Navigating the Shift: From Traditional Sales to Product-as-a-Service (PaaS)

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Abstract. This paper considers alternative revenue models for companies traditionally reliant on transactional sales models. The research question explores viable revenue strategies for a firm with a traditional transnational revenue model and wants to transition to a product-as-a-service-based revenue model. To understand the transition, the study employs a multi-stage methodology that includes assessing the product-service system and analytical tools for contextual understanding. Insights into different approaches and their practical applications were gained, with detailed analyses based on avatar mapping, lifecycle examination, and a total cost of ownership analysis that must be adapted for data scarcity. Where data is unavailable, the paper provides an approach to support collecting the necessary lifecycle costs to allow PaaS models to be developed based on the average spend profile.

Keywords: Revenue Models · Product-as-a-Service · Revenue Transformation · Subscription Model · Product-Service System

1 Introduction

The motivation behind drafting this study aligns with the trends observed in many businesses. Manufacturing companies transformed the transaction-based business model into a customer value-based subscription business model (such as Product-as-a-Service or PaaS), aiming to monetize the potential of digitization in times of saturated markets and increasing competitive pressure [1], whereas others [2] showed that many firms decide to move into a different business model to increase their revenues. Many firms found new business models to adapt to varying scenarios since it became clear that the traditional business models, based on transactional product sales, were no longer efficient [3]. This entails a shift from conventional models to increasingly customer-centric models, capable of enhancing customer loyalty and market penetration independently or in conjunction with existing models. This transition has been made possible by increasing technological innovation and facilitating connectivity between manufacturing companies, their products, and customers. It has been reported [2] that firms desire to move

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Published by Springer Nature Switzerland AG 2024
M. Thürer et al. (Eds.): APMS 2024, IFIP AICT 732, pp. 215–228, 2024.
https://doi.org/10.1007/978-3-031-71637-9_15

to alternative revenue models, yet there is an apparent gap in how firms can achieve the switch without undue risks to their cash flows. This is coupled with many firms needing more data to complete a lifecycle cost analysis, primarily due to capacity constraints and lack of data [4].

The research question is: "*What are the different revenue models that a company based only on a transactional model could adopt where lifecycle cost data may be limited?*".

Based on the research question, this paper is structured first with a short literature review to introduce the core concepts and methodology, then the study results, before moving to the discussions, where the research question is answered. The paper closes with conclusions, recommendations, and limitations.

2 Literature Review

The literature review examines research relevant to revenue model evolution in transaction-based revenue models to PaaS revenue models in situations where data may be scarce. This analysis combines key concepts, focusing on the cost of ownership and lifecycle costs, customer-centric business models, and the impact of technological advancements on revenue diversification.

2.1 Product-Service Systems

The Product-Service System (PSS) is a model that combines products and services to create value [5]. This model, which contrasts with traditional product-centric approaches, emphasizes sustainability and long-term customer relationships [6]. By integrating products and services, companies can offer comprehensive solutions catering to their customers' specific outcomes, increasing customer satisfaction and loyalty. The essence of PSS lies in its ability to provide functional value rather than merely selling physical products. This approach allows companies to focus on offering solutions that meet customer needs through a combination of goods and services, leading to more sustainable consumption patterns and a reduction in environmental impact [7]. For example, a company might offer a product along with maintenance and repair services, ensuring that the product remains functional longer and reducing the need for frequent replacements.

PSS models encourage companies to innovate in designing, producing, and delivering their offerings [8]. By focusing on the functionality and the service aspect, companies are driven to consider the entire lifecycle of their products, from design to disposal [9]. This holistic and customer-centric view fosters the development of more sustainable and efficient products and services, contributing to the circular economy. Implementing PSS can also provide a competitive advantage, enabling companies to differentiate themselves in the market. Firms can cater to unmet needs and create new market opportunities by offering combinations of products and services. However, transitioning to a PSS model requires a shift in mindset from focusing on selling products to providing solutions. It may involve challenges such as redesigning business processes and developing new competencies.

