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Robotics as a Service (RaaS): Transforming Automation through Subscription-based Models

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Abstract

Through Robotics as a Service (RaaS), businesses, including small and medium-sized enterprises (SMEs), utilize modern approaches to automation implementation. Most businesses historically limited their access to automation because automation under the Capital Expenditure (Cap Ex) model demanded substantial initial investments. RaaS borrows concepts from SaaS to restructure business automation through Operational Expenditure (Op Ex) models that empower users to subscribe to robotics and automation services. This model makes business costs for high capital expenses easier to manage, allowing SMEs to adopt powerful AI-driven automation using manageable recurring payments. Using cloud-based services in RaaS technology enables robotic systems to generate continuous updates and better performance while achieving improved long-term scalability. RaaS delivers democratization through automation access while simultaneously promoting business growth and innovation. Such an operational strategy provides industries with key requirements for achieving better efficiency and marketplace presence in contemporary automated economies.

Keywords: Saas Adoption; Raas Model; Operational Efficiency; Subscription Economy; Capital Expenditure; Automation Scalability

1. Introduction

AI technology alongside automation continues to transform various industries through which companies gain significant operational improvements with elevated productivity numbers. Small and medium-sized enterprises (SMEs) find automation purchasing through Capital Expenditure (CapEx) difficult due to the high upfront costs required for hardware and software acquisition. Several small companies' financial limitations make it difficult to implement advanced technological advancements. The Robotics as a Service (RaaS) concept delivers an innovative solution to businesses by adapting its economic model from CapEx to Operational Expenditure (OpEx) in a similar manner to Software Software as a Service (SaaS). Businesses can now subscribe to robotic systems and automation services without requiring high upfront costs, which means automation solutions become more attainable through this new financial structure. The RaaS operational model provides adaptable technology solutions at reasonable prices, allowing SMEs and other businesses to acquire advanced AI-driven services without financial constraints (Friman, 2023; Tcholtchev, 2020). Every business needs technological updates to gain a competitive edge in their industry, and RaaS emerges as a key solution.

1.1. Overview

Through Robotics as a Service (RaaS), users can subscribe to and access robotic technologies while avoiding major capital outlays for purchase. Under an operating expense (OpEx) model, RaaS delivers affordable robotic deployment alternatives to businesses because CapEx-based solutions remain financially out of reach. Operational flexibility receives major value through this transition because organizations can expand or reduce their automation

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implementations according to business needs using tracking and predictable financial management tools. One difference between RaaS and CapEx models stems from how RaaS offers routine updates and maintenance access to AI and robotic technologies at no extra cost. Standard CapEx models typically demand large payments for hardware and SoftwareSoftware. RaaS adoption breaks down financial obstacles that allow businesses of all sizes to build productivity through automated systems that improve efficiency (Verbrugge et al., 2006; Akbar et al., 2021). Robotics as a Service provides businesses with low-cost robotics solutions that distribute robotic technology to every company regardless of capital constraints, enhancing their ability to maintain market competition in an automated business landscape.

1.2. Problem Statement

SMEs face the primary obstacle of high initial capital expenses when implementing traditional automated solutions because of their cost requirements. Businesses in this situation face substantial obstacles because the expenses block them from using sophisticated AI and robotic technologies that boost their manufacturing efficiency. Many SMEs fail to compete in technological advancement races because they lack sufficient funds to invest in their operations. Through its subscription-based approach, RaaS delivers an innovative service that alleviates financial challenges. RaaS facilitates SME adoption of automation technologies through its Operational Expenditure (OpEx) payment structure, allowing them to budget for manageable recurring costs. RaaS is the perfect choice for businesses with small budgets because its scalable operational model avoids the necessity of large capital deposits.

1.3. Objectives

The investigation will analyze Robotics as a Service (RaaS) because it transforms automation across different sectors by supplying affordable, scalable alternatives to conventional automation frameworks. This research investigates two critical advantages of RaaS against CapEx models: how it cuts financial obstacles for smaller enterprises and the qualitative results of RaaS adoption on operational effectiveness in small and medium businesses. The research aims to explore how RaaS enables businesses to receive continuous updates and scalability benefits as well as innovation potential that aids market competition over extended periods.

