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Control System as a Service

Standardizing Service Model and Pricing Principles

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ABSTRACT:
The service business has aided manufacturers to supplement their new equipment sales across many fields of businesses. The service business has proven to generate steady portions of total revenues, but even larger percentual portion of total profits. Since customers have the tendency to focus more and more on their core competencies and capabilities, services have grown steadily day in and out.

Not many studies have been made about the potential that a control system as a service can provide to a company. Through market saturation and globally competitive markets, companies meet the challenges to operate effectively in the service business, have a standardized way of working and to price their services optimally.

In this master's thesis I will explain how services and service portfolio can be standardized and what pricing principles are to be considered for them. First, the servitization as a trend in an industrial context is reviewed along with service strategies and service orientation. Also, the pricing contexts around services and the value aspect of it are reviewed. Lastly, the literature review highlights cloud services with a comparison to traditional IT services.

Next, I will study how the offerings can be readjusted to offer control systems as a service with the help of cloud services and what costs to take into considerations, and how the pricing of the service could include.

By comparing a traditional model and a service model, the total cost of ownership during the lifecycle has different phases. The total cost of ownership is calculated to be less for a traditional model during one traditional lifecycle. However, as a new lifecycle is initialized with a lot of investment costs for software and hardware, thereby making the service model is yet again cheaper for the next couple of years.

Consequently, the comparison between the models is dependent on the customer preferences and their IT strategy; the level of outsourcing it wants to practice, what cost structure it wants to pursue, and how much predictability it can have for the future, as a traditional model is not as scalable as a service model.

KEYWORDS: product service system (PSS), SaaS, SaaS pricing, pricing strategy, service design

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TIIVISTELMÄ:
Palveluliiketoiminta on auttanut yrityksiä täydentämään uusien tuotetarjontaansa monilla liiketoiminta-alueilla. Palveluliiketoiminnan on osoitettu tuottavan tasaista, mutta usein jopa muuta liiketoimintaa suurempaa kokonaistuottoa yritysten tuloksista. Asiakkaiden keskittyminen ydintoimintaansa on kasvattanut muiden osa-alueiden ulkoistamista.

Automaatiojärjestelmien tuottamista palveluna ei juurikaan löydy tutkimustuloksia. Markkinoiden kyllästymisen sekä maailmanlaajuisen kilpailun vuoksi palveluliiketoiminnalla haetaan optimaalisia malleja kilpailuun ja uusiin ydinkyvykkyyksiin.

Tässä tutkielmassa tutkitaan, miten palvelut ja palveluportfolio voidaan standardoida ja mitä hinnoitteluperiaatteita kohdeyritys voisi tarjonnassaan hyödyntää. Ensiksi tarkastellaan palvelullistamista trendinä teollisessa kontekstissa yhdessä kanssa. Myös palvelujen hinnoittelua ja sen arvoa tarkastellaan. Lopuksi kirjallisuuskatsauksessa korostetaan pilvipalveluja verrattuna perinteisiin IT-ratkaisuihin.

Seuraavaksi tutkin, kuinka nykyinen tarjontamalli voidaan muokata tarjoamaan automaatiojärjestelmää palveluna pilvipalvelujen avulla. Myös kustannusrakennemuutokset sekä palveluhinnoittelu ja sen tulevat menetelmät otetaan huomioon.

Vertaamalla perinteistä mallia ja palvelumallia, kokonaiskustannuksilla elinkaaren aikana on eri vaiheita. Perinteisen mallin kokonaiskustannusten lasketaan olevan pienemmät yhden järjestelmän perinteisen elinkaaren aikana. Sen sijaan, heti uuden elinkaaren alkaessa, kohdistuu asiakkaalle paljon ohjelmistojen ja laitteistojen investointikustannuksia, jolloin palvelumallin kustannusrakenteen arvioidaan muodostuvan kustannusnäkökulmasta asiakkaalle muutamaksi vuodeksi edullisemmaksi.

Näin ollen, mallien vertailu riippuu asiakkaan mieltymyksistä ja heidän IT-strategiastaan; kuinka paljon ulkoistamista asiakas haluaa järjestelmälleen ja minkälaista kustannusrakennetta se suosii liiketoiminnassaan. Myös ennustettavuus on järjestelmäkontekstissa merkitsevää, sillä palvelumallin skaalautuvuus tuo paljon etuja perinteisiin investointiprojekteihin verrattuna.

AVAINSANAT: palvelullistaminen, SaaS, hinnoittelu, hinnoittelustrategia, palvelumuotoilu

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Abbreviations

AMS	Application management services
CAPEX	Capital expenditure
CERT	Computer emergency response team
CSaaS	Control system as a service
CVP	Cost volume profit
DMS	Distribution management system
EOL	End of life
ESW	Embedded software
FAT	Factory acceptance test
FCM	Full cost model
IED	Intelligent electronic device
IoT	Internet of things
IT	Information technology
KSF	Key success factor
MFSD	Multi-factor service design method
OEM	Original equipment manufacturer
OS	Operating system
PSS	Product service system
QFD	Quality function deployment
R&D	Research and development
RFQ	Request for quotation
RTU	Remote terminal unit
SaaS	Software as a service
SAT	Site acceptance test
SCADA	Supervisory control and data acquisition
SE	Service engineering
SEEM	Service engineering methodology
SIEM	Security information and event management
SLA	Service level agreement
SPOC	Single point of contact
SW	Software
T&C	Terms and conditions
TCO	Total cost of ownership
VM	Virtual machine

1 Introduction

The purpose of the master's thesis is to further develop the service offerings of a case company in Finland that operates globally around energy systems and helps its customers with grid infrastructure, automation and control. The trend towards servitization and customers' interest in their own core capabilities continues strong across various industries.

Another trend across many industries is the shift from products towards services, integrated solutions, and PSSs (product service systems). Rather than making larger investments, many customers value recurring and predictable costs along with the expertise some service providers can create through outsourcing and partnerships.

The thesis proposes a guideline and standardized content for offerings of control systems as a service and the pricing approaches according to internal requirements and market needs. The research includes interviewing internal stakeholders with experience in offerings and service function, analyzing costs and pricing practices for different services and service level agreements.

The goal of the study is that the proposed service content guideline and pricing model will meet the requirements the case company has from the markets and internally in the business model and cash flow context. The model should also meet the future expectations that the customers have around control systems and support in various segments. The choice of highlighting service standardizing and pricing in the core of this study comes from their relevance to the case company and across all businesses.

Services have been dominant in various industries across many businesses by increasing amounts. Service offerings are fluid, dynamic, and regularly cocreated in real time by suppliers, customers, and technology, and often accumulate additional revenue and profit for the supplier, along with the cocreation of value in exchange for all parties. Service providers have different positionings and strategies. One does basic repair and maintenance, whilst some act with customers as sourcing partners. Services typically create an outcome and a customer experience, and up to 80 percent of all economic activities in the developed world can be defined as services.

Along with the service-dominant development across many businesses, also integrated solutions and product service systems have widely been adapted to the offering of industrial companies. This can be seen across the industries through customers' focus in their core capabilities and letting a service partners to handle repair and maintenance actions, along with strategic and operational advanced services for their production systems and installed products, software and other supporting parts in their operations.

Customers increasingly value services that fulfill their needs of the proficient excellence, and the purchasing price alone is not the only determining factor of the purchasing decision. By providing durability or lower life cycle costs, companies have the possibility of realizing the benefits of services and pricing power by providing more value than the next-best options customers can.

Pricing has also a huge impact on profitability (Hinterhuber, 2008) and price is the only "P" in the 4P marketing mix to directly generate revenue for a company. Pricing, at the same time, is often a challenging task for companies, and often requires its own function to be executed effectively. Hinterhuber (2008) found that when approaching more profitable pricing approaches, such as value-based pricing, companies seem to adapt more straight-forward cost-based and competition-based pricing approaches, as they find it difficult to measure and sometimes even to know what customer value is, how the market is segmented and how value can be communicated.

1.1 Background of the study

Many traditional ways of doing business have changed and manufacturing companies are a great example of this. Through the development of PSSs, they have turned their product and core strengths with service elements to achieve innovation and growth. The

PSSs differ depending on the business context and customer needs. Similarly, in this study the framework for moving from a traditional control system delivery towards servitization of the whole lifecycle of the system is addressed. The variables around the servitization and standardization of the service model of the control system and its pricing are tied to the variables of product, customer value, actor, service, business model, interaction context and time space.

The study aims to address, whether a service model for control system can lower the total cost of ownership to the customer, when compared to the traditional system delivery, the services they buy outside, and internal hours used to maintain and service the system.

Another point of interest for the study is to find out how the service model with the scope to be included can be built to using an adequate pricing model to fulfill the needs of different sizes of systems customer have across various segments. This mean that the standardization and pricing method should be scalable and to satisfy and create value for both the case company and its customers, from small to large.

2 Literature review

In the literature review the servitization, service design, strategy and cloud services are addressed. An introduction to value creation, pricing and service pricing is also given.

2.1 Servitization

Services have become increasingly dominant across many industries throughout the years. Service as a business has evolved from the belief of having no tangible value to providing superior value though the emphasis in customer experience management, and creating long-lasting, emotional bonds with business partners through cooperation and cocreating bundled products and services (Bitner et al., 2008). Service offerings are cocreated for the customers to accumulate revenue and profit, as well as to cocreate value for both parties in an exchange. The strategies to cocreate this value vary from company to another. One could focus its services towards basic repairs and maintenance activities, whereas another could function as an outsourcing-partner or a R&D partner. The following subsections will address different service strategies, service offerings and orientation in companies.

2.2 Service strategies

Gebauer et al. (2010) highlight that the overall strategy and service strategy must be correlated to be effective. The study highlights the importance of efficient and well-thought management of services:

> *In order to manage the shift from a manufacturing-based to a service-provider model, companies need a service strategy. Implementing a service strategy is, however, not a straight road to success. There is a risk that companies may end up in a mismatch between their organizational arrangements and their strategic market offerings. The implementation of service strategies includes building up an ability to deliver services, training personnel to become service oriented, and to a certain extent, developing a new organizational culture. There is also a risk that customers may not adopt the new service or that it will take too much time for the customers to reach the critical mass necessary for the service to become profitable.*

There have generally been two approaches for a company to transition from goods to services, a goods-dominant logic and a service-dominant logic. The first logic underlines “value-in-exchange”, and in which services are looked as goods. The second logic, therefore, highlights value-in-use, and where service is considered more of a process rather than a unit of output. Value-in-exchange could in practice be the exploitation of new service opportunities through temporal expansion, temporal reconfiguration, spatial expansion, or spatial reconfiguration. Adding services to the activity chain (i.e. temporal expansion) expands the service activities of companies in presales, sales, and aftersales phases. By adjacent activity chains, companies offer services independent of the activity chain associated with the product. Consequently, the reconfiguration of customer activities in both primary and adjacent customer activity chains can create additional business opportunities. (Gebauer et al., 2010.)

The second logic suggests that service orientation of a company is more than purely adding new services to existing product. Instead, the service-dominant logic proposes that value is cocreated with customers and service means a view of value creation to customer itself through the value-in-use. Enablers for customer’s value cocreation could include products/services, as well as integrations of these, or any kind of information. Hence, the value is created in a collaborative cocreated process rather than merely by the product/service provider itself. Some suggestive actions to consider when shifting to more service focus include thinking of:

- the aim of assisting customers in their own value-creation processes,
- cocreating value with customers and partners, rather than just thinking about selling or producing value,
- to see company resources as operant, i.e. intangible resources such as knowledge and skills. (Gebauer et al., 2010.)

Davies (2004) suggests that product/service providers are either systems integrators and provide services that operate and maintain their products or system integrators that move downstream into services that were used to be carried out internally by their customers or partners. The strategic positioning of the different services, according to Davies, is distinguished into three different service strategies: system integration, operational services, and business consulting. All these strategies can be argued to contain a specific mix of unique skill and competence in the collaborative process of value cocreation.

Davies' (2004) study examined the shift towards high-value integrated solutions and presented a value stream framework. The study showed that many companies are not just moving towards services, but they are moving towards integrated solutions provision from different strategic positions on the capital goods value stream. For instance, upstream manufacturers have shifted towards integrated solutions and maintain and service their products. Services can also be offered to support and integrate their competitor's products. This could occur for example when supplier and the customer agree on a system care agreement, where there are serviceable products from both the supplier, but also from 3rd parties. Traditional downstream companies are also changing, as they tend to move towards services that are actions previously taken care of by the customer internally. This could include operating a customer's SCADA system or security alert analysis of hardware and software.

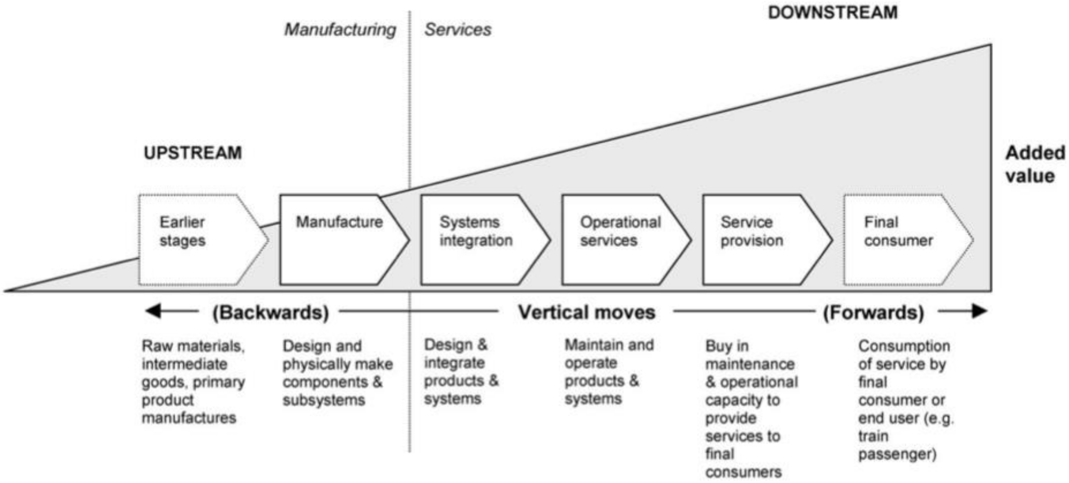

Figure 1. The Capital goods value stream framework (Davies, 2004).

Davies (2004) considers that to support a strategy shift towards core capabilities in system integration, many companies aim to develop a new set of capabilities. As a systems integrator, own products and customers must be known thoroughly to provide operational services. To manage one's core activities, effective outsourcing and oversight of upstream product manufacturers is required, and by offering entire solutions with the help of organization's own operational services, business consultancy and financial services. Vendors must avoid moving too downstream and start to compete with their customers, however, and manage the risks related to providing life-cycle solutions.

Gebauer et al. (2010) categorizes advanced services for industrial vendors. This categorization could apply for both manufacturing firms, as well as some project or PSS (product-service systems) providers, as it varies in literature based on the author. However, the main classification still can be grouped in five different categories:

1. Firm applying customer-service strategy
    a. Services are exclusively provided in the sales phase
2. After-sales provider
    a. Basic repair and maintenance services for existing product/install base

3. Customer-support service provider
    a. Advanced, preventive maintenance
4. Outsourcing-partner
    a. Manages customer processes and lowering customer's operational risk and burden
5. R&D partner
    a. Services complement customer processes by knowledge intensive R&D activities

These strategic categorizations are reinforced by exclusive organizational design factors, corporate culture, service orientation of HRM (human resource management), and the service orientation of organizational structures. (Gebauer et al., 2010.)

2.3 Service offerings and service orientation

As servitization, the transition towards services has been a dominant trend for years, the holistic empirical evidence about the factors that address industrial services and sales and profit performance remains limited. There are some studies addressing the relation between services and business performance. Gebauer et al. (2005) has found that services benefic companies by increasing their competitive advantage, and Kohtamäki et al. (2013) by adding more stable (and up to 50% additional) revenue streams and overall profitability through the product lifecycle. Kohtamäki et al. (2015) found that in servitization, both the service offerings but also service orientation of the company is important. Bundling both the service strategy and service orientation must address the culture of the company and value creation in customer's perspective (Lightfoot and Gebauer, 2011; Homburg et al., 2003).