2.2 Total Cost of Ownership and Cost Drivers

Lifecycle costing assesses all expenditures related to the acquisition, ownership, operation, and eventual disposal or recycling of a product, covering the spectrum from the initial purchase to the end-of-life phase [10]. This approach is pertinent for understanding the long-term financial implications of products and services, particularly those entailing substantial initial and ongoing costs for maintenance and operation. Lifecycle costing enables firms to make decisions that account for the costs, not the initial purchase price [11]. This includes future expenses such as repairs, upgrades, energy usage, and disposal fees, advocating for a long-term perspective that identifies cost-effective and sustainable solutions and requires manufacturers to understand the costs through the lens of the customer [12]; yet, many firms do not develop TOC or lifecycle cost analyses for their products.

Similarly, the total cost of ownership offers a framework for calculating the comprehensive costs of purchasing and operating a product or system throughout its operational lifespan. The total cost of ownership is essential for understanding the initial acquisition costs and subsequent expenses incurred during the product's life [13]. This includes installation, maintenance, operational expenses, and disposal or decommissioning costs. The total cost of ownership provides a framework for businesses to make informed, long-term financial decisions that transcend the initial purchase price [14]. It highlights the significance of long-term cost considerations in financial planning and budgeting. Adopting a total cost of ownership perspective enables organizations to identify cost-saving opportunities, refine investment strategies, and enhance operational efficiency.

Additionally, total cost of ownership analysis encourages a sustainable business approach by prompting companies to consider the environmental impacts of their purchases over the product's lifecycle, aligning with the increasing focus on sustainability in corporate strategies [15]. Implementing total cost of ownership analysis necessitates data collection and analysis, underlining the need for accurate and comprehensive data on all ownership costs for a reliable evaluation [16]. This methodology requires forecasting future expenses and a deep understanding of the product's operational dynamics and external factors affecting its performance and costs from the customer's perspective [12]. The total cost of ownership facilitates informed, economically sound decisions [9]. It serves as a reminder of the product's value and cost, far exceeding its initial purchase price [17], and provides a link to lifecycle costing.

2.3 Value Propositions, Related Revenue Models

It is crucial to understand various business models, including subscription services, freemium models, and licensing agreements, which offer pathways to revenue generation [8]. Subscription models (i.e., product-as-a-service) are often preferred because of a steady, predictable income stream by charging customers regularly for continued access to a product or service [3]. This model fosters customer loyalty and can lead to higher customer lifetime values. Other revenue models, based on pay-per-use, exist, Xerox being one of the most well-known; others exist and have been supportive of the supplier as they align fee structures with the customer's revenues (i.e., Rolls-Royce's TotalCare),

although in the case of Rolls-Royce the ownership of the engine rests with the custom. In the Xerox case, it remains with the supplier [18].

Each business model is paired with a revenue model that aligns with the company's operational structure and market positioning [19]. This emphasizes the need for businesses to carefully consider their choice of model, as it impacts revenue generation, customer engagement, and potentially product development strategies. The analysis also suggests that companies may employ multiple revenue models simultaneously to address different market segments with a tailored value proposition. The difference between the costs and structure and revenues from the customer should be expressed as the margin; this can be represented on an individual contract or at a business level [10].

3 Methodology

This study uses an in-depth single case [20] on which we validate a novel methodology to address the research question. This methodology integrates different approaches to tackle the need for more analytical data regarding revenues and costs from sales of products and services. This is crucial for laying the groundwork for this study. The insights from the literature review played a role in understanding the context and determining the analytical tools necessary for this study. The research approaches the process through a flow chart (Fig. 1), demonstrating the steps taken. For confidentiality, all financial data and the product type have been redacted from the results.

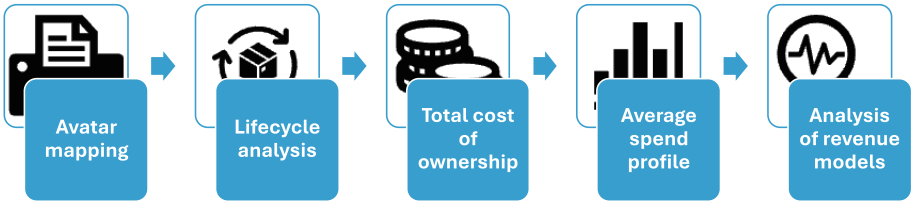

Fig. 1. Data collection forces for the development of the case.

Initially, the study utilized an Avatar Map [21] to gain an in-depth understanding of the lifecycle. This visual tool represented the interactions and components of the machine, essential for comprehending the product and its associated services.

