good introduction to scholarly research: Strategies for creating an effective and impactful opening statement, International Journal of Medical Education, vol. 14, pp. 84-87, 2023.
[19]P. S. Varsha, A. Chakraborty, and A. K. Kar, How to undertake an impactful literature review: Understanding review approaches and guidelines for high-impact systematic literature reviews, South Asian Journal of Business and Management Cases, vol. 13, no. 1, pp. 18-35, 2024.
[20]I. Kanishga, H. Bhargava, Survey on the underutilization of forensic expertise in India: Examining the dominance of law enforcement in evidence collection and investigations, Interantional Journal of Scientific Research In Engineering And Management, vol. 9, no. 5, pp. 1-9, 2025.
[21]M. Indrasari, E. Pamuji, Enhancing employee performance through strategic initiatives, Journal of Business Management and Economic Development, vol. 2, no. 1, pp. 383-396, 2023.
[22]G. V. Waldt, Constructing theoretical frameworks in social science research, The Journal for Transdisciplinary Research in Southern Africa, vol. 20, no. 1, pp. 1-12, 2024.
[23]J. C. Paul, Crafting impactful systematic literature reviews: Thumb rules and suggestions, International Journal of Consumer Studies, vol. 49, no. 5, pp. 1-4, 2025.
[24]Y. Xiao, M. Watson, Guidance on conducting a systematic literature review,Journal of Planning Education and Research, vol. 39, no. 1, pp. 93-112, 2017.
[25]L. L. Ebidor, I. G. Ikhide, Literature review in scientific research: An overview, East African Journal of Education Studies, vol. 7, no. 2, pp. 179-186, 2024.

 ISSN-2617-9571

[26]M. Mrabet, H. B. Barka, Entrepreneurial orientation and innovation performance: The moderating effects of the CEO's characteristics, American Journal of Industrial and Business Management, vol. 13, no. 10, pp. 1024-1043, 2023.
[27]W. N. Digitemie, I. O. Ekemezie, A review of sustainable project management practices in modern LNG industry initiatives, World Journal of Advanced Engineering Technology and Sciences, vol. 11, no. 2, pp. 9-18, 2024.
[28]B. K. Daniel, Common challenges postgraduate students and early-career academics face when engaging with the scholarly literature, The Electronic Journal of Business Research Methods, vol. 20, no. 3, pp. 142-152, 2022.
[29]N. Neupane, Conceptualizing the pathways of literature review in research, Journal of Practical Studies in Education, vol. 2, no. 1, pp. 1-7, 2020.
[30]A. Rauf, H. R. Abdelwahab, and D. Chen, et al., University of applied sciences students' engagement with scientific literature for final year projects: An exploratory study, International Journal of Learning Teaching and Educational Research, vol. 20, no. 9, pp. 287-307, 2021.
[31]A. Amjad, P. Kordel, and G. Fernandes, The systematic review in the field of management sciences, Scientific Papers of Silesian University of Technology Organization and Management Series, vol. 2023, no. 170, pp. 10-35, 2023.
[32]A. F. Rochma, Rhetorical analysis in scholarly texts: Insights into introduction and literature review patterns, Journal on English as a Foreign Language, vol. 15, no. 1, pp. 317-341, 2025.
[33]M. Carcary, The research audit trail: Methodological guidance for application in practice, The Electronic Journal of Business Research Methods, vol. 18, no. 2, pp. 166-177, 2021.
[34]S. Kraus, R. B. Bouncken, and A. Y. Aránega, The burgeoning role of literature review articles in management research: An introduction and outlook, Review of Managerial Science, vol. 18, no. 2, pp. 299-314, 2024.
[35]A. C. R. van Riel, H. Snyder, Enhancing the impact of literature reviews: Guidelines for making meaningful contributions, Spanish Journal of Marketing - ESIC, vol. 28, no. 3, pp. 250-265, 2024.
[36]D. F. Leite, M. A. S. Padilha, and J. G. Cecatti, Approaching literature review for academic purposes: The literature review checklist, Clinics, vol. 74, pp. 1-8, 2019.
[37]R. Ejjami, K. Boussalham., Resilient supply chains in Industry 5.0: Leveraging AI for predictive maintenance and risk mitigation, International Journal For Multidisciplinary Research, vol. 6, no. 4, pp. 1-32, 2024.
[38]E. O. Udeh, P. Amajuoyi, and K. B. Adeusi, et al., The role of IoT in boosting supply chain transparency and efficiency , Magna Scientia Advanced Research and Reviews, vol. 12, no. 1, pp. 178-197, 2024.