Kohtamäki et al. (2015) highlight that additional extended services will not alone lead to enhanced financial performance or competitive advantage. Instead, the study suggests that fundamental structural and cultural changes are important to see service offerings show in financial performance. The interactive process can tailor the products and services together with the customer, leading to maximal value creation.

The service orientation of a company must be prominent in employees' behavior, recruitment, training, and assessment. Service orientation is a KSF (key success factor) facilitating relationships between service offerings, revenue, and perhaps most importantly, profits. (Kohtamäki et al., 2015.)

2.4 Service design

Design is a relationship between the wanted achievement and the process of achieving it. From a project-perspective, in the beginning there are design parameters involved, describing the wanted achievement and the answer to "how we will achieve it". Only being aware of the desired vendor-specific information is not enough, as the organization must be also aware of truly understanding customer's needs and transform these into guiding specifications. These specifications shall function as functional requirements, which tries to describe and fulfill customer needs. Another goal of axiomatic design is "to establish scientific basis for design and to improve design activities by providing the designer with the theoretical foundation based on logical and rational thought processes and tools". (Lee et al., 2001.)

In product design, the importance lays highly in the design and development stages, as they define the sustainability impacts for products. Along with environmental issues, also economic issues have been emphasized in product design. Traditionally, the QFD (quality function deployment) framework has been used, but axiomatic design is regularly used too.

In a study, Alkire et al. (2019) highlight some definitions and characteristics of service design. First, the value aspect of service design is defined as "an explorative approach to creating novel forms of value cocreation". Next, the transformative force of it is highlighted as service design is "a transformative force for changing institutional arrangements in service ecosystems". Service design is also "connected with innovation and increasingly being viewed through a service ecosystem perspective". That means, that service design is seen as a sum of creative practices, that through methods and tools can modify service ecosystems toward preferred future.

Fisk et al. (2018) similarly describe service design as "multidisciplinary field with a wide range of tools and methods for creating and improving service systems". The article also highlights that most of the service design literature is focused on small scale (customers, organizations) service systems, rather than wider nation or statewide service systems. Originated from Shostack's (1984) article on service blueprinting, service design is an evolving field and the multidisciplinary contributions have been used in research, design, IS, interaction design and operations management (Teixeira et al., 2019).

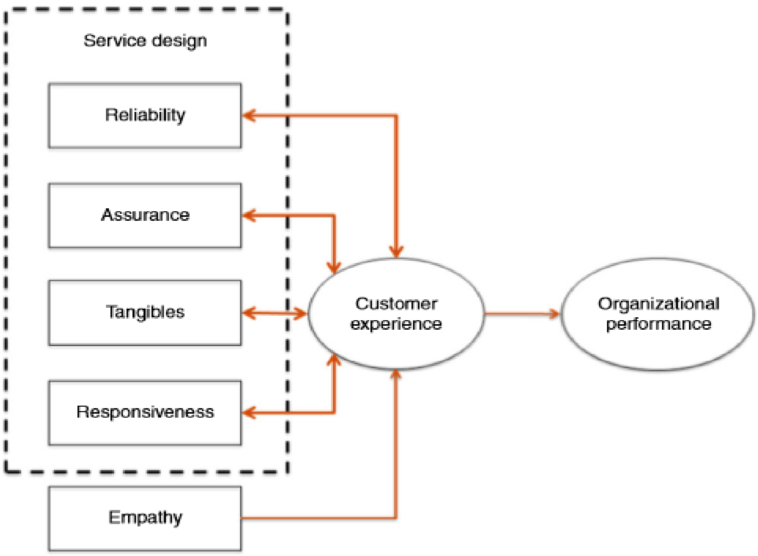

Figure 2. Service design as a turbocharger of quality, experience, and performance (Andreassen et al., 2016).

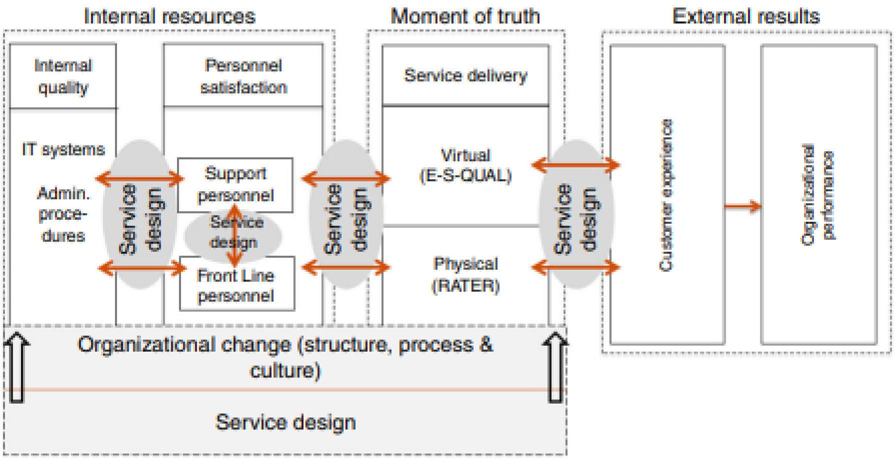

Figure 3. Service design for organizational change and enhanced value creation (Andreassen et al., 2016).

Through a human-centered approach, service design creates new service futures, in which contextual and holistic understanding of customer experience plays a role, and so does the aligning of system actors to support customer experience and supporting design and pilots or prototypes with creative tools. Some methods and tools in service design vary from service blueprinting to customer journey mapping, as well as process-chain network and integrated approaches for designing technology-enabled services. The classification of these methods can be based on the area where the method is applied, for which function it is considered, and where the focus is (product/process). (Sanhueza & Nikulin, 2019.)

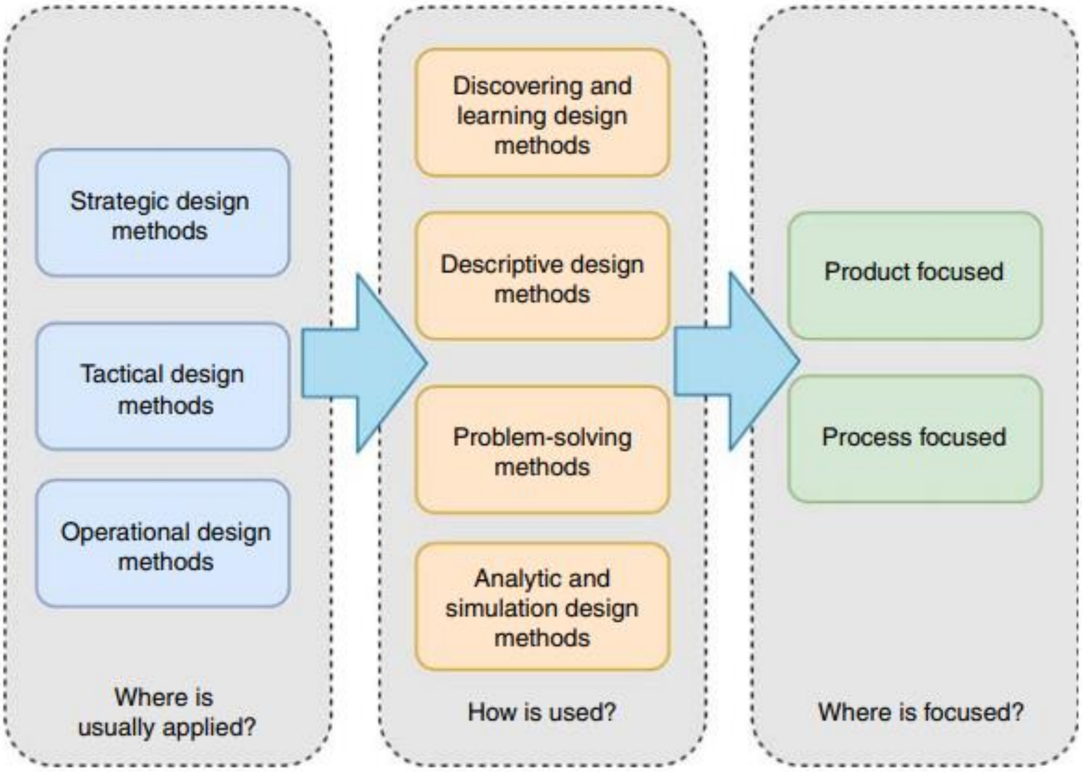

Figure 4. Graphic representation of method classifications (Sanhueza & Nikulin, 2019).

The design methods, however, cannot be excluded from different classifications, as methods often fit in more than one classification. Consequently, the authors propose a scale from 0 to 7 to measure the classifications. The evaluation scale tries to obtain a better usefulness of methods and models used. The table below presents the scale.

Table 1. Classification criteria (Sanhueza & Nikulin, 2019).

Scale	Assessment description	Semantic description
7	Method, model or techniques that are strongly represented by the proposed classification in the state of the art. Moreover, the case studies are easy to identify in literature	Strongly
6	…	
5	Method, model or techniques are a suitable candidate for the proposed classification, nevertheless, in literature is quite difficult to identify direct literature about the topic	Suitable
4	…	
3	Method, model or techniques are partial or slightly related with the proposed classification. Also, its application is difficult to find or insufficient for the classification	Slightly
2	…	
1	Method, model or techniques are poorly related to classification or nearly have a non-existent relationship with the proposed classification. Also, its applications in this classification results inappropriate	–

Lim et al. (2019) propose a "multi-factor service design method" (MFSD) for the value creation of customers. The method includes three steps. First, the method investigates the customer and service preliminary, and tries to understand the customer. Next, the service idea ought to be generated and refined. Last, the design method addresses service concept and the delivery process design. The design method addresses the occasional difficulty of designing complex services, affected by varying factors.

The MFSD method (Lim et al., 2019) contributes to previous literature on multivariate nature of service and is built upon studies that address the customer aspect in service design. Consequently, the method proposes a three-step approach:

1. Identify key components that create value in service
2. to outline the service design space on the first step
3. to design and represent services based on the significant points of service. (Lim et al., 2019.)

MFSD method proposes an approach to each of these steps. First, the mechanism of the service that will create value should be designed, visualized, and analyzed. Next, the service design space should be represented, that sorts the services. The service design ought to represent the most important key aspects of service. Third, the service concept and delivery processes are designed in alignment to the service design space. Another important thing in the third approach is to use customized service representation templates to include all significant points of the service in its design. Although the approach can be understood as linear, the authors highlight that the method usually has multiple iterations before the final product. (Lim et al., 2019.)

Another service design method mentioned by Texeira et al. (2019) and Sanhueza & Nikulin (2019) is service blueprinting. Service blueprinting is a customer-focused approach for service improvement and innovation, that can help addressing challenges in service design and innovation and is especially applicable in customer experience design. Service design is distinguished by other more process-oriented design methods by being customer-focused, visualization of the service processes, points of customer contact, and the physical evidence of service from customers' perspective. Blueprints can also illuminate and connect supporting roles in the organization that can help execute and support a customer-focused service strategy. Ultimately, service blueprinting can help in developing new services, updating, and upgrading existing services, and help cross functional communication in a customer-focused business area. (Bitner et al., 2008.)

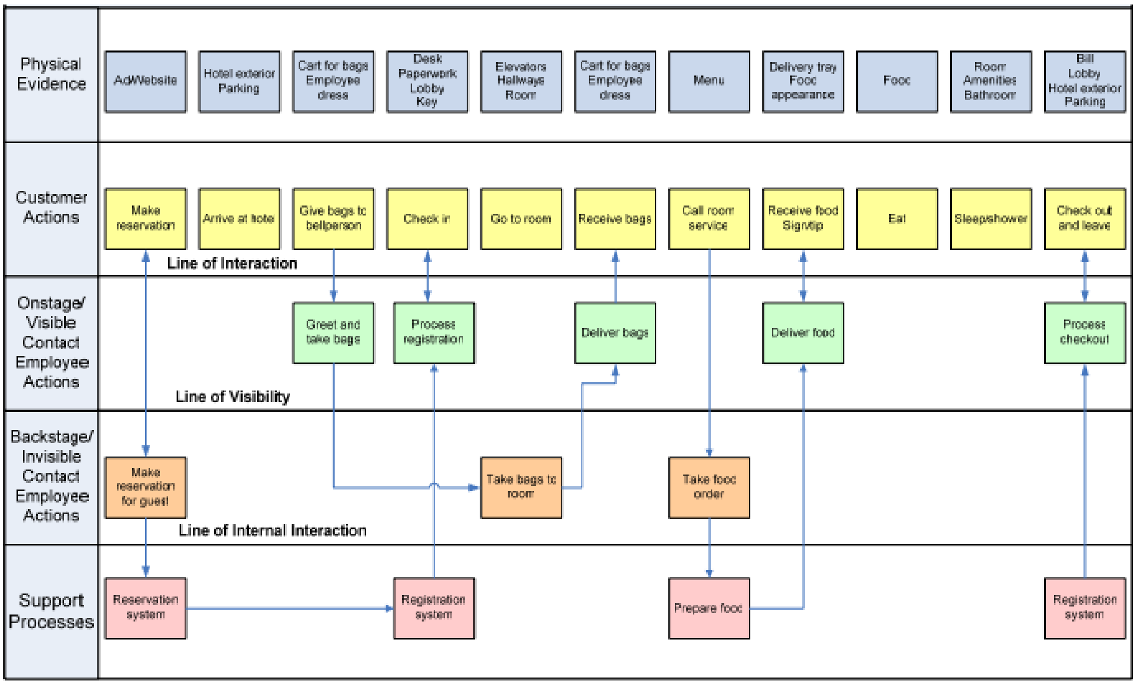

Figure 5. Service blueprinting for a service (Bitner et al., 2008).

The components of a typical service blueprint include:

- Customer actions,
- visible contact employee actions
- invisible contact employee actions

- support processes and
- physical evidence.

Customer actions are steps or things where customer is active when taking part of the service delivery process. Customer actions are presented at the top of the blueprint. Unlike in other flowcharts, customer activities are central, and all other activities seen as supporting the value proposition offered to or cocreated with the customer. The second component of the blueprint is visible contact employee actions. These include face-to-face encounters and "moment of truths", which composite negative or positive feelings in the customer. This can even include what happens after a customer has clicked a link to contact employee. Invisible contact employee actions, therefore, are not seen by the customer. These include nonvisible interaction with the customers (phone calls) and other activities to prepare to serve customers. Fourth critical component is support processes. This component includes actions in the company, not contact employees, that need to happen for to deliver the service to the end customer. Lastly, for all service actions and "moment of truths", the physical evidence is described at the top of the blueprint. All these tangibles can affect customers' quality perceptions. (Bitner et al., 2008.)

Service design is a sum of creative practices, that through methods and tools can transform services towards the wanted future. Similarly, Pezzotta et al. (2016) has studied how to engineer industrial product-service systems in power and automation industry. The research is based on the found research around the design and development of PSS and how Service Engineering (SE) can be used to support the systematic development and design of services. The paper identifies gaps and proposes a method for company to adjust external performance with longer term business sustainability goals. The method is constructed based on existing literature on PSS design and SE, and found four main phases from the existing research:

1. customer analysis (identifying customers' features and needs),

2. requirements analysis (definition of product or service requirements to address customers' needs),
3. PSS design (identification and design of solutions, satisfying customers)
4. PSS test and implementation (test the performance of the identified solution and implement it). (Pezzotta et al., 2016.)

There are multiple methods for addressing the above phases in the PSS design and SE literature. Table 2 shows an overview for different tools and methods for addressing the corresponding phase in the development process model.

Table 2. Summary of PSS design and SE methods (Pezzotta et al., 2016).

Phase	Methods
Customer analysis	• Persona model • Cost–benefit analysis
Requirements generation and analysis	• Quality function deployment (QFD) • Benchmarking • Functional analysis/FAST – Function analysis system technique • AHP • Agent based simulation
PSS design	• Functional analysis/Function analysis system technique (FAST) • Service blueprinting
PSS evaluation and implementation	• Simulation (discrete event simulation and continuous simulation) • QFD • 3D visualization • Failure mode and effects analysis (FMEA) • ANP • AHP

The table shows that for understanding customer needs, cost-benefit analysis or persona model can be used to collect, analyze, and summarize data. Another benefit of persona model is its visual way to present data trough market segmentation surveys or interviews. The second phase generate and more deeply analyze the customer requirements and outline the service with tools and methods such as the quality function deployment model (QFD). QFD is a widely used tool to structure customer needs into product-service functions. The third phase, therefore, focuses on the identification and design of solutions and customer satisfaction. The methods include service blueprinting, which can present the service delivery process from customer perspective and the touchpoints and visibilities of customer and service provider interactions. Fourth, the designed PSS system can be evaluated and implemented, if applicable. (Pezzotta et al., 2016.)