Subsequently, an equipment lifecycle analysis was conducted, incorporating methodologies and insights [2, 22]. This analysis provided a holistic view of the product's utilization stages, emphasizing the importance of understanding each phase of the lifecycle.

The total cost of ownership analysis followed [11, 23]; this step was crucial for incorporating all costs associated with the equipment's life, enabling a comprehensive assessment of the machine's total expense to the customer, including subsequent services. An average spend profile approach was introduced as an adjunct to the total cost of ownership analysis [23]. This method offered a deeper exploration of customer spending patterns by analyzing aftermarket revenues to gain insights into sales trends associated

with services, thus enhancing the understanding of the company's revenue streams and providing proxy data to fill gaps in the total cost of ownership model from the customer's perspective [12].

Finally, the selected revenue models were analyzed, focusing on revenue streams, initial implementation phases, and potential future developments. This phase identified the necessary data for effective implementation. It aligned each revenue model with various customer profiles, ensuring a structured approach to evaluating and integrating revenue models within the project's context.

4 Results

In this section, we present the findings from our exploration of alternative revenue models for transaction-focused companies shifting towards PaaS. Here, we analyze the machine and its assumed operational and financial data. Initial results, including avatar mapping and lifecycle analysis, set the stage for discussing the viability and implications of various revenue strategies.

4.1 Avatar Map of the Equipment

A conceptual avatar map was constructed to analyze the operational dynamics of a printing machine production line, exemplified in Fig. 2 for a generic industrial printer with a long operational life. This approach is based on the premise that all printer models from the company share a common operational framework. The machine requires two primary inputs: consumables, including in-house inks and components like printing rollers subject to wear, and operational and maintenance inputs, covering spare parts, preventive maintenance, repairs, upgrades, and help desk services.

Consumables need periodic replacement, with inks typically lasting one shift every three days, although this varies based on customer usage patterns. Operational and maintenance activities ensure the machine's longevity, with services potentially provided by the firm or the customer (it was essential to identify all activities and tasks).

The machine's outputs are final products, data, and waste. Final products include blister packaging for tablets and printed vials, contributing direct value to the customer. Data output, such as print cycles, operating times, and error logs, must be utilized due to the industry's traditional and highly regulated nature, limiting external data sharing. Waste production encompasses defective parts and downtime, potentially reducing customer revenue significantly due to maintenance or malfunctions. Machines typically operate with an Overall Equipment Effectiveness (OEE) of 30%–40%.

Crucially, the effective integration of the machine within the production line necessitates trained operators. The firm provides training during the initial installation, commissioning, set-up, and subsequent upgrades and emphasizes the importance of skilled operators in maintaining operational efficiency and productivity.

4.2 Equipment Lifecycle Analysis

The Equipment Lifecycle Analysis of a generic printer model within pharmaceutical packaging lines reveals the comprehensive services essential for optimal operation and

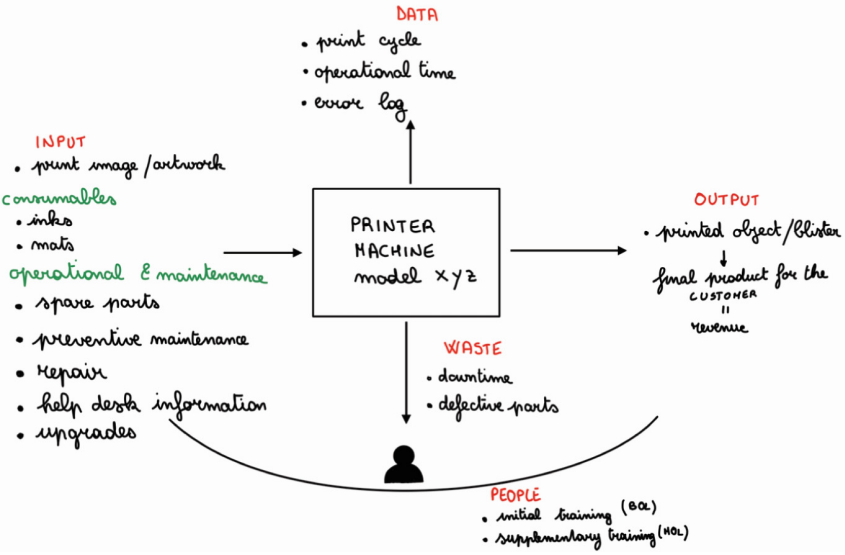

Fig. 2. The printer's Avatar map was developed to support activity-based costing in the total cost of ownership model.

performance across the machine's lifespan. This analysis, depicted in Fig. 3, highlights the significance of the aftermarket phase, which contributes substantial additional revenue for the company.