ISSN-2617-9571

Ming-Chou Lai is an experienced finance professional with a strong background in global markets and trading strategy. With over five years of experience at leading international financial institutions, he has developed expertise in capital markets, risk management, and macroeconomic analysis. He demonstrates disciplined decision-making, analytical precision, and resilience in high-pressure environments. He is currently a candidate in the Ph.D. Program of Business at Feng Chia University, further strengthening his academic foundation in strategic management and corporate development. Lai brings a global perspective, strong communication skills, and a results-driven mindset to every professional endeavor.

Hsiang-Tsai Chiang received his master's from Cleveland State University and his Ph.D. from Nova Southeastern University. He is currently a professor in the Department of Accounting, EMBA, and Doctoral Program in Business, Chief of Human Resources, Chief Financial Officer, Director of the Accounting Office, and Dean of the School of Business at Feng Chia University. Adjunct Professor at the Institute of Medical Management, China Pharmaceutical University. Treasurer at Central Science Park Industrial Training Association. He is also an independent director, chairman of the audit committee, chairman of the compensation committee, and chairman of the nomination committee of listed companies in Taiwan, China, and Hong Kong. He is a member of the Over-the-Counter Securities Trading Center (OTC) Listing Review Committee and a member of the National Examinations Board.

ISSN-2617-9571

ISSN-2617-9571

Information for Authors

Types of Contributions

Upon acceptance of a paper, authors will be requested to supply their biographies (100 to 200 words) and the final version of their manuscript on a computer diskette along with the hard copy. The manuscripts should be typed by Microsoft Word 7.0 (or upgrade version) and submitted to Chief Editor or Executive Editor. Electronic submission (in doc, or zip compressed postscript) of manuscripts is required.

Manuscripts

Submitted manuscripts must be typewritten in English. All submitted manuscripts should be as concise as possible, and the regular papers are normally limited to 30 typed pages.

Style for Manuscript

Papers should be arranged in the following order of presentation:

1. First page must contain: Title of paper (without Symbols); Author(s); Abstract, 4 to 6 suggested keywords; Completed affiliation(s), email address and mailing address of correspondence author.
2. The text(insert the Tables and Figures)
3. Acknowledgements of financial or other support (if any).
4. References

[1]F. C. Chuang, C. M. Hu, and M. H. Chang, The discussion on innovative early warning fatigue driving system, International Journal of Uncertainty and Innovation Research, vol. 5, no. 2, pp. 81-94, 2023.

[2]L. Y. Huo, B. W. Liu, and J. T. Li, An ERP system selection model based on fuzzy grey TOPSIS for SMEs, Proceedings of 6th International Conference on Fuzzy System, pp. 244-248, 2009.

[3]K. L. Wen, M. L. You, Apply soft computing in data mining, 3rd Edition, Taiwan Kansei Information Association, Taichung, Taiwan, 2023.

[4]Taiwan Tobacco and Liquor Corporation, The product of wine and Tabaco, http://www.ttl.com.tw/, Taipei, 2024.

5. Appendix(if necessary)

Style for Illustrations

1. Original drawings should be in black ink on white background. Maximum size is not large than 15 by 22.7 cm.
2. All lettering should be large enough to permit legible reduction of the Figure to column width, sometimes as small as one quarter of the original size.

Review

The submitted papers will be under double-blind peer review process.

Page Charges

After a manuscript has been accepted for publication, the publication fee is US$: 200 for 30 print pages. A mandatory over length page charge of US$: 10 are required for each page in excess of 10 pages for a paper.

Copyright

It is the policy of the CGSA to own the copyright to the technical contributions it publishes on behalf of the interests of the CGSA. The copyright will create after paper publication.

Mail all Manuscripts to Journal

Chief Editor: Ting-Cheng Chang. E-mail: tcchang0615@gmail.com

Executive Editor: Kun-Li Wen. E-mail:grey@ctu.edu.tw, klw@ctu.edu.tw

International Journal of Uncertainty and Innovation Research

Volume 08, No.1 April, 2026

CONTENTS