Pezzotta et al. (2016) concluded, based on their literature review, that an industrial tested method for addressing both customer perspective and the internal performance of the company is lacking in PSS design and SE. For a better alignment between the academic methods and industrial use, they propose a Service Engineering methodology (SEEM). SEEM consists of two main areas; the customer area, which addresses customer analysis, and the company area, which supports the service delivery process and company external and internal performance. Consequently, SEEM addresses the most used phases in the SE models, consisting of offering identification and analysis, customer needs analysis, process prototyping, and process validation.

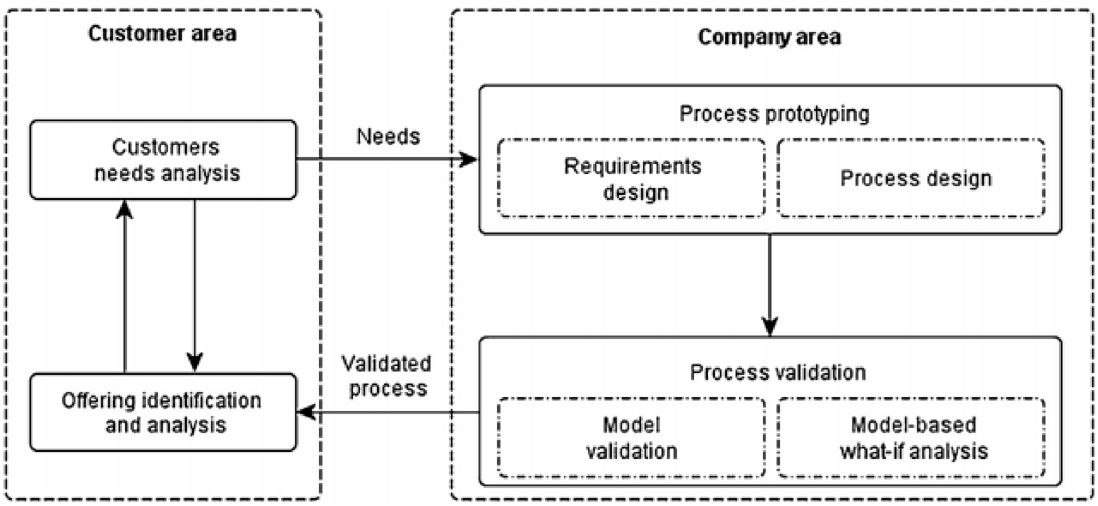

Figure 6. The SErvice Engineering Methodology (SEEM) (Pezzotta et al., 2016).

The first two phases in engineering a PSS is the analysis of customers' needs and the assessment of the current solution portfolio. The goal is to understand the customer needs that are wished to be fulfilled by the method's outcome(s). First, the current offering of the company and the market in general should be analyzed to understand in which way company is fulfilling customer needs. Next, customers' needs need to be understood thoroughly. The needs should be reflected to products, services and expected performance. The analysis of the requirements and needs should lead to the segmentation of customers in different classes. The segmentation can be done e.g. by conducting market research, interviewing customers, focus groups or expert panels.

2.5 Service pricing

Pricing has a huge impact on profitability and the methods often vary across different industries or marketing strategies. Over the years, several methods have been created, but generally these methods can be narrowed down to following categories:

1. cost-based pricing,
2. competition-based pricing, and
3. value-based pricing (Hinterhuber, 2008).

Some common considerations in pricing would be customers' price sensitivity, costs, competition, and lifecycle. Most believe that companies can price naturally with small effort, but instead pricing is a capability for a company (Dutta et al., 2003). To enhance its capability to adjust pricing to right price level, company must invest in its resources and operative model. Pricing resources, operations and skills can help or obstruct a company to reach an optimal price – and therefore value creation. According to Dutta et al. (2003) seeing pricing as a capability contributes to resource-based view, since this view considers the value creation process in strategy work and its enabled competitive advantage.

This view also contributes to economics, as strategic decision making of pricing capabilities leads to an economic action, price setting. Without effective pricing processes, business leaders may be unable to set prices that adapt customer expectations. Variation from the optimum might lead to customer (or the seller) exploitation and unreasonable monetary discount. Consequently, seeing pricing as a capability links the resource-based view directly to the core of economic theory – the use of maximum available resources.

In large, continuously growing, and progressive markets it is particularly important that companies continually enhance their pricing strategies. With a wrongfully adjusted pricing strategy, a company could lose a remarkable portion of revenue or profit (Hogan et al., 2006). In the early 2000s economic recession, the defending of market shares by lowering prices gave customers the signal that prices are even further negotiable and could be lowered even more. Companies had to bundle their core products with supplement products and service, to cultivate their supplies and do enough sales. This method proved itself problematic, as by ceding products, services or other value creating for free, the expenses rose and the customers learned, that the seller's services in fact are not that valuable (Hogan et al., 2006). According to Hogan (2006) these short seeing baselines of pricing might have held sales in good figures but taught the customer to look at the price and to neglect value.

Other obstacles leading to poor pricing decisions may include not applying the same principles to pricing decisions as other marketing decisions and to focus on the costs and forget about the customer (Nagle, 2002, p. 1–2). These factors are especially important in services, as value is the binding factor between the stakeholders. To succeed in customer relationships, company must understand how their marketing decisions are evaluated by customers. Success is potential if the customer's response to those decisions is what business partner expected. This potential to success can get higher probability through careful attention to the customers, not to mention that customer may decide value over price. A common mistake is that managers think about the customer's perspective only in reflect to product, promotion, and placement. For pricing this might lead to focusing on future cash flows with a set price and not considering the customer when pricing. After all, it is the customer who determines which products or services sell and which companies earn profit. Customers can be attracted to a product or a service, but they cannot be coerced to make the ultimate purchasing decision.

A modern customer seeks the most value for their money (Nagle, 2002, p. 2) and for value creation it is fundamental to put selling prizes to an optimal level. This often means they try to obtain lowest possible prices or pay premium for perceived superiority of a brand. The latter could mean paying extra for a brand known to provide superior service and maintenance during the product life cycle and therefore providing more value for the customers. Lowest possible prices could be sought after in commodities or inbound logistics. Seller's profit margins, cash flows and production costs are not among the things a buyer is concerned of. Instead, their main concern is to obtain their money's worth. Therefore, pricing is inefficient if done only on the firm's own financial needs.

By its brief definition, price is the amount of money that is payed for a product or a service. Its more extensive definition, though, price is the sum of value that customer relinquishes to be able to use a specific product or service. Historically, price has been the most critical factor in buying decisions. Even in these days, price is still affecting companies' market shares and economic performances, but alongside has emerged new factors leading to a buying decision. (Kotler & Armstrong, 2010.)

Price affects companies' profits generally in two different ways. First, price has an influence in profitability through profit margins, that is through the difference between sales price and a product's direct costs, such as raw materials and labor costs. Second, price affects through price elasticity, that is how responsive or elastic the customers and their demands change when price, and price only, of a product or a service changes. (Anttila & Fogelholm, 1999, p. 17–18.)

When McCarthy's 4P model's[1] product, place and promotion only result in costs, price is the only factor in 4P producing revenue directly. It is also the most agile part of 4P model, since, in contract to supply chains or product design, it can effortlessly be changed even in real time. Pricing, however, is not easy, subsequently profit margins need to be remained at worthy levels and at the same time avoid not to price too high and therefore price oneself out of the markets.

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[1] McCathy's 4P sees consumers as rational actors and the model is especially used in consumer marketing. Some common extended versions also exist, such as the 7P model.

Price is often linked to other competitive tools, for example to quality. One goal of marketing and research and development departments of a company is to provide the possibilities to use of price more freely as a competitive tool. Product differentiation, market structure, costs, and customer's quality expectations et cetera have a major impact in the freedom of pricing a product or a service. Generally, the freedom to price a product/service correlate with product differentiation and these other mentioned factors. Company processes, indeed, aim towards enhanced competitive tools and thus also to increased economic profits through price. (Anttila, 1999, p. 18–19.)

From industrial marketing aspect, value-based pricing is an attractive model. In contrast to other type of pricing methods, the value-based method is challenging due to its challenging informative backgrounds. The goal of the method is to evaluate the value delivered to customers with help of customer surveys and studies (Hinterhuber, 2008). According to a survey made by Hinterhuber and Liozu (2012), organizations practicing value-based pricing often have a dedicated team working exclusively on the pricing of the goods. Other companies, practicing e.g. cost-based pricing do not have them as often and in them, pricing decisions can ultimately be a result of a just an individual decision based on a survey (sometimes even a guess). These teams are closely integrated with marketing departments, there the value of a product can be presented from early stages (Hinterhuber & Liozu, 2012).

Exclusively, value-based pricing considers competition in the markets, yet demand. Hence, value-based pricing can be considered the most advanced pricing method. On the other hand, practicing it requires use of data, knowledge, and a lot of organizational resources (Hinterhuber & Liozu, 2012). Nevertheless, value-based pricing is found the best approach in literature, see Hinterhuber (2008), but the implementation is still minor across industries, hence its labor-intensive nature (Hinterhuber, 2008).

In theory, customer value is defined in two main ways in literature: Either as customer maximum willingness to pay (customer reservation price) or as the remainder between benefits and price (customer surplus). Liozu et al. (2012) studied practitioners' understanding of value-based pricing in different companies and the results were consistent with the existing literature.

> *"A vast majority of managers practicing value-based pricing defined value as either customer benefits over the best competitive alternative or as customer willingness to pay. This definition is thus fully in line with the current literature, namely Forbis and Mehta (1981), Golub and Henry (2000), Nagle and Holden (2002), and Priem (2007)."* (Liozu et al., 2012)

In the new era of industrial markets with digitalization and servitization, value pricing could be conceptualized e.g. by PPU (pay per use, (also; "pay per click", "pay per hour", "pay per km")), that has been adapted in some firms. There, value is easy to calculate as how operative a product or a service (e.g. a machine) of a manufacturer is.

Another feasible way to price value is to use market-based price[2] and add a supplier's superiority-/inferiority-premium (Kulmala 2006). In the model supplier evaluates the current price level of the product and adds the sum, which represents customer's standpoint on the product's superiority or inferiority to other similar product in the market. A tractor or automotive manufacturer could price its superiority as below:

X	Other similar product in markets
+a	Premium for better mean durability
+b	Premium for lower mean number of defects
+c	Premium for better maintenance and serviceability
+d	Premium for longer mean warranty period
Y	Acceptable price from customer standpoint

First, when using this method, the practitioner must know and provably be able to measure every price lowering/raising feature, so that price level is suitable from customers

[2] Here market-based price is suggested as the *next best alternative* for the customer.

standpoint. Second, the supplier could have to consider details, that when brought up, would not de facto promote the sale. If e.g. the warranty period is by mean lower than the competitors', it would be undesirable to be presented in this pricing approach. (Kulmala, 2006.)

Hinterhuber (2008) assessed the implementation of value-based pricing strategies and formulated a coherent framework for the implementation process. First, the company and its objectives are taken into consideration. Second, the key elements of the pricing decision are revised. This could include analyzing the economic value, cost-volume profits, and competitive analysis. The objective is to include key strategic objectives of customers, company, and competitor perspective for effective analysis. This results in the decision and the selection of profitable price ranges. At last, the price changes are implemented by the company.

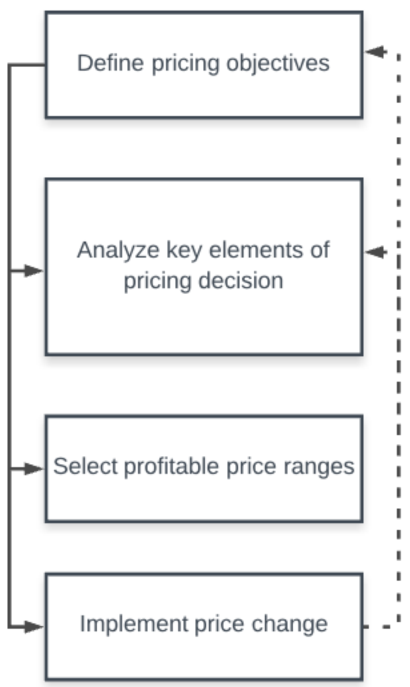

Figure 7. Decision process of value-based pricing (Hinterhuber, 2008).

Pricing objectives should be aligned with the company's strategy. Pricing could, in the short term, decide to use market penetration strategies to reach maximum market share. Pricing objectives could differ between products and the time scope, also within a firm or business unit. The main objective of the pricing process is to determine strategy to be profitable in the medium to long term. (Hinterhuber, 2008.)

In the analyzation of the key elements of pricing decisions the customer, company and competition are analyzed. In the past, management could have been resilient towards pricing new product above prevailing price levels, even if the value for the customers would be greater. This phase, however, gives the management the possibility to implement profitable pricing policies, thus grow long-term profits. Cost volume profit (CVP) analysis is used to create an internal perspective of a company., competitive analysis can be used to gather the perceptions of competing strategies, and economic value analysis is to understand how customers value products or services. (Hinterhuber, 2008.)

Economic value analysis is a tool for the management to understand and to measure the product's sources of value for a customer. As explained already in the thesis, the value has different lines of thoughts for the customer, but the hard thing is that the value could change as new products emerge. To measure economic value rightly, Hinterhuber (2008) presents a six-step process.

Firstly, the cost of competing product and process (of customer's best alternative) should be identified. Second, based on customer's preferences, the markets should be segmented. The economic value could differ largely between the customers and how they use and value a product. Observation and field research, along with lean production, give a company the possibility to comprehend sources of customer value. Third, all factors and details differentiating from a competing product and process should be identified. Hinterhuber (2008) lists down some differentiating factors, closely related to the concept of competitive advantage, being: "reliability, performance, ease of use, longevity, life cycle costs, user and environmental safety, service, superior esthetics and prestige”. Fourth, these differentiating factors should be determined in the value-perspective for a customer.

The identified differentiative factors should be given the monetary values, aligned with the market segments. A simple identification of this could be done with a conjoint analysis[3]. Fifth, the reference value and the differentiation value are summed to gain the total economic value. However, even if being a simple addition, the sum of these do not create a precise monetary value of a product, but instead a *value pool*, assessing the different product values of customer segments. Sixth, the value pool can be used to evaluate future sales as particular price points. For the varying price points, large portions of each market segment can be reached with adjusted prices. (Hinterhuber, 2008.)

The cost volume profit (CVP) analysis is used to analyze the effect of price changes to company profits.

$$Break\ even\ sales\ change\ (\%) = \frac{-(\%Price\ change}{\%Contr.Margin + (\%Price\ change)} = \frac{-\Delta P}{CM + \Delta P} \quad (1)$$

This means that a product with a low margin demands a large sales volume increase for the price reduction to be beneficial. However, for high-margin products price increases, if volumes do not decline significantly, can company attain increased profitability. (Hinterhuber, 2008.)

The final step to analyze the key elements of pricing decisions is through competitive analysis. Hinterhuber (2008) lists the dimensions to consider for the analysis:

- threat of entry
- price trends in existing markets

[3] A conjoint analysis could ask the customer “Would you prefer a low price with no technical support, or higher price with technical support.”

- competing strategies
- information (e.g. market share, size, and sales volume forecast) of distribution channels
- reference values of customer segments
- reception of price changes.

From the output of the analyzation of economic value, competition and the CVP analysis, companies can validate and estimate the outcomes of price increases. Internal stakeholders and a focus group of customers can be piloted for the estimation of actual volume loss. If the price elasticity of customers and the volume loss is smaller than the those gathered from CVP calculations, the company would have a strong argument for the price increases. (Hinterhuber, 2008.)

At last, the price changes should be implemented. Necessary managerial step is to communicate effectively and to control the operative sales force accordingly. A positive incentive to control the sales force is to involve them in the strategy process, and to reward them for selling value (profits) and not volumes. (Hinterhuber, 2008.)