Figure 3 categorizes the lifecycle into three phases: Beginning of Life (BOL), Middle of Life (MOL), and End of Life (EOL). The BOL phase, spanning approximately twelve months, encompasses initial evaluations, machine acquisition, production, factory acceptance testing to ensure it meets customer specifications, installation, operational context testing, and initial employee training.

The MOL phase extends over fifteen years, representing the machine's primary operational period. This phase includes managing spare parts, replacing consumable inks and materials, preventive maintenance, repairs, software, and hardware upgrades to maintain performance, help desk support, additional training following updates, and returning defective parts for repair. Here, the machine's avatar maps were supportive in identifying and understating the different activities. In the EOL phase, which lasts about eight months, the focus shifts to disposing of the equipment once its helpful life concludes. This phase marks the end of the machine's lifecycle.

This lifecycle analysis underscores the aftermarket's pivotal role in maintaining customer engagement and driving revenue through extended services. By extending the lifecycle through quality after-sales support, the firm enhances customer satisfaction and maximizes revenue opportunities from aftermarket services. It illustrates the intertwined relationship between product lifecycle management and revenue generation.

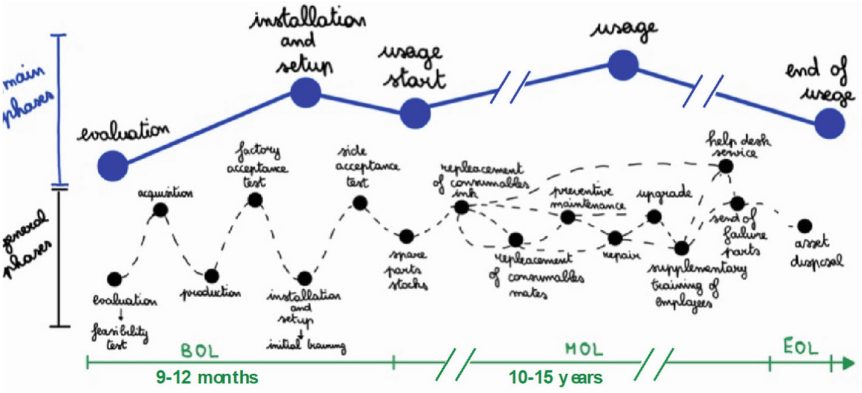

Fig. 3. The lifecycle of the equipment captures different activities.

4.3 Total Cost of Ownership

Figure 4 shows the total cost of ownership model. This model encompasses the printer's lifespan, detailing expenses from acquisition to operation and eventual disposal. The operating context reveals that ink changes are required every three days when in operation and an assumed life expectancy of 15 years. This was the initial static model rather than a dynamic simulation.

Following a contextual evaluation from the two prior steps, a detailed cost analysis required collaboration to gather data on the customer-incurred expenses based on expert input and CRM/ERP data. This analysis identified drivers influencing the costs over the printer's life. Figure 3 lists the cost elements such as direct operating costs, consumables, maintenance, repairs, and upgrades, highlighting the operational factors that drive the variable costs. The machine's operational use and conditions impact consumables replacement frequency, repair, and maintenance costs. The study also considers personnel costs and asset disposal, attributing these expenses to the machine's operational phase and disposal stage.

Despite aiming for accuracy and granularity, the model encountered challenges incorporating specific machine usage parameters and conditions due to the pharmaceutical sector's regulatory and confidentiality constraints. This limitation underscores the difficulty in obtaining detailed customer data, affecting the depth of the total cost of ownership analysis. Nevertheless, the model's findings provide insights into the primary cost components faced by customers. An NPV calculation was not completed as part of the study as the appropriate discount rate and tax rates applicable can significantly impact the figure, and the firm has no control over these external factors.

4.4 Average Spend Profile

The average spend profile was developed due to the need for more detailed data for a comprehensive total cost of ownership evaluation. This analysis began by collating data on the company's installed base in the market from 2019 to 2023, followed by gathering annual sales data for the same period, including forecasted values for 2023.

