

Maximizing After Sales Service and Service Recovery to Increase Customer Satisfaction (Literature Review of Industrial Control System customers in Indonesia)

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ABSTRACT: After-sales service (ASS) and service recovery (SR) are increasingly recognized as critical elements in sustaining customer satisfaction and supplier credibility. While prior studies have examined these concepts across consumer and manufacturing sectors, their specific role in Industrial Control Systems (ICS) remains underexplored, particularly within the Indonesian context. ICS represents a high-value, capital-intensive asset that requires continuous operation and long-term supplier support, making after-sales activities a strategic necessity. This study aims to analyze the extent to which ASS and SR contribute to strengthening customer satisfaction and safeguarding supplier reputation in the ICS sector. Unlike earlier research that largely repackages established concepts, this paper critically frames the unique challenges of ICS such as warranty limitations, post-warranty risks, and the vulnerability of installed bases to highlight gaps in both theory and practice. The methodology employed is a structured literature review, drawing from peer-reviewed journals indexed in Scopus, Google Scholar, and Semantic Scholar, complemented with ICS technical references and supplier documentation. From this synthesis, the paper develops a conceptual framework positioning ASS and SR as antecedents of customer satisfaction, which subsequently reinforces supplier reputation and long-term loyalty in capital-intensive industries. The study concludes that effective ASS and SR are not only operational requirements but also strategic levers that determine competitiveness. By contextualizing these concepts within ICS in Indonesia, the research contributes a more critical perspective and offers both theoretical insights and practical implications for sustaining supplier–customer relationships.

Keywords: ICS, Installed Base, After Sales Service, Service Recovery, Satisfaction.



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INTRODUCTION

After-sales service (ASS) has increasingly become a strategic dimension in sustaining business competitiveness. In a globalized economy where technological advancement and customer expectations evolve rapidly, companies cannot rely solely on product quality to ensure survival and

growth. Instead, they must complement product delivery with comprehensive after-sales services that assure customers of reliability, long-term support, and adaptability. Numerous studies highlight that effective after-sales service strengthens customer satisfaction, enhances loyalty, and contributes to maintaining the credibility and reputation of suppliers in highly competitive markets ([Aljabar & Hasibuan, 2021](#))

The scope of after-sales service extends beyond the provision of repair and maintenance. It encompasses product installation, training, troubleshooting, technical consultation, warranty management, spare parts provision, and even system upgrades ([Wang & Chang, 2018](#)). These activities ensure that customers derive continuous value from their investments and that products can be utilized optimally under varying conditions. The significance of after-sales service also lies in its ability to generate feedback loops, where customer insights become valuable inputs for suppliers to innovate, refine products, and tailor services. In this way, ASS is not only reactive but also proactive in shaping the long-term relationship between suppliers and users.

Alongside ASS, the concept of service recovery (SR) has gained attention in service management literature. SR refers to the systematic efforts undertaken by suppliers to resolve failures, restore customer confidence, and prevent dissatisfaction from escalating into reputational damage. When executed effectively, SR contributes directly to customer trust and loyalty, demonstrating the supplier's commitment to accountability and responsiveness ([Nilsson & Sandberg E, 2010](#)). In the context of business-to-business (B2B) markets, where transactions are complex and investments in equipment are significant, the integration of ASS and SR into a holistic service strategy is essential for ensuring operational continuity and safeguarding long-term supplier–customer relationships ([Mohamed Ali, 2020](#)).

This study focuses on the Industrial Control System (ICS) sector, which represents a critical component of industrial automation and process management. ICS technologies are deployed in various capital-intensive industries, including energy, petrochemicals, water treatment, manufacturing, and infrastructure. These systems enable automated monitoring and control of industrial processes, often operating under strict requirements of efficiency, safety, and reliability. The operational environment of ICS is characterized by its demand for uninterrupted functionality, where systems must run continuously to support production cycles that cannot tolerate downtime. In such contexts, after-sales service and service recovery play a crucial role in mitigating risks, ensuring compliance with safety standards, and sustaining productivity ([Sunarya & Jamaludin, 2022](#)).

The provision of warranties is one of the most common mechanisms through which suppliers formalize their commitment to product quality and customer assurance. Warranties typically cover repairs, spare parts, or replacements within a specified period, reflecting the manufacturer's confidence in the durability of its products ([Posumah, 2022](#)). Beyond their economic function of reducing financial risks for customers, warranties also symbolize a contractual form of trust, reinforcing the legitimacy of the supplier in the eyes of users. In sectors such as ICS, warranties reduce the risks associated with complex technologies, minimize downtime, and provide users with technical support during the adaptation and evaluation phase. In doing so, warranties indirectly strengthen brand reputation and promote repeat purchasing decisions.

However, challenges inevitably emerge when the warranty period expires. Users of ICS often face uncertainty about the continuity of technical support, especially when systems are geographically distant from service offices. Suppliers that adopt short-term strategies may exploit this gap by offering costly services, thereby straining relationships with customers. Such practices not only risk losing the installed base but also jeopardize long-term competitiveness. Since industrial control systems are high-value, long-life assets, losing the installed base could mean losing opportunities for the next decade. This highlights the importance of long-term after-sales strategies that extend beyond the warranty period, focusing instead on sustainable service models that balance customer affordability with supplier profitability ([Dunković & Knežević, 2023](#)).