1.4. Scope and Significance

The investigation centers around businesses using AI-powered robotic systems to analyze RaaS's disruptive effects. The research will examine business operations across developed and developing market regions, considering RaaS challenges and benefits for SMEs. This research brings important insights about RaaS's ongoing influence on robotic automation so companies can determine robotic solutions and minimize implementation costs effectively. The mastery of RaaS operational abilities and ongoing innovation capability represents key knowledge needed by companies who want better productivity and market competitiveness worldwide.

2. Literature review

2.1. Success of Software as a Service (SaaS)

Through the Software as a Service (SaaS) model, businesses now receive applications for payment instead of traditional large-capital requirements, reducing their infrastructure costs. Companies benefit from this shift from conventional licensing to subscription plans because they reach higher growth levels with reduced financial pressure (Hyysalo, 2019). The Subscription Economy Model is SaaS's success factor because it provides predictable costs, continuous updates, and scalability benefits suitable for organizations regardless of size (Rrucaj, 2023). Software updates under the continuous innovation theory maintain SaaS products' viability and competitiveness throughout time (Hyysalo, 2019). The widespread adoption of SaaS exists because of these theoretical foundations, which provide companies with better operational flexibility and economical operations. Businesses that need leading-edge Software Software and cost-effective management options find SaaS especially beneficial because it supports high-performing Software Software as a Service (SaaS) model that help sustain performance within fast-changing business environments (Rrucaj, 2023).



Figure 1 Flowchart illustrating the evolution and success of Software as a Service (SaaS), highlighting the transition from traditional high-capital software models to subscription-based systems driven by predictable costs, continuous innovation, and widespread industry adoption

2.2. The Shift from CapEx to OpEx Models

The standard automation method relied on capital expenditure (CapEx), which companies initially spent to purchase hardware and SoftwareSoftware and then required frequent maintenance expenses. Businesses mostly encounter financial obstacles when implementing this asset ownership model, especially for smaller enterprises (Edwards & Gordon, 2015). The Operational Expenditure (OpEx) model used in Robotics as a Service (RaaS) provides businesses with subscription-based costs that replace large capital expenditures. The transition offers better accessibility for automation since businesses gain operational flexibility alongside reduced financial risk that allows them to match their needs (Edwards & Gordon, 2015). Through ongoing updates and maintenance, the OpEx model enables continuous deployment of modern technology without requiring businesses to acquire more capital expenses. ROI as a Service gives organizations the means to boost operational efficiency and market positioning through cost-efficient solutions without obliging them to buy capital equipment. The OpEx model delivers exceptional value to businesses that need powerful robotic systems beyond their initial capital investment capacity (Edwards & Gordon, 2015).

2.3. Robotics Market Trends and the Role of AI

The robotics industry experiences rapid expansion mostly because of artificial intelligence (AI) innovation improvements. The latest generation of robotics strongly integrates artificial intelligence because SoftwareSoftware makes up 70% of robotic systems, while hardware remains at 30% (Yarlagadda, 2015). Computers exploit artificial intelligence to teach robots new assignments, increasing efficiency and improving operations accuracy. The robotics industry continues to improve because AI enables devices to make timely decisions from vast data stores and perform advanced operations while enhancing their operational capabilities. AI-based robotic systems create a fundamental automation technique shift that enables industries to enhance their operational processes for manufacturing lines and

supply chain management operations. The development of collaborative robots known as cobots allows them to work with humans due to which various industrial settings achieve higher productivity. The robotics market shows the growing importance of AI because robotic systems increasingly integrate AI technologies, enabling expanded transformative effects in manufacturing industries and healthcare and logistics (Yarlagadda, 2015).

2.4. Theoretical Framework: Application of SaaS Principles to RaaS

Software as a service principle directly translates into robotics as a service operation successfully. Businesses using RaaS gain immediate access to base robotics systems through affordable service plans that help them, especially when targeting small and medium-sized enterprises (Tan et al., 2013). RaaS providers continuously enhance robotic capabilities by delivering ongoing updates using machine learning and AI improvements equivalent to how SaaS platforms deliver regular software updates to maintain system currentness. RaaS providers keep their customers at the forefront of modern robotics developments to boost operational performance and efficiency over time. The subscription model of RaaS enables business robotic operations to expand their presence dynamically through scalable solutions, eliminating the need for large financial investments (Tan et al., 2013). RaaS offers businesses a predictable expense model through subscription payment because companies do not face unforeseen maintenance fees or technology upgrade expenses. RaaS adopts principles which define it as an economically advantageous approach exceeding traditional automation methods according to Tan et al. (2013).