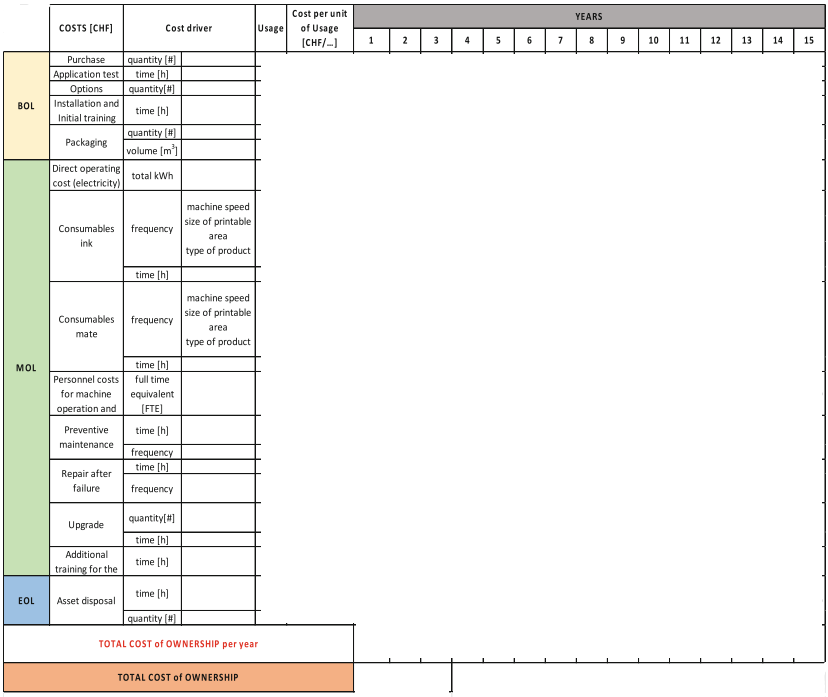

Fig. 4. The total cost of ownership model for the equipment over an assumed life of 15 years. The data has been redacted for confidentiality reasons.

This information, collected in kCHF (and redacted for confidentiality), was used to calculate the yearly sales value per machine by dividing the total annual sales by the number of machines installed each year. This figure was further broken down by each revenue category and summing these averages. Additionally, maximum and minimum values for each category were identified to provide insight into spending variances.

This Average Spend Profile details trends in customer expenditure in the aftermarket, highlighting the significance of spare parts (49%), inks (34%), and other consumables (11%), with additional services accounting for the remaining (7%). These insights help explore alternative revenue models, offering a clear view of the most critical revenue streams during the aftermarket phase. This analysis supports the understanding of current spending patterns but also identifies potential areas for revenue optimization.

4.5 Analysis of Revenue Models

The final stage of this research analyses various revenue models proposed for the company, aiming to offer expansive insights into the research question (Table 1). The primary focus is detailing different revenue streams for each model, considering initial implementation phases and future growth potential. A critical step in this analysis involves identifying the necessary data types for adopting these models, highlighting the gap due to insufficient company data. Furthermore, an association is established between

these revenue models and defined customer profiles, allowing the firm to discern which customer segment might prefer one model over another.

Eight revenue models are developed, each presenting distinct degrees of transformation and implications for the company. These models range from maintaining current transactional sales to introducing innovative approaches such as leasing and subscription services and even transitioning towards offering semi-finished products. This shift signifies a profound change, moving from being a mere equipment supplier to leveraging internal expertise in producing semi-finished goods. This strategy involves setting up a mini production line for these products, marking a diversification in service offerings.

For models involving aftermarket contracts and subscriptions, the analysis identifies a shift towards enhancing customer service relationships, which are critical for profitability and customer satisfaction. Each model was classified each model according to a product-service system (PSS) framework [80], further describing their strategic fit and operational implications. This model, alongside others such as pay-per-use and leasing options, reflects the company's strategic movement towards more customer-centric and flexible revenue structures.

This evaluation of revenue models addresses the initial research question and lays the groundwork for subsequent analyses and reflections. It underscores the importance of after-sales services, the potential for diversified revenue streams, and the need to align strategically with customer preferences and market demands. The findings from this section are pivotal for exploring alternative revenue models, offering a nuanced understanding of their implications, advantages, and challenges. This analytical approach ensures a robust foundation for the company's strategic decisions, aiming to optimize revenue generation in alignment with evolving market landscapes and customer needs.