Despite the recognized importance of ASS and SR, gaps remain in the literature regarding their specific impact on customer satisfaction and supplier reputation in the ICS sector, particularly in emerging economies such as Indonesia ([Gustafsson, 2009](#)). While existing studies broadly affirm the relevance of after-sales services, fewer have addressed how these practices interact with service recovery strategies to secure the installed base and protect long-term supplier–customer relationships in technologically demanding industries. Moreover, the majority of research tends to emphasize consumer markets rather than B2B contexts, leaving a lack of empirical and conceptual exploration in sectors where system reliability and supplier support are paramount.

Although a growing body of research has examined after-sales service (ASS) and service recovery (SR), much of the literature has concentrated on consumer markets or general manufacturing settings ([Mohamed Ali, 2020](#); [Wang & Chang, 2018](#)). Prior studies typically address service speed, complaint handling, or customer retention strategies, but rarely engage with the complexity of industrial B2B contexts. In particular, research seldom highlights how ASS and SR function in high-value, capital-intensive sectors where the risks of downtime, technology obsolescence, and warranty expiration are critical factors. Moreover, empirical and conceptual studies on ASS and SR in emerging economies remain limited, with the majority of insights derived from developed markets. This indicates a clear gap: the lack of systematic analysis of how ASS and SR interact to influence customer satisfaction and supplier reputation in Industrial Control Systems (ICS), where operational continuity and long-term supplier–user relationships are crucial.

This study therefore aims to examine the role of after-sales service and service recovery in shaping customer satisfaction and safeguarding supplier reputation within the ICS sector in Indonesia. By employing a literature review approach, it synthesizes findings from peer-reviewed journals, technical references, and industry reports to develop an integrative perspective. In doing so, the research contributes to both theory and practice: theoretically, by addressing the gap in service management literature concerning industrial automation systems; and practically, by offering insights for suppliers and users on how to optimize relationships throughout and beyond the warranty period. Ultimately, this study underscores the strategic value of ASS and SR as essential components of marketing and operational strategies in sustaining competitiveness in the industrial services sector.

METHOD

This study adopts a structured literature review approach to examine the role of after-sales service (ASS) and service recovery (SR) in Industrial Control Systems (ICS). The review process was conducted in three stages involve scholarly sources, including indexed journals and technical literature on ICS. First, relevant academic sources were identified from major databases such as indexed journals, complemented with ICS technical manuals, industry reports, and supplier documentation. To ensure quality and credibility, only peer-reviewed journal articles, conference papers, and authoritative books published between 2015–2024 were included, with a focus on B2B service management and industrial automation.

Second, the selected literature was screened based on relevance to key themes: (1) definitions and dimensions of ASS, (2) approaches to SR in B2B contexts, (3) links between ASS, SR, customer satisfaction, and supplier reputation, and (4) evidence specific to capital-intensive or ICS-related industries. Studies that did not address service management or lacked applicability to industrial contexts were excluded.

Third, the literature was analyzed through thematic categorization. Concepts were grouped into clusters—such as warranty management, complaint handling, technical support, downtime risks, and supplier–customer relationships—and critically synthesized to identify theoretical gaps. This step enabled the development of a conceptual framework positioning ASS and SR as antecedents of customer satisfaction, which in turn strengthens supplier reputation and loyalty in the ICS sector ([Marinković & Kalinić, 2017](#)).

In addition to secondary sources, insights were enriched through informal discussions with managers from ICS suppliers and agents handling technologies such as Distributed Control Systems (DCS), Safety Instrumented Systems (SIS), Programmable Logic Controllers (PLC), Power Control Systems (PCS), and Supervisory Control and Data Acquisition (SCADA). These perspectives provided contextual depth and ensured alignment with real-world practices in industries including oil and gas, power generation, petrochemicals, water treatment, textiles, and other process-based sectors.

RESULT AND DISCUSSION

The results of this research and discussion will explain several things that are closely related to the title of the literature study.

Industrial Control System (ICS).

Industrial Control Systems (ICS) serve as integrated platforms for controlling and monitoring industrial operations in sectors such as energy, petrochemicals, and process manufacturing. ([Aslam et al., 2024a; Nasution et al., 2010](#)). ([Aslam et al., 2024](#)). They typically incorporate components including Human–Machine Interfaces (HMI), Distributed Control Systems (DCS), Safety Instrumented Systems (SIS), and Programmable Logic Controllers (PLC), which are interconnected with sensors and actuators to facilitate automation and operational safety.

In a survey conducted by Frost and Sullivan, a business consulting firm based in Mountain View, California that is involved in market research and analysis including providing training to several industries in Asia Pacific including Indonesia, it was shown that the ability to provide good technical services is one of the keys for users in choosing a particular ICS. The results of a survey of key influencers conducted by Frost and Sullivan in Asia Pacific on ICS users showed that of the 6 key influencers, there was a service factor (servicing capabilities) as one of the important keys besides technology and performance factors (Bento, 2018).