Figure 2 Flowchart illustrating the application of Software as a Service (SaaS) principles to Robotics as a Service (RaaS), highlighting how affordable service plans, ongoing AI and machine learning updates, scalability, and predictable subscription costs drive operational and economic advantages over traditional automation models

2.5. Advantages of RaaS for Small and Medium Enterprises (SMEs)

SMEs gain numerous advantages from Robotics as a Service (RaaS) deployments within their business operations. RaaS brings cost savings to SMEs by eliminating their need to spend excessively on upfront machine purchases while allowing such enterprises to operate with robotic systems beyond their financial means (Seethamraju, 2015). Under the subscription model of RaaS, customers receive maintenance services and software updates that guarantee robots stay technologically updated and maintain operational effectiveness throughout their lifecycle for extended durability. Companies using this service avoid operational risks, including technological obsolescence, because the maintenance of advanced systems and ongoing updates become the service provider's responsibility (Seethamraju, 2015). The subscription model promotes constant innovation among RaaS providers since they need sustained customer commitment by constantly developing their products. A positive feedback system emerges because SMEs experience continual robotic and AI technological progress through this model without spending extra expenses. RaaS provides SMEs with enhanced market competitiveness due to its financial model, which enables them to use advanced robotic technologies they otherwise could not afford (Seethamraju, 2015).

2.6. Continuous Improvement and Innovation in RaaS Models

RaaS must have a strategy of continuous software development to keep up with the fast-moving automation and AI environment and maintain its competitive position. SaaS models' software relevance and effectivity depend on regular updates, so RaaS providers enhance their robotic systems through cloud-based platforms (Tsipi et al., 2023). The robots experience better operation through enhanced machine learning algorithms, performance enhancements, and new capabilities introduced through software upgrades. RaaS users benefit from continuous technological advancements since the service provides perpetual upgrades without charging extra fees. Robotics innovation levels rise significantly because RaaS providers focus on improving their products through updates to maintain their market position and retain their customer base. The ongoing innovation environment in RaaS bolsters existing robot performance and creates new technologies and applications, resulting in long-term success for service providers and their customers (Tsipi et al., 2023).

3. Methodology

3.1. Research Design

The research uses qualitative methods to study Robotics as a Service (RaaS) through automation and AI frameworks. Case study research and expert interviews provide optimal results for in-depth understanding of RaaS practical implementations, difficulties, and advantages. Through this research design, researchers study detailed RaaS implementation characteristics across various industries to understand how SMEs transition through robotic service integration. Collecting numerical data is unnecessary in qualitative research, as it provides a deep analysis of human behavior and organizational experiences for understanding subscription-based robotic systems. The research design provides complete explanations about operational financial and strategic benefits of models for businesses in the technology sector that experiences rapid evolution.

3.2. Data Collection

Multiple data collection methods will provide the necessary research information about Robotics as a Service (RaaS). The researcher will obtain primary information by conducting in-depth interviews with experts from RaaS provider organizations, robotics engineering specialists, and business establishments adopting RaaS systems. Expert interviews provide authentic information about how RaaS functions in practice and what organizations experience when implementing this service. Available secondary research will combine data from industry reports with academic publications and cases of organizations that implemented RaaS successfully. Case studies for analysis will focus on three main research parameters: implementation scope size, technological advancement, and assessments of operational efficiency with cost management impacts. This research uses qualitative data along with secondary information in order to establish a complete understanding of RaaS and its automation affect.