Table 1. Analysis of revenue models based on the availability of data today.

Option	Equipment	Services	Comments/analysis
1	Transactional	Transactional	Current model
2	Transactional	Contractual	Minor change to current model
3	Transactional	Subscription	Would need cap on allowable prints, risk of miss pricing
4	Rental	Contractual	Would need more capital or financing business to hold assets. Minor change to aftermarket
5	Rental	Subscription	Would need more capital or financing business to hold assets. Risk of miss pricing
6	Leasing	Contractual	Similar to 4 but with different accounting treatment
7	Leasing	Subscription	Similar to 5 but with different accounting treatment
8	Leasing	Pay-per-print	Similar to 7 but need to fully understand the cost drivers

5 Discussion

The avatar map effectively provided a clear understanding of the machinery's operations, supporting the identification of the activities necessary for its functionality [23]. It allowed hidden aspects to become visitable and support ongoing modeling. This underscores the growing complexity of products and the shift towards integrating services to enhance customer experiences, aligning with current scholarly discourse on expanding product-service systems within corporate strategies. Further analysis of the equipment's lifecycle illustrated the range of services that must accompany it throughout its life, highlighting the value derived from aftermarket services (e.g., that the capital cost of the equipment was less than the 'aftermarket' revenues). This aspect underscores the emerging trend of service-dominant revenue models, where the product's sale becomes almost secondary to the potential of service-based revenue streams, mainly when free cash flow is considered. The avatar map and the equipment lifecycle provided clear insights into the machine's life. They supported the total cost of ownership modeling by helping to ensure that everything was noticed.

The total cost of ownership describes the expenses associated with machinery ownership, emphasizing the significance of understanding and managing these costs for the firm and its customers [2, 11]. The equipment lifecycle and the avatar map supported the total cost of ownership by providing a visual story to the model supporting activity-based costing. The complexity of cost drivers and the role of customer-specific parameters underscore the necessity of a deep understanding of how individual customers operate and maintain their machines.

The average spend profile analysis further corroborated the importance of aftersales services, identifying key revenue streams within the aftermarket and the trends related to the installed base increase. When firms move from transactional to relational revenue models, they shift their view on the installed base, which becomes a significant revenue driver ('*money printing machines*', as managers say). It is, therefore, essential to understand how revenues and costs will develop based on different revenue models (or fee structures) and agreements and concerning changes to the installed base. The case showed that the data collected with the average spend profile could support the expected annual sales from the installed base. The average spend profile can then be transformed to support sales forecasting and market analysis and support a more data-driven approach to the sales process and, at the same time, start to refine the use of the sales data to allow more advanced revenue models to be offered.

This exploration leads to the compilation of possible revenue models for the firm, ranging from maintaining traditional transactional sales to innovative approaches like leasing or subscription-based. Each model presents reflection and highlights the firm's risk compared to the conventional approach [8]. The results show that the firm has data missing today, and the data holes need filling. These gaps can be seen when assessing the machine's avatar model. The collation of expert input and ERP/CRM data required to be completed, and gaps were left, meaning that risks would exist in the pay-per-print revenue model.

5.1 Data Collection Methods and Revenue Model Adoption Strategies for Transaction-Based Companies

Data collection was a significant challenge for this study, partly because there was no direct relationship between sales data, field service data, and the individual machine, nor was the data tied to the machine's actual operation. This agreed with the TCO challenges identified by others [24]. The digital thread needed to be fixed and more reliable, resulting in uncertainty about the total cost of ownership. The cost drivers were known yet poorly understood due to the breakdown in the data flows, which limited the ability to do activity-based costing. In particular, the link between the individual machines and the operational units produced must be included, meaning that the firm needed help understanding the valuable operational costs.