2.6 Cloud services

Cloud services have been defined as an on-demand self-service over-the web, used in real-time, and which may include computer software, application development platforms, or virtual servers, and which the customer may reserve as needed. In addition, scalability and resource sharing were also defined as related to the cloud service. (Mell & Grance, 2011.)

The definition of cloud service used above is quite difficult to understand and does not quite reveal all the key features of a cloud service. Thus, according to NIST (National Institute of Standards and Technology), the five key features of a cloud service are:

• on-demand self-service,

• access to the service via web,
• resource pooling,
• service elasticity as well
• measurability.

On-demand self-service refers to the customer's independent ability to deploy additional computing resources, such as server capacity, as needed without having to contact the service provider separately.

Access via web means in practice the possibility to use the cloud service via a web browser, in which case it is not connected to a specific device or to a specific location. In some cases, however, a separate add-on may be required for the browser (Heino, 2010).

Resource sharing (multitenancy), sequentially, means that a service provider can dynamically allocate resources from the same center to multiple customers according to their needs (Mell & Grance, 2011.) For example, a single server may run applications for multiple users at the same time, depending on the situation. Similarly, a single user may simultaneously access the resources of several different servers, and those servers may be located geographically in completely different parts of the world.

Service elasticity, on the other hand, means automatic scalability of capacity. Server resources can be easily utilized and freed up on demand. This process also takes place invisibly to the end user (Mell & Grance, 2011.)

Measurability, in turn, enables accurate monitoring, management, and reporting of resource use, ultimately leading to service transparency (Mell & Grance, 2011). Good measurability also creates the framework for usage-based pricing.

2.7 Types of cloud services

Cloud services can be divided vertically to a stack model (Heino, 2010). Additionally, clous services can be divided based on the implementation model of the cloud, i.e. cloud type (Mell & Grance, 2011).

2.7.1 Stack model

Based on the ontology by Youseff et al. (2008), the stack of cloud services is constructed by five different layers, which have been represented in the following figure:

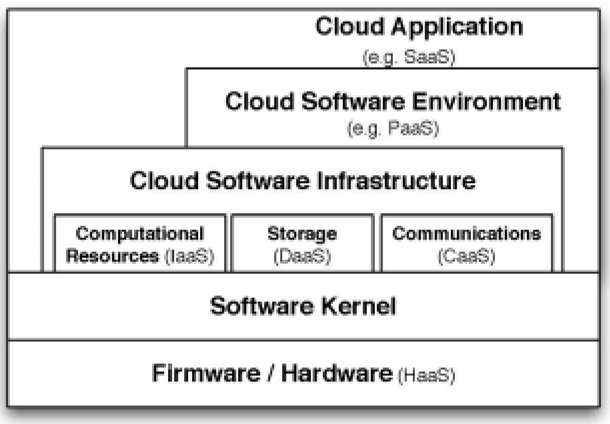

Figure 8. Cloud Computing Ontology: Layer model (Youseff et al., 2008).

The stack illustrates the functioning of cloud services. Services provided on a layer is composed of the layers below. The customer can choose from which layer it wants the services. The layers that remain under the chosen layer, will stay invisible for the customer and are provided by the service provider.

At the top level of all the stack is the cloud application. For the average application user, this layer is the most visible of all (Youseff et al., 2008). For example, a user of office software used as a cloud service is not interested in anything other than the application used and at most the related settings and configurations. All software, operating system or hardware solutions under the application are the sole responsibility of the cloud service provider. Such a service model in which the customer uses only the top level, i.e. the cloud application, is called SaaS (Software as a Service).

At the second highest level is the cloud software environment. Within this level, the customer has the access to programming language level environment with interfaces and development tools. At the level, customer can build their own applications and be run on the platform as well. A service model, in which the cloud software environment is provided as a cloud service is called a PaaS (Platform as a Service).

Below the software environment is the infrastructure level. This level is supplemented with services that are categorized into three different groups: computational resources, data storage and communication. The computational resources include e.g. the virtual machines on which the customer can install its operating systems and software. The infrastructure provided as a service is called Infrastructure as a Service (IaaS).

In the ontology by Youseff et al. (2008) between the infrastructure and hardware layers is a kernel layer, which takes care of the management of physical hardware resources. At the layer, as an example operating system core, middleware for clustering and management and monitoring of virtual machines. Practically, the layer combines the server resources allocated to the customer’s use with the correct hardware resources.

At the lowest level are the firmware and hardware, the components that make the system. A service model in which the customer only receives a system constituted of hardware components, is called HaaS (Hardware as a Service). Such service model is close to leasing of hardware, with the difference that the hardware is yet used through an information network.

From the presented ontology, it should also be noted that the cloud application and software environment layers can, if necessary, bypass the infrastructure layer by which efficiency advantages for example can be achieved. However, this complicates the development process (Youseff et al., 2008). The existence of an infrastructure layer is also a factor that increases cyber security, as customers cannot access each other's data directly through hardware resources.

2.7.2 Implementation models

Cloud services can further be subdivided based on the implementation model, which include private cloud, community cloud, public cloud and hybrid cloud. In private cloud the service solution is one complete cloud infrastructure is used by just one organization. The cloud provider could also be a third party provider. In community cloud, the infrastructure is shared by trusted collaborators, but community of users in evidently limited. A public cloud is a model where the infrastructure is open to all potential customers. In a hybrid cloud, therefore, two or more types of cloud environments serve the same organization in an integrated manner simultaneously. Different infrastructures may be connected through common interfaces to transfer data and align hardware resources. (Mell & Grance, 2011.)

2.8 Cloud services from the service provider’s perspective

Next, the service provider’s perspective to offering cloud services and its specific features are addressed. The features include but are definitely not limited to pricing and cost structure of cloud services, customer engagement and the development process.

2.9 Pricing and cost structure of cloud services

According to Paleologo (2004), the more traditional pricing models are not suitable for pricing of usage-based services. The reasoning behind this is a shorter duration of contracts, higher probability of changing the service provider, uncertainty around the development in demand trends and a shorter lifecycle of services.

Hence, pay-per-use could be a key feature of cloud service. The use can be measured in different ways, but a lot of monthly subscription based pricing is also used (Youseff et al., 2008).

Usage-based pricing could establish challenges to the service provider. The costs associated with the service differ remarkably from the traditional business models in IT. The offered solutions are generic, and typically do not have to be tailored individually to each customer. Also, the multitenancy and elasticity enable more productive usage of the server resources. In general, the uptime of the server can be sold to multiple clients simultaneously. Another benefit is that the data centers do not have to be in a specific location but can be distributed around the globe.

2.9.1 Low customer engagement

There is no similar degree of commitment between the cloud service provider and the customer, compared when purchasing of a software license. A software license is more of a one-time investment for the customer, the benefits of which can only be realized after prolonged use. In usage-based pricing, a similar situation does not arise, so it is easy to change the cloud service provider if, from the customer's point of view, a greater benefit is obtained from another service provider. This is a risk that the service provider must consider in its own business. (Fox et al., 2009.)

2.9.2 Product development and maintenance process

According to Youseff et al. (2008), it is simple to develop new applications on top of a software environment offered as a cloud service because the software environment already provides automatic scalability, load balancing, and ready-made interoperability with other services in the software environment. It is also noteworthy that a service provider developing cloud applications may choose to purchase the software platform as a PaaS service from another service provider instead of implementing everything from the hardware itself.

It is also easier to maintain the products, as the customer does not have to be asked to install updates on the applications, it is enough to install the updates on their own servers, so that the latest versions are automatically available. (Youseff et al., 2008.)

2.10 Cloud services from customer's perspective

On the contrary, some things that are perceived as risks from the service provider's perspective are considered pros from the customer's perspective. The following is an overview of the benefits of cloud services from the customer's perspective, as well as the expectations and risks experienced by customers.

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2.10.1 Perceived benefits

A key issue in business is cost efficiency. Traditionally, the company's IT functions have been the so-called fixed costs that are not related to sales or other costs related to sales (Heino, 2010). Such costs include, for example, software licenses, data center rents, hardware purchases, and maintenance costs. The above costs are poorly scaled as operating income increases or decreases.

The biggest benefit of cloud services is their cost-effectiveness. Some IT functions can be converted into variable costs when information technology needs can be purchased as a service and paid only according to usage (Heino, 2010). Cost savings are generally seen as the strongest benefit of cloud services (Benlian & Hess, 2011). Other benefits can be directly derived from cost-effectiveness. Scalable costs reduce barriers to entry and time to market (Marston et al., 2011). For the customer is also easy to change the service provider without much costs and effort associated. Then, the vendor-lock-in situation is more delicate when the customer is not dependent on the solution and the service provider.

The pros from customer perspective include the hardware independence of cloud services, as even applications that require a lot of hardware resources can be used with a simpler terminal device such as a laptop or smartphone (Marston et al., 2011).

2.10.2 Customer perceptions and risks

Customers often have clear expectations about what features cloud services can require. Some of the expectations may be unrealistic. The cloud service is expected to be reliable and liability issues are expected to be clear in possible incidents. Privacy and cyber security are also expected to be in order and customer information is not expected to be compromised under any circumstances. Likewise, availability, access to the service and copyrights are expected to be realized on the customer's terms. (Jaeger et al., 2008.)

Although in practice the limit is not easily met, according to Fox et al. (2009), customers have an idea of endless performance and storage capacity that is immediately available.

According to Benlian and Hess (2011), the biggest risks for IT managers who have introduced cloud services are service availability and strategic risks, which refer to the organization’s ability to change, flexibility, responsibility issues and contractual risks.

Equally clear risk is the loss of physical control of the data and the consequent security issues. In addition, the high availability requirements for critical systems may not be met. (Marston et al., 2011.)

2.11 Key differences between software licensing and cloud services

The following table summarizes the traditional software licensing and cloud services, and their key differences.

Table 3. Comparison between software licensing and cloud services.

	Traditional software	Cloud services
Pricing	Lump sun or ongoing monthly subscription	Usage-based pricing or monthly payment
Cost effectiveness	Fixed costs, are entered in the balance sheet	Good, IT costs variable costs
Use of the software	Installed on your own computer	Used through a web browser or the like, hardware independent
Hardware and maintenance	Under the responsibility of the customer	Under the responsibility of the service provider
Elasticity	Weak	Good
Risks	Dependency on the software vendor	Data protection, user rights, service guarantee, contractual risks

3 Method

The method chapter will introduce what will be researched in the case company, why the study is relevant and how the information will be gathered in the case company's business context and customer needs, ultimately leading to the building of the PSS design and its service concept, business model strategy and interaction information.

3.1 Motivation for research

The aim of the study is to find out, whether a service model could provide more added value to the customer or not, and to compare its scope to traditional system delivery model and support services provided currently. The service model of SaaS is utilized, as it is the most comprehensive cloud service model and deviations to the scope can be later considered based on customer requests by making subtractions to the model. Also, the internal capabilities and resources needed in both the traditional delivery and SaaS are assessed and compared against each other. The primary interest is in the total cost of ownership (TCO) of the traditional system delivery and SaaS service models. Based on previous research (e.g. Kostiainen, 2019) it is expected that the price of the control system as a service model compounds to a high price in comparison to the traditional control system delivery model. The study, however, is not considering total cost of ownership calculations or assess the value created to both parties of the exchange.

The study wants to address, whether the service model can lower the total cost of ownership of the control system to the customer, when compared to the traditional system delivery and its associated support services and internal works made by customers in the traditional model.

The total cost of ownership will be calculated with the help of information of recent traditional system updates customer companies. The calculations also include the support services and care agreements provided by the case company to its customers for lengthening the lifecycle of the system and improving the availability and reliability of the critical system. These deliveries are then calculated from a cost perspective using the SaaS delivery model.

Part of the data collection is also a table of responsibilities that the case company has with the selected customers. This should include comprehensively all tasks related to the control system, and to list the responsible part for the dedicated action.

Another point of interest is to assess the pricing and standard scope of the possible new service model and support services. The standardized work of pricing and building these service models should be optimized to gain the effects of *Kaizen*[4], to serve customers better and to enhance the performance of offering and service delivery of the new concept. Also, the study wants to find out if the service model with the scope to be included can be built using feature-based pricing to satisfy both the case company and its customers, creating value for both the customer and the case company. The service model is also built in accordance to SaaS model requirements, support services requirements and company pricing guidelines and policies.

3.2 Research method

The method of this study will follow the guidelines of a case study and design science since the model is a new developed service and business model. The familiarization to the literature is conducted and next the pricing and service delivery model is built, whilst considering the internal and external requirements needed to conduct such service. The requirements are then reflected to the SaaS service model, support services, and the adequate pricing behind both SaaS in the control system context and its support services.

The results chapter will introduce the case company's current operating model, and the present state of control system offerings, service business, installations, and support services. Next, the results will show in-detail the content of offering and implications on

[4] Kaizen is a Japanese term for continuous improvement in the Lean context.

price. This includes the current price and pricing principles in a control system offering and how the collection and allocation of price information is assigned to the system delivery. This part will also express other pricing methods used in the case company, also in their system care agreements.

Followed by the basics of control system offerings, the next step is to analyze the typical lifecycle of the control system in a traditional control system delivery model. By understanding the control system and the whole associated costs bound to its, customers' total cost of ownership (TCO) should be lower in the created new service model than in the traditional model. Ideally, the case company should be able to offer some support services together with the new service model while keeping the total costs to the customers lower than with the traditional model system delivery and the possible support services offered through the care agreement through the lifecycle. This way, the case company could capture more added value, and enlarge its service portfolio penetration to the end customers while keeping the total costs and the initial CAPEX costs to the customer lower than with the traditional model.

3.3 Data collection

The data collection of this research aims to follow the PSS design process in the control system provider context and the service concept and strategy behind its business model. The study will present the case company's product, customer value aspects, services, the business model behind the system and the interaction context and time space. To do this, the company is introduced, its current operation model is introduced as it is, the products and services they provide will be familiarized with. Another point of interest for the above is also the context of the pricing principles behind the offerings and if or how the current operating model can adjust to or meet the possible future changes in the service concepts.

In the customers' context, the cloud services pros and cons are assessed and the value to the customer is considered from a performance perspective.

The CSaaS standard module scope is developed using the traditional capabilities of a cloud service, the case company's current offerings and expert interview with three internal stakeholders. Control system as a service should at least include the capacity for the customers product(s), software subscription for control system, cyber security, performance monitoring and control, and updates to the operating system and control system versions, along with other services tied to the service model.

Then, the control system as a service model is priced using case company's internal requirements and the best practices of suitable pricing methods from literature, if no internal policy in place.

4 Control System as a Service

This chapter will introduce the case company (hereafter “SERVICE PROVIDER”) and the context for creating a new service model using cloud services and a new subscription-based model for software instead of buying the licenses and servers and other hardware required for the control system.

4.1 Case company

The SERVICE PROVIDER is a multi-national technology company operating globally. Although its main market being in Asia, it is a recognized company all over the world with a solid product/service portfolio through its various group companies. The portfolio consists of IT, energy, industry, mobility, smart life, research & development as well as the new IoT platform segment. SERVICE PROVIDER’s mission is to contribute to society trough the development of superior, original technology and products. Its values continue to reflect its founding spirit, consisting of harmony, sincerity, and pioneering spirit. All in all, its vision is to deliver innovations that answer society’s challenges. With its talented team and proven experience in global markets, it believes to inspire the world.

The SERVICE PROVIDER’s group company is a global leader in power technologies, providing pioneering and digital solutions across the power value chain. The group company employs 36000 experts across the globe in 90 countries, which of approximately 600 work in the Finnish local office. The company consists of four different global business units. The group company’s product portfolio is composed of complex offerings such as medium and high voltage power products, power systems, solutions for industrial processes optimization, automation products, and low voltage products for electrical application.

The SERVICE PROVIDER for this research is the business unit that provides hardware, software and services portfolio with expertise and innovative technologies that help customers to optimize the critical systems that power, move, and connect us in e.g. energy, mobility, IT, industry, and infrastructure sectors. The business unit main tasks include selling, design, and engineering of SCADA (supervisory control and data acquisition), DMS (distribution management system) and other control systems, that help to boost capacity, enhance security, and improve productivity. Also, a large and continuously growing portion of the business comes from services. This includes remote technical support, system maintenance activities, software and hardware services, cyber security services, spare parts, and training.