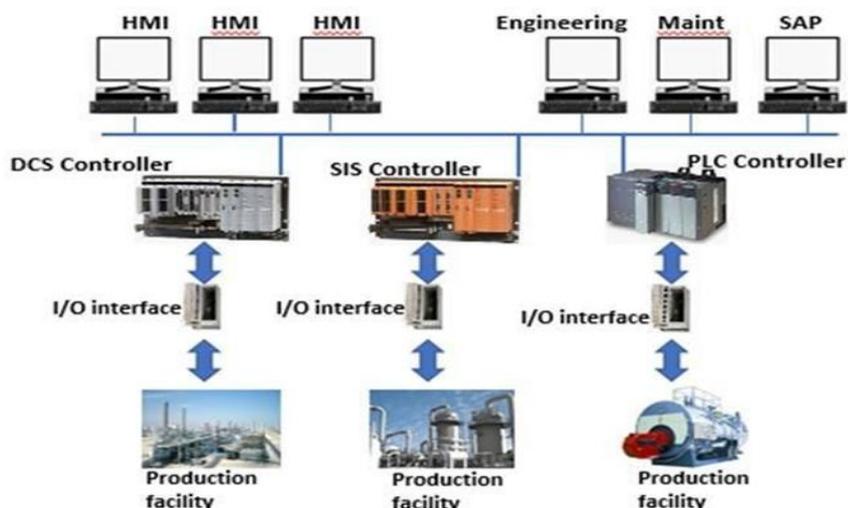


Figure 1. DCS configuration system

The survey results (figure 2) show that from several key influencers that Frost and Sullivan are concerned about. What is shown by ICS consultants, shows that the hardware capabilities of each ICS brand are no longer something that ICS users should doubt. All brands have their own advantages including the standardization recommended by the industrial

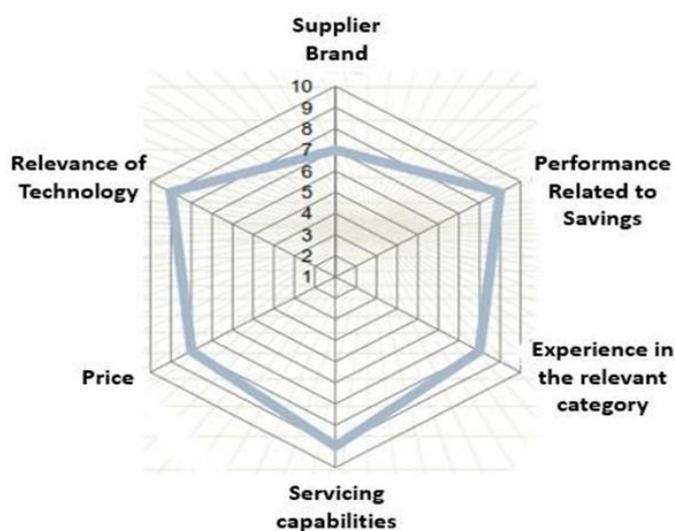


Figure 2. Results of ICS user survey (Frost and Sullivan, 2019).

world standard before the product is marketed. The survey results confirm that after-sales service plays a significant role in enhancing customer satisfaction, consistent with prior studies that

emphasize its impact on supplier credibility and long-term customer loyalty. In general, ICS hardware has met international standards in several categories such as:

1. Safety and Security Standards

The implementation of rigorous safety and security standards ensures operational reliability and minimizes risks, which directly strengthens customer trust and satisfaction in Industrial Control System services. For ICS customers in Indonesia, compliance with international safety and cybersecurity protocols is not only a regulatory requirement but also a key factor that enhances confidence, leading to higher perceived service quality and customer satisfaction ([Lin et al., 2020](#)). Known as IEC 61508, which is a Standard for functional safety in electronic and electrical systems. Relevant for the development and certification of SIS Safety Instrumented Systems).

- Determines the level of safety integrity (Safety Integrity Level, SIL).
- Supports the design of systems such as SIS, which are often used with DCS and PLCs.
- Also compliance to meet IEC 61511 which is a derivative Standard
- of IEC 61508, specifically for Safety Instrumented Systems in the process industry, such as chemical and oil/gas.

2. Having the ISA/IEC 62443 standard in ICS is crucial as it provides a comprehensive framework to safeguard systems against cyber threats while ensuring operational safety, thereby enhancing reliability and customer satisfaction. ISA/IEC 62443 Standard which is a cybersecurity standard for ICS, namely with tasks including:

- Protection of DCS, SCADA, and PLC networks from cyber threats.
- Focus on cyber risk management and security integration in ICS design.

3. Interoperability and Communication Standards

Interoperability and Communication Standards such as IEC 61131 and IEC 61850 ensure seamless integration and effective data exchange between diverse industrial control devices, enabling consistent performance and improved system reliability. IEC standards are a set of guidelines developed and published by the International Electrotechnical Commission (IEC). These IEC standards cover various aspects of electrical, electronic and related technologies, such as electrical safety, labeling, performance and test methods.