Data collection is not trivial when customers limit online access to individual machines and have been seen to make activity-based costing impracticable. Nevertheless, significant data exists with the firm's CRM system and should be curated to support an estimation of the total cost of ownership. Without this data, the firm would be unwise to move towards a pay-per-print revenue model due to the existing risks. The firm should start to capture critical operational data (i.e., number of prints, sheets, ink coverage) from planned and unplanned inspections and capture time between services (i.e., actual rather than from the maintenance manuals). They also should, where possible, link sales (or activities) to individual machines; otherwise, they should link the sales to a specific site. From the data triangulation, the firm should then be able to create a dynamic cost model for the total cost of ownership and understand the statistical breakdown performance of the machines.

Adopting alternative revenue models is not recommended without a clear understanding of the cost drivers and the 'normal' cost of the ownership model, which includes planned and unplanned costs and consumable costs. An approach to building a model has been described above. Without understanding the cost structure and the revenue model, a firm risks losing money or providing the services at too high a price to be competitive in the market. Moving to a pay-per-use revenue structure benefits the supplier by tying in the customers. It could also help the customer by removing the one-off cost of acquiring the machine. This has been a significant advantage Hilti offers, for example, with their fleet rental model, where fees align with the construction project, or with Roll-Royce, where the maintenance costs are accrued based on operational hours.

5.2 Academic Implications

Even though manufacturers are recommended to base their designs on a total cost of ownership model, the firm in this study needed to collect data to enable total cost of ownership analysis to be undertaken systematically and agree with the literature [13]. The logic was outside its CRM system, so the firm could not have a transparent total cost of ownership for its printers. Today, the literature [1] also suggests that subscription and pay-per-use revenue models are preferred. There should be a reflection in the literature on how firms can collect the necessary data to move to what could be considered advanced service modes, agreeing with the literature [9, 23]. There is a need for more studies to understand how firms can collect this data to allow them to move away from traditional

cost-plus models, as they need to know how to collect the data and then model it; from this study, this is a non-trivial task.

5.3 Managerial Implications

Firms should only move to subscription and pay-per-use revenue models if they understand the total cost of ownership of the product they supply, and to do this, they need to implement active-based costing. To transition to advanced services, they need to understand the total cost of ownership in-depth and be able to separate these into different line items to create a model. This implies they must understand the embedded risks associated with the chosen revenue model. They also need to collect data on the cost drivers so that they know both the fixed and variable costs of ownership. In some cases, they need help to collaborate fully on a model.

Nevertheless, they need to understand the possible impact on margins and, hence, understand the risks that the management is experiencing. It is enticing for managers to jump to advanced services. However, it is essential to remember that the difference between the cost structure and the revenue streams is the margin the firm can expect to move to advanced services. With a data-driven understanding of costs and revenues, firms create risks that could cause material damage to the firm.

6 Conclusions, Limitations, and Recommendations

This research investigates alternative revenue frameworks for companies traditionally anchored in transactional sales, notably emphasizing the transition towards PaaS or subscription-based revenue models. It underscores the role of the total cost of ownership or lifecycle costing and confirms the need for revenue strategies to be aligned with customer outcomes. A significant insight from the study is the critical importance of gathering detailed operational and financial data, which is fundamental to successfully adapting to PaaS and deploying other revenue modes associated with advanced services. Such endeavors require a thorough understanding of fixed and variable costs. However, effectively implementing these revenue models hinges on data collection challenges and understanding cost drivers and consumer usage patterns. The study advises companies to evaluate these models, considering their characteristics and the total cost of ownership, before proceeding to a PaaS-based revenue model. The study states in the managerial implications that firms should transition to subscription and pay-per-use revenue models only if they fully understand the total cost of ownership for the products they provide (by implication, this includes the embedded risks).

Given its focus on a single case study, the research needs to be revisited with additional cases to become generalizable. The findings, while insightful for the specific company and context examined, may not be directly applicable to other firms with different operational settings or industry dynamics. This constraint emphasizes the need for caution when extrapolating the study's conclusions to broader contexts or different sectors, highlighting the importance of context-specific data analysis and model validation in adopting new revenue models.

For future research, the study advocates for a deeper investigation into data collection methodologies that can support the systematic analysis of total cost of ownership for companies transitioning to Product-as-a-Service (PaaS) and other advanced service models. This includes exploring how firms can integrate and analyze operational and financial data to adopt subscription-based and pay-per-use revenue structures. Addressing this gap is crucial for enabling companies to move from traditional transactional models to more sustainable and customer-centric business strategies.

Disclosure of Interests. The authors have no competing interests to declare relevant to this article's content.

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