4.2 Control system offering

The SERVICE PROVIDER is not the only company offering SCADA systems, and many competitors provide SCADA systems to their own partners in various industries. SERVICE PROVIDER's main offerings are gathered under the SCADA product group (hereafter "PRODUCT GROUP"). The software often serves critical infrastructure, hence the software is created with redundancy in mind, so that each system may have a standby variant running simultaneously on a different computer or a server. The software provides reliable IEC 61850 certified automation and control solutions for power utilities, industries, infrastructure, transportation, and renewables. With the global install base standing at 14000 systems as of 2021, the SERVICE PROVIDER has with 30 years of experience proven its suitability for any application environment.

Product 1 is a SCADA solution, ensuring optimized control and reliable operation for the switchyard through integration and connectivity between devices and systems. It covers a wide range of standard communication protocols and interfaces. Based on HTML5, the interface can be accessed from control rooms and most hand-held devices. The extensive system availability enables fast and accurate use of system data and rapid response time to situations in the network.

For substation automation applications, Product 1 offers real-time monitoring and control of primary and secondary equipment in transmission-band distribution substations.

It provides easy and safe interaction with protection and control intelligent electronic devices (IEDs) and with the process though operator's workplace.

The substation automation system defines data from the process and is capable to categorize and prioritize it for operator's desired use at right time. The types of entries can be colorized to draw the operator's attention, reducing possible outage times and other situations. It also features disturbance analysis and access to an event list and information about faults. The automatically or manually controlled objects by Product 1 can include breakers, disconnectors and tap changers. Additionally, automatic alarms can be put in place for optimized maintenance timing by monitoring breaker operations, total circuit breaker wear or motor startups. Lastly, power quality optimization is monitored and presented through harmonic distortions, voltage drops and peaks that protection and control IEDs measure. Consequently, the process information and all the data can be stored with Product 1 and refined into meaningful information and allows optimized utilization of power and primary equipment.

Product 2, therefore, is another tightly integrated system containing both SCADA and Distribution Management System (DMS) functionalities. The system enables real-time applications for network monitoring and outage management by SCADA's on-line network monitoring data and complemented with a DMS network database.

Subsequently, the state of the whole network is easily geographically presented to the operators of the electric companies. The geographic view reduces outage times as the fault location can be easier determined. Along with that, DMS can also provide other functionalities such as automatic fault location determination, restoration, and network reconfiguration. The Product 2 also complement the traditional SCADA functionality of on-line network monitoring data with an advanced DMS network database.

Product 3 is a data logging and reporting functionality that can create valuable reports and analyses of the primary process data, such as critical grid information. Simply put, it is a system to be connected to Product 1 system to understand what has happened, and what is happening in a power grid.

Product 4 is a software-based tool that enables data management needs. It is able to keep the install base under control, such as RTUs and relays and their management, e.g. through firmware upgrades and data security improvements and access management. All in all, it is a central tool for managing these.

A traditional control system delivery consists of both project design and execution elements to establish a critical control system. The traditional system delivery is based on a RFQ (request for quotation), where the functional requirements of the system are typically presented, and it could also include hardware configuration specifics. In the domestic markets, the preliminary tendering takes around six months, whereafter the design, factory acceptance test (FAT), engineering, site acceptance test (SAT) and handover a total of 4-12 months, totaling a duration of 8-18 months from RFQ to handover, depending on the system size and number of features. The SERVICE PROVIDER and customer often have in place frame agreements for product and service deliveries, or the terms and conditions (T&C) are familiar to both parties, often published by the Finland Chamber of Commerce or a similar entity.

A typical offer is based on the RFQ and consists of price, payment terms and schedule, delivery terms and time, warranty, offer validity and the applicable general conditions. Most importantly, referring to the RFQ, the scope of supply lists precisely the content; hardware, software and the works included.

Most of the Finnish control systems, though, are control system upgrades when the hardware reaches its end of life. Software and hardware are typically updated within the same project. Depending on the previous version of application software, re-engineering of system could be required. The updates and replacements of servers can take as little as four months from the customer’s purchasing decision to handover.

The first phase of the project is base design. The base design precisely provides the hardware components, like servers and field devices, which may slightly change from the tender specifications and the sales phase. Server specification could change a little, e.g. from a rack model to a tower one. After the customer approves the base design, detail design, manufacturing and engineering can begin.

In the detail design phase, the functional design specifications are approved by the customer, which dictate the software functionality and user interface. Manufacturing and engineering include substation protection and control devices and remote terminal unit engineering. As signal database is ready, also the display engineering of the SCADA can take place and in some cases interfaces to other systems too.

The FAT includes hardware and software license inspections, system functionalities, operation and other tests. This often is the first phase, where the customer or its representative is present and can participate and oversee the functioning of the system. After an approved FAT, the system is often packed and shipped to customer site with agreed incoterms. At the customer location, further SAT, handover and more can be done, too.

4.3 Service offering

The SERVICE PROVIDER'S strategic service target is to be the main partner of the customers and being close to the customer, at all times. The service offering is aimed to provide added value to the customer and on the emphasis on the customer being the most important thing, but growth is sought after and in the best case, the services enable a win-win situation and a positive customer experience. Together with customers, the aim is also to develop current and future services.

The service portfolio consists of assessments and consultations, installations and commissioning, lifecycle care, trainings, updates and upgrades, and cybersecurity is interconnected and valuable factor in all of these. Most of the services are offered within care agreements, but some are offered on a non-recurring basis, with some campaigns in place occasionally. Spare parts are often delivered together with the control system delivery to ensure the availability of critical replacements when the accident happens. Another option is to purchase the spares later to customer's premises or pay a recurring fee for the availability of preconfigured customer-specific spare parts at the SERVICE PROVIDER's premises.

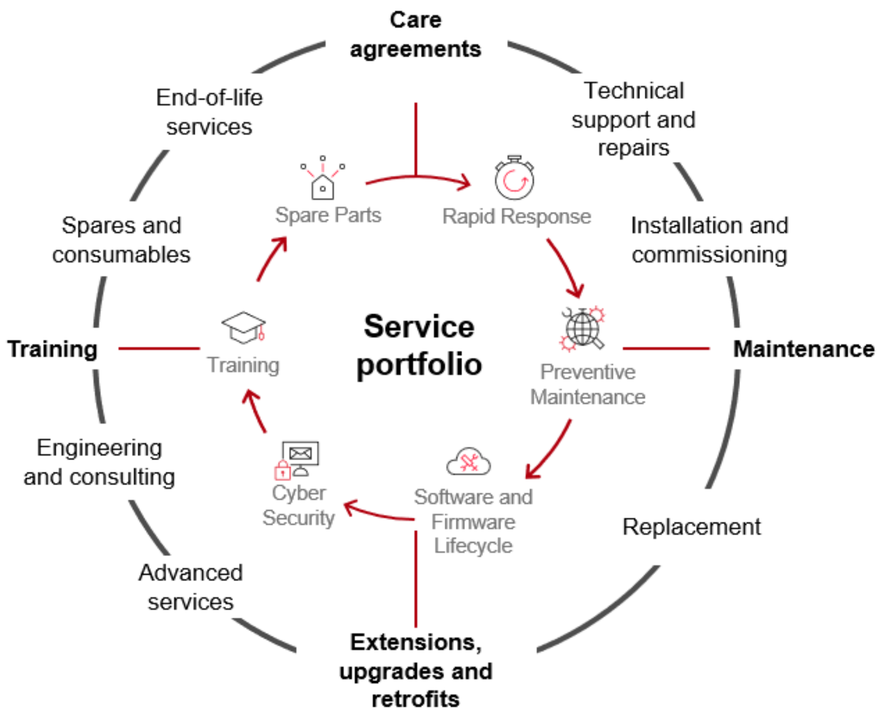

Figure 9. Service portfolio offering.

Trainings are often provided on a non-recurring basis when needed. Some customers however choose to pay for yearly tailored or standard training package. Trainings are provided as classroom trainings at the local office in Finland or through webinars or seminars.

On the cyber security side, the SERVICE PROVIDER provides on-demand consultation and commissioning, such as hardenings and cyber security appraisals, network and hardware scanning, physical security assessment on site and other on-demand consultations. Other advanced one-time offerings include tactical SIEM (security information and event management) setups or a host intrusion detection and prevention systems. On the care agreement side also anti-malware solutions and patch management for 3rd party software (e.g. operating system), which are then tested in a verification process to approve the update's usage along with the critical control system. Another important component for the proficient operation of the system is backup and recovery, so that the system can be restored to the previous version when an error occurs.

The most common tool in the service portfolio is the rapid response service. The service includes components such as remote technical support through remote connection to the system, telephone support, extensions to the support hours outside of office hours (24/7), which include continuous support around the clock or during a few days or a week during seasonal storms. Remote technical support is the most common component of rapid response and provides technical expertise of the system and SERVICE PROVIDER's resources for a standard number of hours per year, providing answers and solutions to almost any customer needs and requests.

Preventive maintenance is often made on a yearly basis for medium to larger sized systems and covers all products in the PRODUCT GROUP. Another option is to make these during when needed, for example at the last third of the system total lifecycle or when the warranty of the hardware or software is about to expire, to lengthen the system lifecycle and its performance until the system is updated in the future. The site visit included is often 3-5 days, depending on the system size. The content of the preventive maintenance visit is often mutually agreed between the parties and can vary depending on the needs of the year. However, the content is often based on a standard scope designed for all customers, with small variations and can be even be made remotely if a remote connection is available with almost the same scope.

Software and firmware lifecycle services include a software update subscription to the control system license the customer has purchased. The subscription grants access to software's new releases, versions and hotfixes with no additional license costs. Lifecycle services can even be extended to the hardware of the system, to workstations and servers, to mimic a HaaS (hardware as a service) concept. The hardware lifecycle service includes the replacement of EOL (end of life) hardware at the end of its lifecycle with premade configurations and system hardening and to make the installations on site during a maintenance visit. By nature, the services are tailored to ease the customer's procurements processes and to optimize and lengthen the lifecycle of the scope of the service.

Closely related to preventive maintenance, a site audit can provide a lifecycle assessment, cyber security interview, diagnose the health status of installation and assets, as well as to check the latest updates. The audit helps to establish a thorough understanding of customer's installation and assets, which can cocreate an understanding a guideline for system knowledge and requirements for further development and care agreement scope.

The SERVICE PROVIDER offers care agreements for the products has delivered as well as the whole system where its products often play an important role. Normally, the case company provides its services for the whole system with the scope of the supported products and components listed by detail, which of almost all are delivered by the case company but some from 3rd party providers. The care agreements under its continuous monitoring include almost one hundred local (Finnish) agreements tailored for electrical utilities, hospitals, energy, infrastructure and mining segments. Approximately a dozen agreements are also signed between the SERVICE PROVIDER and tits international customers outside of Finland.

The care agreements are built from 6 different service modules (figure 10). The service modules include spare parts, training, cyber security, rapid response, preventive maintenance and software and firmware lifecycle services module. Included modules are based on customer needs and delivers an effective course of action for customer's requirements.

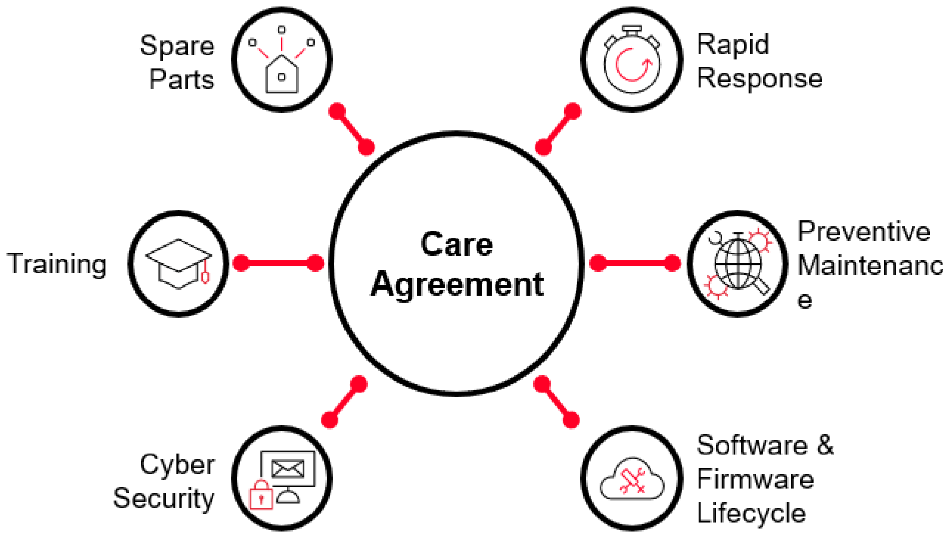

Figure 10. Service modules for Care agreement.

Rapid response includes services to support customers through the diagnosing problems remotely and to provide root cause analyses remotely and to assist with engineering, assistance and consultancy. Services also include case reporting and on-site support for some customers, as well as 24/7 telephone support.

Preventive maintenance includes tools and knowledge to optimize and extend the life of the equipment by addressing its connectivity, reliability and efficiency

The software and firmware lifecycle services include training, software and firmware updates (and upgrades) and update and patch information to the customer.

Cyber security services include cyber security appraisal and assessments, backup and recovery, patch management and hardening, malware protection, procedures and policies and training. The service team can help to assess and modernize customers processes and to provide and design cost-effective and future proof solutions. In addition, the commercial and proprietary applications are aimed to improve operational efficiency.

Training is also provided through scheduled classroom trainings remotely and at the Finland factory. Some customization is also provided to offer tailored courses for customers in Finland or at customer site.

Spare parts are also offered for substation automation products and systems. The offering is aimed to offer a spare parts pool to provide maintenance, migration and obsolescence planning.

4.4 TCO of a traditional control system

A traditional control system has a lot of varying parts and add-ons; hence the implementation cost may vary from project to project. The biggest cost driving factors include the number of tags or points in the system, the number of users that want to simultaneously view the system, the amount of resiliency required, work and labor to design and integrate the system and the products the customer wants in the system.

Cost driver 1: Materials and selection of control system software

The first cost component of the control system is the hardware and software the customer wants to have and/or is recommended based on system features and size. Some solutions are provisioned to larger enterprise environments, whereas others to single application-type environments.

Consequently, a small to medium sized manufacturing plant should have a different solution than a national transmission system operator. If the system capabilities are over specified and underutilized, the system owner is ultimately wasting money on materials. The license should cover the estimated system increase during the system lifecycle, which is normally anywhere from 5 to 7 years.

Cost driver 2: Number of concurrent users

Multiple stakeholders need to have visibility to the running control system. For example, in a manufacturing plant these stakeholders can include:

- plant partners (consultants, service providers and integrators),
- plant managers (property management companies, operations and maintenance subcontractors) and
- plant owner(s).

Control system cost correlates with the number of concurrent users. Thus, it is important to specify the number of users when addressing the system requirements (or when creating an RFQ), so that the SERVICE PROVIDER can scope the software/license and optimize costs and system size.

Number of excessive users on the license may also lead to additional hardware costs, which represent sunk costs and are hard to obtain back in the future.

Cost driver 3: Redundancy

Hot-Stand-By Redundancy is not required in every environment, but it is crucial in systems where set point control is required if the system becomes unavailable for some time. Redundancy is more critical, when there are not enough personnel available to diagnose, remedy and to bring the system back online.

For the costs of the system, redundancy usually leads to additional software license costs. Typically, the server/computer costs are to double in a redundant system. The bearable downtime of the system and its effects for the plant characteristically determine the need for redundancy.

Cost driver 4: Number of points

The amount of equipment and devices (IEDs, RTUs, relays etc.) controlled and monitored influence the points needed in the system and license. Over-specified points can lead to waste and excessive costs and that is why only the required amount of points for operations and maintenance of the plant is needed.

These four cost drivers characterize the software features that affect the control system license price and hardware costs to some degree. Additionally, a lot of costs come from operations and maintenance of the system. These include the personnel to use the software, occasional updates and patches to the operating system, hardware maintenance actions, cyber security and internet connection costs. A major but a non-recurring cost is the end of control system's maintenance period, when there might be more failures occurring more frequently and at the same time the procurement process around the system replacement is running.

In the following steps in this subchapter, three customer companies are assessed in terms of TCO calculations based on SERVICE PROVIDER's sales and service history with the customers. The calculation is done mainly to understand and analyze the cost structure and lifecycle costs of the system thus the level of outsourcing the customers are currently transacting towards the SERVICE PROVIDER.