IEC 61131 Standard for Programming Logic Controllers (PLC):

- Sets a standard programming language for PLCs (ladder diagram, function block diagram, structured text, etc.).
- Supports interoperability between devices from different vendors.

IEC 61850 Communication standard for electrical automation:

- Used primarily in power systems (substation automation), but its principles also apply to SCADA.

- Ensures interoperability with modern protocols such as Ethernet.

Modbus, Profibus, OPC UA (Open Platform Communications Unified Architecture)

- Communication protocols often used in ICS.
- OPC UA is a modern protocol that supports secure connections and cross-platform communication.

4. Industry Specific Standards.

Standards such as API RP 554, ANSI/ISA 95, and NIST SP 800-82 play a vital role in maintaining the performance and integrity of ICS, including SCADA, DCS, and PLC systems. By providing structured guidelines for process control, integration, and cybersecurity, these standards help ensure system reliability, efficiency, and resilience against operational and security risks.

- API RP 554 (American Petroleum Institute)

Guidelines for the design and management of Distributed Control Systems (DCS) in the oil and gas industry.

- ANSI/ISA-95 (American National Standards Institute/International Society of Automation).

Standard for the integration of control systems and enterprise management systems (Enterprise Control System Integration).

- NIST SP 800-82 (National Institute of Standard and Technology Special Publication)

5. Standards for Monitoring and Operation

- IEC 62591 (Wireless / HART)

Wireless communication standard for the integration of SCADA devices and sensors.

- IEC 62337

Standard for commissioning automation systems, including SCADA, DCS, and PLCs.

ICS also has specific reliability performance requirements ([Shahzad et al., 2014](#)) and uses operating systems, applications and procedures such as those owned by information technology. These requirements are top priorities including process management where if not implemented properly, it will pose a risk to production facilities, health and safety risks to human life including environmental damage. This is something that ICS users always avoid, because it not only causes losses as explained, but also has the potential to tarnish the user's reputation. In short, ICS is a critical asset in modern industrial control and automation. It enables real-time monitoring and control of complex industrial processes by distributing control tasks across the system. By integrating with other systems and providing advanced control strategies, ICS can improve efficiency, reliability and safety in a variety of industrial applications.

Installed Base

The installed base refers to the population of customers that actively utilize a company's equipment or services. Managing this base is critical because it represents both the foundation of future revenue and the benchmark for customer trust. Rather than merely preventing equipment failure, suppliers are required to adopt a strategic approach that combines continuous monitoring of system performance with an understanding of evolving user requirements. Effective installed base management therefore entails segmentation of assets, identification of obsolete units, and timely renewal or replacement strategies. These activities enable suppliers to optimize resource allocation and sustain measurable performance outcomes.

From the user perspective, expectations extend beyond the warranty period. Industrial Control System (ICS) customers prioritize operational continuity and reliability, even in the absence of formal coverage. They anticipate sustained support in the form of technical consultation, software updates, and spare parts provision, which reflects their need to minimize downtime and extend asset life. The willingness of users to pay for such services illustrates a market opportunity for suppliers to design post-warranty service models that are both cost-effective and value-adding. Instead of being reactive, suppliers who critically frame installed base management as a long-term partnership can reinforce customer satisfaction, protect their brand reputation, and secure competitive advantage in capital-intensive industries.

Beyond its relevance to operations, marketing, and service strategy, the discussion of after-sales service (ASS) and service recovery (SR) in Industrial Control Systems (ICS) can also be enriched through the perspective of service design. Service design literature emphasizes how services should be systematically structured, mapped, and delivered in order to create value for customers while ensuring efficiency and consistency for providers. Core concepts such as service blueprinting, customer journey mapping, and touchpoint management provide analytical tools to understand how service interactions are experienced by users and how they can be improved.

Applied to the ICS context, this perspective highlights that extended warranties, maintenance contracts, training, and modernization programs are not only technical or contractual arrangements but also designed experiences that shape customer perceptions. For example, the design of a warranty process involves clear communication of terms, accessibility of claims procedures, and alignment with customer risk expectations. Similarly, the structuring of maintenance contracts can be analyzed through service blueprinting, which identifies bottlenecks, critical touchpoints, and opportunities for co-creation between supplier engineers and customer operators. Training programs further illustrate how service design supports knowledge transfer by framing the learning journey of customer staff, while modernization initiatives can be aligned with customer journey mapping to ensure smooth transitions across system life cycles.

Integrating service design into the analysis therefore solidifies the disciplinary alignment of this study. It demonstrates that ICS after-sales and recovery mechanisms are not only operational imperatives or strategic levers but also designed systems of interaction that require careful planning and continuous improvement. By linking ASS and SR with service design literature, this research strengthens its contribution to both theory and practice, positioning ICS as a domain where

complex service architectures must be intentionally crafted to sustain satisfaction, reputation, and long-term competitiveness ([Aslam et al., 2024b](#))

The above expectations arise because users are concerned with:

- High repair costs.