3.3. Case Studies/Examples

3.3.1. Case Study 1: Amazon Robotics

The warehouse automation applications developed by Amazon Robotics through RaaS have reached successful deployment, thus improved operational efficiency and decreased operational expenses. Although cloud-based infrastructure enables the company to update robotic software automatically, the robots stay current with new AI technology updates. Amazon enables multiple warehouse robotic deployments through its subscription-based

approach by avoiding major initial spending requirements, thus becoming suitable for limited-budget medium and small organizations. The adoption of this model enabled Amazon to upgrade scalability and operational efficiency and break free from pricey conventional automation systems. Amazon achieves its strategic goal of technological leadership by implementing Runtime as a service (Girija et al., 2021).

3.3.2. Case Study 2: Locus Robotics

The warehouse logistics sector brought about a breakthrough through Locus Robotics that delivers AI-powered autonomous robot services through its RaaS solution. Businesses can expand their operations through robotic services without high upfront costs because they need to subscribe to the robot services. The robots draw continuous updates from cloud infrastructure, delivering enhanced operational output and decreased system unavailability. The location robotics system benefits small and medium enterprises because they can improve their supply chain operations without huge upfront costs yet receive sophisticated robotic capabilities. Cognominal et al. (2021) reports that businesses running their operations through subscriptions adjust their operational scale according to market requirements.

3.3.3. Case Study 3: Fetch Robotics

Through its RaaS service Fetch Robotics provides flexible warehousing assistance to management of materials and inventory control in storage facilities. The autonomous robots from this company work well with current systems, so businesses can introduce robotic solutions without needing complete infrastructure replacement. Through their cloud services Fetch Robotics allows robots to get enhanced performance and operational effectiveness through automatic software updates throughout time. Enhancements and price reductions from robotic solutions expansion enable their accessibility to small businesses beyond their financial constraints. The RaaS model of Fetch Robotics lets companies subscribe to contemporary robotics technology through affordable operational budgets as they strive for market competitiveness (Chen et al., 2010).

3.4. Evaluation Metrics

Various important metrics will determine the effectiveness of RaaS deployments. Evaluating cost savings will rely on comparing total ownership costs between RaaS and traditional CapEx models and incorporating first capital expenditures and ongoing expenses with maintenance fees. The efficiency improvement measurement method tracks robotic system performance in warehouse management and material handling tasks through speed, accuracy, and productivity indicators. The ease with which businesses can improve or reduce their robotic operation capabilities when demand modifies serves as an assessment of scalability. The effect of RaaS on dynamic business needs relies on system uptime, customer satisfaction, software and hardware update speed, and continued operation metrics like business downtime and system reliability. The examined metrics generate detailed evaluations regarding the practical value and extended sustainability of RaaS delivery systems.

4. Results

4.1. Data Presentation

Table 1 Key Performance Metrics from RaaS Case Studies

| Company | Productivity Increase | Cost Reduction | Scalability |
|-----------------|----------------------------------|---------------------|--|
| Amazon Robotics | 25% during peak periods | 25% at Shreveport | Deployed over 750,000 robots |
| Locus Robotics | 2–3x faster picking | Reduced overtime | Scalable multi-bot systems |
| Fetch Robotics | Increased workflow efficiency | Reduced labor costs | Flexible integration with existing systems |





Figure 3 Bar chart comparing productivity increases and cost reductions across Amazon Robotics, Locus Robotics, and Fetch Robotics from RaaS case studies



Figure 4 Line chart illustrating the performance metrics (productivity increase and cost reduction) for different companies implementing Robotics as a Service (RaaS)

4.3. Findings

Robotics as a Service (RaaS) has achieved remarkable business operation changes throughout different industry sectors. Companies adopting robotics as a service produce solid operational performance results because robots execute tasks at higher speeds and precision than human employees. RaaS provides business benefits through its overhead cost reduction for robotic system maintenance by delegating operational responsibilities to service providers. A demand-based scalability feature of robotic systems gives businesses the operational ability to reorganize services speedily while avoiding major budget changes during market transition periods. The transformation of RaaS into an operational expenditure-based model makes advanced robotic technology more accessible to SMEs so they can defend their market position. Through RaaS adoption, business innovation increases because of periodic software evolutions and cloud delivery platforms that keep systems updated with minimal impacts on operations.