4.5 Control system as a service

The control system as a service concept should consist of an implementation project and a continuous scope of service with the required solutions provided by the SERVICE PROVIDER along with any kind of additional support (i.e. support services), that may vary from customer to customer.

The first part of the delivery includes an implementation project of a control system environment in which the customer can control, maintain and operate various activities with the products from the PRODUCT GROUP.

In the second phase, the scope of the CSaaS delivered will be transferred to a service level agreement with the services and scopes determined. This means, that the end customer will continue to purchase the agreed functionalities as a service. The SERVICE PROVIDER, therefore, is responsible for maintaining, updating and supporting the system and to provide the additional support services agreed upon.

A high key success factor for the SERVICE PROVIDER is its service orientation. That means, that the orientation is contextualized by service offerings, revenue and profits. It is also visible in employees' behavior, recruitment, training and assessments. Both the service and sales functions are close to the customer on a frequent basis.

A lot of internal case company capabilities exist for the continuous operation of the CSaaS model already. The challenge is, that to some extend the service model is new, and the employees would not be familiar with the concept from the beginning for some of its products and services. The more products and installations the SERVICE PROVIDER has for the customer when delivering the system, customer needs for additional maintenance of the system and the need for additional services tends to be higher too.

In general, many of the largest customers have centralized platform solutions and IT systems in place, and the software can be placed in their own existing virtual environments, depending on the IT strategy they have. That is, if the customer offers a virtual platform to install the control system to, if often has the expertise to run it itself. Smaller and medium sized customers often depend more on the SERVICE PROVIDER and the servers are normally placed physically in their location.

4.6 Requirements for CSaaS

Kostiainen (2019) concluded that the productization of the CSaaS model would require actions such as portfolio management, business relationship management, service desk and incident management and access management. Additional requirements include system monitoring and maintenance, compatibility-tested operating system patch management strategy and process application management.

Another important requirement for the CSaaS method includes the management of the subscription, and billing and cash flow management. For many of the highly customized enterprise SaaS solutions, an implementation project is a standard practice, and CSaaS similarly requires a lot of customization and expertise in the design phase, along with a lot of fixed costs from both hardware and software, and these are difficult to provide strictly as a service, as the duration of the subscription is unknown and the cash flow would stay negative for years.

Risks for the service model include the right pricing of the service. From the negotiations and early sales phase, the SERVICE PROVIDER should have the right pricing or packaging in optimized already, as it highly challenging to adjust the price later on after the implementation is made. The possible depreciation of the currency used is another major risk that the service and longer subscription lengths will adduce.

The service model should also correspond to the internal requirements regarding profitability and align with the or SERVICE PROVIDER's service strategy targets. The service model should be able to reach required financial targets for each agreement and create added value to both parties in the exchange. Important for the goal setting for this thesis is also to have a standard scope or packaging in the service model for easy adaption and tendering process to various customer needs.

For the product side of the control system includes the software of the control system, the market price should continue to determine the price of the product, but with feature-based components when scaling up the system size and the content of the product. The content is determined by different modules that affect the price, content, and user interfaces of the product. The product often has a fixed cost portion that is based on the market price and thereafter the modules are priced using feature-based pricing.

Customer needs for cyber security and the physical location of the data center and the location of the infrastructure hosting the control system may vary from customer to customer, and some are looking for a on-premises location whereas another customer does not require a specific way of the capacity hosting. The SERVICE PROVIDER should have the capabilities to correspond to these various customer needs and the different types of cloud environment implementations should be provided.

As common requirements for the SaaS concept, distinguishing the service model from traditional software licensing, the pricing effectiveness, use of software, hardware and maintenance, elasticity and risks should correspond with the requirements and standardized practices of the service model.

4.7 CSaaS

The CSaaS scope of services included should be standard from customer to customer and the features of the software scalable depending on customer or their control system environment size. The need for SaaS type of license rental has been identified and internal capabilities have been built into the way of operating to meet market expectations.

The customer should receive an up-to-date system and the product is future-proof and additions and features can be added along the way. As of in the current operating model, the customer has after the purchase right to an unlimited right to use the software version it has purchased, but no updates, if not subscribing for the use of a specific update service. The evergreen licensing, however, still requires the customer to first purchase the license and therefore the model is more of a lifecycle service for the already purchased software license, instead of a subscription in the SaaS context. In the new service model, the licensing should correspond to the cloud service model with a subscription-based access rights and pricing with a scalable software features depending on whether the customer is small, medium or larger company from various utilities to the manufacturing segment.

Table 4. Current offering vs. CSaaS scope and responsibilities.

Tasks	Traditional system		Control system as a Service		
	Customer	Care agreement	Customer	CSaaS	Support Services
Using the software	•		•		
Software License	•			•	
Server (or Cloud capacity) and VMs	•			•	
Operating system	•			•	
Application Management Services (AMS)	•	•		•	•
OS cyber security	•			•	
Contract management -Service manager for the SLA, KPI reporting, meetings, billings		•		•	
Rapid Response -Technical Support, Assistance and Consultancy		•			•
Rapid Response -Remote Engineering Support		•			•
Rapid Response -Extended Availability		•			•
Rapid Response -Online Incident Management		•		•	
Rapid Response -On-Site Incident Management		•			•
Preventive Maintenance -Online and on-site options		•			•
Software & Firmware Lifecycle -Evergreen licensing (version and hotfix updates)		•		•	•
Cyber Security -Malware Protection		•		•	•
Cyber Security -Patch Management		•		•	•
Training		•			•
Spare Parts		•			•

From customer perspective, the value of the control system comes from the flawless usage of the system, which the supplier will provide as a service, including support for the system during their lifecycle. The CSaaS model does not require a large investment and the customer pays for the content it needs based on system size. The system remains up-to-date and secure and the SERVICE PROVIDER can also assist with the system. Also, customers can focus on their own core competencies and budgeting. Another advantage of the CSaaS model is predictability, costs are known in advance even for a long time to future. Predictability could get easier, as customer knows the features that affect the price in the service model. For example, if they would like to add ten new substations in their automation system, they would know in advance how the service price scales upwards as a result and how much would it cost if the SERVICE PROVIDER did the engineering work (application management services) as well.

Support services can be used to ensure the highest possible availability and efficiency for the service. The support services are to be built on various service packages that support the operation of the system and the user experience in different ways. The services enable the fulfillment of individual needs so that the customer is able to flexibly supplement its own expertise and the resources at its disposal.

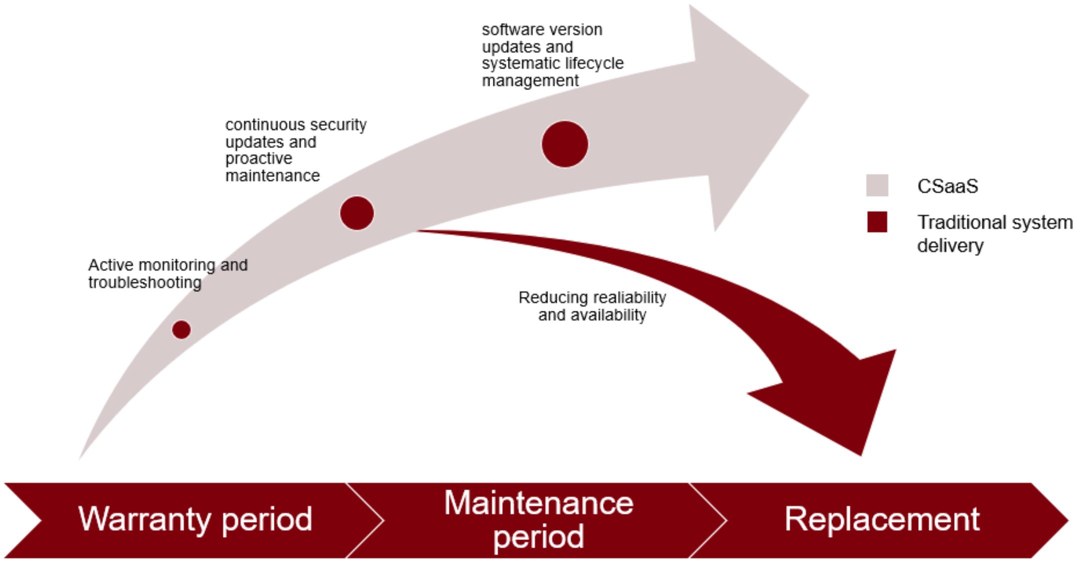

Figure 11. System reliability and availability comparison.

The services are provided in accordance with the standards established by the service providers Information Security Council. The developed operating guidelines follow the best practices of several well-known standards (e.g. NERC CIP, ISO/IEC 27000) and include instructions related to the implementation of information security for products, project delivery and services provided. The SERVICE PROVIDER's "Minimum Cyber Security Requirements for service" is a set of guidelines that defines the minimum security level related to the service, operating methods and mandatory training for the personnel involved in providing the service.

Table 5. CSaaS standard scope.

CSaaS standard scope	Summary
Software License	Subscription-based access to software and its customer-specific features. All software updates, hotfix updates and feature pack updates and other releases included
Capacity	SERVICE PROVIDER's standard capacity from its partner or customer-specific capacity from its preferred cloud provider or data center
Operating System (OS)	Operating System licenses Operating System Management: Patch Management Configuration Management Proactive Monitoring
Application Management Services (AMS)	User Support, Application Support, Monitoring, Extensions
Cyber Security	OS Malware Protection and more
Contract management -Service manager for the SLA, KPI reporting, meetings, billings	See AMS
Rapid Response -Online Incident Management	See AMS
Software & Firmware Lifecycle -Evergreen licensing (version and hotfix updates)	See Software License
Cyber Security -Malware Protection	See Cyber Security
Cyber Security -Patch Management	See Operating System (OS)

The SERVICE PROVIDER actively monitors the CERT (Computer Emergency Response Team) communications of various countries worldwide in order to maintain its situational awareness, which enables it to respond to security vulnerabilities related to the SERVICE PROVIDER’s products, systems and services. Response times are determined by the criticality of the observed gap, and a report of significant findings is prepared, reporting the criticality of the vulnerability, potential impacts, and recommended remedial action.

In the traditional system delivery model, usually both software and OS (operating system) related problems tend to occur more frequently towards the end of its lifecycle. Based on historical data by the SERVICE PROVIDER, after using for five years, a hardware failure is more common and the cyber security updates for the operating system often become obsolete. With upgrading the system components in time, the lifecycle of the hardware and software can be lengthened, whilst keeping the system both adequately reliable and available. By using cloud services instead of aging hardware components and firmware, the system can continuously be monitored, and any issues solved remotely by the SERVICE PROVIDER. With continuous updates for the VMs (virtual machines), PRODUCT GROUP software, and applying a systematic lifecycle management program, the system can keep or even enhance its usability with no decreases in its reliability as opposed to the traditional system delivery model.

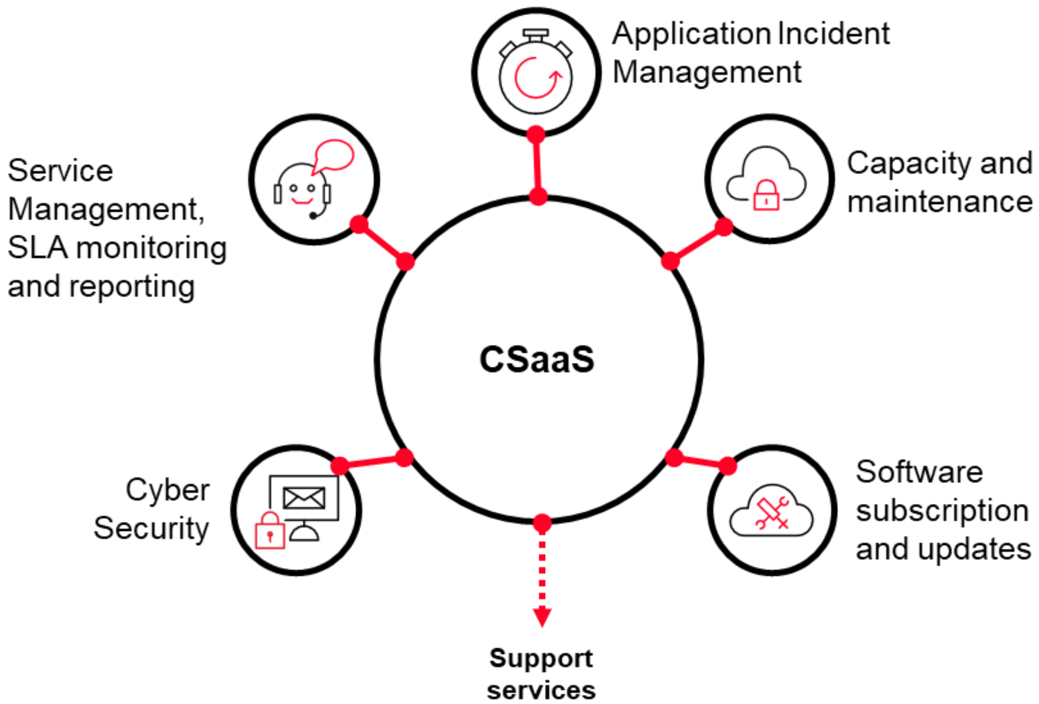

Figure 12. CSaaS content standard modules.

Application Incident Management

The SERVICE PROVIDER should always include the support for the application and system in case there are any downtime caused by the SERVICE PROVIDER or a third party under the SERVICE PROVIDER’s control, which include at least the cloud or data center capacity providers. Downtime caused by customer or a third party under the customer’s control, therefore, will be managed through support services. Incident management will respond to incidents where the solution or the services from the standard modules are not working as specified, excluding during scheduled maintenance, which may take place during a specified and scheduled maintenance window without prior notice. The SERVICE PROVIDER shall also classify the incidents using a grouping. One example of the categorization is presented in table 7.

Table 6. Incident classification and response times (example)[5]

Severity	Description	First Response Time	Target Fix Response time
Level 1 Critical	Conditions that severely affect service to the customers and require immediate corrective action	< 3 business hours	Continuous work until neutralization of the critical condition and/or bringing system into pre-incident state
Level 2 Major	Conditions that seriously affect system operation and require immediate attention (non-customer revenue affecting)	next working day	5 working days or with the next planned SW/ESW Patch if possible.
Level 3 Minor	Conditions that do not significantly impair the functioning of the System and do not affect the service to customers	5 working days	≤ 30 working days or with the next planned SW/ESW Patch if possible.
Level 4 Normal	Questions to routine technical problems. Information for applications, installation and configuration, support and consulting	5 working days	Case by case handling.

Service management, SLA monitoring and reporting

The SERVICE PROVIDER should also measure the service availability, service performance and service response times accordingly. This means, that the monitoring should be objective and automated, and the incidents should be reported through a single point of contact (SPOC) for the prompt resolution of all incidents to customer with response times visible to both parties. The SERVICE PROVIDER is using a web-based SPOC where

[5] Here in target fix response time SW=software and ESW=embedded software

incident classifications and response time reports are available, and some variations can be made depending on the customer and the agreed SLA (service level agreement).

There are multiple application/solution monitoring tools also available in the markets, such as Datadog and AppDynamics, by which the availability can be calculated. As incidents related to customers and their third-party partners should not affect the performance monitoring, a viable calculation of the availability can be:

$$Solution\ Availability\ \% = 100\% - \frac{(Total\ Downtime - Customer\ downtime)}{Uptime} * 100\% \quad (2)$$

However, the availability % can generally never be 100% and should be reduced from 100% to adjust to the criticality of the system (e.g. 99,X% for critical systems and 99% for less critical) and the agreed SLA target. The scheduled maintenance window should not be reducing the availability %. Additionally, there might be a need for some unscheduled maintenance for the system, in which case the SERVICE PROVIDER shall provide the customer advance notice. For cyber security related patches, emergency repairs and updates, the notice could and shall be agreed to be sent with a shorter notice.

Cyber security

The SERVICE PROVIDER should be responsible for all cyber security related things around the solution. This includes but is not limited to malware protection, virus definition updates and operating system security updates in its infrastructure. A third party under the control of the SERVICE PROVIDER can also in some situations support the system in cyber security according the best practices and established standard such as NERC CIP, ISO/IEC 27000 and IEC 62443.