If damage occurs after the warranty period, users are worried about facing very expensive repair or component replacement costs.

- Availability of Spare Parts

Replacement parts or components may be difficult to obtain or take a long time to deliver. This concern is even greater if the ICS is an old model or if the manufacturer has stopped producing certain parts.

- Unexpected Downtime

System failures that are not handled quickly can cause operational shutdowns, resulting in major financial losses. As is known, ICS are often used in operations that require high continuity, so downtime is a serious risk.

- Lack of Technical Support.

Manufacturers may no longer provide full technical support, especially if the system used is outdated. Suppliers and users may have difficulty finding experts or consultants to help repair or maintain the system.

- Decreased System Performance

Over time, ICS components may experience performance degradation that can affect system efficiency and accuracy. Minor damage that is not immediately repaired can cause bigger problems in the future.

- Technology Obsolescence

The ICS technology used is obsolete compared to new types, thus reducing the user's competitiveness in the market. Modern industry is very dynamic, with new technologies constantly emerging to improve efficiency and safety.

The expectation of ICS user concerns is an opportunity for suppliers to continue to innovate in after-sales service and service recovery when something happens. Suppliers should not remain silent because what is a negative issue can continue to become negative word of mouth. Various actions can be taken by users if they feel that unsolved ICS problems will be the concern of their top management. Complaining to the local supplier company is one consideration to get a solution to the problem as soon as possible. Experience shows that top management of ICS users is more confident in utilizing the relationship they have built with supplier management when discussing ICS procurement for the first time.

Something that is really avoided by ICS users in certain processes is not stopping operations when the supplier is carrying out the recovery process for the ICS that is having problems. Stopping a

process that causes production facilities to be disrupted is a big problem for ICS users. Like all other engineering equipment, control systems require careful planning and design to handle every predictable situation, including ICS failure. No technology is perfect, so the types of failures must be identified and mitigated with certain efforts to avoid losses on the user.

After Sales Service

When the warranty period ends, Industrial Control System (ICS) users continue to expect reliability, technical support, and efficient maintenance solutions. In B2B industrial markets, these expectations reflect not only customer needs but also strategic opportunities for suppliers to safeguard the installed base and maintain long-term relationships. Addressing such expectations requires suppliers to go beyond standard service delivery and adopt structured service solutions. The following mechanisms—extended warranty, maintenance contracts, training, and modernization—can be critically evaluated as instruments of customer retention and reputation building.

Extended Warranty

An extended warranty is a contractual arrangement that prolongs the standard coverage period, often at additional cost ([Kim & Nayakankuppam, 2023](#)). From an academic perspective, extended warranties function as risk-transfer mechanisms that reduce customer uncertainty regarding asset reliability. For suppliers, they generate additional revenue streams while reinforcing customer trust and loyalty ([Paays, 2024](#)).

The effectiveness of extended warranty programs depends on the alignment between pricing strategies and customer segmentation. Customers with critical production facilities may prefer comprehensive protection despite higher costs, while others may demand more basic, cost-effective plans. Literature suggests that flexibility in warranty design increases perceived fairness and empowers users to make rational choices ([Dunković & Knežević, 2023](#)).

Thus, the extended warranty is not only a commercial add-on but a signal of supplier accountability. By institutionalizing responsibility for performance over an extended lifecycle, suppliers strengthen reputation and mitigate the risk of installed base erosion.

Maintenance Contract

A maintenance contract formalizes preventive and corrective service provision through scheduled inspections, spare-part replacement, and response-time guarantees. Rather than being seen as routine activities, maintenance contracts represent a structured governance mechanism that regulates the supplier–customer relationship ([Febrian et al., 2024](#)) and distributes risks of system downtime.

From an academic lens, these contracts enable suppliers to institutionalize trust while offering measurable service outcomes. The components of such contracts often include:

1. Work schedules and routine inspections, ensuring system performance is continuously monitored.
2. Status checks and environmental assessments, which support compliance with reliability standards.
3. Provisions for emergency response, crucial for geographically distant users.
4. Alignment with regulatory frameworks, especially in highly regulated industries such as oil, gas, and pharmaceuticals.
5. Knowledge transfer through expert support, allowing organizational learning on the user side.

The critical evaluation of maintenance contracts shows that they are not only operational tools but also strategic assets for ensuring compliance, reducing unplanned downtime, and enhancing resilience in capital-intensive operations.

Training and Competence Development

Training represents an investment in human capital for both suppliers and customers. By equipping internal staff with technical and managerial competencies, organizations reduce dependency on external service providers and enhance their adaptive capacity.

From an analytical standpoint, training functions as a knowledge-transfer process that contributes to organizational learning and resilience. Periodic training (e.g., every six months) ensures customer engineers remain updated with system operation, troubleshooting, and maintenance standards. Such programs also build customer confidence in long-term system utilization while indirectly reinforcing supplier reputation as a reliable knowledge partner.