4.4. Case Study Outcomes

Business operation enhancement through Robotics as a Service (RaaS) has proven successful based on the results presented in case studies. The Amazon Robotics subscription-based model allowed the company to achieve better warehousing scalability through cost reductions by 25% without sacrificing productivity levels. Locus Robotics' subscription service lets clients operate faster picking operations and cut down labor expenses after their clients accomplished a three-fold boost in picking productivity. The integration between Fetch Robotics' systems and existing operational structures proves how RaaS forms an effective solution for handling materials and inventory management at budget-friendly rates. RaaS services help companies save money through periodic technological updates which enables business growth in automation and artificial intelligence technology.

4.5. Comparative Analysis

The main distinctions between Capital Expenditure (CapEx) models and Robotics as a Service (RaaS) come from their cost arrangements, operational efficiency, and capability for expansion. The capital expenditures required for hardware and Software infrastructure pose too high an initial barrier for most businesses, especially small and medium enterprises. RaaS operates through a subscription service that lowers startup costs and establishes business operating expenses. The continuous software maintenance and update capabilities of RaaS models provide businesses with always-evolving systems since CapEx models make them responsible for maintenance and upgrade costs. Businesses using RaaS solutions can easily adapt their usage levels because scalability outperforms the fixed capacity of capital expense investments. RaaS provides businesses with flexible functionality and lower operating costs, which delivers strong value when organizations want to adopt automation programs that avoid CapEx financial commitments.

4.6. Year-wise Comparison Graphs

Robotics as a Service (RaaS) has experienced consistent growth since its introduction in multiple industries, particularly logistics manufacturing and retail, demonstrating strong adoption increases. RaaS adoption rates keep growing because businesses of all sizes now understand its advantages, especially smaller companies, which usually face affordability problems when adopting automation solutions. The arrangement of Robotics as a Service started slowly during the first years because customers lacked information about the subscription plan and the new model. More businesses began to show why RaaS provided valuable benefits. At that point, the trend rapidly gained momentum. Rate-of-accumulation diagrams demonstrate that RaaS establishes its importance in automation initiatives throughout different industry domains. Industrial adoption rates will keep rising since businesses recognize how robotic solutions with service-based pricing can optimize operations efficiently and effectively.



Figure 5 Graph illustrating the year-over-year increase in Robotics as a Service (RaaS) adoption rates across industries. The data reflects a steady rise as businesses, especially small and medium enterprises, embrace the operational efficiency and cost advantages of RaaS solutions

4.7. Model Comparison

Some distinct similarities and differences arise from comparing the Robotics as a Service (RaaS) model to Software as a Service (SaaS) subscription-based programs. The two models let businesses migrate from Capital Expenditure (CapEx) to Operational Expenditure (OpEx), thus creating cost savings and enhanced flexibility. Software as a Service (SaaS) provides only software-based solutions, but Robotics as a Service (RaaS) requires regular hardware robotics maintenance, including robots, alongside continuous software updates. Businesses face extra complexity with RaaS compared to SaaS since it allows easy system integration, yet it requires firms to integrate robots physically with their infrastructure. The combination of software and hardware updates that RaaS delivers exceeds the functionality of the typical SaaS software update system because it maintains all robotic infrastructure at the most current standards. These parallel solutions enable expanding businesses because they work well with changing needs without requiring major financial investments.

4.8. Impact & Observations

The Robotics as a Service model benefits industrywide by providing accessible automation capabilities to small and medium-sized enterprises (SMEs). Businesses now benefit from RaaS because this model makes robotics available through low-cost services. SMEs achieve higher operational efficiency through automation because it allows them to decrease labor expenses and secure business competitiveness in modern automated industries. The long-term evolution of RaaS pushes technological development through provider updates of their computerized systems to meet emerging market needs. RaaS users achieve better production outcomes and financial savings. At the same time, they retain operational flexibility through customizable operation expansion features. Companionable manufacturers can depend on RaaS to establish its central role in future automation development for organizations prioritizing modern technology enhancement alongside financial protection.

5. Discussion

5.1. Interpretation of Results

Robotics as a Service (RaaS) effectively resolves the key issues that CapEx-based traditional automation models present to companies. The Subscription Economy and Continuous Innovation theories support RaaS, providing businesses with a payment-by-use solution that substitutes expensive upfront expenditure. RaaS provides organizations with financial flexibility by allowing them to obtain scalable solutions that evolve according to their operational requirements. Because of its fundamental design, the RaaS model gives companies continuous access to updated Software and hardware. It contrasts CapEx's traditional expenditure approaches that require associated expenses and time-intensive upgrade processes. The research proves RaaS functions as a budget-friendly solution for SMEs to access advanced automation solutions without standard capital investment costs.