Software subscription and updates

Through the software updates, the new updates to the version and upgrades, feature packs and feature packs should be shared with the customers. Existing infrastructure and products are already available for the update service but instead of the license cost at the exchange, a subscription should be made available from the subscription start.

Capacity

Cloud or capacity from data center should function as an engine for the service model. The infrastructure is rented from a third party provider and should correspond with the availability target, system criticality and with the redundancy, if chosen for the product.

4.7.1 CSaaS implementation project

Implementation of a new system has come faster with the introduction of cloud-based services. Implementation can take no less than a few hours to go live, whereas in some highly customized enterprise SaaS it can take years from the project definition to go live.

As a control system is a critical system and customized to every customer to fulfill the needs, a relatively large implementation project is needed for the system and service setup. Similarly, to on-premise deliveries, the CSaaS implementation will include data migration, configuration, integrations, training and consultation. Implementation will also include the scoping and purchase/setup of the needed products and infrastructure from control system product unit and cloud infrastructure provider.

The implementation project should include the following project phases with work estimations:

1. project definition phase
2. initialization of the cloud service
3. data conversion/transfer
4. support for UI sample image configuration work
5. factory tests
6. testing and deployment support.

The project should have six deliverables:

- commissioning the system
- creating interfaces and sample calculations
- database conversion and creation of sample objects
- communication testing for the cloud capacity
- deployment training
- documentation and operating instructions.

During the implementation project, the SERVICE PROVIDER will initialize and install the system and train the customer's representatives to operate the system.

Additionally, a pool of hours can be reserved for testing and implementation support. Support hours can be used, for example, to solve problems in application building, training or implementing customer objects. This also includes two days of factory tests in factory locations, which also serves as implementation training

To add objects to the system, the service provider can define a contact point (firewall) to which the objects' communications are linked. Objects added after the deployment project will be billed separately as add-ons in the CSaaS scope.

Once the implementation project is closed, the CSaaS can be handed over to SERVICE PROVIDER's account management and service team with CSaaS standard modules and the additional support services.

4.7.2 Support services

In the traditional system delivery model, the support services help the customers to have the access to the expertise that the SERVICE PROVIDER according to the agreed scope and SLA of the care agreement. Support services continue to be provided to ensure the highest possible availability and efficiency of the system. The support services are to be built on various service modules that support the operation of the system and the user experience in different ways. The services enable the fulfillment of individual needs so that the customer is able to flexibly supplement its own expertise and the resources at its disposal.

In the new service model, the services from the service portfolio can continue to be provided to all products in the PRODUCT PORTFOLIO. For the products, the care agreement offering is to some extent replaced by the CSaaS scope (visible in table 5), which means that the SERVICE PROVIDER will cover more steps in the service value stream than in the traditional model. The additional steps include a few modified modules in the CSaaS scope, which makes the software infrastructure available through web or a Windows application. Therefore, the support services are aimed to help the customer through user support, technical assistance, engineering work and possible R&D related works.

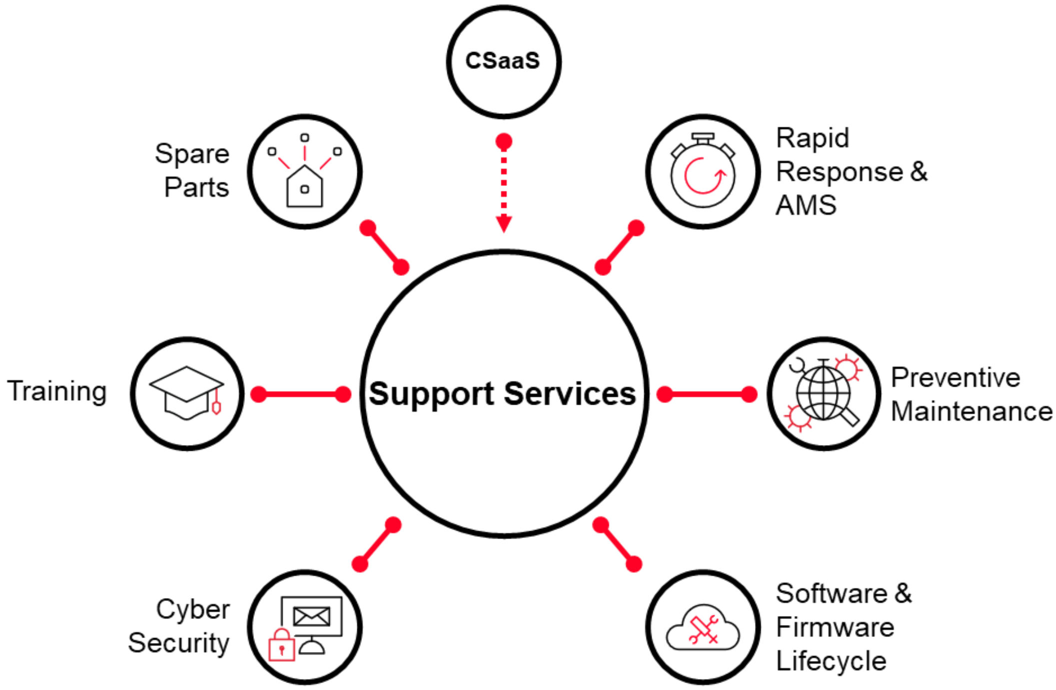

Figure 13. Support service modules in CSaaS.

Unlike in the CSaaS modules, the support service modules are not mandatory and can be provided to CSaaS and for example help with the use of the software, but also with the communication systems, substation products and 3rd party OEM products. The Rapid Response and AMS are most likely the most included service and can be offered through an hourly pool for a year at a time, for assisting the customer with the products and to help their budgeting and at the same time help the SERVICE PROVIDER to allocate resources for the account. A detailed description of the support services was given in chapter 4.4. in this paper.

4.7.3 Service value considerations

The value of the CSaaS to the customer comes from the features and deliverables of the product, its availability and the service availability, performance, and response times to customer contact requests and incidents. The service quality mostly visible to both parties in reports made available at least in the performance meetings, if not continuously made visible to both parties constantly.

As the value comes from the usability and availability of the system, a service level credit system should be in place, which compensates a credit of the service fee, if the service level target is not met. To add to the motivation to the SERVICE PROVIDER to excel in the service and to create value to the both parties in the exchange, a bonus system could also be negotiated between the SERVICE PROVIDER and the customer to monetarily give bonus to the SERVICE PROVIDER for meeting the target or exceed it.

Table 7. Service Availability bonus and compensation table.

Service Availability %:	**Compensation**
99,X % - 100 %	No compensation
XX,X % - XX,X %	X % of the service price
XX,X % - XX,X %	X % of the service price
XX,X % - XX,X %	X % of the service price

The value-based approach can also be complemented with a service performance bonus and compensation table. The service performance could measure the performance of the service in various ways. Another important and value adding feature in such system would be that the customer compensates the operational excellence it may achieve by using the system with compensating the excellence to the SERVICE PROVIDER.

The CSaaS service modules make the SERVICE PROCIDER to cover more of the value stream of the control system and aligns the SERVICE PROVIDER strategically to more of an outsourcing partner taking care of processes previously solely handled by the customer. Outsourcing in this context can see as providing customer more easily budgeted service and reducing the internal requirements and capabilities tied around the system. The capacity maintained and covered by the SERVICE PROVIDER is the largest change between the traditional model and CSaaS, however the different approach to software licensing is also a major one. The new change does not itself create much value and the change in value between the different offering methods are not easily measurable. Easier to address value is to use the bonus/compensation table in table 8, a possible performance table and through support services, which already have the strategic target to have a value-based approach in the modules and their pricing.

The support services provide the access to the SERVICE PROVIDER service, engineering and R&D teams through user support, application support, monitoring and extensions for the CSaaS. Also, the whole connected substations, IEDs and other products and services connected to the control system are supported through cyber security services, maintenance, spare parts, updates and upgrades and training. The SERVICE PROVIDER has criteria in place for the value consideration of the services in the care agreement. The criteria generally include but are not limited to consider:

- customer location,
- customer segment,
- system criticality,
- competitive edge of the service,
- added value of the system,
- response times and holistic importance of service and

- overall system lifecycle.

The criteria are valued for the added value to the customer on a scale from 1 (not significant) to 5 (much added value) and represented as value parameters. If the parameter is not true for the specific customer, the parameter gives a value less than 1, which ultimately leads to the deviation from target gross margin percentage. In short, if the parameters measure added value (product more than 1) it raises the gross margin target and if little to none added value (product 1 or less than 1), the gross margin percentage is lowered for the sales price.

4.8 CSaaS pricing strategy

Next the pricing strategies behind the service will be considered with the associated considerations behind the different parameters, pricing methods and risk and change management.

4.9 Pricing of CSaaS implementation, CSaaS standard modules and support services

An important detail about knowing how to offer and productize the control system as a service model is to know from what the artifacts of the service it consists of and how to price the service itself, its implementation project and support services.

The SERVICE PROVIDER has a full cost model (FCM) for the pricing and cost planning of projects and services. Full costing marks up variable cost with the contribution margin per unit, which includes the fixed cost. Then, FCM converges to the optimal price when the firm can estimate its equilibrium income. In short, price of a product or a service is calculated on the basis of its direct costs per unit of output plus a markup to cover overhead costs and profits. Consequently, the FCM calculation can produce viable information for products and services net margins, gross margins and cash flow estimations.

The general overheads include fixed costs such as R&D and sales, etc. It is important to revise the percentages periodically for effective allocation of costs and to stay cost effective in the customer's perspective.

Direct costs for products and services include the purchase price of a products/service or a license and project manager/-engineering hour allocation, possible travel and shipping costs. If any travel is included, the calculation should include allowances, kilometers when driving, possible flights and accommodation.

Next, the implementation scope is listed is included CSaaS implementation project pricing, CSaaS standard modules pricing and support services and their pricings are assessed.

4.9.1 CSaaS implementation project pricing

The CSaaS implementation project may vary from customer to customer and most of the scope include project manager, design and engineering work. Work could include commissioning also at the premises of the customer, which would add site work hour allocation to the project. In the implementation project, the product from the PRODUCT GROUP is calculated for the cost (which comprises of the sales price that the internal product sales team has for the product). The product sales team has a feature-based pricing approach to the products it is selling, and the SERVICE PROVIDER often has a small margin for the software license and possible hardware included in the product. Other than software licensing, the costs comprise of the calculation in the FCM calculation, and the hours and project's desirable scope and outcomes can be estimated together or with the approval of the service or engineering manager.

The product sales team has a tool for the software pricing and its scope and price implications for the different options included in the product. The options which comprise the price of the product from the product sales team include options such as the product (and its standard cost), number of concurrent users, redundancy, number of points and possibly other modules, content and their value for the product. All in all, the software is priced by another team and the SERVICE PROVIDER shall have a margin for the price and sell or productize it based on customer or market needs.

Following the bid preparation process, the table 9 is filled in order to create an understanding of the work to include and direct costs for the project. The order of calculation should track the following order:

1. CSaaS implementation project
    a. Direct costs in red font color
    b. Variable costs, such as hours, with white font color
2. Base fees for CSaaS
    a. Variable costs in white font, if any
    b. Direct costs from capacity provider
    c. Direct costs from product sales team (software value) in red font
3. The price change in black font color adjustment to align the net margin target percentage with the company standard and strategic target for projects

Table 8. FCM calculation of the implementation project.

Item	Description	Model	Qty	Price, EUR	NM	Unit, EUR	Discount	Units EUR	Cost link	PM 0 h	DE 0 h	FT 0 h	ST 0 h
	CSaaS implementation project			**0**									
1.1	Commissioning the system	SERVICE PROVIDER	1	0	0,00%	Input	0,00%	0		0	0	0	0
1.2	Creating interfaces and sample calculations	SERVICE PROVIDER	1	0	0,00%	Input	0,00%	0		0	0	0	0
1.3	Database conversion and creation of sample objects	SERVICE PROVIDER	1	0	0,00%	Input	0,00%	0		0	0	0	0
1.4	Communication testing for the cloud capacity	SERVICE PROVIDER	1	0	0,00%	Input	0,00%	0		0	0	0	0
1.5	Deployment training	SERVICE PROVIDER	1	0	0,00%	Input	0,00%	0		0	0	0	0
1.6	Documentation and operating instructions	SERVICE PROVIDER	1	0	0,00%	Input	0,00%	0		0	0	0	0
	Base fees for CSaaS			**0**									
2.1	Capacity setup cost	3RD PARTY	1	0	0,00%	Input	0,00%	0		0	0	0	0
2.2	Product subsription setup cost	PRODUCT SALES TEAM	1	0	0,00%	Input	0,00%	0		0	0	0	0

All the costs and steps to comprise the price can be done by the sales team and a technical expert, however an agreed percentage of the value (i.e. transfer price) of the software should be agreed upon with the product sales team to cover their fixed costs and enhance the cash flow of them in the new model.

Consequently, the implementation project follows a cost-based pricing method, where the costs are estimated, and the margin applied to find the price. Only deviation to the logic is the product setup transfer price, which first follows a feature-based pricing approach for the product and then an agreed transfer price (a percentage of the software value) is redirected as a cost to the implementation project.

4.9.2 CSaaS standard scope pricing

The CSaaS pricing should also follow the logic from the FCM calculation. Here, the challenge is that the works and scope are considered ongoing services, and should be paid more attention to, hence the risks associated with them. The contractual quality could also address the risks with subscription length, terms and addressing the change management also.

Another interesting feature of the CSaaS FCM calculation is that the incident management is considered standard scope of the service and both the number of incidents is unknown and like so the associated works to find a workaround or a fix to the system is unknown. Thus, the definition of an incident versus technical assistance and other AMS works, which are considered support service instead of CSaaS standard scope should be clearly defined. Incidents, altogether, respond to deviations in the service level.

Following the bid preparation process, an understanding of the work is needed to include and direct costs for the service. The order of calculation should track the following order:

1. product feature generation and the cost for a subscription
2. capacity requirement analysis and cost calculation from cloud/data center
3. SLA requirement analysis and incident reservation for possible incidents
4. cyber security license costs and yearly work estimation
5. licenses for availability monitoring, account/service manager reporting hours, meetings and billing
6. price adjustment (black font in table) to align the net margin target percentage with the company standard and strategic target for services.

Table 9. FCM calculation for the CSaaS standard scope.

Item	Description	Model	Qty	Price, EUR	NM	Unit, EUR	Discount	Units EUR	Cost link	PM 0 h	DE 0 h	FT 0 h	ST 0 h
	CSaaS standard scope - FCM calculation for one year			0									
1.1	Product subscription trasfer price	Product sales team	1	0	0,00%	Input	0,00%	0		0	0	0	0
1.2	Capacity for required SLA and product -includes infrastructure maintenance	3rd party	1	0	0,00%	Input	0,00%	0		0	0	0	0
1.3	Incident management availability and reservation for yearly hours	SERVICE PROVIDER	1	0	0,00%	Input	0,00%	0		0	0	0	0
1.4	Cyber security -Licenses and patching	SERVICE PROVIDER	1	0	0,00%	Input	0,00%	0		0	0	0	0
1.5	Service management -SLA monitoring and reporting	SERVICE PROVIDER	1	0	0,00%	Input	0,00%	0		0	0	0	0

All the costs and steps to comprise the price can be estimated by the sales team and a technical expert. The subscription price of the product is a percentage of the total value of the license cost of the product, which is correlated with the license investment cost (in the traditional control system delivery) and a traditional lifecycle of the product. The software value is following a feature-based pricing and correlated periodically with the market prices.

Consequently, the CSaaS standard modules will follow a cost-based pricing approach, where the costs are estimated, and the margin applied to find the final subscription price. However, the value-based approach will be applied through service availability and performance measurement bonus and compensation system indicated in table 8. Subsequently, the ultimate net margin for the service will deviate from the service strategic net margin percentage by the bonus received or the compensation to the customer based on the performance.

4.9.3 Pricing of support services

The support services can continue to be offered based on the need of the customer. This may vary from segment to segment and customer size and its capabilities, but depending on their own knowledge in control systems, the similar approach and service offering can be offering with CSaaS that in the traditional system delivery model. Here we consider support services as ongoing additional services conjoined to the mandatory service modules in the CSaaS subscription, as well as consulting or similar nonrecurring services.