Hence, training should not be viewed merely as a service offering but as part of a capability-building strategy, enhancing collaboration and co-creation of value between suppliers ([Siemieniako et al., 2025](#)) and users in the ICS ecosystem.

System Modernization

Modernization addresses challenges of technological obsolescence and cyber vulnerability in ICS. It includes audits, upgrades, and replacements that ensure alignment with evolving production requirements and security standards ([Frankó et al., 2020](#) ; ([Frankó et al., 2020](#); [Ghazali & Anuar, 2017](#)).

A critical evaluation shows that modernization can be conceptualized as part of lifecycle management. Beyond technical improvements, modernization influences the total cost of ownership (TCO), operational efficiency, and alignment with customer strategic objectives. Incorporating cybersecurity audits further ensures compliance and resilience in critical infrastructure such as energy, transportation, and water treatment systems.

Rather than being reactive, modernization strategies should be planned collaboratively, ensuring that system upgrades contribute not only to efficiency but also to long-term partnership sustainability between suppliers and users

Taken together, these four mechanisms highlight that after-sales service in ICS contexts must be framed not as isolated commercial offerings but as integrated strategic levers. Extended warranties secure accountability, maintenance contracts formalize risk-sharing, training builds organizational competence, and modernization sustains system relevance over time. Each of these solutions contributes to customer satisfaction while simultaneously protecting supplier reputation and competitiveness.

By critically reframing after-sales service in this manner, the analysis demonstrates that managing post-warranty expectations is not simply about meeting technical needs. Instead, it reflects the strategic co-dependence between suppliers and users, where sustainable relationships, reputation management, and long-term value creation are at stake

Service Recovery

Service recovery has long been recognized as a fundamental determinant of customer satisfaction. In industrial markets, where failures often carry significant operational and financial consequences, recovery efforts become even more critical. Research highlights that the quality of a supplier's service recovery has a direct and significant effect on customer satisfaction: the stronger the recovery response, the higher the resulting level of customer trust and loyalty ([Mohamed Ali, 2020](#)). In this sense, service recovery is not merely a corrective action but a strategic mechanism that contributes to safeguarding supplier reputation.

In the context of Industrial Control Systems (ICS), service recovery poses particular challenges. Failures frequently occur in critical production processes, where downtime or system instability may lead to high costs, reputational damage, or even regulatory non-compliance. Users often experience heightened anxiety when alarms or malfunctions emerge, particularly if these relate to safety or continuous operations. In such situations, the role of suppliers extends beyond technical expertise to include effective communication and relationship management. Prompt responses grounded in accurate system data—such as alarm logs, performance indicators, or failure histories—are essential for initial diagnosis and for reassuring customers that corrective measures are underway.

Scholars such as recovery ([Johnston & Michel, 2008](#)) emphasize that fair treatment and transparency during recovery processes are crucial in sustaining customer confidence. Failures should therefore be reframed not solely as operational setbacks but as opportunities to demonstrate accountability, strengthen relationships, and capture organizational learning. Similarly, [Dovaliene et al., 2007](#) argue that in B2B relationships, recovery should be viewed as an ongoing process of trust-building, where long-term relational capital is as important as short-term technical fixes ([Dovaliene et al., 2007](#))

Based on prior studies and practice, three principles emerge as central to effective service recovery in ICS contexts. First, empathetic communication is essential. This involves listening actively, acknowledging the user's concerns, and maintaining professionalism without adopting a defensive stance. Second, problem validation and explanation ensures that complaints are taken seriously, supported by factual evidence from system data, and accompanied by clear updates on remedial steps. Third, collaborative resolution highlights the need to involve cross-functional expertise—

from engineering and service teams to project management—to design effective and timely solutions. By condensing earlier long lists of suggested practices into these three analytical dimensions, service recovery can be understood more systematically and with greater academic clarity.

When handled effectively, complaints provide more than an opportunity to restore system performance; they serve as feedback loops that test the supplier's commitment to improvement. As (Marr & Schiuma, 2003) note, well-managed complaints can transform negative experiences into sources of competitive advantage. In ICS contexts, two dimensions of satisfaction can be observed. Functional satisfaction arises when recovery allows production to continue with minimal disruption, for example, through online troubleshooting that prevents downtime. Emotional satisfaction stems from users' confidence that suppliers support not only system reliability but also the personal accountability of managers responsible for production assets and their key performance indicators (KPIs).

Ultimately, service recovery in ICS should be interpreted as both a technical and relational practice. It provides immediate solutions to failures while also reinforcing long-term customer loyalty and protecting supplier credibility. By approaching recovery through the lenses of empathy, validation, and collaboration, suppliers can turn service failures into opportunities for value creation and strategic differentiation.

Customer Satisfaction

Customer satisfaction is defined as the consumer's assessment of how well a product or service fulfills expectations and delivers a positive level of fulfilment resulting from consuming a product and service. On the other hand, it is considered that Satisfaction is the result of expectations, while expectations partly come from previous experiences (Susilo & Ikhsan, 2020). Expectations come from experiences, which can be adjusted to the benefits to customers. Kotler argues that Satisfaction is a kind of customer cognitive assessment process that compares actual product performance and expectations, while say that Customer Satisfaction is basically a customer's assessment of the extent to which a product or service meets expectations or fails (Ahyani, 2023).