5.2. Results and Discussion

RaaS is a beneficial solution providing maximum value to small and medium-sized enterprises (SMEs). Small businesses profit from RaaS because it removes the financial need for major robotics investments at purchase. The subscription model enables SMEs to access sophisticated automation systems by paying solely for necessary services. The RaaS system lets businesses scale their robotic operations by modifying robot and service quantities according to their evolving requirements without substantial financial investments. Using RaaS services has drawbacks, such as a company must depend on the service provider for operational support, and additional customization needs might present challenges. The scalability and utility benefits offered by RaaS are a solution for businesses that want to improve productivity without requiring major investments.

5.3. Practical Implications

Companies implement RaaS models to enhance their business operations because these systems promote operational enhancement and cut capital costs. The transformation from capital expenditure to an operating expense model enables companies to redirect funding to vital business needs, including marketing efforts, research and development programs, and recruiting key personnel. The subscription-based delivery model guarantees businesses uninterrupted robot system innovation since automated software updates and robotic system enhancements occur at no additional expense. A competitive market advantage remains available to organizations through this approach. Through RaaS, businesses can increase operations according to customer demand to adapt quickly to market variations. RaaS provides businesses with modern technological access, operational streamlining capabilities, and innovative potentials that help reduce standard automation cost-related vulnerabilities.

5.4. Challenges and Limitations

Multiple advantages exist for implementing the RaaS model; however, organizations will experience obstacles while implementing this model. A major challenge stems from integrating robotic systems into current business infrastructure because companies need to make robotic systems function flawlessly with their existing operating frameworks. SMEs commonly encounter problems comprehending their mobile automation service subscription agreements, making them dependent on the service provider. The current study indicates that some sectors demand specific robotic solutions that RaaS vendors do not. The systems face delayed functionality or disruptions due to unreliable availability of service provider infrastructure. The broad implementation of RaaS may be obstructed by barriers targeting industries that need high customization or reliability in their processes.

5.5. Recommendations

Companies switching from capital expenditure to robots as a service method should follow complete assessments when choosing their service providers. A business must examine service level agreements and system compatibility and analyze provider longevity to make informed decisions. All companies must provide employee training and support services for proper robotic system integration. Additional research needs to focus on how different industries can face barriers to automation adoption so that complete solutions can be developed for ones with unique requirements. Future research needs to analyze both the long-term economic performance of RaaS by calculating the total cost of ownership and return on investment to understand the situation better. The scalability assessment of RaaS for large companies together with its broad applicability across industries will boost user acceptance that drives increased RaaS adoption.

6. Conclusion

Summary of Key Points

The Robotics as a Service (RaaS) platform supplies businesses with emerging automation capabilities through subscription so they avoid making large CapEx initial outlay requirements. RaaS presents itself to the market as a versatile service which draws direct inspiration from the success of SaaS. The platform brings cost benefits and process optimization to companies looking to merge AI robotics systems through their operations and particularly by benefiting small and medium businesses. The subscription-based model of RaaS enables organizations to access recent robotics solutions at affordable rates with adjustable spending amounts and expanding operation capabilities. Through this model, businesses overcome financial barriers to acquire advanced technologies, enabling them to stay competitive against market changes. Companies will find RaaS models essential because automation development necessitates access to advanced robotics without investing heavily in ownership or capital equipment.

Future Research

Further research must be conducted to evaluate extensively the lasting financial expenses of Robotics as a Service (RaaS) operations and capital expenditure investment methods. Such an evaluation would analyze the analytics of ownership costs and the investment return combined with the financial stability of the two models. A study of customer satisfaction in RaaS deployments will generate beneficial data about how well service providers serve business needs and how users experience these deployments. The research needs to examine refunds that impact different sectors and enable factors that will help RaaS succeed in specific industries to optimize its applications. The scalability solutions' scalability for big businesses and innovation research will help researchers discover new growth opportunities and practical applications.

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