There are two main requirements for pricing the support services. First, the services should provide added value for the customer, e.g. the criticality of the system and customer's own expertise have an impact. Secondly, another internal requirement for the case company is that there should be a gross margin target of a certain percentage. Further, the value aspect is also highlighted in pricing and with certain value parameters the first two main requirements are believed to be met and a longer-term relationship to be created. The value parameters could be linked to characteristics of the customer and its location, risks involved and the system the service is covering, and moves the gross margin percentage downwards or upwards from the expected gross margin, that is covering the hours, effort, licenses, material and other costs.

For the value-based pricing approach, the value can be added as a discount or a premium on price, depending on the preset pricing decisions. For the case company, 7 different value parameters are suggested, all coming from internal requirements and the suitability to the operating environment where the case company and its customers are operating in. These are value parameters and their influence on the price change from are calculated on a spreadsheet (table 3). Price results (sum of values divided by the number of parameters) in a factor of slightly lower or equal to or higher than 1, and therefore can lead to a discount or in a surplus. The distance from 1 to the parameter (impact) result varies depending on the parameter impact on value, customer surplus and customer reservation price (customer willingness to pay).

The value parameters in table 11 are built from the criteria described in chapter 4.7.3 and are not precisely presented in the table due to business confidentiality.

Table 10. Value parameters for support services.

Question that determines added value for a value parameter	Added value 1=Yes 0=No	
Value parameter 1	1	1,2
Value parameter 2	1	1,4
Value parameter 3	0	0,9
Value parameter 4	1	1,4
Value parameter 5	0	0,9
Value parameter 6	1	1,3
Value parameter 7	0	0,9
	Result	**1**

The result from the calculation is then multiplied with the price, consisting of costs (that follows a full cost model) and the strategic gross margin percentage, that the SERVICE PROVIDER has in its strategy, leading to a slightly lower or higher gross margin percentage that the (initial) expected gross margin percentage is. The answers to the questions should represent the best-known answer from people working day in, day out close to the customer and ideally involve the expertise from both service and sales personnel. Overall, the offerings of actual gross margin in the portfolio should correspond with the target service gross marking percentage, with fluctuating from the mean depending on the customer. If the trend remains above or lower than the strategic gross margin percentage, the Hinterhuber's (2008) decision process for value-based pricing (figure 7) can be iterated to change either the value parameter valuations or strategic guidelines for the gross margin percentage to:

- redefine pricing objectives,
- analyze key elements of pricing decision,
- select profitable price ranges and

- implement price changes.

Table 11. Support service price calculation for local costs.

Services	Hourly rate	Effort (Hrs)	Local cost for the service in LOC	0	
Service 1	0	0	0	0	
Service 2	0	0	0	0	
Service 3	0	0	0	0	
Service 4	0	0	0	0	
Service 5	0	0	0	0	
Service 6	0	0	0	0	
Service 7	0	0	0	0	
Service 8	0	0	0	0	
Service 9	0	0	0	0	
Service 10	0	0	0	0	
Licence cost				0	
Licence cost				0	
Material cost				0	
Material cost				0	
Other cost				0	
Other cost				0	
			Gross Margin expected (fill margin in %)	0,00 %	
			Cost + price	0	
			Proposed sales price	**0**	**#DIV/0!**

4.10 TCO comparison between traditional control system and CSaaS

A total cost of ownership (TCO) calculation can be made by estimating the costs for services, investments and internal costs for the customer associated with the system and its lifecycle. The suitable lifecycle calculation addresses customer's investment, operation, training and outsourced services. Generally, internal hours used in an organization are always cheaper than outsourced services and works made by a supplier, such as the SERVICE PROVIDER.

A lifecycle cost estimation for three medium-sized customers is made and the costs allocated to different phases in the system lifecycle. The customers have a relatively same system size and the outsourced services for the SERVICE PROVIDER are alike. Customer costs can be calculated by reviewing the services it outsources to the SERVICE PROVIDER through service agreements, the transaction history and knowledge from the SERVICE

PROVIDER personnel. The internal work for the training and tendering process can only be estimated, but they are estimated to not play a significant role in the lifecycle cost. The cost calculation for the customers in the traditional model includes:

- tendering costs,
- commissioning,
- hardware costs,
- software costs,
- engineering work,
- training costs and
- services with the SERVICE PROVIDER.

The calculation excludes operator labor, which may vary from customer to customer among the reviewed three companies but is typically the largest cost driver in the TCO during the lifecycle.

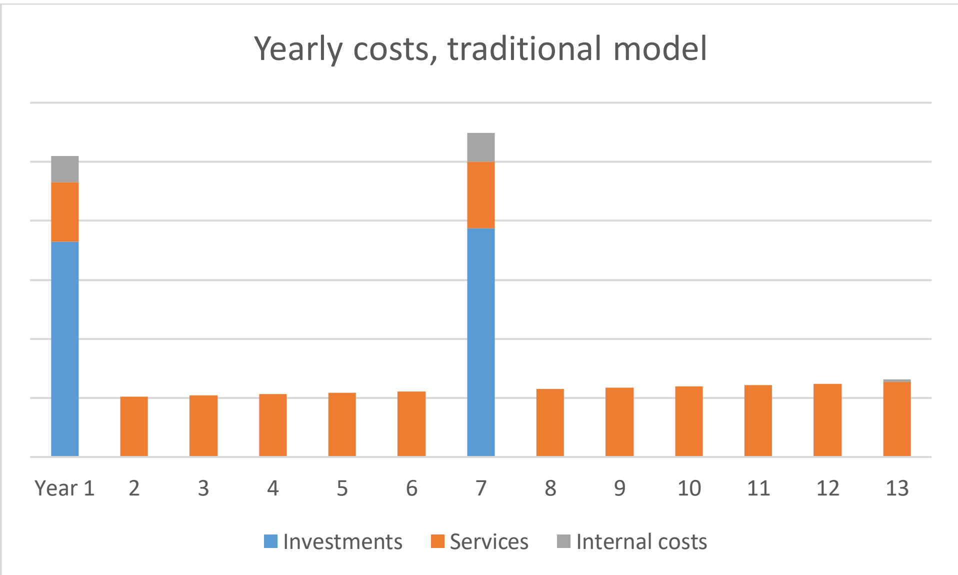

Figure 14. Cost calculation of the traditional model, excluding operator labor.

The TCO calculation is indexed to a random number and the y-axis values are hidden, but the TCO can be seen quite clearly. A typical lifecycle duration is seven years and the investments and internal costs for the year of the tendering process and system upgrade is a lot greater and often needs an internal confirmation from customer's board of directors for the investment approval and budgeting.

The TCO in the CSaaS model, therefore, can be estimated by calculating the cost for the implementation project and the continuous standard service scope of the CSaaS model. This calculation, as in the traditional model TCO calculation, does not include operator labor by the customer.

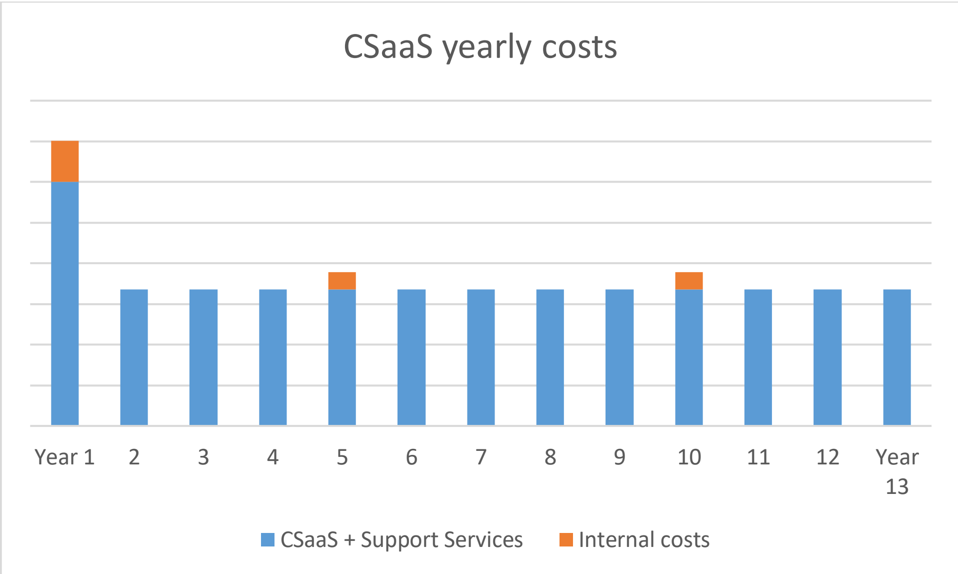

Figure 15. Yearly cost calculation of CSaaS, excluding operator labor.

The TCO calculation for CSaaS also includes the services that the three reviewed customers have included in the service agreement currently, but that are not included in CSaaS by default. Those kinds of services include spare parts and preventive maintenance, to mention a few. As seen in figure 15, the variable cost for year 1 is greater due to the implementation but for the following years the variable cost stays quite stable. The control system's new version releases follow a 5-year cycle, which makes a slight, but visible variation for years 5 and 10 due to additional training for the operators.

When comparing the cost calculations for CSaaS and the traditional model from year to year (figure 16) and as a trend (figure 17), the CSaaS is a lot more predictable from year to year and could bring cost savings to customers especially when a system lifecycle upgrade is taking place.

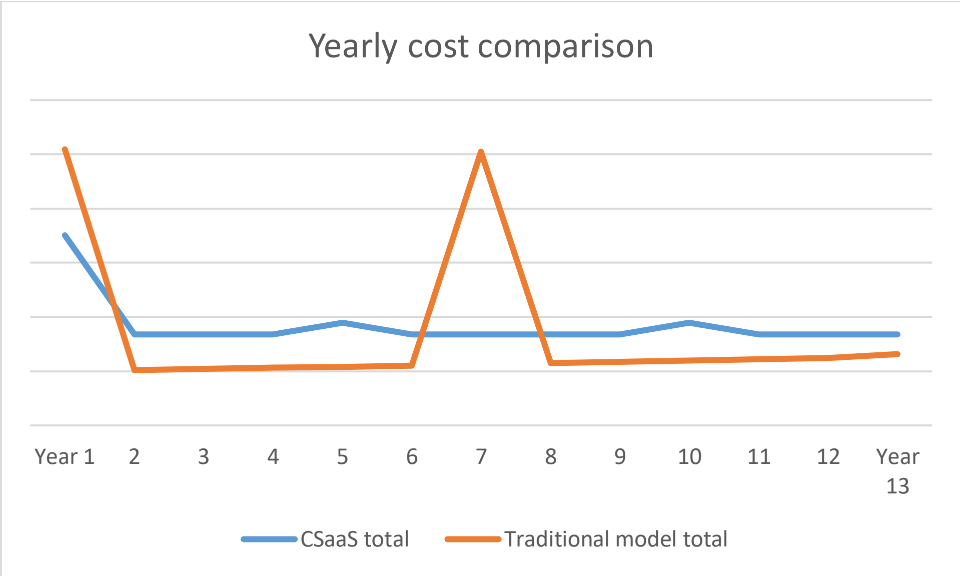

Figure 16. Yearly cost comparison during two traditional system lifecycles.

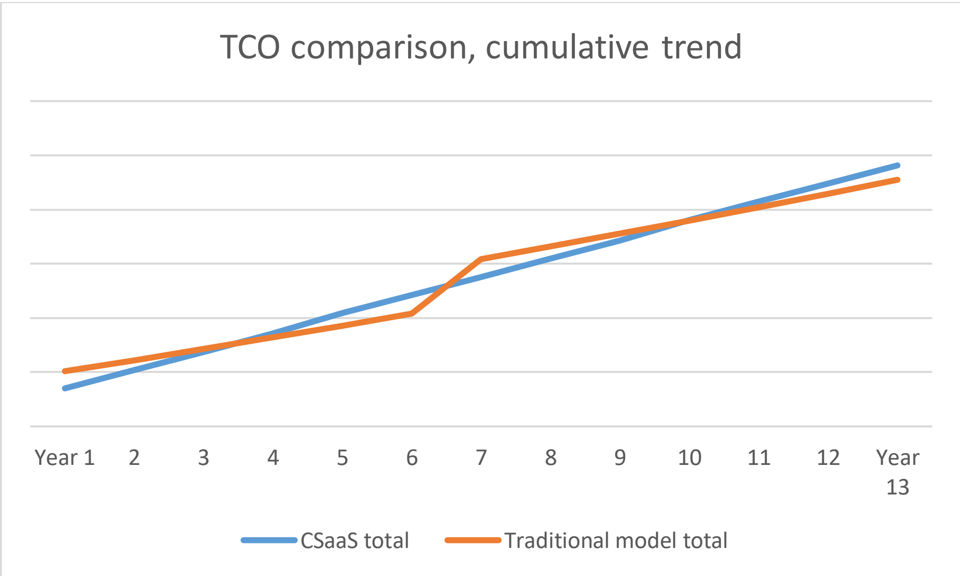

Figure 17. TCO comparison, cumulative trend during two traditional system lifecycles.

Hereby, the CSaaS can create value for the customer in the cost perspective as being predictable for budgeting, consisting of variable costs and expected to being cheaper during the first three years of operation. The traditional system is more affordable from a TCO perspective from the end of the fourth year until the hardware and software reaches end of life status and is upgraded again. However, the risks associated with a failure increase in the traditional model during the last years of its lifecycle.

5 Discussion

The aim of this study was to assess services and service offerings, and how they can be adjusted and standardized for a more advanced service strategy. The transition includes adding new services to its service portfolio, some pricing adjustments and reconsiderations for the production of the service, employees' behavior, training and assessments. As servitization in the industrial companies continues to change products into service business, the case company should reassess its product offering in the context of applications and possible cloud solutions.

Instead of following a lifecycle status of the products it offers, a new service model would create a more stable revenue stream and make its operation in sales, R&D, service and engineering more predictable by nature and covering more actions around the control system value stream.

The change in the total coverage of the value stream would readjust the case company's service strategy from after sales provider (providing repair and maintenance services) and customer support service provider (advanced services & preventive maintenance) towards being more of an outsourcing partner and an R&D partner, both by through monitoring the availability, performance and possible incidents. Thus, the case company could easily readjust the service to fit to the actual need of the customer whenever the customer needs require scaling up or downwards, and to make changes in its products through R&D and engineering.

The study showed that the current service portfolio would require adjustments to fill the gap between current offerings and a SaaS concept or a cloud-based solution. However, the changes required for its products are relatively familiar and most of the functionalities and new service modules to include are already used in its other solutions. Hence, the model should include a separate product for the standard functionalities of the service model and the customer specific services should be considered as support services. By doing this, the case company could provide the service for customers from all segments and all sized, and hence keeping its service promise to be close to them and always being willing to make the customer needs fulfilled.

In the service model, the learning curve for the customer operators and the service that the case company provides can be expected to develop over time, and by outsourcing the service to the case company, the customers can focus more on their core capabilities and serving their customers moreover.

Pricing should consider the value aspect, as well as the received benefits and added value from the service model. The offerings, revenue and profits would more and more consist of services that are predictably by nature. Hence, the price should fit and consider the risk from pricing and contractual point of view. It might be difficult to adjust price later on, but on the other hand the price should not decrease the volume and market share of the case company.

Consequently, the benefits and added value would come through ease of use of service, scalable, elastic and feature-based pricing, variable cost structure and by not being dependent on aging hardware and software. Also, the customer could outsource much of the control system to the case company and instead focus on its own key success factors. The risks include, from customer point of view, data protection, user rights, service guarantees and contractual risks. Ideally, the risks could be shared by the parties in the value exchange and encourage both parties to operate effectively, promptly and have a bonus/sanction system in place to urge the performance and availability of the system for maximum value creation. A bonus system could also be in place to award the case company for its customers' success – the output from the usability of the system or the value that the customer creates for its end customers.

The TCO calculation for this study showed that the costs to medium-sized customers with an existing care agreement in place, would stay quite the same when addressing the costs from a lifecycle aspect. However, for a large or small customer with a smaller scope of existing services, the TCO calculations would quite surely look be more expensive for a service model, compared to the traditional model. However, the calculations excluded the operator works done by the customer, which would quite likely add a significantly larger cost for customers in the traditional model than in service model due to the lack in the level of outsourcing that the service model would introduce.

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