Customer satisfaction is widely understood as the consumer's evaluative response to the extent a product or service fulfill expectations (Pandey, 2024). In line with Expectancy-Disconfirmation Theory, satisfaction arises when actual performance meets or exceeds prior expectations, while failure to do so leads to dissatisfaction. In the context of Industrial Control Systems, this perspective is particularly relevant since reliability, service recovery, and warranty coverage directly shape user expectations and their subsequent disconfirmation. Furthermore, drawing on Service-Dominant Logic, customer satisfaction can also be viewed as the outcome of value co-creation between suppliers and users through ongoing service interactions, technical support, and collaborative problem-solving. By integrating these theoretical perspectives, satisfaction is not only an emotional or functional response but also a strategic construct linking after-sales service and service recovery to long-term supplier reputation.”

In relation to After-Sales Service and Service Recovery, Customer Satisfaction is a preliminary bond from the repurchase process and customer retention which ultimately benefits the supplier company. Satisfaction provides many benefits for the company, one of which is important, namely enabling the achievement of Customer Loyalty ([Mohamed Ali, 2020](#)) said that Satisfaction is a function of expectations of perceived performance. If the performance of a product or service is lower than expected, consumers will feel dissatisfied. If the performance of the product or service is as expected, consumers will feel satisfied and if the performance of the product or service exceeds expectations, consumers will feel very satisfied.

Future interests and retaining customers, Customer Satisfaction is a barometer that predicts customer behaviour for the future. Therefore, customer satisfaction is an emotional response to experiences related to certain services purchased or even buyer behaviour patterns, as well as overall market conditions.

Satisfaction is a measure of the overall evaluation of the exchange relationship based on past performance. In the B2B market, without the Satisfaction factor, the relationship could be lost, but if the supplier succeeds in satisfying the buyer, a long-term relationship can occur. Customer Satisfaction is the foundation needed for companies to retain existing customers.

In assessing service innovation, what has been explained by Lusch and Vargo which states that "A service-centered view is inherently customer-oriented and relational, which means more or less emphasizing that through a service-based approach, it will have an orientation that naturally focuses on customers and the relationships between the parties involved, in this case suppliers and customers. A service-centered approach changes the focus of the business from simply selling products to providing value generated through services. This means that value is in the interaction. Furthermore, value is not inherent in the product itself, but is created through the process of use (value-in-use). For example, customers not only buy a photocopier, but also a solution to make it easier to print documents.

In addition, there is Co-creation of value ([Vargo & Lusch, 2017](#)), which means that customers and service providers or suppliers collaborate to create value. Companies must understand the unique needs of customers and adjust their services to create a satisfying experience. This approach directly focuses on customers, which is the core of the concept of customer satisfaction. The implication of all this is a deep understanding of customer needs, which means that businesses must have deep insight into customer desires, expectations, and contexts in order to provide relevant solutions. Companies do not just offer generic products, but also personalized services. For example, software providers offer customer training and support that is tailored to the user's business needs. This customer-centric approach increases satisfaction because customers feel their needs are understood and valued.

Sustainable relationships emphasize the importance to build long-term relationships with customers. In the context of customer satisfaction, this means commitment. Long-term commitments born from service-oriented relationships require ongoing interactions, not just one-time transactions. By creating deep relationships, companies can increase customer trust, which is a key element in long-term satisfaction ([Dovaliene et al., 2007](#)). Customers are not only satisfied

with the results (outcomes) but also with the process (experience) during their interactions with service providers/service suppliers.

Customer satisfaction has long been positioned as a central construct in service management, defined as the evaluative response of consumers to the degree a product or service fulfills their expectations ([Alireza et al., 2011](#)). Classical perspectives often treat satisfaction as an outcome of consumption, yet more recent theoretical lenses provide deeper insight into its antecedents and implications ([Oliver & L., 1997](#)). Two frameworks in particular—Expectancy-Disconfirmation Theory (EDT) and Service-Dominant Logic (SDL)—offer valuable perspectives for analyzing after-sales service (ASS) and service recovery (SR) in the Industrial Control System (ICS) context.

Expectancy-Disconfirmation Theory posits that satisfaction is determined by the comparison between initial expectations and perceived performance. Positive disconfirmation occurs when performance exceeds expectations, while negative disconfirmation arises when it falls short. In ICS environments, where downtime or service failures can lead to substantial financial and operational consequences, customer satisfaction is strongly tied to whether after-sales and recovery processes meet these critical expectations. Extended warranties, responsive service recovery, and preventive maintenance therefore function as mechanisms to minimize negative disconfirmation and reinforce trust in suppliers.

Service-Dominant Logic (SDL) extends this perspective by framing satisfaction not merely as an evaluative judgment but as the outcome of value co-creation between suppliers and users ([Vargo & Lusch, 2017](#)). From this viewpoint, after-sales interactions such as training, collaborative problem-solving, and modernization planning represent opportunities for suppliers and customers to jointly create value over the system's lifecycle. Satisfaction thus reflects not only the technical performance of ICS but also the relational quality and shared responsibility embedded in the service process.

Integrating EDT and SDL provides a stronger theoretical anchor for this study. EDT explains the cognitive process through which customers evaluate supplier performance relative to expectations, while SDL highlights the relational and interactive dimensions of service provision. In the ICS domain, where reliability, safety, and continuity are non-negotiable, these perspectives together clarify how ASS and SR shape both functional and emotional satisfaction. This dual lens situates customer satisfaction as a strategic construct linking technical service quality with supplier reputation and long-term competitiveness.

CONCLUSION

This study highlights the critical role of after-sales service and service recovery in shaping customer satisfaction within the Industrial Control System (ICS) industry in Indonesia. Beyond merely addressing warranty and maintenance concerns, the findings emphasize that the success of ICS providers depends on their ability to embed reliability, safety, and security standards into their service framework. By integrating these dimensions, firms can create sustainable value for customers while reinforcing trust in highly sensitive and complex operational environments.

Theoretically, this research contributes to the growing body of literature on customer satisfaction by extending it to the context of ICS, a sector where technological complexity, interoperability, and system security create unique challenges compared to traditional service industries. The discussion demonstrates how established theories such as Expectancy-Disconfirmation Theory and Service-Dominant Logic can be adapted to explain satisfaction and loyalty dynamics in ICS, thereby offering a stronger conceptual anchor for future empirical research.

From a managerial perspective, the study provides important implications for practitioners in the ICS sector. Companies must move beyond transactional service delivery and adopt a more holistic approach that combines technical reliability, effective communication, and proactive service recovery. Furthermore, the implementation of international standards—such as ISA/IEC 62443 for cybersecurity, IEC 61131 and IEC 61850 for interoperability, and NIST SP 800-82 for system security—represents not only compliance with global benchmarks but also a strategic investment in customer confidence and long-term partnerships. These standards, when combined with responsive after-sales strategies, can significantly enhance both operational performance and customer satisfaction.

Looking ahead, several avenues for future research remain open. Empirical testing of service recovery models specifically tailored to ICS customers would provide deeper insights into the mechanisms linking after-sales practices and satisfaction outcomes. Similarly, the development of context-specific measurement frameworks for ICS satisfaction and loyalty would allow both academics and practitioners to better assess the effectiveness of service initiatives. Cross-industry comparisons—such as between energy, water treatment, and manufacturing sectors—may also reveal critical differences in customer expectations that can guide more targeted service strategies.

This activity also serves as a driver of brand awareness, ultimately strengthening customer loyalty. Another thing that can contribute to improving relationships is providing recommendations for emergency communication channels to make it easier to contact the supplier's technical staff for recovery or consultation purposes.

In conclusion, this study underscores the importance of aligning after-sales service and service recovery with broader strategic priorities such as safety, security, and interoperability. By doing so, ICS providers can not only strengthen customer satisfaction and loyalty but also ensure sustainable business growth in an increasingly competitive and technologically demanding environment. The contributions of this research lie in its theoretical adaptation, managerial implications, and its potential to inform future empirical investigations that further advance the understanding of customer satisfaction in the ICS industry.

Future Research

Several studies have shown that satisfied customers are more likely to become loyal customers ([Harzaviona et al., 2020](#)). In the ICS industry or similar industries, customer satisfaction factors must be optimized by fulfilling customer expectations in the best possible way, such as providing quality services, offering better products with greater flexibility and reasonable costs, respecting customers, and most importantly, making their needs a priority ([Susilo & Ikhsan, 2020](#)).

Future research should move beyond general satisfaction–loyalty relationships and focus on more specific empirical testing within the ICS context. For example, studies can explore how after-sales service and service recovery influence both satisfaction and loyalty, particularly in industries where safety, security, and interoperability standards play a critical role.

Possible directions for future research include:

- Empirical testing of service recovery models (e.g., speed, fairness, and communication effectiveness) and their direct impact on customer satisfaction and trust in ICS suppliers.
- Developing ICS-specific measurement frameworks for customer satisfaction that incorporate factors such as operational reliability, compliance with ISA/IEC 62443, and integration with interoperability standards like IEC 61131 or IEC 61850.
- Investigating mediating and moderating effects, such as the mediating role of service recovery quality between after-sales service and customer loyalty, or the moderating role of safety/security perceptions ([Chaanine & Sleilati, 2024](#)).
- Conducting cross-industry comparisons (e.g., energy, water treatment, manufacturing) to identify sector-specific determinants of satisfaction and loyalty in ICS applications.

Despite the growing attention to loyalty programs in competitive markets, limited research has examined their long-term impact on customer retention and firm performance, particularly in the context of industrial control systems. By conducting such targeted research, scholars can validate theoretical models in the ICS context and provide practical recommendations for companies to design effective after-sales and service recovery strategies that enhance loyalty and long-term business sustainability.

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